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Past year high-intensity drinking moderates the association between simultaneous alcohol and marijuana use and blackout frequency among college students

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Abstract

Objective: The role of simultaneous alcohol and marijuana (SAM) use in the experience of blackouts among college students is unclear. To clarify discrepancies, the current study evaluated whether the association between SAM user status and blackouts was moderated by high-intensity drinking (HID).

Participants and Methods: College students ($N = 1,224$; 63.7% female) reported on their past year experiences of blackout, marijuana use, SAM use, and HID (i.e., drinking at least twice the binge threshold).

Results: SAM users had more past year blackouts than non-SAM users, but this effect was only significant among SAM users who had engaged in HID in the past year (non-binge: $F_{(5,37)} = 0.50$, $p = 0.49$; binge: $F_{(5,138)} = 0.23$, $p = 0.63$; HID: $F_{(5,328)} = 4.52$, $p = 0.03$).

Conclusions: Effects of SAM user status on the experience of alcohol-related blackouts may be limited to individuals who engage in HID.

Keywords

blackout; high intensity drinking; marijuana use; alcohol use; simultaneous alcohol and marijuana use

Introduction

Alcohol-induced blackouts refer to periods of impaired memory formation during a drinking episode¹. While in a blackout state, individuals may appear relatively normal and engage in tasks, despite not encoding these events into long-term memory^{2,3}. About half of individuals who drink socially will experience a blackout in their lifetime^{4,5}. Blackouts are arguably

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one of the more serious acute consequences of alcohol use and are associated with various negative outcomes, including sexual victimization^{6,7} and injury^{8,9}. Blackouts may also serve as behavioral indicators of the impact of alcohol use on the brain¹⁰.

As would be expected, level of alcohol consumption is one important predictor of blackout, with heavy alcohol consumption often preceding these experiences^{11,12}. An extreme form of binge drinking, known as high-intensity drinking (HID; i.e., drinking at least twice the binge threshold of 4+/5+ drinks for women/men, respectively), is particularly associated with risk for experiencing acute physiological consequences of alcohol use, including blackouts¹³. While twice the binge threshold is the typical cutoff for HID, some studies have explored the possible utility of an additional HID-3 cutoff (i.e., drinking at least three times the binge threshold¹³⁻¹⁷). The distinction between HID-2 and HID-3 may be particularly useful for more severe alcohol-related consequences like blackout. For example, in one study of adult Australians, individuals who drank to HID-3 levels were significantly more likely to report blackouts compared to those who drank to HID-2 levels¹³.

Other factors, such as simultaneous alcohol and marijuana (SAM) use, may also play a role in the experience of alcohol-related consequences, including blackouts. Two recent studies comparing individuals who use alcohol and marijuana simultaneously to those who use the two substances concurrently (i.e., non-simultaneously) found that SAM users reported higher rates of alcohol-induced blackouts than concurrent users^{18,19}. Other research using daily diary reports has found increased rates of alcohol consequences on SAM use days compared to alcohol only days, despite no differences in level of consumption or subjective intoxication²⁰. These findings suggest that using marijuana simultaneously with alcohol confers added risk.

However, some studies have cast doubt on the role of SAM use in blackouts. In an ecological momentary assessment study of college students, SAM use did not increase the likelihood of experiencing a blackout at the event-level¹¹. Similarly, another event-level study found that binge drinking occasions did not differ from binge drinking plus marijuana use occasions in terms of consequences experienced, suggesting that adding marijuana posed no additional risk for consequences (including blackouts) beyond that already posed by binge drinking²¹. Some of these conflicting findings may be due to simultaneous marijuana use only conferring additional risk for blackout under certain drinking conditions. Given that HID is strongly associated with blackouts¹³, those who engage in HID may be especially vulnerable to risk associated with SAM use.

Present Study

In a large college student sample ($n = 1,234$), we assessed the prevalence of HID, marijuana use, SAM use, and blackout. Potential interactive effects of HID and SAM use on blackout occurrence and frequency were explored among the subset of college students who had consumed alcohol in the past year ($n = 997$). We hypothesized that the effects of SAM use on blackout would be stronger among those who consumed alcohol at the high-intensity level than those who consumed at the binge or non-binge levels. We further hypothesized that this effect would be detected in a step-wise fashion across levels of drinking (i.e., non-binge, binge, HID-2, and HID-3).

Materials and Methods

Participants

Study procedures were approved by the University of Missouri Institutional Review Board. Participants were 1,234 students who completed an online survey for course extra credit. 63.9% of participants were female, and most were college freshmen (81.3%; see Table 1). Participants were about 18 years old on average ($M = 18.42$, $SD = 1.07$, range = 17–31). The sample was representative of the state population, with the exception that there was a higher proportion of individuals of mixed race/ethnicity in the current sample as compared to the state (2.3%)²²; 77.1% were white, 10.3% were of mixed race/ethnicity, 6.6% were Black/African American, 3.2% were Asian/Pacific Islander, 1.6% were Hispanic/Latino, < 1% were Native American or “other”.

Measures

Quantity and Frequency of Alcohol Use.—Typical quantity of alcohol use was assessed by asking, “During the last 12 months, how many alcoholic drinks did you have on a typical day when you drank alcohol?” Response options ranged from ‘1 drink’ to ‘25 or more drinks,’ with an additional option for individuals who had not consumed alcohol in the past year. Typical frequency of use was assessed with the question: “During the last 12 months, how often did you usually have any kind of drink containing alcohol?” Response options ranged from ‘Never’ to ‘every day.’ Participants who had consumed alcohol provided the age at which they had their first drink.

High-Intensity Drinking.—In the current study, two levels of HID were assessed: HID-2 (i.e., drinking twice the binge threshold; 8–11/10–14 drinks for females/males) and HID-3 (i.e., drinking 3 times the binge threshold; 12+/15+ drinks for females/males). HID-2 was assessed with the question: “During the last 12 months, how often did you have 8 to 11 (for females) or 10 to 14 (for males) drinks containing any kind of alcohol on the same occasion?” HID-3 was assessed with a similar question but substituting the 12+/15+ cutoff. Participants were also asked about the frequency with which they engage in binge drinking (women: 4–7 drinks, men: 5–9 drinks). Response options for these items ranged from ‘never’ to ‘every day.’ Three-level (non-binge, binge, any HID) and four-level (non-binge, binge, HID-2, HID-3) past year HID status variables were created based on the peak drinking level reported by a participant.

Marijuana Use.—Participants reported frequency of marijuana use, age of initiation, and SAM use. To assess frequency of use, participants were asked, “During the last 12 months, how often did you usually use marijuana?” Response options ranged from ‘1 or 2 times in the past year’ to ‘every day.’ Participants could also indicate they had not used marijuana in the past year or that they had never used marijuana. Next, participants completed questions regarding SAM use. Participants were asked, “During the last 12 months, have you used marijuana at the same time as alcohol?” Participants could indicate yes; that they had not used the two substances together in the past year, but had before; or that they had never done so. Individuals who reported past year SAM use were considered SAM users, while those who had not done so in the past year were considered non-SAM users.

Participants also provided some indirect information on their frequency of SAM use. In the interest of exploring the temporality of alcohol and marijuana use within a substance using episode, participants were asked how often they consumed marijuana after drinking (never, almost never, less than half the time, about half the time, more than half the time, almost always, always) and how often they drank alcohol after using marijuana (same response options).

Blackouts.—Participants were asked the number of times they had experienced blackouts with the following item: “During the last 12 months, approximately how many times have you had an alcohol-related blackout where you forgot parts of a drinking episode (e.g., not remembering how you got home, forgetting something you said to others while drinking, etc.)?” Responses were used to code dichotomous indicators of lifetime and past year occurrence of blackout, as well as frequency in the past year. Blackout frequency was coded such that never/none = 0, ‘1’ = 1, ‘2–5’ = 3.5, ‘6–10’ = 8, and ‘more than 10’ = 10. Participants also reported on whether they had experienced a blackout in their lifetime or in the past year following SAM use.

Data Analysis

Descriptive analyses were conducted within SAS 9.4 to examine the prevalence and frequency of blackouts, HID, marijuana use, and SAM use, along with sample characteristics (see Table 1). When testing for sex differences in substance use behaviors and consequences, a Bonferroni adjusted significance threshold of 0.0036 was used ($0.05/14$ comparisons = 0.0036). Remaining analyses were conducted among the subset of past year drinkers ($n = 997$). Binary logistic regressions were used to predict blackout occurrence, and general linear models were used to predict the frequency of blackouts. All models controlled for gender and past-year quantity and frequency of alcohol use. Models examining SAM user status as a predictor controlled for frequency of marijuana use as well. To investigate whether effects of SAM use varied as a function of HID status, models were fit including interaction terms between SAM user status and past year HID status (i.e., a participant’s peak drinking level in the past year: HID, binge, or non-binge) to predict blackout.

Results

Prevalence of Substance Use Behaviors

Descriptive statistics are presented in Table 1. The majority of the sample reported using alcohol in their lifetime (84.9%) and the past year (80.0%), with average drinking onset around age 16 ($M = 16.07$, $SD = 1.57$). Of those who had consumed alcohol in the past year ($n = 997$), three-quarters of male alcohol users (74.14%) and half of female alcohol users (49.81%) had engaged in HID-2 drinking. Over half of men (61.03%) and 29.68% of women had consumed alcohol to HID-3 levels. Over a third of participants who drank in the past year reported they had experienced a blackout (38.82%). Among individuals with a history of HID-2 drinking (but not HID-3 drinking) in the past year, 44.81% reported experiencing a blackout, and among those who drank to HID-3 levels, 65.31% had experienced a blackout. On average, individuals who had experienced a blackout reported having 2 to 5 blackouts in the past year ($M = 3.55$, $SD = 2.76$).

Lifetime marijuana use was reported by over half (55.3%) the sample, with first use typically occurring at age 16 ($M = 16.42$, $SD = 1.68$; see Table 1). Rates were even higher among the subset of those who had consumed alcohol in the past year, with almost three-quarters endorsing lifetime marijuana use (71.53%). Most of those who had ever used marijuana in their lifetime had also used it in the past year (86.8%), on average 2 to 3 times a month ($M = 3.89$, $SD = 2.66$).

SAM use was very common. Of those who had used marijuana, 76.09% reported lifetime and 67.15% reported past-year SAM use. Among lifetime SAM users, using marijuana after drinking alcohol appeared to be slightly more common ($M = 1.86$, where '2' corresponds to using marijuana less than half the time after using alcohol, $SD = 1.39$) than the alternate of drinking alcohol after using marijuana ($M = 1.43$, where '1' corresponds to using alcohol almost never after marijuana use, $SD = 1.10$). Just over half of lifetime SAM users said they had experienced a blackout following SAM use (51.65%), and about a quarter had experienced a blackout after SAM use in the past year (23.58%).

Independent Associations of High Intensity Drinking and Simultaneous Alcohol and Marijuana Use with Blackout

Any past year HID (i.e., either HID-2 or HID-3) was associated with greater odds of experiencing a blackout ($OR = 2.69$ [$1.86 - 3.89$]) and higher frequency of blackout ($F_{1,954} = 15.36$, $p < 0.0001$, model $R^2 = .30$). Gender was not related to blackout occurrence ($OR = 0.68$ [$0.47 - 0.97$]) or frequency ($F_{1,954} = 0.76$, $p = 0.39$). As expected, greater quantity and frequency of past year alcohol use was associated with increased likelihood of experiencing a blackout (quantity: $OR = 1.15$ [$1.07 - 1.24$]; frequency: $OR = 1.60$ [$1.44 - 1.76$]) and with more frequent blackouts (quantity: $F_{1,954} = 38.96$, $p < 0.0001$; frequency: $F_{1,954} = 94.30$, $p < 0.0001$).

After controlling for self-reported past year quantity and frequency of alcohol use, engaging in more frequent HID-2 drinking was associated with increased odds of experiencing a blackout ($OR = 1.15$ [$1.01 - 1.29$]) and with experiencing a greater number of past-year blackouts ($F_{1,955} = 44.49$, $p < 0.0001$; model $R^2 = 0.32$). HID-3 drinking frequency was not significantly associated with blackout occurrence after accounting for quantity and frequency of past year drinking ($OR = 1.05$ [$0.94 - 1.19$]), but HID-3 frequency was associated with a greater number of past-year blackouts ($F_{1,954} = 38.69$, $p < 0.0001$; model $R^2 = 0.32$).

Engaging in past year SAM use was associated with an 82% increase in the likelihood of experiencing a blackout ($OR = 1.82$ [$1.20 - 2.78$]), even after accounting for the quantity and frequency of past-year alcohol use and frequency of marijuana use. Among participants who had used alcohol and marijuana in the past year ($n = 540$), those who engaged in SAM use were more likely to report experiencing a blackout compared to those who used the two substances concurrently (61.86% vs. 36.49%, respectively; $t(500) = -5.34$, $p < 0.0001$). SAM users also reported a greater number of past year blackouts than those who used alcohol and marijuana concurrently (2.50 vs. 1.20, respectively; $t(500) = -4.71$, $p < 0.0001$).

Does the Effect of Simultaneous Alcohol and Marijuana Use Depend on High Intensity Drinking Status?

Among participants who used alcohol and marijuana in the past year ($n = 540$), there was a significant interaction between SAM user status and past-year HID on blackout frequency ($F_{(1,508)} = 10.49, p = 0.001$; see Figure 1). Among college students who consumed alcohol at the non-binge and binge levels, SAM user status was not associated with an increase in the number of past year blackouts (non-binge: $F_{(5,37)} = 0.50, p = 0.49$; binge: $F_{(5,138)} = 0.23, p = 0.63$). For participants who had engaged in any form of HID in the past year, however, SAM user status was associated with a greater number of blackouts ($F_{(5,328)} = 4.52, p = 0.03$).

Following up on this finding, we explored whether SAM user status conferred differential risk for experiencing a blackout across levels of HID (i.e., HID-2 and HID-3). Among high-intensity drinkers ($n = 340$), the level of HID was related to blackout frequency, such that HID-3 drinkers experienced more blackouts than HID-2 drinkers ($F_{(6,327)} = 6.64, p = 0.01$). On average, those who drank to HID-2 levels reported experiencing between one and two past-year blackouts ($M = 1.5, SD = 2.22$), while those who drank to HID-3 levels experienced more than double that number of blackouts in the past year ($M = 3.26, SD = 3.33$).

Finally, we compared rates of post-SAM blackouts between HID-SAM users (individuals who endorsed SAM use and had also drunk to the high intensity level in the past year; $n = 276$) and non-HID SAM users (individuals who reported past year SAM use but had engaged in only binge or non-binge drinking; $n = 138$). Whereas a third of HID-SAM users (32.70%) reported experiencing a past-year blackout following SAM use, only about one in ten non-HID SAM users (11.57%) reported a post-SAM use blackout ($t(1) = 19.21, p < 0.0001$).

Discussion

As expected, high-intensity drinkers had elevated odds of experiencing alcohol-induced blackouts. HID was relatively common in this sample (43.7%), and previous research has suggested HID may be especially prevalent among college students²³, which may make this population uniquely vulnerable to harmful effects of drinking, including memory impairments. For example, in the current study, 59.04% of those who engaged in HID in the past year reported experiencing a past year blackout, compared to 25.26% of individuals with a past year history of binge drinking (but no HID), and just 3.45% of those without a past year history of binge or HID.

Of particular interest was the finding that SAM users experienced more frequent blackouts than non-SAM users, but only if they had engaged in HID in the past year. Additionally, compared to non-HID SAM users, SAM users who had drunk to high-intensity levels in the past year were more likely to experience a blackout on a SAM use occasion (32.70% vs. 11.57%, respectively). These findings could help explain discrepant results from the blackout literature on the effects of marijuana use^{11,24,25}. SAM use may be a risk factor for more frequent blackouts, but only among those engaging in particularly heavy drinking. Among individuals without a history of HID, there was virtually no added risk

for blackout associated with SAM use. Therefore, for individuals engaging in light drinking or even binge drinking, simultaneous use of marijuana may pose no additional risk for the experience of blackouts, consistent with recent event-level research²¹. Given that Mallett and colleagues (2019) defined heavy drinking occasions based on binge criteria (4+/5+ drinks), both binge drinking and HID were lumped together, which may have obscured their ability to detect effects of SAM use during HID occasions. Future research should continue to explore interactions between marijuana and alcohol use patterns, with particular attention to HID.

Findings suggest that targeting HID may help reduce college students' experiences of harmful consequences following alcohol use. In addition to acute consequences like blackouts, this hazardous form of drinking could also have long-lasting impacts on brain development and maturation among underage drinkers, such as the majority of college students. Heavy drinking during adolescence has been linked to alterations in normal brain development^{26,27}. In addition to increasing college student awareness of the harms associated with HID, college students should be educated on the risks associated with blackouts, which include sexual victimization⁶, neurological disruptions¹⁰, and risk of injury or overdose⁸. Though associated with various negative outcomes, many college students (46.6%) do not view blackout experiences negatively²⁸, suggesting they may not be aware of these deleterious effects; therefore, education and feedback may be critical for increasing student perceptions of blackout-related risk.

Blackout prevention and intervention efforts would benefit from informing students of risk factors that increase their likelihood of experiencing a blackout, with particular attention to the potential role of HID and SAM use. Toward this aim, for college students using marijuana and alcohol, interventions may focus on more responsible use of the two substances by moderating alcohol consumption. While education on the harms of heavy drinking may be useful for some college students, these approaches alone are unlikely to be sufficient²⁹⁻³¹. Instead, such efforts may be more effective if combined with harm reduction approaches, which focus on motivating college students to reduce risky substance use behaviors³². One widely-used harm reduction approach for alcohol use on college campuses is the Brief Alcohol Screening and Intervention for College Students (BASICS)^{33,34}, which has been shown to produce long-term reductions in both alcohol consumption and negative consequences among heavy drinking college students^{35,36}. BASICS's efficacy may be due in part to its multi-pronged approach, (1) using motivational interviewing, with the goal of exploring and resolving ambivalence about change³⁷, (2) providing education and personalized feedback on alcohol use and consequences (e.g., blood alcohol levels, normative comparisons), and (3) helping students develop protective behavioral strategies to minimize their experience of deleterious consequences^{38,39}.

A similarly styled intervention providing personalized feedback on marijuana use and encouraging the use of protective behavioral strategies among college students effectively reduced frequency of marijuana use and increased their use of protective behavioral strategies⁴⁰. Combining these two efforts (i.e., explicitly targeting both alcohol and marijuana use in interventions) may be needed for co-occurring alcohol and marijuana users, as alcohol interventions alone have not been shown to be effective at reducing marijuana

use^{41,42}, and use of marijuana may predict poorer alcohol intervention outcomes^{43,44}. Based on our findings and the findings of others^{45,46}, even a minor reduction in alcohol use (for example, from the HID level to binge level) could produce considerable health benefits. Additionally, interventions that successfully reduce blackout rates on college campuses may lead to institutional savings and fewer alcohol-related injuries⁹.

Limitations

The current study's findings should be interpreted in light of several limitations. First, although gender, typical drinking patterns, and frequency of marijuana use were controlled for in analyses, there are a number of other ways in which SAM and non-SAM users (or HID and non-HID drinkers) may differ. For example, one study found that individuals who were higher in sensation seeking were more likely to be simultaneous polysubstance users than concurrent users⁴⁷. These and other personality differences may partially account for the increased rates of blackouts seen in SAM and HID users. However, it could be difficult to disentangle these personality traits from the resulting substance use behaviors, since they are likely related in a complex fashion. Instead, it may be more feasible to make within-person comparisons using event-level data to understand the direct effects of HID and SAM use occasions on blackout experiences.

Second, the retrospective nature of the study makes it difficult to determine whether blackouts occurred at higher rates among HID-SAM users because of the increased volume of alcohol consumed or because of differences between HID-SAM users and non-HID SAM users that may predispose the former to more risky drinking (e.g., sensation seeking, risk taking, etc.). HID-SAM users were more likely to report experiencing a blackout following SAM use compared to non-HID SAM users (32.70% vs. 11.57%), but it was unclear if those SAM use events that led to a blackout occurred in the context of high-intensity drinking. In the future, event-level data could be used to examine whether SAM users are more likely to experience a blackout after an HID-SAM use occasion compared to an HID/no marijuana use occasion.

Third, the assessment of blackout is inherently complicated by its reliance on self-report, and it is possible that there were drinking occasions in which individuals experienced a blackout but were not aware they had done so. If missing memories are not salient ones (i.e., if an individual is missing memories of a conversation they had with a friend, this may be less salient than missing memories of how one got home), they may be disregarded entirely and never interpreted as a blackout. Fourth, this study used dichotomous (yes/no) indicators of SAM use. It will be important for future studies to take into account the frequency of SAM use. Finally, these findings are based on a sample of predominantly underage college students. Though this population is one of the most at-risk groups for HID⁴⁸, findings may not generalize to other groups.

Future Directions

An important direction for future research will be to examine these associations using event-level data to further clarify the nature of blackout risk among individuals using alcohol and marijuana simultaneously. Also, given that HID has been studied primarily among

college students, research is needed on non-college-attending young adults. Regarding marijuana use, both college students and their same-age non-college attending peers have similar rates of use, though non-college attending young adults are more likely to engage in daily marijuana use⁴⁹. Given their greater frequency of use, research on the role of SAM use in blackouts should consider including non-college attending young adults. Future research may also benefit from assessing use of specific forms of marijuana. Marijuana products differ in their cannabinoid profiles (i.e., higher or lower levels of delta-9-tetrahydrocannabinol (THC), the main psychoactive component in marijuana), and this may affect the experience of memory-impairing effects like blackouts.

Conclusions

This study found that SAM use may most substantially increase risk for blackouts among college students who also engage in HID. In particular, there appeared to be step-wise effects, such that the impact of SAM use on blackouts was increasingly greater at each successive level of drinking (i.e., from non-binge to binge to HID). Harm reduction strategies that focus on moderating alcohol consumption among individuals engaging in SAM use may produce reductions in rates of blackout and related consequences.

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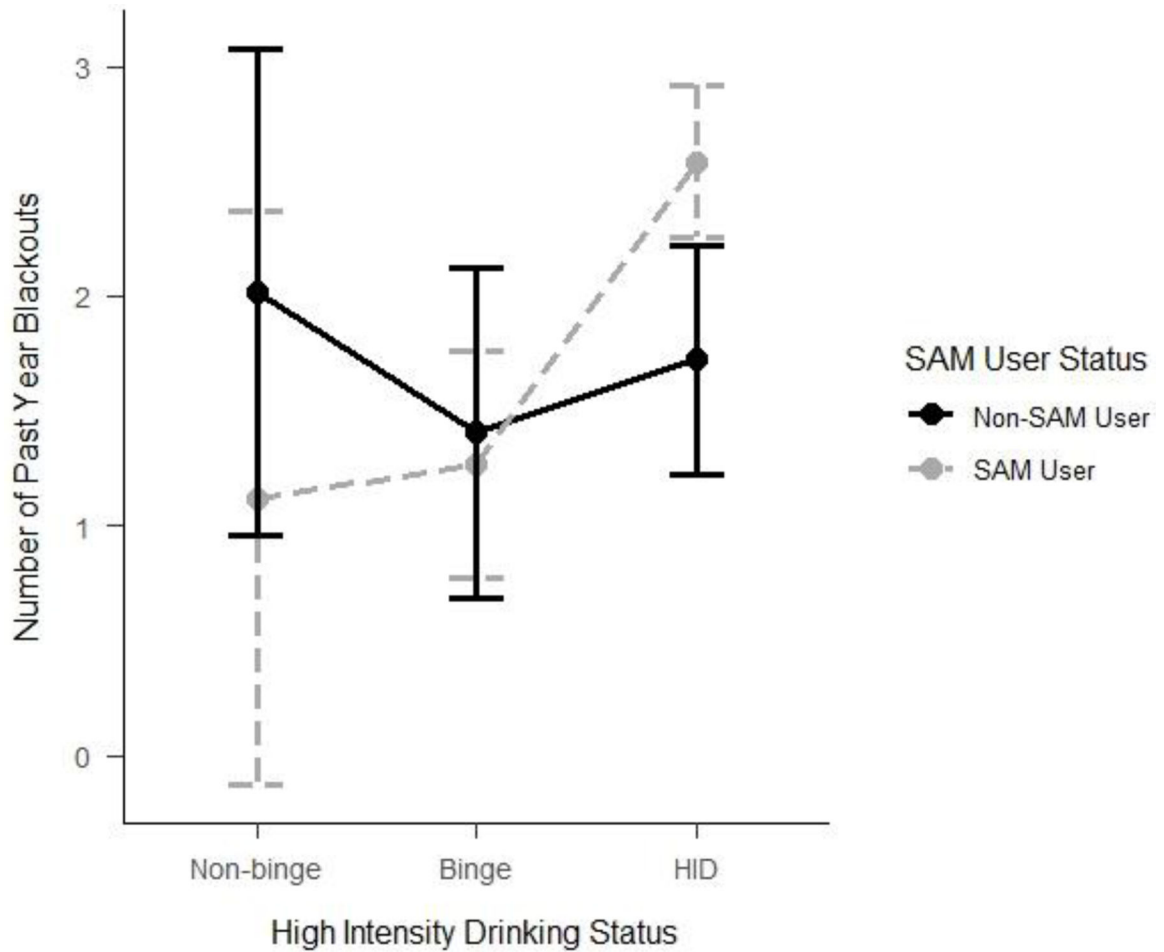


Figure 1.

Interaction between high-intensity drinking status and simultaneous alcohol and marijuana user status on past year experiences of blackout among participants who used alcohol and marijuana in the past year (n = 540).

Note: SAM = Simultaneous alcohol and marijuana; HID = high-intensity drinking. Analysis controls for gender, typical frequency of marijuana use, and quantity-frequency of alcohol use.

Table 1.

Sample characteristics and substance use behaviors.

	Mean (SD) or % (N)			χ^2 difference
	Full Sample (N=1234)	Men 35.71 (n=436)	Women 63.88 (n=780)	
Age	18.42 (1.07)	18.68 (1.40)	18.28 (0.79)	48.42*
Year in school	% (n)	% (n)	% (n)	25.64*
Freshman	81.33 (989)	75.00 (324)	85.20 (662)	-
Sophomore	12.58 (153)	15.05 (65)	11.07 (86)	-
Junior	3.95 (48)	6.25 (27)	2.57 (20)	-
Senior and above	2.14 (26)	3.71 (16)	1.16 (9)	-
	Mean (SD)	Mean (SD)	Mean (SD)	
Age of first alcohol use	16.07 (1.57)	15.95 (1.85)	16.16 (1.35)	33.00*
Age of first marijuana use	16.42 (1.68)	16.29 (1.87)	16.52 (1.51)	27.58
Lifetime Measures	% (n)	% (n)	% (n)	
Blackout	39.47 (461)	42.44 (174)	37.72 (281)	2.47
Marijuana use	55.34 (637)	60.45 (243)	52.51 (387)	6.63
SAM use	40.46 (462)	43.78 (176)	38.60 (281)	2.89
Blackout after SAM use	20.40 (225)	24.10 (94)	17.95 (126)	5.90
Past Year Measures	% (n)	% (n)	% (n)	
Any HID	43.72 (508)	55.53 (226)	36.98 (274)	36.78*
Blackout	32.79 (383)	37.56 (154)	30.20 (225)	6.50
Marijuana use	44.81 (553)	50.00 (218)	42.18 (329)	6.91
SAM use	32.84 (375)	36.57 (147)	30.77 (224)	3.95
Blackout after SAM use	9.25 (102)	11.79 (46)	7.55 (53)	5.48
	Mean (SD)	Mean (SD)	Mean (SD)	
Number of blackouts	3.55 (2.76)	3.85 (3.04)	3.29 (2.46)	15.15

Note:

* indicates significance at a Bonferroni-adjusted p-value of 0.0036. SAM = simultaneous alcohol and marijuana, HID = high-intensity drinking. Number of blackouts were recoded such that 'never/none' = 0, '1' = 1, '2-5' = 3.5, '6-10' = 8, and 'more than 10' = 10.