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## Simultaneous Alcohol and Marijuana Use among College Students: Patterns, Correlates, Norms, and Consequences

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### Abstract

**Background:** Alcohol and marijuana users often engage in simultaneous alcohol and marijuana (SAM) use (i.e., using the two substances together so that their effects overlap), which can result in more negative consequences than using either substance alone. Nevertheless, little is known about SAM use among contemporary college students to aid in the development of preventive interventions. This study examined SAM use patterns, demographic correlates of SAM use, and normative influences on SAM use and related negative consequences among college students.

**Methods:** Students who had used alcohol and marijuana in the past year were recruited from three state universities in states with different laws regarding recreational marijuana use ( $N=1,389$ ). They completed an online survey, which assessed their own alcohol, marijuana, and SAM use and related consequences, their perceptions of the proportion of same-gendered peers and close friends who engaged in SAM use, marijuana access, and demographic characteristics.

**Results:** About three-fourths of participants reported at least one occasion of SAM use in the past year with an average frequency of twice per month among SAM users. There were significant differences in SAM use prevalence and frequency by sociodemographic characteristics controlling for past-year alcohol and marijuana frequency. Students in a state with decriminalized recreational marijuana use reported higher frequency of past-year SAM use than students in states with legalized or criminalized use. There were significant demographic differences in perceived norms regarding SAM use among close friends and same-gender peers. SAM users endorsed significantly higher perceived peer and friend norms than nonusers. Also, higher perceived norms predicted more frequent SAM use and more negative consequences of use.

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Notes

**Conclusions:** Results indicate a need for prevention programs on college campuses that address SAM use. Interventions that use personalized normative feedback may be effective.

### Keywords

alcohol; marijuana; simultaneous; SAM use; college students

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## Introduction

Alcohol and marijuana use are significant public health concerns and rates of use are high among college students. National data indicate that in 2017 the annual prevalence of marijuana use for college students was 38%, with 21% and 4% reporting current monthly and daily use, respectively (Schulenberg et al., 2018). With respect to alcohol use, 76% of college students drank alcohol in the past year and 62% in the past month, 33% consumed 5 or more drinks in a row in the past 2 weeks, and 35% had been drunk in the prior 30 days (Schulenberg et al., 2018).

College student alcohol use is often characterized by co-use with marijuana, either concurrently or simultaneously. Concurrent use refers to use of two substances in the same time period (e.g., past month, past year), potentially on separate occasions, whereas simultaneous use refers to use of two substances at the same time or during the same occasion (Earleywine & Newcomb, 1997; Ives & Ghelani, 2006; Martin et al., 1992; McCabe et al., 2006; Midanik et al., 2007). Simultaneous alcohol and marijuana (SAM) use can have more serious negative consequences than using either substance alone (for a review see Yurasek et al., 2017). These include driving under the influence and having alcohol-related accidents (Arterberry et al., 2017; Chihuri et al., 2017; Lipperman Kreda et al. 2017; Terry-McElrath et al., 2014), cognitive impairment (Mallett et al., 2017) and substance use disorder symptomatology (Agrawal et al., 2009; Mallett et al., 2017; Midanik et al., 2007; Subbaraman & Kerr, 2015). The majority of individuals who use alcohol and marijuana engage in SAM use on at least some occasions (Agrawal et al., 2009; Brière et al., 2011; Collins et al., 1998; Midanik et al., 2007; Pape et al., 2009; Subbaraman & Kerr, 2015). National data among high school seniors in 2011 indicate that, among those with past-year marijuana use, 62% reported any SAM use and 13% reported frequent (most or all of the time) SAM use (Terry-McElrath et al., 2013). In follow-up studies using the same national dataset, one-fourth (24%) of 19–20-year-old 4-year college students reported past-year SAM use (compared to 17% of 2-year college students and 24% of non-students in the same age range), and about one-third (30%) of past-year alcohol users age 19–22 reported SAM use (Terry-McElrath & Patrick, 2018).

Little research has focused on college student SAM use since the recent shifts in approval of marijuana use associated with legal changes in medical and recreational marijuana use (Fleming et al., 2016; Okaneku et al., 2015; Salas-Wright et al., 2015; Sarvet et al., 2018). Identifying which students may be at risk for problematic SAM use and its related consequences necessitates a better understanding of the normative context surrounding use.

## Normative Influences on Substance Use

Perceived descriptive norms, which represent perceptions of the typical actions or behaviors displayed by group members, are powerful influences on an individual's behavior (Ajzen, 1991; Bandura, 1986). Perceived norms are among the strongest influences on college students' alcohol (Neighbors et al., 2007; Perkins, 2002) and marijuana (Kilmer et al., 2006; Neighbors et al., 2008) use. Furthermore, there are often significant misperceptions of these norms (i.e., beliefs about the percentage of people who use a substance, their frequency of use, and how much they actually use) (e.g., Martens et al., 2006; Perkins, et al., 1999; Thombs et al., 1997), with the heaviest users often demonstrating the largest over-estimation of norms (Wolfson, 2000). Higher perceived estimates of alcohol and marijuana use are, in turn, associated with greater use and more negative consequences of use (e.g., Kilmer et al., 2006; Larimer et al., 2004; Neighbors et al., 2007).

No studies have investigated norms regarding SAM use. Because norms are often the targets of substance use interventions, and SAM use (and its correlates) are different from concurrent use, obtaining accurate SAM use norms from contemporary college students and understanding how they relate to use patterns will be informative for developing interventions and evaluating the public health impact of SAM use.

## Current Study

In the current study we examine the associations between perceived SAM use norms and SAM use behaviors and related negative consequences. We also fill a gap in the literature by including students from three different public state universities with potentially different normative environments. School A is located in a state where recreational marijuana use is criminalized, School B is located in a state where it is decriminalized, and School C is located in a state where recreational use is legal for adults over the age of 21. All three states have legalized medical marijuana use. Schools A and B are in the Northeast region of the country and School C is located in the West; both areas are known for heavier substance use among college students (Wechsler & Nelson, 2008). Schools A and C are located in urban environments, whereas School B is in a suburban community. There are more than twice the number of undergraduates enrolled in School A (approximately 36,000) and School C (approximately 31,000) than School B (approximately 15,000). All three schools participate in Division I athletics.

We also examine demographic differences in SAM use. It is critical to distinguish demographic correlates of SAM use from demographic correlates of alcohol and marijuana use. For example, gender differences in SAM use have been found among college students (Arterberry et al., 2017) as well as 12<sup>th</sup> graders (Collins et al., 1998; Patrick et al. 2018), young adults (Patrick et al., 2019) and adults (Midanik et al., 2007), indicating that males, compared to females, are more likely to report SAM use. However, studies controlling for frequency of alcohol and marijuana use have found that women report more frequent SAM use (Collins et al., 1998; Hoffman et al., 2000; Terry-McElrath et al., 2013). Inconsistent racial/ethnic group differences in SAM have also been observed. Some studies have found that white, compared to black, youth report higher SAM use (Patrick et al., 2019; Terry-McElrath et al., 2013), whereas others have found the converse (Arterberry et al., 2017;

Collins et al., 1998) or no racial/ethnic group differences (Patrick et al. 2018). The current study fills a gap in the literature by controlling for existing differences in alcohol and marijuana use while examining sociodemographic differences in SAM use among college students.

We hypothesize that SAM use will be higher at School C due to greater availability and easier access to marijuana. However, once we control for alcohol and marijuana use, we expect rates of SAM use to be similar across the three campuses. Based on the alcohol and marijuana literature, we also hypothesize that higher perceived norms for SAM use will be associated with greater frequency and more negative consequences of SAM use.

## Materials and Methods

### Design and Sample

In the fall of 2017, 24,000 (8,000 at each of three universities described above) students ages 18–24 years who were randomly chosen by each school's registrar based on expected year of graduation (i.e., 2,000 in each of the next four graduating classes) were sent email invitations to participate in an online screening survey. Other students on campus were also permitted to access the screening survey through the project website. The screening survey assessed sex, race, ethnicity, age, student status (full-time versus part-time), year in college, school, and alcohol and marijuana use to determine eligibility for the baseline survey. A lottery to win a \$100 [Amazon.com](https://www.amazon.com) gift card (10 per campus) was offered as an incentive for completing the screening survey.

A total of 7,000 students completed the screening survey (30.4% School A; 35.7% School B; 33.8% School C; and 0.1% from another school). Compared to the invited sample who did not complete the screener, screening completers included more women (61.5% versus 48.8%; Cohen's  $h = .26$ ), more white students (54.6% versus 51.3%;  $h = .07$ ), fewer black students (3.3% versus 4.6%;  $h = .07$ ), more Asian students (21.7% versus 15.3%;  $h = .17$ ), and more Hispanic/Latinx students (11.7% versus 8.0%;  $h = .12$ ). Screening completers were also more likely to report being younger (i.e., 18–21) than the invited sample (89.0% versus 84.7%;  $h = .13$ ). Effect sizes of differences in the demographic characteristics were small, indicating that the screening sample was fairly representative of the students attending the three universities. Among screened students, 80.6% drank alcohol in the past year and 65.5% in past month; 48.4% used marijuana in the past year and 31.7% in the past month.

Out of those screened, 2,874 students met study eligibility criteria for the baseline survey. These criteria included: 1) being enrolled full-time at one of the three universities, 2) being between ages 18 and 24; 3) having used both alcohol and marijuana in the past year; 4) being on the registrar's list as validated by email addresses in the contact information (for Schools B and C this entailed using the same university email address as on the registrar's list; for School A, we could not validate the exact email address from the registrar's list due to several different iterations of email addresses being possible but we could validate that it came from that university); and 5) having provided contact information.<sup>1</sup> From the 2,874 eligible students, we invited a random sample of 2,501 students stratified by school to take the baseline survey. We over-sampled students who had used alcohol and marijuana in the

past month to ensure that enough students were eligible for the second phase of this study (which collected daily data).

A total of 1,524 students (60.9% of those invited) completed the baseline survey but only 1,498 had usable data due to technical issues. No respondents were excluded due to failure on three attention checks. After examining baseline responses, 1,390 were deemed eligible (30.6% School A; 34.5% School B; and 34.9% School C). The sample was 62.4% female with a mean age of 19.8 (SD = 1.3); 63.8% were non-Hispanic white, 2.7% non-Hispanic black, 12.5% Asian, 12.2% Hispanic/Latinx, 0.2% Native Hawaiian or other Pacific Islander, 0.1% American Indian or Alaskan Native, 0.8% Other, and 7.7% more than one race/ethnicity. Fewer students were freshmen (20.9%) compared to 24.8% sophomores, 24.5% juniors, and 29.8% seniors.

All procedures were approved by the coordinating university institutional review board and a Certificate of Confidentiality was obtained from NIDA to preserve participant confidentiality. Students received a \$25 [Amazon.com](https://www.amazon.com) gift card for completing the baseline survey.

## Measures

**Alcohol, marijuana, and SAM use.**—The present study defined SAM use as use of alcohol and marijuana together “so that their effects overlap” (Pakula et al., 2009). This definition, relying on overlapping effects, is currently being used in national studies (e.g., Terry-McElrath et al., 2018). Students reported on their frequency (how often) of alcohol, marijuana, and SAM (“using alcohol and marijuana at the same time so that their effects overlapped”) use. Frequency of use in the last year and last 3 months were measured on an 8-point ordinal scale ranging from 0 = did not use to 7 = daily/more than daily. These variables were recoded to interval scales by taking the midpoint of the categories when appropriate and converting the ordinal frequencies to days per year (ranging from 0 to 365) and days per past 3 months (ranging from 0 to 90), respectively. Frequency of use in the past month was the number of days used in the past 30 days (ranging from 0 to 30).

**SAM use consequences.**—Students who engaged in SAM use in the past 3 months were asked whether or not they experienced 28 different negative consequences in the past 3 months “due to using alcohol and marijuana so that their effects overlapped.” We summed these dichotomous items (yes/no) to create a score of total number of consequences experienced. We bounded six outliers at 18 consequences. The consequence items were from the 24-item Brief Young Adult Alcohol Consequence Questionnaire (BYAACQ; Kahler et

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<sup>1</sup>We conducted analyses comparing mean demographic and substance use levels among the eligible versus non-eligible participants in the screening data ( $n = 7,000$ ). Compared to non-eligible participants in the screening data, students who met study eligibility criteria were more likely to report past-month alcohol use (90.3% vs 68.9%;  $\Phi = .27$  for those eligible versus ineligible, respectively), past-month marijuana use (65.9% vs 55.5%;  $\Phi = .04$ ), higher frequency of drinking alcohol ( $M = 65.45$ ,  $SD = 65.82$  versus  $M = 27.91$ ,  $SD = 44.08$ ;  $\eta^2 = .10$ ) and higher frequency of using marijuana ( $M = 86.69$ ,  $SD = 126.48$  versus  $M = 14.80$ ,  $SD = 0.58$ ;  $\eta^2 = .05$ ). Those eligible were significantly more likely to be white students (68.9% versus 50.5%;  $\Phi = .19$ ) and less likely to be Asian students (12.5% versus 31.6%;  $\Phi = -.23$ ) than those ineligible, which is consistent with the broader literature on ethnic/racial group differences in alcohol and marijuana use. Those eligible were also older on average ( $M = 19.77$ ,  $SD = 1.37$  versus  $M = 19.56$ ,  $SD = 1.54$ ;  $\Phi = .005$ ). There were no significant differences on sex (61.1% versus 62.1%;  $\Phi = -.01$ ); black race (3.6% vs. 4.2%;  $\Phi = -.01$ ), or Hispanic ethnicity (12.4% versus 11.1%;  $\Phi = .02$ ). These differences in substance use and demographic characteristics related to substance use were expected due to the eligibility criteria (i.e., selecting only past-year alcohol and marijuana users).

al., 2005) and the 21-item Brief Marijuana Consequences Questionnaire (MACQ; Simons et al., 2012); collapsing the two scales yielded 28 unique items. Both scales have been used reliably with college students (Kahler et al., 2005; Simons et al., 2012). In our sample, the Cronbach alpha was  $\alpha=.91$  for the SAM consequence scale. Sample items include “Have woken up in an unexpected place after using heavily”; “My school work has suffered because of my use”; “Have felt very sick to my stomach or thrown up after using.” Students who did not engage in SAM use in the past 3 months received a score of zero on this scale.

**SAM use norms.**—Students were asked to estimate the percentage of students at their university of their same gender and year in school who use alcohol and marijuana together so that their effects overlap at least monthly. This measure of perceived peer SAM use ranged from 0% to 100%. They also reported on how many of their close friends engage in SAM use at least monthly. Responses options were coded on a 5-point ordinal scale (0 = none, 1 = some, 2 = about half, 3 = most, and 4 = all).

**Access to marijuana.**—Students responded to the item “How difficult is it for you to obtain marijuana?” Response options on a 5-point scale included “Very easy” and “Fairly easy” with the bottom three categories (“Probably impossible,” “Very difficult,” and “Fairly difficult”) combined due to very low base rates and labeled as “Difficult.”

**Socio-demographic characteristics.**—We assessed gender identification, which was a check all that apply variable. Anyone who selected trans male/trans man, trans female/trans woman, gender queer/gender non-conforming, and gender different identity was coded as non-binary; those who only selected male were coded as male; and those who only selected female were coded as female. Other socio-demographic characteristics included age (under 21 vs. 21+ to discriminate legal access to alcohol at all schools and to marijuana at School C), year in school (freshman, sophomore, junior, senior+), race/ethnicity (Asian, non-Hispanic black, non-Hispanic white, Hispanic, other, mixed), fraternity/sorority status (non-member, member), and athlete status (none, intramural/club, varsity).

## Analyses

First, we examined frequencies on all measures and one student was dropped from the analyses due to constantly being an outlier on substance use and SAM consequences as well as on perceived norms. We conducted chi-square analyses to examine demographic, school, and marijuana access differences in any SAM use in the past year and ANCOVAs to examine these differences in frequency of SAM use in the past year among students who had engaged in SAM use with controls for past-year frequency of alcohol use and marijuana use. For the ANCOVAs SAM use frequency was logged to reduce skew. ANOVAs were used to examine demographic, school, and marijuana access differences in perceived norms. Tukey post hoc tests were conducted to examine group differences in the ANOVAs and ANCOVAs. *t*-tests were used to compare past 30-day SAM users to nonusers and to compare frequent to infrequent SAM users on perceived norms.

We then conducted negative binomial regression analyses to test whether perceived SAM norms were associated with SAM frequency in the past 30 days and SAM consequences in

the past 3 months. We used negative binomial regressions because of the distributions of the two outcome variables.<sup>2</sup> In these analyses we controlled for gender (male vs. female with non-binary excluded due to the small sample size [ $n = 29$ ]), race/ethnicity (white vs. Asian vs. all others as the reference group), school attendance (School A vs. School C vs. School B as the reference group because it was in the middle in terms of severity of laws [decriminalized] and this way we could contrast it with School A [illegal] and School C [legal for adults]), and access to marijuana (very easy vs. easy vs. difficult as the reference group). We also controlled for frequency of alcohol and marijuana use in the past 30 days for the SAM frequency outcome analyses (because the norms were based on past-month SAM use among peers and friends) and past 3-month SAM frequency for the SAM consequence analyses (because the consequences were assessed in the past 3 months).<sup>3</sup> First, we ran these models separately for peer norms and friend norms and then combined them into a single model. Multicollinearity was not an issue in these models.

## Results

### SAM Use Patterns and Socio-Demographic Differences in SAM Use

Across universities, 73.0% of the total sample engaged in SAM use in the past year; 58.9% of all students were past-3-month SAM users, and 49.8% were past-month SAM users. On average, past-year SAM users reported 24 days of SAM use in the past year; past-3-month SAM users reported 7.1 days in the past 3 months; and past-30-day SAM users reported 3.4 days in the past month, although the majority of past-month SAM users reported past 30-day SAM use only one or two times.

Table 1 presents socio-demographic, school, and marijuana access differences in prevalence of past-year SAM use. There were significant differences by school ( $\chi^2 [2, n = 1389] = 8.90, p < .001; \Phi = .08$ ); students at School B and School C reported higher prevalence of SAM use than students at School A. There were also significant differences by gender ( $\chi^2 [1, n = 1389] = 6.40, p < .05; \Phi = .07$ ; non-binary students reported the lowest prevalence) and by race/ethnicity ( $\chi^2 [5, n=1389] = 23.05, p < .001; \Phi = .13$ ; black, white, Hispanic, and mixed race students reported higher prevalence than Asian students and students of other races/ethnicities). Intramural/club athletes and nonathletes reported higher prevalence than varsity athletes ( $\chi^2 [2, n = 1389] = 7.46, p < .05; \Phi = .07$ ). Finally, those with greater self-reported marijuana access reported higher prevalence ( $\chi^2 [2, n=1389] = 30.44, p < .001; \Phi = .15$ ). There were no significant differences in past-year prevalence of SAM use by age ( $\Phi = -.01; p = .79$ ), year in school ( $\Phi = .02; p = .93$ ), and Greek status ( $\Phi = .05; p = .08$ ).

We also examined whether there were differences in past-year SAM use frequency (among past-year SAM users) across sociodemographic, school, and marijuana access categories controlling for frequency of past-year alcohol and marijuana use (Table 1). Students at

<sup>2</sup>. Within the full sample, past-month SAM frequency ranged from 0 to 30 ( $M = 1.70$ ;  $SD = 3.22$ ; skew = 3.78; kurtosis = 19.39) and SAM consequences ranged from 0 to 18 ( $M = 1.60$ ;  $SD = 3.06$ ; skew = 2.69; kurtosis = 8.00).

<sup>3</sup>. We also had a measure of the number of days in the past 30 days of heavy episodic drinking (HED; defined as 5+ drinks per occasion for men, 4+ for women) and a measure of total hours high on marijuana in a typical week in the past month. When we conducted analyses including these “quantity” measures in the negative binomial regressions (see below), the results remained basically the same. Given that HED was highly correlated with alcohol frequency ( $r = .73$ ) and hours high was highly correlated with marijuana frequency ( $r = .80$ ), we chose not to include them in the models.

School B reported engaging in SAM use on significantly more days than students at Schools C and A (for school,  $F[2, 1009] = 18.81, p < .001; \eta^2 = .02$ ). Gender (males higher than females;  $F[2, 1009] = 7.95, p < .05; \eta^2 = .01$ ), race/ethnicity (white students higher than Asians and others;  $F[5, 1006] = 8.45, p < .001; \eta^2 = .03$ ), age (older higher than younger;  $F[1, 1010] = 5.66, p < .05; \eta^2 = .003$ ), year in school (juniors and seniors higher than sophomores;  $F[3, 1008] = 4.93, p < .01; \eta^2 = .008$ ), Greek status (members higher than nonmembers;  $F[1, 1010] = 26.31, p < .001; \eta^2 = .01$ ), and athlete status (intramural/club athletes highest and varsity athletes lowest;  $F[2, 1009] = 7.02, p < .001; \eta^2 = .01$ ) were all significantly related to frequency of SAM use. Those reporting very easy access to marijuana reported higher SAM frequency than those reporting fairly easy and difficult access ( $F[2, 1009] = 55.78, p < .001; \eta^2 = .06$ ).

### Demographic Differences in Perceived SAM Use Norms

On average, students perceived that 33.9% of their same-gender, same-year students at their school engage in SAM use at least monthly.<sup>4</sup> Perceptions of peer SAM use differed significantly by school ( $F[2, 1384] = 101.63, p < .001; \eta^2 = .13$ ); students at School B perceived the highest percentage of same-gender peers on their campus as engaging in SAM use and students at School A perceived a higher percentage than students at School C. There were also significant differences by gender (female students higher;  $F[2, 1384] = 5.15, p < .01; \eta^2 = .01$ ) and race/ethnicity (white students higher than Asian students;  $F[5, 1381] = 3.16, p < .01; \eta^2 = .01$ ). Marijuana access was positively associated with peer norms (students with very easy access reported higher norms than those with fairly easy or difficult access;  $F[2, 1384] = 9.23, p < .001; \eta^2 = .01$ ). The other sociodemographic variables were not significantly related to perceptions of peer use ( $\eta^2$  from .0001 to .002; see Table 2).

On average, students perceived that between “some” and “half” ( $M = 1.4$ ) of their close friends engaged in SAM use at least monthly. There were significant differences by school ( $F[2, 1385] = 16.18, p < .001; \eta^2 = .02$ ); students at School B perceived more close friends engaging in SAM use than students at School A or School C. There were also significant differences by race/ethnicity (white students higher than Asian and Hispanic students;  $F[5, 1382] = 8.12, p < .001; \eta^2 = .03$ ), Greek status (members higher than nonmembers;  $F[1, 1343] = 10.37, p < .01, F[1, 1386] = 14.78, p < .001; \eta^2 = .01$ ), athlete status (intramural/club athletes and nonathletes higher than varsity athletes;  $F[2, 1385] = 4.26, p < .05; \eta^2 = .01$ ), and marijuana access (greater access was associated with higher friend norms;  $F[2, 1385] = 42.40, p < .001; \eta^2 = .06$ ). Although the model for gender was significant ( $F[2, 1385] = 3.57, p < .05; \eta^2 = .005$ ), post hoc tests revealed no significant group differences (see Table 2).

<sup>4</sup>Note that this percentage appears lower than the 49.8% SAM monthly prevalence rate among respondents; however, this was a sample ultimately recruited with inclusion criteria related to alcohol and marijuana use, so we do not actually have campus-wide SAM use rates to be able to assess the accuracy of this perceived norm. Over three-fourths (75.4%) of our past-year SAM users used marijuana in the past month compared to 31.7% of the screening sample. The latter sample more closely reflects actual use rates on campus but rates would need to be explored further.



### Associations between SAM Use and Perceived Norms

We compared norm perceptions between those who engaged in past 30-day SAM use and those who did not. SAM users, compared to nonusers, perceived that a greater percentage of their same-gender peers ( $t[1385] = 4.66, p < .001$ ) and their close friends ( $t[1340.5] = 16.15, p < .001$ ) were SAM users (see Table 2). When we repeated these analyses including only participants who reported using both alcohol and marijuana in the past 30 days, the results remained the same (i.e., significantly higher perceived peer and friend norms among simultaneous versus concurrent users; not shown).

We also divided SAM users into those who used only one or two times ( $n = 411$ ) in the past 30 days and those who used more than twice ( $n = 279$ ). More frequent SAM users perceived that more of their same-gender peers and more of their close friends engage in SAM use ( $t[688] = 3.30, p = .001$  and  $t[540.79] = 9.93, p < .001$ , respectively; see Table 2).

### Associations of Perceived Norms to SAM Use and Consequences

Table 3 presents the results from the negative binomial regression analyses assessing the association of perceptions of same-gender peer SAM use with students' own frequency of SAM use in the past 30 days (Table 3a) and SAM-related consequences in the past 3 months (Table 3b). These analyses controlled for demographic characteristics, perceived access to marijuana, and either frequency of alcohol use and marijuana use in the past 30 days (for the SAM use frequency analysis) or frequency of SAM use in the past 3 months (for the SAM consequences analysis to match the past 3-month time frame for the consequence measure). Higher same-gender peer norms were significantly related to greater SAM frequency and more SAM consequences accounting for all the control variables. Past 30-day frequency of alcohol and marijuana use and easier access to marijuana were related to higher SAM use frequency. Similarly, higher SAM use frequency, easier access, and attending School C vs. School B were significantly related to more SAM-related negative consequences.

Table 4 presents the results from the analyses assessing the association of perceptions of close friends' SAM use with students' own SAM use frequency (Table 4a) and SAM-related consequences (Table 4b). Higher perceptions of close friend SAM use was significantly related to greater SAM frequency and consequences. Substance use, marijuana access, and school attendance were significant covariates (see Table 4 for details).

Tables 5a and 5b present the results considering both same-gender peers and close friends' SAM use in the same model. Higher perceptions of close friends' SAM use was significantly related to higher SAM use frequency and more consequences but perceptions of peer use was not. Again, covariate effects were similar to those in previous analyses (see Table 5 for details).

## Discussion

In this sample of college students who used alcohol and marijuana in the past year, rates of SAM use were extremely high. Almost three-fourths of those who used alcohol and marijuana reported that they used them simultaneously on at least one occasion in the past year, and half used them simultaneously on at least one occasion in the past month; the

average student with SAM use did so approximately 2 to 3 days a month. Because simultaneous use of alcohol and marijuana represents a drug interaction and can result in excessive depression of the central nervous system (Seamon et al., 2007) and more negative consequences than using either alone (Yurasek et al., 2017), SAM use poses a potential risk for increased harm to students who engage in it. Thus, a large majority of students in this sample may be at risk for serious harm, and prevention/intervention efforts that seek to reduce or eliminate simultaneous use of substances could impact student health on college campuses.

We had hypothesized that SAM use would be greatest in the state where recreational marijuana use is legal for adults 21 years old and older (School C). Although SAM prevalence rates were lowest in the criminalized state school (School A), SAM frequency at School B (decriminalized) was actually greater than at School C (legalized recreational use), controlling for alcohol and marijuana use. School B also had significantly higher rates of marijuana use than the other two schools (not shown). School B and School C saw their state legislation around the status of marijuana use occur in the same year, though subsequent implementation dates related to new policies varied across the states. Whereas a higher percentage of students at School C (52%), compared to School B (47%) and School A (36%), reported very easy access to marijuana, access did not appear to account for the school differences found. Evidence is mixed with regard to the effects of state policy-related changes on marijuana use, attitudes regarding risk and acceptability, and norms (Blevins et al. 2018; Lynne-Landsman et al., 2013; Mason et al., 2016). Students at School B perceived higher norms for SAM use among same-gender peers and close friends compared to students at the other two schools, suggesting that the normative environment of a campus, which is affected by everything from perceived harm to enforcement of policies and laws on campus, may be more important for SAM use than the state's legal environment. Alternatively, race differences across the schools may have accounted for observed differences in SAM use and perceived norms. For example, there were significantly more white (84.8%) and fewer Asian (2.3%) students at School B than at School A (49.7% and 19.1%, respectively) and School C (55.5% and 16.9%, respectively); in our analyses reported above, white students, compared to Asian students, reported higher SAM use rates and perceived norms. When we examined SAM use rates only among white students, SAM prevalence and frequency did not vary significantly across campuses (not shown). It is also possible that differential prevention programs or enforcement strategies among the campuses could account for school differences in SAM use or perceptions of SAM use. Thus, more research is needed to determine what factors influence SAM use and normative perceptions on college campuses.

Our second hypothesis was supported; we found a strong association between a student's perceptions of SAM use among same-gender peers and close friends and the student's own SAM use and related negative consequences that persisted above and beyond use of alcohol and marijuana and access to marijuana. This finding is consistent with the alcohol and marijuana literature (Kilmer et al., 2006; Neighbors et al., 2007; Neighbors et al., 2008; Perkins, 2002). In addition, SAM users, compared to nonusers, reported higher SAM use norm perceptions as did those who engaged in SAM use frequently compared to infrequently. Thus, consistent with previous literature on alcohol and marijuana use (e.g.,

Lewis et al., 2015a; Wolfson, 2000), those who report heavier SAM use also report higher normative perceptions.

In addition, we found that perceptions of close friend SAM use, compared to peer use, were more strongly related to SAM use and consequences. The salience of close friend norms is consistent with other research highlighting the role of close friends on norms and/or actual behavior for alcohol use (Lee et al., 2007; Lewis et al., 2015b; Lewis et al., 2014) and marijuana use (Buckner, 2013; Ecke et al., 2014; Neighbors et al., 2008). It is interesting that norms predicted negative SAM consequences even after controlling for SAM use itself. Those experiencing the most consequences may also have friends who are heavier SAM users and who reinforce risky behaviors that lead to experiencing consequences. It may also be that the heavier users with higher perceived norms have personality traits, such as impulsivity, that increase their risk for engaging in harmful behaviors and, thereby, for experiencing negative consequences. The examination of psychosocial predictors of consequences is beyond the scope of the present study but should be explored in future research.

Personalized normative feedback interventions (PNFs) have been found to be among the most effective college prevention programs for heavy drinking (Carey et al., 2009; Crouce & Larimer, 2011; NIAAA, 2015; Walters & Neighbors, 2005; White, 2006), although see Huh et al. (2015), an integrated data analysis study of a large sample of college students from multiple U.S. campuses, which did not find main effects of PNF on alcohol use or related problems. Commonly, PNFs include the presentation of what students' own substance use looks like (e.g., frequency and quantity), what they perceive the use of their peers to look like, and what the actual use of their peer group is. For students who want to "fit in" or do what "everyone else" is doing, this personalized feedback could develop a discrepancy between their values and goals and what the status quo suggests, which could serve to elicit a personally-relevant reason to change. Whether PNFs will be effective for reducing SAM use remains to be tested and should be explored in future studies.

There were significant subgroup differences in SAM use patterns that were consistent with prior work showing greater use by male and white students in both the alcohol (Gardner et al., 2018; Lewis & Neighbors, 2004; O'Malley & Johnston, 2002) and marijuana (Lee et al., 2010; Suerken et al., 2016) literature. Likewise, tests of campus group differences in SAM use revealed greater use by Greek members and by intramural/club (but not varsity) athletes, consistent with studies on heavy drinking (e.g., Larimer et al., 2001; Barry et al., 2015, respectively). Notably, these subgroup differences were evident even adjusting for frequency of alcohol use and marijuana use. Given that risk for SAM use increases as a direct function of the frequency of alcohol and marijuana use (Patrick et al., 2017), it is clear that there is something specific to SAM use behavior (both any use and degree of use) beyond simply using its constituent substances. This is an important finding because selective prevention efforts on college campuses often occur with intact groups (e.g., sports teams, fraternities or sororities, etc.) and prevention content tends to vary depending on group composition (e.g., intercollegiate athletics would have an emphasis on impacts to athletic performance that might not be covered in programs for the general student body). Thus, prevention efforts

with these groups could have a more intentional focus on risks associated with drug interactions and SAM use specifically.

The results of this study need to be considered within the context of some limitations. We relied on self-report for SAM use and consequences. Nonetheless, self-report data have consistently been associated with improved accuracy when using objective measures (and those with established validity), allowing participants to complete surveys on their own devices with the ability to skip any question that makes them feel uncomfortable, and taking steps to assure confidentiality (Kypri, et al., 2016; Laforge et al., 2005; Simons et al., 2015), all of which were true for this study. Our findings are based on a sample of students who used both alcohol and marijuana in the past year and we did not ask about rates of SAM use in the screening survey. Therefore, we cannot determine accurate rates of SAM use on each of our campuses, nor can we compare perceived campus SAM use norms to actual campus rates. However, for the purposes of this study, we were able to examine the relationship between perceived SAM use and students' actual SAM use, which showed a strong relationship, and we demonstrated socio-demographic differences in both norms and use. Our sample had small numbers of black students and non-binary students; replication in more diverse samples is an area for future research. Finally, our sample was limited to volunteer college students on only three campuses and, thus, may not generalize to other college students or emerging adults who do not attend college.

Despite these limitations, this is the first study that we are aware of to examine associations between SAM use norms and SAM use frequency and consequences, and one of the first studies to examine patterns and correlates of SAM use among contemporary college students, while controlling for alcohol and marijuana use. Thus, this study makes a significant contribution to the literature. In addition, our sample included students from three different universities in states with different laws regarding marijuana use extending the generalizability of our findings beyond a single university. Overall, our results indicate that SAM use is quite prevalent among college students and a topic that needs to be addressed in prevention programs on college campuses. As campuses continue to express the importance of academic outcomes for their students, addressing barriers to success should be a priority. Research compellingly shows that among students who use alcohol and marijuana at higher rates, grade point averages are lower (Meda et al., 2017). With increased potential harms associated with simultaneous use, prevention and intervention efforts that aim to reduce the harms of overlapping substance use could pay dividends in the classroom and across campuses.

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**Table 1:**

School, Sociodemographic and Access to Marijuana Differences in Past-Year SAM Use and Frequency of SAM Use among Past-Year SAM Users

Variable	(N Total Sample) (n = 1389)	% Using SAM in the Past Year (n = 1389)	Mean (SD) Number of SAM Days <sup>#</sup> (n = 1013)
School			
A (illegal)	425	67.8	21.0 (39.4) a
B (decriminalized)	479	76.2	29.9 (44.9) b
C (legal for 21+)	485	74.4	20.4 (32.0) a
Gender			
Male	519	75.3	27.3 (43.1) a
Female	841	72.2	22.0 (36.9) b
Non-binary	29	55.2	18.7 (38.6) ab
Age			
<21	930	73.2	22.4 (37.0) a
21+	459	72.6	27.2 (43.8) b
Year in School			
Freshman	291	72.2	22.0 (34.5) ab
Sophomore	344	72.1	20.3 (34.5) a
Junior	340	73.8	24.9 (40.3) b
Senior+	414	73.7	27.6 (44.9) b
Race			
Asian	174	59.8	19.2 (35.1) a
Black	37	70.3	16.5 (25.0) ab
White	886	76.5	27.3 (43.7) b
Hispanic/Latinx	170	71.8	16.1 (20.6) a
Other	15	60.0	20.0 (37.6) ab
More than one	107	70.1	16.1 (26.4) a
Greek			
No	1038	71.8	21.3 (36.1) a
Yes	351	76.6	31.3 (46.6) b
Athlete			
No	1163	72.1	23.0 (36.8) a
Intramural	207	79.7	29.9 (51.2) b
Varsity	19	57.9	7.1 (2.4) c
Access to Marijuana			
Difficult	138	58.3	16.0 (34.8) a
Fairly easy	620	70.0	16.4 (25.7) a
Very easy	630	79.2	31.9 (47.6) b

Notes: For frequency, within each variable, means followed by different letters differ significantly ( $p < .05$ ) from each other.

# In the ANCOVAs SAM use frequency was logged to reduce skew but unlogged means are shown here.

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**Table 2:**School, Sociodemographic and Access to Marijuana Differences in Perceived Norms<sup>#</sup>

Variable	Perceived Peer Norms (n = 1387)	Perceived Friend Norms (n = 1388)
School		
A	31.2 (18.2) a	1.25 (0.90) a
B	43.4 (20.1) b	1.56 (1.02) b
C	26.8 (17.4) c	1.27 (0.87) a
Gender		
Male	31.7 (19.2) a	1.44 (0.93) a
Female	35.2 (20.2) b	1.32 (0.95) a
Non-binary	32.0 (20.8) ab	1.14 (0.95) a
Age		
<21	33.9 (20.1) a	1.36 (0.95) a
21+	33.8 (19.4) a	1.37 (0.94) a
Year in School		
Freshman	32.0 (19.8) a	1.33 (0.94) a
Sophomore	34.2 (19.3) a	1.39 (0.95) a
Junior	34.0 (20.4) a	1.35 (0.95) a
Senior+	34.7 (20.0) a	1.38 (0.94) a
Race		
Asian	28.9 (17.3) a	1.02 (0.85) a
Black	35.2 (20.1) ab	1.24 (1.09) ab
White	35.0 (19.8) b	1.47 (0.97) b
Hispanic/Latinx	33.8 (21.7) ab	1.22 (0.84) a
Other	38.4 (27.4) ab	1.20 (0.94) ab
More than one	31.8 (19.8) ab	1.30 (0.85) ab
Greek		
No	33.6 (20.1) a	1.31 (0.94) a
Yes	34.5 (19.3) a	1.53 (0.93) b
Athlete		
No	33.9 (20.1) a	1.35 (0.95) ab
Intramural	33.6 (18.4) a	1.47 (0.93) a
Varsity	32.5 (25.4) a	0.84 (0.69) b
Access to Marijuana		
Difficult	30.2 (19.9) a	0.98 (0.84) a
Fairly easy	32.2 (18.7) a	1.21 (0.87) b
Very easy	36.3 (20.8) b	1.60 (0.98) c
SAM Use Past 30 Days		
Yes	36.4 (19.7) a	1.7 (0.94) a

Variable	Perceived Peer Norms ( <i>n</i> = 1387)	Perceived Friend Norms ( <i>n</i> = 1388)
No	31.4 (19.8) b	1.0 (0.79) b
SAM Use among Users <sup>+</sup>		
Infrequent	34.3 (18.8) a	1.46 (0.82) a
Frequent	39.3 (20.6) b	2.15 (0.95) b

Notes:

<sup>#</sup> Perceived peer norms measured as percentage; perceived friend norms measured as 0 = none, 1 = some, 2 = about half, 3 = most, 4 = all.

<sup>+</sup> The *N*s for this variable were 279 (for peers) and 280 (for friends) for infrequent users and 411 for frequent users. Within each variable, means followed by different letters differ significantly ( $p < .05$ ) from each other.

**Table 3a:**

The Association between Perceived Same-Gender Peer SAM Norms and SAM Frequency in the Past 30 Days  
(*N* = 1357)

Parameter	Estimate	Standard Error	IRR; 95% Confidence Limits			Wald Chi-Square
			Low	IRR	High	
Intercept	-1.87	0.19	-2.25		-1.49	92.44***
Peer Norms	0.01	0.00	0.002		0.01	9.00**
Male	0.03	0.07	-0.11		0.17	0.21
White	0.09	0.09	-0.09		0.27	0.95
Asian	-0.05	0.13	-0.31		0.22	0.12
School A	0.17	0.09	-0.02		0.35	3.23
School C	0.10	0.09	-0.08		0.29	1.13
Fairly Easy Access	0.43	0.15	0.13		0.73	7.80**
Very Easy Access	0.37	0.15	0.07		0.67	5.82*
Alcohol Frequency	0.09	0.01	0.08		0.10	191.31***
Marijuana Frequency	0.07	0.00	0.07		0.08	409.70***
Dispersion	0.66	0.06	0.55		0.80	-

**Table 3b:**

The Association between Perceived Same-Gender Peer SAM Norms and SAM Consequences in the Past 3 Months ( $N=1358$ )

Parameter	Estimate	Standard Error	IRR; 95% Confidence Limits			Wald Chi-Square
			Low	IRR	High	
Intercept	-1.14	0.28	-1.68		-0.60	17.06***
Peer Norms	0.01	0.00	0.003		0.02	9.45**
Male	0.02	0.11	-0.20		0.24	0.03
White	0.01	0.14	-0.26		0.28	0.00
Asian	-0.35	0.20	-0.73		0.04	3.10
School A	0.07	0.15	-0.22		0.36	0.21
School C	0.37	0.15	0.09		0.66	6.49*
Fairly Easy Access	0.64	0.21	0.22		1.05	9.13**
Very Easy Access	0.81	0.21	0.39		1.22	14.49***
SAM Frequency	0.07	0.01	0.05		0.08	67.75***
Dispersion	3.15	0.21	2.76		3.60	-

Notes: IRR = Incidence rate ratio. Alcohol and marijuana frequency are measured in the past 30 days (3a). SAM frequency is measured in the past 3 months (3b). Other is the reference group for White and Asian. Female is the reference group for male; those who selected a non-binary gender identity ( $n=29$ ) were eliminated from these analyses. School B (decriminalized) is the reference group for School A (illegal) and School C (legal for 21+). Difficult access to marijuana is the reference group for Fairly Easy and Very Easy access.

\*  $p < .05$ ;

\*\*  $p < .01$ ;

\*\*\*  $p < .001$ .

**Table 4a:**The Association between Perceived Friend SAM Norms and SAM Frequency in the Past 30 Days ( $N= 1358$ )

Parameter	Estimate	Standard Error	IRR; 95% Confidence Limits			Wald Chi-Square
			Low	IRR	High	
Intercept	-1.98	0.18	-2.33		-1.63	123.03***
Friend Norms	0.37	0.04	0.29		0.44	95.81***
Male	0.03	0.07	-0.11		0.16	0.15
White	0.04	0.09	-0.13		0.22	0.24
Asian	-0.04	0.13	-0.29		0.22	0.09
School A	0.18	0.09	0.01		0.36	4.18*
School C	0.08	0.09	-0.09		0.25	0.82
Fairly Easy Access	0.33	0.15	-0.04		0.62	4.96*
Very Easy Access	0.21	0.15	-0.08		0.51	2.08
Alcohol Frequency	0.09	0.01	0.07		0.10	192.50***
Marijuana Frequency	0.07	0.00	0.06		0.07	337.48***
Dispersion	0.57	0.06	0.47		0.69	-

**Table 4b:**

The Association between Perceived Friend SAM Norms and SAM Consequences in the Past 3 Months ( $N=1359$ )

Parameter	Estimate	Standard Error	IRR; 95% Confidence Limits			Wald Chi-Square
			Low	IRR	High	
Intercept	-1.31	0.26	-1.81		-0.81	26.10 ***
Friend Norms	0.45	0.07	0.32		0.58	45.89 ***
Male	0.04	0.11	-0.18		0.25	0.10
White	-0.05	0.13	-0.31		0.22	0.12
Asian	-0.30	0.19	-0.68		0.07	2.47
School A	-0.06	0.14	-0.22		0.34	0.15
School C	0.34	0.14	0.07		0.60	6.14 *
Fairly Easy Access	0.57	0.21	0.17		0.98	7.61 **
Very Easy Access	0.68	0.21	0.27		1.09	10.54 **
SAM Frequency	0.05	0.01	0.04		0.07	54.77 ***
Dispersion	2.97	0.20	2.60		3.40	-

Notes: IRR =Incidence rate ratio. Alcohol and marijuana frequency are measured in the past 30 days (4a). SAM frequency is measured in the past 3 months (4b). Other is the reference group for White and Asian. Female is the reference group for male; those who selected a non-binary gender identity ( $n = 29$ ) were eliminated from these analyses. School B (decriminalized) is the reference group for School A (illegal) and School C (legal for 21+). Difficult access to marijuana is the reference group for Fairly Easy and Very Easy access.

\*  $p < .05$ ;

\*\*  $p < .01$ ;

\*\*\*  $p < .001$ .



**Table 5a:**

The Association between Perceived Same-Gender Peer and Friend SAM Norms and SAM Frequency in the Past 30 Days ( $N= 1357$ )

Parameter	Estimate	Standard Error	IRR; 95% Confidence Limits			Wald Chi-Square
			Low	IRR	High	
Intercept	-1.99	0.19	-2.36	-1.62	109.23***	
Peer Norms	0.00	0.00	-0.003	0.004	0.05	
Friend Norms	0.37	0.04	0.29	0.44	86.42***	
Male	0.03	0.07	-0.11	0.17	0.16	
White	0.04	0.09	-0.13	0.22	0.24	
Asian	-0.04	0.13	-0.30	0.22	0.09	
School A	0.19	0.09	0.01	0.37	4.16*	
School C	0.09	0.09	-0.10	0.27	0.86	
Fairly Easy Access	0.33	0.15	0.04	0.62	4.92*	
Very Easy Access	0.21	0.15	-0.08	0.50	2.02	
Alcohol Frequency	0.09	0.01	0.07	0.10	191.57***	
Marijuana Frequency	0.07	0.00	0.06	0.07	335.7***	
Dispersion	0.57	0.06	0.47	0.70	-	

**Table 5b:**

The Association between Perceived Same-Gender Peer and Friend SAM Norms and SAM Consequences in the Past 3 Months ( $N=1358$ )

Parameter	Estimate	Standard Error	IRR; 95% Confidence Limits			Wald Chi-Square
			Low	IRR	High	
Intercept	-1.44	0.28	-1.98		-0.90	27.19***
Peer Norms	0.004	0.00	-0.002		0.01	1.62
Friend Norms	0.43	0.07	0.29		0.57	38.65***
Male	0.04	0.11	-0.18		0.25	0.10
White	-0.04	0.13	-0.31		0.22	0.11
Asian	-0.30	0.19	-0.68		0.08	2.43
School A	0.09	0.15	-0.19		0.38	0.41
School C	0.40	0.14	0.12		0.68	7.68**
Fairly Easy Access	0.56	0.21	0.16		0.97	7.32**
Very Easy Access	0.66	0.21	0.25		1.07	9.82**
SAM Frequency	0.06	0.01	0.04		0.07	55.53***
Dispersion	2.96	0.20	2.59		3.38	-

Notes: IRR = Incidence rate ratio. Alcohol and marijuana frequency are measured in the past 30 days (5a). SAM frequency is measured in the past 3 months (5b). Other is the reference group for White and Asian. Female is the reference group for male; those who selected a non-binary gender identity ( $n=29$ ) were eliminated from these analyses. School B (decriminalized) is the reference group for School A (illegal) and School C (legal for 21+). Difficult access to marijuana is the reference group for Fairly Easy and Very Easy access.

\*  $p < .05$ ;

\*\*  $p < .01$ ;

\*\*\*  $p < .001$ .