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RESEARCH ARTICLE

Longitudinal examination of high-risk drinking contexts: Daytime drinking, pregaming, and drinking games linked to high-risk alcohol use and negative consequences in young adults

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Abstract

Background: The contexts in which young adults drink alcohol play a salient role in alcohol-related outcomes and negative consequences at an event-level, but less is known about longitudinal risks. We collected longitudinal monthly data across 2 years on (a) daytime drinking, (b) pregaming/pre-partying, and (c) playing drinking games. We then examined associations between drinking in these contexts and within-person variability in alcohol consumption, consequences, and simultaneous alcohol and marijuana (SAM) use in a given month. We also examined the extent to which drinking in these contexts predicted hazardous drinking (using Alcohol Use Disorders Identification Test (AUDIT) scores) at a distal follow-up timepoint, controlling for baseline AUDIT scores.

Method: A community sample of 759 young adults (M_{age} = 21.1 years; 56.4% female) completed monthly surveys for 24 consecutive months and a distal 30-month follow-up. Multilevel models estimated within- and between-person associations between drinking context frequencies (daytime drinking, pregaming, drinking games) and alcohol-related outcomes (weekly consumption, consequences, SAM use). A single-level negative binomial regression tested associations between drinking context frequency averages across a two-year period and changes in AUDIT scores from baseline to a follow-up 2.5 years later.

Results: Over 75% of the sample of non-abstaining young adults reported drinking in each of the three contexts at least once during the 24-month period. Within-persons, young adults reported greater consumption, more negative consequences, and increased likelihood of SAM use during months that they drank in these contexts more often than usual. Each context was associated with negative consequences, even when controlling for alcohol use frequency. More frequent daytime drinking and pregaming, but not drinking games, were associated with increases in AUDIT scores at the 30-month follow-up, suggesting that there are potential long-term risks of drinking in these contexts.

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Conclusions: Findings suggest that daytime drinking, pregaming, and playing drinking games are high-risk contexts in terms of month-to-month and long-term risks. Additional research is needed on the various contexts in which young adults drink alcohol and the extent to which contextual factors interact with one another to amplify/reduce risks and harms.

KEYWORDS
alcohol, AUDIT, cannabis, pre-partying, simultaneous alcohol and marijuana

INTRODUCTION

Young adults are a high-risk demographic for alcohol use and related harms (Merrill & Carey, 2016; Schulenberg et al., 2021), but some situational contexts may amplify the associated risks. Identifying high-risk drinking contexts is critical to prevention as understanding situations that increase risk can inform intervention messaging, harm-reduction strategies, and policies for young adults. With the growing number of event-level alcohol use studies in the past decade, there has been increased understanding that some drinking contexts may be riskier than others in terms of acute harms (see review Stevely et al., 2020). Indeed, studies have revealed that some aspects of drinking contexts, such as *who* is present (e.g., close friends, solitary use), *what* the occasion is (e.g., 21st birthday, Spring Break), or *where* the drinking takes place (e.g., bar/house party), momentarily expose young adults to relatively greater risk of negative consequences (Fleming, Mason, et al., 2021; Gilson et al., 2021; Lee et al., 2017; Lewis et al., 2012; Neighbors et al., 2011; Patrick et al., 2016; Terry-McElrath et al., 2022; Waddell et al., 2021). Additionally, studies are beginning to reveal that the contexts regarding *when* and *how* young adults use alcohol may be predictive of negative consequences and harms (Arterberry et al., 2023).

Three prevalent high-risk drinking contexts for young adults are currently in focus: daytime drinking, pregaming (also referred to as pre-partying), and playing drinking games. Each of these contexts are associated with greater risks/harms at the event-level (Calhoun & Linden-Carmichael, 2022; Calhoun & Maggs, 2021; Ray et al., 2014). Although identifying these risk factors has been valuable to the development and refinement of prevention efforts (e.g., protective behavioral strategies; Fairlie et al., 2020), less is known about potential longer-term consequences associated with these high-risk drinking contexts. As such, there is a need to build upon studies examining event-level risks by expanding the scope to longer intervals and more distal outcomes.

Drinking contexts may entail increased risk in terms of alcohol-specific outcomes, such as increased consumption or greater likelihood of negative consequences, but may also increase young adults' proclivity to engage in other health-risk behaviors. One such risk behavior that may be associated with these drinking contexts is the simultaneous use of alcohol and marijuana (SAM). Emerging literature indicates that SAM use is more likely when young adults are in social contexts (Jackson et al., 2021), and specifically at house parties or locations with more people (Gunn et al., 2021). Moreover, regarding the temporal context, SAM use earlier in the day (i.e., coinciding with daytime drinking) is associated with heavier cannabis use and more negative consequences (Arterberry et al., 2023). Thus, it is likely that young adults who more frequently engage in high-risk social drinking may have an increased risk for SAM use. It is particularly important to identify risk factors for SAM use given the mounting evidence of the numerous health risks (Fleming, Duckworth, et al., 2021; Lee et al., 2022), including poorer sleep health (Graupensperger et al., 2021) and driving while impaired or riding with an impaired driver (Patrick et al., 2021).

Daytime drinking

Drinking alcohol during the day (i.e., "day-drinking") has only recently come into focus within the alcohol use literature as its own unique construct (Calhoun & Maggs, 2021). Although somewhat arbitrary, we presently operationalize daytime drinking as drinking that takes place before 4 PM. Anecdotally, in the US, beginning to drink alcohol early in the day has historically been stigmatized, perhaps due to being a known symptom of alcohol use disorder (Babor et al., 2001), but the current generation of young adults have glorified daytime drinking activities such as brunch, where offers like 'bottomless mimosas and bloody marys' are common (Ramanathan, 2018). In a recent study of college students who drink alcohol, approximately half reported engaging in daytime drinking at least once during the 98-day study period (Calhoun & Maggs, 2021). Moreover, this study found that heavy episodic drinking (i.e., HED; 4/5+ drinks for women/men) and high-intensity drinking (i.e., HID; 8/10+ drinks for women/men) were more likely on days with daytime drinking than other drinking days. Given the prevalence of daytime drinking, and emerging evidence regarding this drinking context, a deeper investigation into the harms and risks of daytime drinking is warranted.

Pregaming

Young adults often engage in pregaming (also called pre-partying or pre-loading), which is the act of consuming alcohol prior to going out to a bar, party, or other event where alcohol may not be readily available (Foster & Ferguson, 2014). It is estimated that approximately two-thirds of college student drinkers have engaged in past-month

pregaming (Zamboanga & Olthuis, 2016), though less is known about non-college young adults. The prevalence and frequency with which young adults engage in pregaming is concerning given evidence that doing so is associated with heavier use, greater intoxication, and experiencing more negative outcomes (Calhoun & Linden-Carmichael, 2022; Merrill et al., 2013). For example, pregaming is associated with blackouts (Labrie et al., 2011), and is also a known prospective risk factor for incapacitated rape (Jaffe et al., 2022). As we continue to learn more about the proximal risks/harms of pregaming, it is becoming clear that there is an unmet need to examine longer-term risks.

Drinking games

Social drinking activities that entail a competition facilitating heavy alcohol consumption (i.e., drinking games; Zamboanga et al., 2013) are common among young adults (Zamboanga et al., 2014). Indeed, estimates of drinking game participation among college student drinkers have been as high as 91% in the past 90 days (Read et al., 2010). As with other high-risk drinking contexts, playing drinking games has been linked, at the event- or day-level, to high-intensity drinking (Fairlie et al., 2015) and negative consequences (Ray et al., 2014), but little is known about long-term risks for young adults who more frequently participate in drinking games.

Current study

The overarching goal of the study was to provide a deeper examination of the risks—both proximal and distal—of daytime drinking, pregaming, and playing drinking games. For the first aim examining proximal risks of these drinking contexts, we estimated associations with alcohol quantity, negative consequences, and engaging in SAM use using a repeated-measures longitudinal design (i.e., monthly assessments for 24 consecutive months). Examining monthly level associations is critical to understanding the extent that fluctuations in these drinking contexts relate to increased risk on a time scale that is longer than daily-level studies, but more fine-grained than annual assessments. We hypothesized that in months in which young adults engage in more frequent daytime drinking, pregaming, and drinking games (relative to their own usual engagement), they will consume greater quantities of alcohol, experience more negative consequences due to alcohol, and have increased odds of SAM use, in that specific month.

The second aim entailed examining long-term risks of daytime drinking, pregaming, and playing drinking games by examining the extent to which these contexts predicted changes in hazardous drinking behavior (measured using Alcohol Use Disorders Identification Test (AUDIT) scores) from baseline to a follow-up 2.5 years later. We hypothesized that more frequent endorsement of these drinking contexts across the 24-month surveys would be associated with increases in AUDIT scores at the distal 30-month follow-up (i.e., 6 months following the final monthly survey).

METHOD

Participants and procedures

Participants were young adults in the greater Seattle, WA metropolitan area originally enrolled into a longitudinal study on alcohol use and social role transitions (Lee et al., 2018; Patrick et al., 2020). Between January 2015 and January 2016, 779 individuals were recruited through social media, newspaper, and community advertisements. Eligibility criteria included being 18 to 23 years old at screening, reporting past-year alcohol use, and living within 60 miles of the study office in Seattle. After screening in, participants came to the study offices for identification verification, consent, and to complete a baseline survey. Starting the following month, 778 participants completed 24 consecutive months of online surveys and a follow-up survey 6 months after the end of the repeated monthly surveys. Invitations to complete monthly surveys were sent out on the first day of the month, and participants had between 7 to 10 days to complete the survey.

The analytic sample was limited to months in which participants reported alcohol use (N_{months} = 12,190) and thereby to participants who reported alcohol use in at least one sampled month ($N_{persons}$ = 759). The mean age of the analytic sample at baseline was 21.11 years (SD_{Age} = 1.70), and 56.4% reported their biological sex as female. In terms of race/ethnicity, the composition of the analytic sample was 55.1% White Non-Hispanic (NH), 18.4% Other NH (e.g., Black/African American, multiple races), 17.5% Asian NH, and 9.0% Hispanic. During the main 24-month study period, 58.8% of participants in the analytic sample reported being four-year college students in at least 1 month, 83.4% reported working part-time in at least 1 month, and 69.3% reported working full-time in at least 1 month. Participants in the analytic sample completed an average of 21.20 (SD = 4.99) out of 24 monthly surveys, with 83.0% completing at least 18 monthly surveys and 58.1% completing all 24 monthly surveys. Retention at the distal follow-up survey was high with 91.4% of the analytic sample participating in the Month 30 assessment.

Repeated monthly measures

Alcohol use quantity

Each month data were collected, participants completed the Daily Drinking Questionnaire (DDQ; Collins et al., 1985), as an assessment of typical weekly drinking in the past month (i.e., total number of drinks in a typical week). This typical number of drinks per week variable was winsorized (i.e., top-coded) at 70 drinks per week.

Alcohol use frequency

From the DDQ, alcohol use frequency was measured by the number of days in a typical week that young adults endorsed drinking alcohol. This variable was included in models as a control variable.

Cannabis use frequency

Each month, participants were asked, "In the past 30 days, how many days did you use marijuana?" Participants responded by entering integers representing the number of days they used cannabis in the past month into a text box.

Any past-month SAM use

In months that participants reported cannabis use, they were asked, "How many of the times when you used marijuana or hashish during the last month did you use it at the same time as alcohol—that is, so that their effects overlapped?" Response options were "Not at all" (0), "A few of the times" (1), "Some of the times" (2), "Most of the times" (3), and "Every time" (4). A binary any past-month SAM use variable was created by recoding responses into two categories with 0 representing no past-month SAM use and 1 representing past-month SAM use.

Negative alcohol consequences

In months participants reported drinking, they completed the Brief Young Adult Alcohol Consequences Questionnaire (Kahler et al., 2008), a 24-item measure assessing past-month consequences of alcohol use (e.g., "I have had a hangover (headache, sick stomach) the morning after I had been drinking"). Response options were "No" (0) and "Yes" (1). Responses were summed to create counts of the number of negative alcohol consequences participants reported in the past month.

Risky drinking contexts

Each month participants reported alcohol use, they were given the prompt, "When you used alcohol in the past month, how often did you use it in each of the following situations?": "During the daytime (before 4:00 pm)", "Before you went out (e.g., pregaming, predrinking, prepartying, prefunking)", and "While playing a game (e.g., quarters, beer pong)." Items were not mutually exclusive, and response options were "Not at all" (0), "A few of the times" (1), "Some of the times" (2), "Most of the times" (3), and "Every time" (4).

Four-year student status

Each month, participants reported their educational situation on a non-exclusive list of education programs (e.g., "not a student", "4-year college or university student"). A binary indicator variable was created to represent months participants were four-year college students.

Full-time work status

Each month, participants reported their work situation on a non-exclusive list of employment statuses (e.g., "working full-time"). A binary indicator variable was created to represent months participants were working full time.

Time in years

Study month (1 to 24) was divided by 12 to create a covariate representing time since enrollment in units of years.

Baseline and follow-up survey measures

Hazardous drinking behaviors

At baseline and at the Month 30 follow-up, participants completed the Alcohol Use Disorder Identification Test (AUDIT; Babor et al., 2001), a 10-item measure of hazardous drinking behaviors in reference to the past 6 months. Items one through eight have five ordinal response options (0 to 4), and items 9 and 10 have response options of 0, 2, or 4, from which a total score is derived, ranging from 0 to 40. The AUDIT is the most extensively validated hazardous drinking (Reinert & Allen, 2007).

Male sex

At baseline, participants were asked, "What was your biological sex at birth?". Response options were "female" (0) and "male" (1).

Age

Participants' exact age at baseline was calculated based on years elapsed between their birthdate and the date the baseline survey was completed.

Race/ethnicity

Participants were asked, "What is your race?", with response options "Asian or South Asian," "Native Hawaiian or other Pacific Islander," "Black or African American," "American Indian or Alaskan Native," "Caucasian or White," "Arab, Middle Eastern, or North African," "More than one race," and "Other." Regarding ethnicity, participants were asked, "Are you Hispanic or Latino/a?". Response options were

"No" and "Yes." Based on responses to these two items, participants were categorized into one of four mutually exclusive race/ethnicity categories: Hispanic, Asian Non-Hispanic (NH), White NH, and Other NH.

Analyses

For aim 1, we used logistic and Poisson multilevel models that were estimated using maximum likelihood estimation based on the Laplace Approximation in the *glmmTMB* package (Brooks et al., 2017) in R (version 4.2.2). All the models included a random intercept, and Level 1 (month level) variables were specified as random when doing so improved model fit based on likelihood ratio tests. Overdispersion in Poisson models was accounted for using a month-level random effect (Gelman & Hill, 2006). Level 1 drinking variables were person-mean centered (Hamaker & Muthén, 2020). Time in years was centered at its midpoint, and the four-year student status and full-time work status variables were left uncentered.[1] Because of this, and because the means of the student and work status variables were not included at Level 2, the coefficients for these variables in model results represent a composite of the within- and between-person associations (Bolger & Laurenceau, 2013; Hamaker & Muthén, 2020; Hox et al., 2017). All Level 2 variables were grand-mean centered. All Aim 1 models controlled for sex, age at baseline, and race/ethnicity at Level 2 and 4-year student status, full-time work status, and time in years at Level 1. Models predicting negative alcohol consequences and SAM use adjusted for alcohol use frequency at both levels, while the SAM use model also adjusted for cannabis use frequency. Models predicting alcohol use quantity did not include alcohol use frequency because the two indicators of alcohol use were derived from the same items and highly correlated ($r = 0.69$ at both levels).

Aim 2 was tested using negative binomial regression. The Month 30 follow-up assessment of the AUDIT was regressed on person-means of the three drinking context variables aggregated over the 24 monthly surveys, baseline AUDIT scores, sex, age at baseline, and race/ethnicity. Multiple imputation was performed using the *MICE* package (van Buuren & Groothuis-Oudshoorn, 2011) according to recommendations by van Buuren (2018) to account for missing data in AUDIT scores at Month 30. Multiple imputation is expected to produce unbiased estimates under the assumption that data are missing at random. Five-hundred imputed datasets were created, and all variables included in the regression were entered as covariates in the imputation model. Summary parameters and standard errors were estimated according to Rubin's Rules, which account for uncertainty within and between imputed datasets (Rubin, 2014). All variables in this model were grand-mean centered.

Relevant to all models, the three drinking contexts have potential overlap that could cause some concerns to interpretation. To assess multicollinearity, we estimated variance inflation factors (VIFs) for each model (Zuur et al., 2009). Across models, all VIF estimates were <2.0, which is below the conservative cutoff of 2.5 and well below the common cutoff of 5.0. We explored sensitivity models with each context as a covariate separate from the other two contexts, and findings showed that including all three contexts in a single model did not create issues with unreliable or unstable parameter estimates.

RESULTS

Descriptive statistics

Descriptive statistics are presented in Table 1. Among participants in the analytic sample (i.e., those who reported using alcohol in at least one sampled month), daytime drinking was reported at least once by 79.8% of participants, pregaming was reported at least once by 77.7% of participants, and playing drinking games was reported at least once by 76.4% of participants. On average, participants reported daytime drinking in 30.1% of months they reported drinking, pregaming in 40.3% of months they reported drinking, and playing drinking games in 31.6% of months they reported drinking. Participants reported experiencing at least one negative consequence in 60.2% of months that any drinking was reported.

As shown in the intraclass correlation coefficients (Table 1), the majority of the variance in each of the drinking contexts was at the within-person level, relative to between-person, which indicates substantial month-to-month fluctuations in young adults' engagement in these drinking contexts. Regarding correlations between the three contexts, at the within-person monthly level, daytime drinking frequency was positively correlated with pregaming frequency ($r = 0.17$, $p < 0.05$) and the frequency of playing drinking games ($r = 0.15$, $p < 0.05$). Pregaming frequency was positively correlated with the frequency of playing drinking games ($r = 0.40$, $p < 0.05$).

Aim 1: Associations between drinking context frequencies and drinking-related outcomes

Alcohol use quantity

Table 2 shows the results of a Poisson multilevel model testing within- and between-person associations between drinking context frequencies and alcohol use quantity, as operationalized by typical number of drinks per week in the past month. At the within-person monthly level, the frequencies of daytime drinking, pregaming, and playing drinking games were all positively associated with typical number of drinks per week in the past month. For each one-unit increase on the 5-point scale in frequency of daytime drinking, pregaming, and playing drinking games, participants consumed an average of 21%, 19%, and 11% more drinks in the typical week in the past month, respectively. These associations are depicted visually in Figure S1a to c in the supplemental materials. At the person level, participants' average daytime drinking frequency and average pregaming frequency across

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TABLE 1 Descriptive statistics.

Variable	*n*	*M* (SD) or %	Min.	Max.	ICC
Month level (*N* = 12,190)					
Daytime drinking frequency	12,017	0.45 (0.74)	0	4	0.29
Pregaming frequency	11,990	0.85 (1.14)	0	4	0.48
Playing drinking games frequency	11,962	0.57 (0.94)	0	4	0.37
Typical no. of drinks per week	11,725	6.13 (7.87)	0	70	0.69
Typical no. of drinking days per week	11,725	2.05 (1.70)	0	7	0.48
No. of past-month cannabis use days	11,362	4.31 (8.67)	0	30	0.78
Any SAM use	12,015	24.7%	0	1	0.70
No. of negative alcohol consequences	12,048	2.63 (2.77)	0	24	0.62
Four-year student status	12,187	38.6%	0	1	0.88
Full-time work status	12,187	34.5%	0	1	0.65
Person level (*N* = 759)					
Male sex	759	43.6%	0	1	
Age at baseline	759	21.11 (1.70)	18.02	24.05	
Race/ethnicity					
Asian NH	759	17.5%	0	1	
Hispanic	759	9.0%	0	1	
Other NH	759	18.4%	0	1	
White NH	759	55.1%	0	1	
AUDIT score at baseline	759	6.63 (5.08)	0	28	
AUDIT score at Month 30 follow-up	662	5.18 (5.16)	0	33	

Note: Hazardous/harmful drinking: AUDIT score ≥8. Response options for daytime drinking frequency, pregaming frequency, and playing drinking games frequency: "Not at all" (0), "A few of the times" (1), "Some of the times" (2), "Most of the times" (3), and "Every time" (4).

Abbreviations: AUDIT, Alcohol Use Disorder Identification Test; ICC, Intraclass Correlation Coefficient; NH, non-Hispanic; SAM, simultaneous alcohol and marijuana use.

months drinking was reported were positively associated with the average number of drinks they consumed in a typical week in months drinking was reported.

Negative alcohol consequences

Table 3 shows the associations between drinking context frequencies and number of past-month negative alcohol consequences when controlling for the typical number of drinking days per week, which was positively associated with negative consequences. At the within-person monthly level, frequencies of daytime drinking, pregaming, and playing drinking games were positively associated with the number of past-month negative alcohol consequences participants reported. For each one-unit increase in the frequency of daytime drinking, pregaming, and playing drinking games, participants experienced an average of 13%, 26%, and 13% more negative alcohol consequences in the past month, respectively. These associations are depicted visually in Figure S2a to c in the supplemental materials. At the person level, participants' average daytime drinking frequency and average pregaming frequency across months drinking was reported were positively associated with the average number of negative alcohol consequences.

SAM use

Table 4 shows the results of a logistic multilevel model testing within- and between-person associations between drinking context frequencies and SAM use, when controlling for typical number of drinking days per week in the past month and number of past-month cannabis use days, which were both positively associated with SAM use. At the within-person monthly level, the frequencies of daytime drinking, pregaming, and playing drinking games were all positively associated with odds of past-month SAM use. For each one-unit increase in the frequency of daytime drinking, pregaming, and playing drinking games, participants had an average of 1.26, 1.19, and 1.32 times greater odds of past-month SAM use, respectively. These associations are depicted visually in Figure S3a to c in the supplemental materials. At the person level, participants' average pregaming frequency across months was positively associated with the proportion of alcohol use months in which participants reported SAM use.

TABLE 2 Poisson multilevel model testing associations between drinking context frequencies and alcohol use quantity.

	Outcome: Typical number of drinks per week	
Fixed effects	**Rate ratio**	**95% CI**
Level 2: Person level		
Intercept	3.17***	2.96, 3.38
Mean daytime drinking frequency	1.54***	1.34, 1.78
Mean pregaming frequency	1.45***	1.32, 1.58
Mean playing drinking games frequency	1.04	0.93, 1.17
Male sex	1.30***	1.15, 1.47
Age at baseline	0.99	0.96, 1.03
Race/ethnicity (Ref.: White NH)		
Asian NH	0.72***	0.61, 0.84
Hispanic	1.00	0.81, 1.22
Other NH	0.85*	0.73, 0.99
Level 1: Month level		
Daytime drinking frequency	1.21***	1.18, 1.25
Pregaming frequency	1.19***	1.17, 1.22
Playing drinking games frequency	1.11***	1.08, 1.13
Four-year student status	1.03	0.98, 1.09
Full-time work status	0.98	0.94, 1.02
Time in years	1.00	0.96, 1.05
Random effects		**SD**
Intercept		0.77
Daytime drinking frequency		0.22
Pregaming frequency		0.11
Playing drinking games frequency		0.12
Time in years		0.43
Overdispersion		0.36

Note: $N = 11{,}470$ person-months within 752 individuals. All Level 2 variables were grand-mean centered. At Level 1, drinking context frequencies were person-mean centered; four-year student status and full-time work status were uncentered. Time in years was centered at its midpoint.

Abbreviations: NH, non-Hispanic; Ref., reference group.

***$p < 0.001$.; **$p < 0.01$.; *$p < 0.05$.

TABLE 3 Poisson multilevel models testing associations between drinking context frequencies and number of negative alcohol consequences.

	Outcome: Number of negative alcohol consequences	
Fixed effects	**Rate ratio**	**95% CI**
Level 2: Person level		
Intercept	1.05	0.96, 1.15
Mean daytime drinking frequency	1.23*	1.02, 1.49
Mean pregaming frequency	1.25***	1.12, 1.40
Mean playing drinking games frequency	1.13	0.98, 1.31
Mean typical no. of drinking days per week	1.35***	1.27, 1.45
Male sex	0.75***	0.65, 0.86
Age at baseline	0.97	0.93, 1.02
Race/ethnicity (Ref.: White NH)		
Asian NH	0.85	0.70, 1.03
Hispanic	0.90	0.71, 1.16
Other NH	0.98	0.81, 1.18
Level 1: Month level		
Daytime drinking frequency	1.13***	1.09, 1.17
Pregaming frequency	1.26***	1.22, 1.29
Playing drinking games frequency	1.13***	1.09, 1.17
Typical no. of drinking days per week	1.17***	1.15, 1.19
Four-year student status	1.11**	1.03, 1.19
Full-time work status	0.98	0.93, 1.04
Time in years	0.83***	0.78, 0.88
Random effects		**SD**
Intercept		0.96
Daytime drinking frequency		0.11
Pregaming frequency		0.15
Playing drinking games frequency		0.15
Time in years		0.46
Overdispersion parameter		0.47

Note: $N = 11{,}413$ person-months within 751 individuals. All Level 2 variables were grand-mean centered. At Level 1, drinking context frequencies and typical number of drinks per week were person-mean centered; 4-year student status and full-time work status were uncentered. Time in years was centered at its midpoint.

Abbreviations: NH, non-Hispanic; Ref., reference group.

***$p < 0.001$.; **$p < 0.01$.; *$p < 0.05$.

Aim 2: Frequency of drinking contexts predicts AUDIT scores at a distal timepoint

Table 5 presents the results of a negative binomial regression testing whether person-level average frequencies of daytime drinking, pregaming, and playing drinking games across the 24 repeated monthly surveys predicted change in AUDIT scores from baseline to the Month 30 follow-up survey (i.e., 6 months after the end of the repeated monthly surveys). Average daytime drinking frequency and average pregaming frequency were positively associated with increases in AUDIT scores at Month 30. Each one-unit increase in average daytime drinking frequency during the 24 repeated monthly surveys was associated with a 32% increase in AUDIT scores from baseline to the Month 30 follow-up. Each one-unit increase in average pregaming frequency during the 24 repeated monthly surveys was associated with an 18% increase in AUDIT scores from baseline to the Month 30 follow-up.

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TABLE 4 Logistic multilevel model testing associations between drinking context frequencies and SAM use.

Fixed effects	Outcome: SAM use (0 = No, 1 = yes) Odds ratio	95% CI
Level 2: Person level		
Intercept	0.06***	0.04, 0.08
Mean daytime drinking frequency	1.23	0.62, 2.43
Mean pregaming frequency	1.72**	1.15, 2.57
Mean playing drinking games frequency	0.77	0.45, 1.32
Mean typical no. of drinking days per week	2.03***	1.59, 2.58
Mean no. of past-month cannabis use days	1.42***	1.36, 1.48
Male sex	0.60	0.36, 1.00
Age at baseline	0.85*	0.73, 0.99
Race/ethnicity (Ref.: White NH)		
Asian NH	0.71	0.36, 1.43
Hispanic	0.87	0.36, 2.06
Other NH	0.82	0.43, 1.58
Level 1: Month level		
Daytime drinking frequency	1.26**	1.10, 1.45
Pregaming frequency	1.19**	1.07, 1.33
Playing drinking games frequency	1.32***	1.17, 1.48
Typical no. of drinking days per week	1.36***	1.23, 1.51
No. of past-month cannabis use days	2.45***	2.09, 2.87
Four-year student status	1.28	0.91, 1.80
Full-time work status	1.02	0.78, 1.32
Time in years	0.88	0.70, 1.09
Random effects		**SD**
Intercept		2.70
Typical no. of drinking days per week		0.40
No. of past-month cannabis use days		0.94
Time in years		0.77

Note: $N = 10{,}693$ person-months within 744 individuals. All Level 2 variables were grand-mean centered. At Level 1, drinking context frequencies, typical number of drinks per week, and typical number of cannabis use days per week were person-mean centered; four-year student status and full-time work status were uncentered. Time in years was centered at its midpoint.

Abbreviations: NH, non-Hispanic; Ref., reference group; SAM, simultaneous alcohol and marijuana use.

***$p < 0.001$.; **$p < 0.01$.; *$p < 0.05$.

TABLE 5 Negative binomial multilevel model testing associations between drinking in particular contexts across 24 months and AUDIT scores assessed 6 months later, controlling for baseline AUDIT scores.

Predictor variables	Outcome: AUDIT score at month 30 Rate ratio	95% CI
Intercept	4.52***	4.25, 4.80
Drinking contexts		
Mean daytime drinking	1.32***	1.15, 1.51
Mean pregaming	1.18**	1.07, 1.30
Mean drinking games	1.08	0.95, 1.22
Baseline AUDIT score	1.07***	1.06, 1.09
Male sex	0.96	0.84, 1.09
Age at baseline	0.93***	0.90, 0.97
Race/ethnicity (Ref.: White NH)		
Asian NH	0.82*	0.70, 0.97
Hispanic	0.85	0.68, 1.07
Other NH	1.02	0.87, 1.20

Note: $N = 759$ individuals. All predictor variables were grand-mean centered.

Abbreviations: AUDIT, Alcohol Use Disorder Identification Test; NH, non-Hispanic; Ref., reference group.

***$p < 0.001$.; **$p < 0.01$.; *$p < 0.05$.

DISCUSSION

Descriptive findings from this longitudinal study support growing recognition of the high prevalence of daytime drinking, pregaming, and drinking games among young adults: Over 75% of the sample of non-abstaining young adults engaged in these three drinking contexts at least once during the 2-year study period. Moreover, young adults in this sample reported daytime drinking and playing drinking games in approximately 30% of drinking months and reported pregaming in approximately 40% of drinking months. Still, drinking in these contexts was a small proportion of all drinking, based on the means for frequency of each context in respect to ones' total drinking (i.e., all three means fell between the response options "Not at all" and "A few of the times"). Intraclass correlation coefficients (shown in Table 1) nevertheless indicated that a substantial amount of the variability in these drinking contexts was within-person, showing that from 1 month to the next, young adults may fluctuate considerably in how often they drink in these high-risk contexts.

Results from the primary analyses generally supported the overall hypothesis that daytime drinking, pregaming, and drinking games entail heightened risk for alcohol-related outcomes. Notably, the multilevel analytic design revealed significant within-person effects indicating that in months in which young adults drank in these contexts more often than usual, they reported greater alcohol consumption, more negative consequences, and increased likelihood of SAM use in those months (specific results discussed below). In partial support of the final hypothesis, we found that more frequent daytime drinking and pregaming, but not drinking games, predicted increased AUDIT scores at a distal follow-up timepoint, suggesting potential long-term risks of daytime and pregame drinking.

Drinking contexts predicting alcohol-related outcomes

Drinks per week

Alongside a significant association at the between-person level, there was a highly significant within-person effect showing young adults drink more than usual during months when a greater proportion of their alcohol use occasions are in the daytime drinking context. That is, daytime drinking was revealed to be both a stable trait-like risk factor as well as one that varied over time as a proximal (month-level) risk factor. Considered alongside daily-level research on daytime drinking (Calhoun & Maggs, 2021), young adults who begin drinking earlier in a given day may drink greater quantities not only on that specific day but also in a given month during which one more frequently engages in daytime drinking. Like daytime drinking, pregame drinking was associated with weekly number of drinks at both within- and between-person levels. This indicates that young adults who pregamed more frequently, as a trait-level characteristic, tended to be heavier drinkers on average and, even beyond this person-level association, months with relatively more pregaming were associated with elevated alcohol use quantity. Unlike the first two contexts, drinking games were not a significant between-person risk factor for weekly drinking quantity, on average; however, young adults drank relatively more than usual during months in which they engaged in relatively more drinking game activities. This builds upon existing research on risks of drinking games (e.g., Zamboanga et al., 2014, 2018), extending the association to the monthly level and highlighting that periods of time in which young adults play more drinking games are marked by greater overall consumption of alcohol.

Taken together, month-level associations between these drinking contexts and increased alcohol use quantity provide further evidence of the increased risk of these drinking contexts. Notably, month-to-month fluctuations in engaging in these drinking contexts are expected to relate to consumption, but the *magnitude* of these effects is worth highlighting. For example, a 21% increase in weekly alcohol consumption for a one-unit increase in daytime frequency (on the 5-point scale) demonstrates the importance of the drinking context for young adults.

Negative consequences

Daytime drinking was associated with more negative consequences at both the between- and within-person levels. Individuals who typically engaged in more frequent daytime drinking reported more negative consequences across the 24-month period, on average. Moreover, young adults reported more negative consequences during months they reported more frequent daytime drinking, and this within-person effect held even when controlling for participants' typical alcohol use frequency. This highlights unique risks associated with daytime drinking, even above and beyond increased drinking frequency, which is somewhat contrary to event-level findings showing that daytime drinking (controlling for number of drinks) may be associated with *fewer* negative consequences on a given day (Calhoun & Maggs, 2021). Although more frequent engagement in daytime drinking was a unique risk factor for experiencing negative consequences over and above drinking frequency in general, future research should continue to clarify the extent to which quantity of consumption and/or time spent drinking drive the elevated risks associated with day drinking. Ultimately, the context of daytime drinking warrants deeper investigation and perhaps more clarification as to what the daytime drinking events entailed given that some daytime drinking events, such as tailgating, could be quite different from other events like drinking while having lunch at a restaurant.

Pregaming also emerged as risky drinking context in terms of negative drinking consequences at both between- and within-person levels. Like daytime drinking, pregame drinking significantly predicted increased negative consequences even when controlling for frequency of alcohol use—thus, pregaming may confer additional risks above and beyond increased alcohol use frequency. Indeed, the magnitude of this effect shows a one-unit increase in pregame drinking, in a given month, was associated with a 25% increase in negative consequences (holding alcohol use constant). This aligns with existing studies on risks of pregaming, such as findings that pregame drinking is a unique risk factor for incapacitated rape (Jaffe et al., 2022). Specifically, drinking alcohol prior to the main event entails impaired judgment from the time an individual arrives at the event, which could decrease one's vigilance in the situation and decrease the use of protective behavioral strategies in the context of pregaming (Hummer et al., 2021; Pedersen et al., 2020).

Drinking games were also associated with greater negative consequences, but only at the within-person level such that months with more frequent drinking game engagement facilitated relatively more negative consequences than usual, even when controlling for alcohol use frequency. This finding, that drinking games may contribute to negative consequences highlights that some aspects of drinking games may be particularly hazardous, such as (a) rapid *rate* of consumption during drinking games (e.g., chugging; Zamboanga et al., 2013), (b) required focus on the game/task not allowing opportunities for breaks or to alternate water/drinks, and (c) that drinking games are more common at house-parties than bars/pubs (Zamboanga et al., 2014) given negative consequences are more likely/prevalent when drinking at homes or parties than at bars (Merrill et al., 2023).

SAM use

In addition to alcohol-specific outcomes, we examined whether engaging in daytime drinking, pregaming, and drinking games would increase the risk of engaging in both alcohol and marijuana simultaneously (i.e., SAM). Findings revealed person-level effects for pregaming, suggesting that those who pregame more frequently were

generally at greater risk of SAM use, across the 24-month study period. Moreover, in support of our hypotheses, all three drinking contexts were related to SAM use at the within-person level; young adults had inflated odds of engaging in SAM use during months that a greater proportion of drinking occurrences were spent in the contexts of daytime drinking, pregaming, and playing drinking games. Notably, these effects held even when controlling for alcohol and cannabis use—highlighting that aspects of these drinking contexts may confer additional likelihood of engaging in SAM beyond simply elevated use of alcohol and/or cannabis, independently. One commonality between daytime drinking, pregaming, and playing drinking games is that they likely entail social and/or enhancement drinking motives, which have been recently identified as a potential risk factor for cannabis use (i.e., probability of cannabis use was elevated in months with increased social and enhancement drinking motives; Fleming et al., 2022). Indeed, shared substance use motives may underly associations between SAM and drinking in these high-risk contexts given SAM use is more likely to occur when young adults are particularly motivated by enhancement reasons (Arterberry et al., 2021; Patrick et al., 2019), which may also motivate engagement in pregaming and drinking games (Bachrach et al., 2012; Johnson & Sheets, 2004), though far less is known about motives for daytime drinking.

Changes in AUDIT scores across 2.5 years

The final aim of the study examined the extent to which daytime drinking, pregaming, and playing drinking games predicted changes in AUDIT scores from baseline to a distal 30-month follow-up (i.e., 6 months after the last monthly survey). Importantly, controlling for participants' baseline AUDIT scores provides a more accurate estimation of these drinking contexts as antecedent risk factors for changes in AUDIT scores. In partial support of hypotheses, young adults who engaged in proportionately more daytime and pregame drinking were predicted to have increased AUDIT scores at the distal follow-up relative to their baseline AUDIT scores.

To our knowledge, this is the first evidence of longer-term risks associated with daytime and pregame drinking which, considered alongside clear event-level risks, further demonstrates that these contexts should be a target for prevention efforts. Beginning to drink earlier in the day may signal that an individual is unable to resist cravings to use alcohol, but may also represent a slippery slope in which an individual begins normalizing or self-licensing going about daily tasks while drinking or following drinking occasions. Similarly, more frequent pregaming that is prior to the primary event, could be an indicator that a young adult needs greater amounts of alcohol to achieve the desired effects (i.e., tolerance) and/or that they are more inclined to use alcohol to enhance other events that may not even entail alcohol use (e.g., pregaming before a concert where alcohol is not sold). Taken together, results suggest that daytime drinking and pregaming may be antecedent risk-factors for hazardous drinking behaviors used to identify alcohol use disorder. As such, daytime drinking and pregaming may be monitored as early warning signs or integrated into common alcohol use screening protocols.

Counter to hypotheses, drinking games did not show indication of long-term risks related to AUDIT scores. Whereas drinking games are highly risky at the event-level, largely due to high-quantity consumption at rapid pace (Zamboanga et al., 2014), this drinking context may not be an indicator or early warning sign of an individual's risk for alcohol use disorder. Nevertheless, these associations warrant additional investigation into potential mechanisms around why/how drinking in these contexts may contribute longitudinally to high risk and disordered alcohol use.

Implications, future directions, and limitations

An essential takeaway from the current findings is that daytime drinking, pregaming, and playing drinking games are high-risk drinking contexts that may vary considerably from month-to-month. When young adults engage in these drinking contexts more often than usual, they are at risk of increased consumption, more negative consequences, and increased odds of SAM use. While this is rather straightforward on the surface, a deeper understanding of the mechanisms is warranted, especially given the current findings showing these contexts relate to negative consequences *above-and-beyond* frequency of use. That is, how often one drinks is not the sole mechanism underlying these associations, and there are more complex processes that could explain why these contexts are linked to negative consequences. At a minimum, prevention efforts should consider targeting these three high-risk drinking contexts, especially daytime drinking and pregaming, which emerged as risk-factors for hazardous drinking at a distal follow-up.

Understanding drinking contexts is a complex domain, and one in which we as a field must continue to examine. To date, most studies (this one included) consider isolated aspects of various contexts. Future studies should more deliberately consider the who, what, where, when, why, and how of drinking *in combination*; simply looking at one aspect of context at a time may not paint a complete picture of the overall drinking context. For example, daytime drinking (when) may be exceptionally risky when done at a tailgate vs. at a casual brunch or backyard barbeque (where) or when daytime drinking occurs with heavy-drinking peers vs. with a romantic partner (who). Understanding the context of alcohol use is inherently multifaceted, but this early-stage evidence regarding daytime drinking, pregaming, and drinking games suggests this is a worthy area of research as identifying contexts of highest risk elucidates clear targets for prevention efforts and protective strategies. The present findings also add to a recent focus on contexts in which SAM use is more likely, relative to alcohol or cannabis use only (Arterberry et al., 2023). Gunn et al. (2021) found, for example, that SAM use is more likely in certain physical and social contexts, such as at parties with friends and when around more people. Additionally, Jackson et al. (2021) found that situational

social and enhancement motives increase likelihood of SAM, relative to cannabis use only, and that the odds of SAM use increase when around others who are using cannabis. These two studies align with the present findings that more frequent daytime drinking, pregaming, and drinking games increase young adults' odds of SAM use in a given month, as these three contexts often entail social situations with more people.

Alongside the strengths of the longitudinal monthly data collection and distal follow-up from a community sample of young adults, several limitations warrant consideration. The sample is fairly representative of the geographic region where data were collected (i.e., the greater Seattle area), but findings may not generalize to other regions (e.g., rural) or cultures, nor areas where cannabis may not be legal for adults of the age of 21 and older (as it is in Washington State). Pertaining to measurement, the context items introduce challenges to interpretation as they ask participants to report how frequently they drank in the given contexts as a ratio of all the times they drank in the past month. Although this was overcome in the negative consequences and SAM use models by statistically controlling for total drinking frequency in the past month, a more straightforward count-based response option may enhance interpretability in future studies. Relatedly, the item for drinking games contexts asks about 'drinking while playing games' with examples of well-known drinking games (i.e., beer pong and quarters), but does not specifically require these games to fit the definition of drinking games. Because drinking contexts items asked about the frequency participants drank in these respective contexts in the past month, we were unable to examine event-level overlap between contexts (e.g., playing drinking games while pregaming), which is an important topic for future study in this domain. As such, stronger measurement paradigms may be prudent when it is necessary to tease apart various potentially overlapping drinking contexts. Despite the longitudinal design warranting temporal/prospective interpretation, causal claims are not warranted without a more standardized experimental design that may be beyond the scope of observational research. Moreover, the within-person effects documented presently do not enable inferences regarding the ordering of associations; for example, the extent that drinking in specific contexts predicts negative consequences in a given month vs. negative consequences predicting increased engagement in certain drinking contexts.

CONCLUSION

The contexts in which young adults drink play a salient role in the risks/harms that are involved with alcohol use. Daytime drinking is only emerging in the literature as a risky context, and the current findings suggest that month-to-month variability in young adults' daytime drinking is linked to alcohol-related risks. More has been known about risks involved with pregame drinking and playing drinking games, though primarily at the event level. Current findings increase understanding of pregaming and drinking games showing that more frequent use in these contexts in a given month confers greater risks related to alcohol use, including increased likelihood of engaging in SAM use during that month. Findings are also among the first to demonstrate longer-term risks of daytime drinking and pregaming, which were prospective risk factors for AUDIT scores at a distal follow-up. Ultimately, more research is needed on the various contexts in which young adults drink alcohol and the extent to which contextual factors interact with one another to amplify or reduce risks and harms.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to disclose.

ETHICS STATEMENT

All the aspects of the present study were approved by the Institutional Review Board at the University of Washington. No adverse events were reported. The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

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ENDNOTE

[1] Time was included to account for potential trends in drinking contexts or outcome variables over time, as recommended by Wang and Maxwell (2015) and Bolger and Laurenceau (2013). Inclusion of time makes person-mean centering more accurate. Time was scaled in years, rather than in months, to aid interpretation.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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