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Daily-level analysis of drinking intensity and acute physical consequences

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Abstract

Objective: We examined associations of drinking intensity on a given drinking day with acute physical consequences in a sample of U.S. young adult drinkers.

Methods: Participants were past 30-day drinkers at modal age 18 in the 2018 12th-grade Monitoring the Future study who were followed up as part of a daily study in 2019 (n = 911). Of these participants, n = 489 reported at least one drinking day. At age 19, they reported their alcohol use and consequences for 14 consecutive days (n = 1051 drinking days). Daily data were used to examine within- and between-person associations of drinking intensity (moderate [1–3 drinks for women, 1–4 drinks for men], binge [4–7/5–9], or high-intensity [8+/10+]) with four acute physical consequences: hangover, nausea, blackout, and passing out.

Results: At least one acute physical consequence was reported on more than half (59.3%) of high-intensity drinking days compared to 40.7% of binge and 4.9% of moderate drinking days. Blackouts and passing out were reported on 17.1% and 9.2% of high-intensity drinking days, respectively. Compared to binge drinking days, high-intensity drinking days were associated with a greater likelihood of any physical consequences (adjusted odds ratio [aOR] = 4.64; 95% confidence interval [CI] = 2.00,10.75), a greater number of consequences (adjusted incident rate ratio [aIRR = 1.99; 95% CI = 1.16,3.42), and a greater likelihood of hangover (aOR = 3.72; 95% CI = 1.58,8.74). Acute physical consequences were also more likely on high-intensity and binge drinking days versus moderate drinking days.

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Contributors

Dr. Evans-Polce collaborated on the conceptualization of the study, conducted the analysis, and drafted the initial manuscript. Dr. Stevenson provided feedback to refine the research questions and analyses and made significant contributions to the writing and editing of the manuscript. Dr. Patrick collaborated on the conceptualization of the study, provided feedback to refine the research questions and analyses, made significant contributions to the writing and editing of the manuscript, and funded the data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2022.107246.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Conclusions: High-intensity drinking days were associated with a distinctly greater risk for acute physical consequences than binge or moderate drinking days.

Keywords

High-intensity drinking; Binge drinking; Alcohol; Young adults; Daily-level; Alcohol consequences

1. Introduction

Alcohol use among young adults is associated with considerable morbidity and mortality and alcohol misuse costs the U.S. $249 billion annually (Hingson et al., 2009). High-intensity drinking (consuming 8 + drinks for women and 10 + drinks for men) (Patrick and Azar, 2018) is a particularly harmful and costly form of drinking (Sacks et al., 2015; Rehm and Shield, 2013; Hingson et al., 2017) that is relatively common in young adulthood (Terry-McElrath and Patrick, 2016; Patrick et al., 2016).

Cross-sectional and longitudinal data focused on between-person differences have found that those who binge drink (consuming 4 or more drinks for women and 5 or more drinks for men) are more likely to experience negative consequences including unintentional injuries, passing out, and hangovers (Hingson et al., 2017; Cranford et al., 2006; Krieger et al., 2018; Naimi et al., 2003; Wechsler et al., 1994; Evans-Polce et al., 2017). Additionally, those who engage in high-intensity drinking have greater risk for later alcohol use disorder symptoms (Linden-Carmichael et al., 2017; Patrick et al., 2021) compared to those who binge drink or drink less. Thus, identifying the distinct risks of high-intensity drinking compared to binge drinking is important.

However, between-person data are not able to identify important within-person variability in drinking intensity and consequences that can be studied at the daily level (Bolger and Laurenceau, 2013; Sliwinski, 2008). Daily-level studies allow for the assessment of the degree to which associations of drinking intensity and consequences are driven by differences between individuals (i.e., between-person) or variability across drinking occasions (i.e., within-person). Further, in daily studies, drinking and consequences are measured in closer temporal proximity to examine acute effects of drinking intensity.

Research using daily-level data has found a greater number of total alcohol-related consequences on greater drinking intensity days (Carpenter and Merrill, 2021) and specifically on high-intensity drinking days compared to binge drinking days (Patrick et al., 2021) and lower drinking intensity days (Cox et al., 2019; Merrill et al., 2019; Patrick et al., 2016; Patrick and Terry-McElrath, 2021). Drinking thresholds above binge drinking levels are optimal predictors of severe acute alcohol consequences including blackouts (Labhart et al., 2018). Using a college sample, passing out and hangovers were more likely on high-intensity vs. binge drinking days (Linden-Carmichael et al., 2018). However, little research has focused specifically on different types of acute physical consequences and none has examined these within-person associations in a national sample of young adults. Acute physical consequences are particularly important to examine given they can lead to serious harm. For example, at the person level, blackouts and passing out significantly increase risk

for overdose, injury, and sexual assault, (Carey et al., 2015; Hingson et al., 2016; Mundt et al., 2012; Valenstein-Mah et al., 2015) and blackout occasions are associated with more negative consequences than non-blackout drinking occasions (Devenney et al., 2019). Other acute physical consequences like hangovers and nausea can also lead to substantial cognitive and physical impairment in the following days (Devenney et al., 2019; Prat et al., 2008; van Schrojenstein Lantman et al., 2017).

In this study we examined within- and between-person associations of drinking intensity (moderate, binge, or high-intensity drinking) on a given day with four negative acute physical consequences (hangovers, nausea, blackouts, and passing out). We also examined associations with any consequence (versus none) and the total number of negative acute physical consequences from a given drinking occasion. We hypothesized that high-intensity drinking occasions would be associated with greater odds of experiencing any consequences, a greater number of consequences, and each individual consequence.

2. Methods

2.1. Sample

The Young Adult Daily Life (YADL) study (Patrick et al., 2021) follows a national sample of adolescents who reported recent alcohol use into young adulthood and is drawn from the 2018 cohort of 12th-graders participating in the Monitoring the Future (MTF) study (N = 2204) (Schulenberg et al., 2020). Individuals who did not report past 30-day alcohol use in 12th-grade, did not provide contact information for follow up (n = 1208), or were selected to participate in a separate MTF longitudinal panel study (Widmark, 1981) (n = 828) were not eligible to participate in the YADL study.

Of those eligible (N = 2204), 911 (41.3%) participated in Year 1 of the study. The study included a 30-minute annual survey and 14 consecutive 5–7-minute daily surveys, all completed online from the end of May through July 2019. The 14-day daily data collection window started immediately following the annual survey. Each daily survey was open for up to three days. Participants could be compensated a total of $100. The study was approved by the University of Michigan IRB.

Mean age at the time of Year 1 YADL data collection was 19.3 years (SD = 0.40). The sample was 65.6% female, 70.0% white, 72.8% were full-time 4-year college attenders, and 83.8% heterosexual. Compared to those eligible who did not participate, YADL participants were significantly more likely to be female ($p < 0.001$), definitely plan to graduate from a 4-year college ($p < 0.001$), and have lower past 30-day drinking frequency ($p < 0.001$) in 12th-grade. Of those who provided at least one daily survey (n = 769; 84%), 78% completed 11 out of the 14 daily surveys and 60% completed all 14 daily surveys. The analysis for this study was limited to days in which participants reported any drinking (n = 486 individuals [63% of individuals that provided at least one daily survey]; n = 1051 drinking days).

3. Measures

Drinking intensity.

Each day participants reported whether they drank alcohol the previous day. If yes, they were asked the number of total drinks they consumed (1 to 25+ drinks) which was categorized into three sex-specific levels of drinking intensity: moderate drinking (1–3 drinks for women, 1–4 drinks for men), binge drinking (4–7 drinks for women, 5–9 drinks for men), and high-intensity drinking (8 + drinks for women, 10 + drinks for men). Previous literature has shown these drinking categories to be distinct (Patrick et al., 2016; Patrick and Terry-McElrath, 2021)

Acute physical alcohol consequences.

For drinking days participants were asked, "Did any of the following things happen to you as a result of your drinking on [day]?" We examined four specific acute physical alcohol consequences: *hangover* ("I had a hangover"), *nausea* ("I felt nauseated or vomited"), *blackout* ("I couldn't remember what I did while drinking"), and *passing out* ("I passed out"). In addition, we created a count variable of the *number of acute physical alcohol consequences* (0–4) and a dichotomous measure of *any acute physical consequences* (vs. no consequences) reported that day.

Covariates.—At the daily level, we controlled for marijuana use, whether the drinking day was a *weekend* (Thursday, Friday, Saturday vs. Sunday, Monday, Tuesday, Wednesday) and the *day of the survey* (0–13).Between-person, we also controlled for person-mean marijuana use, race (white non-Hispanic vs. not), sex (male vs. female), college status (four-year full-time college attender vs. not), and sexual identity (sexual minority vs. heterosexual).

Estimated blood alcohol concentration (eBAC) was calculated based on self-reported weight, sex, number of drinks, and hours spent drinking each day.

4. Analysis

We first examined the proportion of drinking days with acute physical consequences, overall and by drinking intensity. We then examined the association of within-person (i.e., daily report, person-centered) and between-person (i.e., person mean proportion of days, grand-mean centered) drinking intensity with each of the four consequences and a combined outcome of any consequence using multilevel logistic regression models. Analyses were conducted using melogit commands in Stata 17. We used multilevel negative binomial regression (menbreg in Stata) to examine the number of consequences. All analyses used weights to account for sampling design and nonresponse.

5. Results

5.1. Descriptive statistics

Among those who reported at least one drinking day, the mean number of drinking days per respondent was 2.15 (*SD* 1.64, range 1–13). Across drinking days, 10.2% were high-intensity days, 25.4% were binge drinking days, and 64.4% were moderate drinking days.

On high-intensity drinking days eBAC was M = 0.292 (SE = 0.010), on binge drinking days was M = 0.144 (SE = 0.004), and on moderate drinking days was M = 0.045 (SE = 0.001). Overall, individuals reported at least one acute physical consequence on 19.8% of drinking days (Fig. 1. By intensity, at least one acute physical consequence was reported on 4.9% of moderate, 40.7% of binge, and 59.3% of high-intensity drinking days. The most common consequence was having a hangover (14.4% of all drinking days). Hangovers were reported on one-third (32.0%) of binge drinking days and almost half of high-intensity drinking days (46.9%). Blackouts and passing out were reported on 17.1% and 9.2% of high-intensity drinking days, respectively.

6. Drinking intensity and acute physical consequences

On high-intensity drinking days, at least one physical alcohol consequence was four times more likely than on binge drinking days (adjusted odds ratio [aOR] = 4.64; see Table 1. On high-intensity drinking days, there was also a greater number of consequences (adjusted incident rate ratio [aIRR] = 1.99) and a greater likelihood of hangover (aOR = 3.72) compared to binge drinking days. Almost all consequences were significantly less likely on moderate compared to binge drinking days. See Supplemental Table A for model results using moderate drinking as the reference group.

There were no between-person differences for those with greater mean high-intensity drinking. However, those with greater mean moderate drinking were significantly less likely to experience any consequences overall, less likely to experience each of the four consequences individually (aOR range: 0.04 to 0.11), and reported fewer consequences (aIRR = 0.09).

As a sensitivity test, we excluded individuals who only reported moderate drinking days (n = 261). This did not alter our results except the association of day-level high-intensity drinking with passing out was statistically significant (aOR = 5.87, $p < 0.05$) in the model excluding moderate drinkers (where it previously was not, aOR = 5.41, $p = 0.06$).

7. Discussion

The current study examined the within- and between-person relationships between drinking intensity (moderate, binge, and high-intensity) and acute physical consequences (hangover, nausea, passing out, and blackout) in a national young adult sample. Acute physical consequences were much more likely to occur on high-intensity drinking days compared to binge drinking days, consistent with previous literature examining alcohol consequences overall (Hingson et al., 2017; Patrick et al., 2021; Cox et al., 2019; Merrill et al., 2019; Patrick et al., 2016). In fact, young adults reported at least one acute physical consequence on the majority of high-intensity drinking days. Even the most serious consequences—which were quite rare in general—were not rare on high-intensity drinking occasions. One in six high-intensity drinking occasions resulted in blackout and nearly one in ten resulted in passing out. Given the severity of these consequences, these results highlight the substantial risk of high-intensity drinking on a given day. Further, high-intensity drinking days were associated with a greater number of consequences even after accounting for a person's

average drinking intensity, meaning that both heavy and light drinkers experience more consequences when engaging in high-intensity drinking as compared to binge drinking on a given day.

In examining specific acute physical consequences, all consequences showed a similar pattern of being more common on high-intensity drinking days, but only hangovers were significantly more likely on high-intensity drinking days compared to binge drinking days. This is contrary to past research showing that other individual consequences, such as blackouts, (Merrill et al., 2019) are also significantly more likely during high-intensity drinking than binge drinking episodes. This may suggest hangovers are a particularly salient risk on high-intensity drinking days. However, it is also possible that our null findings are from lack of power, given that the only significant effect observed was for the most commonly endorsed consequence (hangovers).

Previous research that has examined within- and between-person effects of high-intensity drinking has also found that within-person factors (e.g., fluctuations in alcohol expectancies (Patrick et al., 2016) and drinking motives (Patrick and Terry-McElrath, 2021)) have important impacts on high-intensity drinking. This points to the need for interventions that address situations and contexts that contribute to high-intensity drinking at the event level. Consistent with past research, there were no between-person differences based on frequency of binge and high-intensity drinking. More frequent moderate drinkers were at lower risk for consequences, highlighting that moderate drinking is protective at both the within- and between-person levels as other studies have found (Witkiewitz, 2013). Future research should examine differential risk of drinking intensity at the occasion level by person-level factors including the typical person-level drinking intensity.

Limitations of the study include its focus on individuals who reported current alcohol use in 12th-grade and, thus, does not include those that initiated drinking later in young adulthood or dropped out of school before 12th-grade. Additionally, we relied on retrospective reports of the previous day. Individuals were asked about consequences that occurred because of the previous day of drinking. Thus, we are not able to differentiate the day consequences were experienced – some may have occurred on the day of drinking and others on the following day.

This study found that acute physical consequences (nausea, hangover, passing out, and black outs) occurred on the majority of high intensity drinking days. Further, although these consequences were more common for binge drinking episodes than moderate drinking episodes, acute physical consequences were much more likely for high-intensity drinking episodes. These results demonstrate the importance of studying high-intensity drinking as a distinctly high-risk form of drinking as compared to binge drinking.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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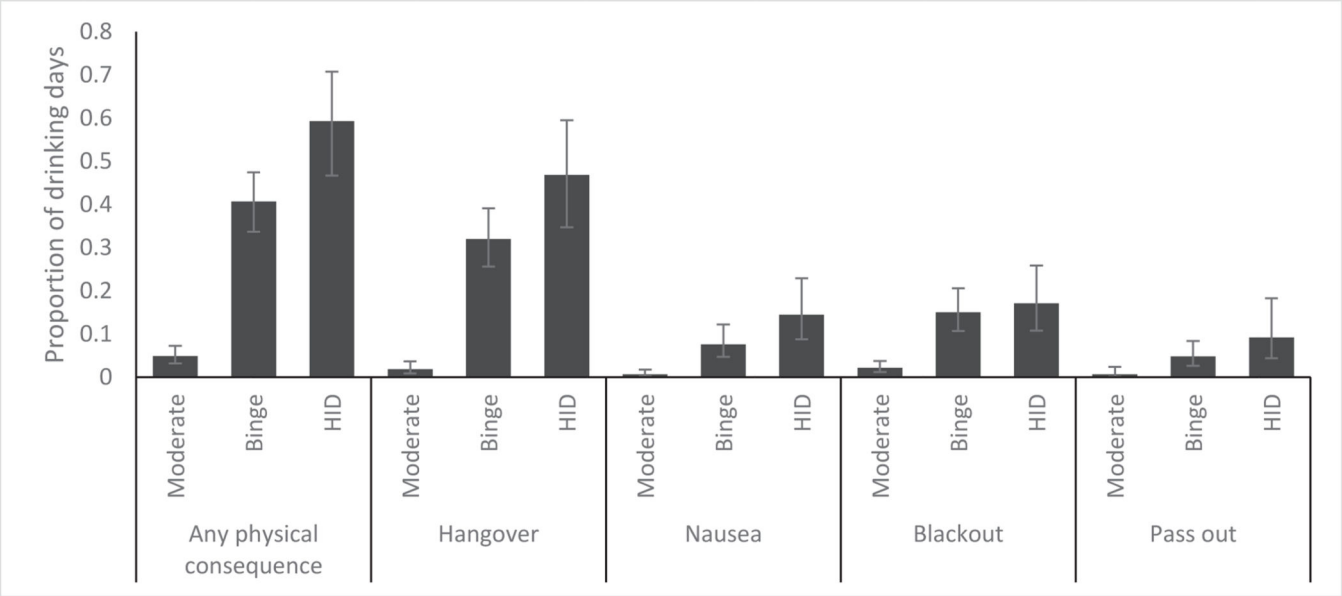

Fig. 1.

Proportion of drinking days with acute physical consequences by drinking intensity (weighted) Note: error bars represent 95% confidence intervals. Moderate = women 1–3 drinks, men 1–4 drinks; Binge = women 4–7 drinks, men 5–9 drinks; and High-intensity = women 8 + drinks, men 10 + drinks.

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Table 1

Weighted associations of drinking intensity with acute physical consequences on drinking days.

	Any physical consequence	# of physical consequences (0–4)	Hangover	Nauseated/Vomited	Blackout	Passed out
	aOR (95% CI)	aIRR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Daily-level						
Drinking intensity						
Moderate	**0.09 (0.05, 0.18)** *	**0.10 (0.06, 0.17)** *	**0.03 (0.01, 0.09)** *	**0.07 (0.02, 0.22)** *	**0.09 (0.02, 0.36)** *	0.34 (0.06, 1.81)
Binge	REF	REF	REF	REF	REF	REF
High-intensity	**4.64 (2.00, 10.75)** *	**1.99 (1.16, 3.42)** *	**3.72 (1.58, 8.74)** *	1.87 (0.50, 6.96)	1.57 (0.50, 4.92)	5.41 (0.93, 31.38)
Weekend	1.35 (0.83, 2.18)	1.07 (0.75, 1.53)	1.32 (0.72, 2.41)	1.01 (0.47, 2.12)	1.26 (0.52, 3.06)	0.82 (0.28, 2.40)
Day (1–14)	1.03 (0.97, 1.09)	1.02 (0.98, 1.05)	1.04 (0.97, 1.12)	0.95 (0.87, 1.04)	**1.09 (1.01, 1.18)** *	1.04 (0.91, 1.18)
Marijuana use	0.93 (0.42, 2.07)	0.75 (0.41, 1.38)	0.44 (0.16, 1.18)	0.29 (0.05, 1.53)	3.04 (0.72, 12.89)	1.20 (0.13, 11.34)
Person-level						
Drinking intensity						
Moderate	**0.07 (0.03, 0.13)** *	**0.09 (0.05, 0.16)** *	**0.05 (0.02, 0.12)** *	**0.07 (0.02, 0.23)** *	**0.11 (0.03, 0.47)** *	**0.04 (0.01, 0.22)** *
Binge	REF	REF	REF	REF	REF	REF
High-intensity	0.91 (0.40, 2.07)	0.97 (0.58, 1.60)	0.88 (0.34, 2.25)	0.82 (0.19, 3.46)	2.70 (0.61, 11.91)	0.41 (0.08, 2.02)
Marijuana use	1.52 (0.82, 2.80)	1.28 (0.89, 1.85)	1.74 (0.85, 3.60)	0.80 (0.27, 2.21)	2.24 (0.94, 5.34)	1.00 (0.25, 4.01)
Female (Ref = Male)	0.95 (0.60, 1.51)	1.10 (0.81, 1.49)	0.88 (0.52, 1.48)	1.31 (0.57, 3.00)	**2.27 (1.06, 4.85)** *	0.73 (0.28, 1.88)
White (Ref = not White)	1.39 (0.77, 2.53)	1.27 (0.83, 1.94)	**2.29 (1.06, 4.97)** *	0.97 (0.39, 2.42)	1.89 (0.77, 4.67)	0.55 (0.20, 1.53)
Sexual minority identity (Ref = Heterosexual)	1.58 (0.89, 2.79)	1.06 (0.77, 1.45)	0.97 (0.41, 2.29)	1.89 (0.68, 5.24)	1.21 (0.41, 3.55)	0.36 (0.08, 1.54)
College attendance	1.16 (0.65, 2.07)	1.05 (0.69, 1.60)	1.44 (0.74, 2.82)	0.67 (0.25, 1.79)	1.84 (0.64, 5.31)	0.53 (0.17, 1.67)

* $p < 0.05$. aOR = adjusted odds ratio, aIRR = adjusted incident rate ratio.