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Energy Drinks and Alcohol: Links to Alcohol Behaviors and Consequences Across 56 Days

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Abstract

Purpose—To examine short-term consequences associated with consuming alcohol and energy drinks compared with consuming alcohol without energy drinks.

Methods—A longitudinal measurement-burst design (14-day bursts of daily surveys in four consecutive college semesters) captured both within-person variation across occasions and between-person differences across individuals. The analytic sample of late adolescent alcohol users included 4,203 days with alcohol use across up to four semesters per person from 508 college students.

Results—Adding energy drink use to a given day with alcohol use was associated with an increase in number of alcoholic drinks, a trend toward more hours spent drinking, elevated estimated blood alcohol content (eBAC), a greater likelihood of subjective intoxication, and more negative consequences of drinking that day. After controlling for eBAC, energy drink use no longer predicted subjective intoxication but was still associated with a greater number of negative consequences.

Conclusions—The consumption of energy drinks may lead to increases in alcohol consumption and, after controlling for eBAC, negative consequences. Use of energy drinks plus alcohol represents an emerging threat to public health.

Keywords

Alcohol; Drinking; Energy drink; Blood alcohol; College; Consequences; Daily

Consumption of energy drinks has risen markedly in the United States since the introduction of Red Bull to the market in 1997 [1,2]. There are hundreds of brands on the market targeted to young people, with names such as Full Throttle, Rockstar Energy, Monster, and Daredevil [2–5]. Caffeine content of energy drinks can range from 50 mg to more than 500 mg per can or bottle, compared with a 12-ounce soda that has 34–54 mg and a 6-ounce brewed coffee that has 77–150 mg [2,6]. The number of emergency department visits resulting from energy drinks doubled between 2007 and 2011 [7]. Mixing alcohol with energy drinks is an emerging trend [2,3,5], with mixed drinks such as vodka Red Bull and Jäger bombs (i.e., dropping a shot of the liquor Jägermeister into a glass of Red Bull) becoming popular among

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youth [4,8]. The public health implications include not only physiological risks to individuals (e.g., blacking out, alcohol poisoning), but also exposing the community to dangerous situations resulting from young adults who may be “wide awake drunk” after a night of partying [6]. Although research on the public health impact of energy drinks and alcohol is emerging, there is currently very little research using repeated measures designs or assessing consumption in naturalistic settings (i.e., outside of laboratories). The purpose of this study is to examine the short-term consequences associated with consuming energy drinks and alcohol compared with consuming only alcohol among college students.

Energy drinks are primarily marketed to adolescents and young adults [5,9]. Among adolescents and young adults, about 30%–50% consume energy drinks [10], based on regional samples. Among college students, 40%–60% report using energy drinks in the past month, with 10% classified as high-frequency users (52+ days in the prior year) [11]. Mixing energy drinks with alcohol is common; one study estimated 24% of college students had done so in the past month [4]. Among energy drink users, 54% report using them with alcohol while partying, and consumption of three or more alcoholic energy drinks during an evening is common [12]. Very little is known, however, about behaviors and consequences on specific days on which students consume both alcohol and energy drinks.

Regulation of alcohol and energy drinks

In November 2010, the U.S. Food and Drug Administration [13] (FDA) issued warning letters to four manufacturers of caffeinated alcoholic beverages that collectively sold products including Four Loko, Core High Gravity, Moonshot, Joose, and Max. The FDA stated that based on a scientific review, caffeinated alcoholic beverages presented a public health concern and that adding caffeine to malt alcohol beverages was an “unsafe food additive” and in violation of the Federal Food, Drug, and Cosmetic Act [13]. The FDA action effectively prohibited the sale of *premixed* alcoholic energy drinks [6]. However, such premixed drinks represented only a small portion of those consumed, and the mixing of alcohol and energy drinks is expected to continue [6,14] as bar patrons are still free to order alcohol mixed with energy drinks by bartenders [15] or by mixing their own. Despite the curtailment of sales of premixed energy drinks with alcohol, the relative lack of regulation of energy drinks more generally has led to vigorous marketing campaigns by producers making unsubstantiated claims that they enhance performance, increase attention, and reduce effects of fatigue and alcohol [2]. Sales of high-caffeine energy drinks without alcohol has continued to rise [16,17].

Effects of energy drinks on behavior and consequences

Caffeine may reduce ability to accurately judge the intoxicating effects of alcohol. Laboratory research shows that participants with the same blood alcohol concentration (BAC) tend to report subjectively lower intoxication when energy drinks and alcohol were consumed compared with alcohol alone [1,18,19]; however, there is also evidence that intoxication rates are *not* objectively lower in caffeine plus alcohol study conditions [20]. Laboratory research on this topic has used small and nonrepresentative samples; however, this early experimental work is key because it provides some of the only available evidence of the links between energy drinks and consequences. In one study, participants who received alcohol mixed with an energy drink reported lower intoxication, including headache, weakness, dry mouth, and reduced motor coordination, compared with those in the alcohol-only condition. Importantly, no differences were observed in *actual* impairment in motor coordination or reaction time resulting from intoxication [18]. In a second study, participants consuming alcohol with energy drinks reported lower subjective intoxication compared with alcohol-only participants, and caffeine counteracted some cognitive effects

of alcohol (e.g., response speed) but not others (e.g., response accuracy), showing the complexity of the drug interaction [19]. A third study concluded that consuming alcohol with energy drinks led to more impairment in behavioral inhibition, although response activation was not as impaired as in the alcohol-only condition [1]. Finally, consuming caffeine with alcohol did not counteract the negative effects of alcohol on driving in a simulator [14,21]. In sum, if drinkers *perceive* themselves as higher functioning and less intoxicated when they also consume caffeine, though caffeine does *not* have these effects, it follows that risks for injury, aggression, and impaired decision-making may increase significantly.

Indeed, in a between-person event-level study in a naturalistic setting, bar patrons who consumed alcohol and energy drinks were more likely to leave the bar highly intoxicated (BAC ≥.08%), intend to drive, leave the bar later, drink for a longer period, and consume more total alcohol [8].

Prior survey and interview research regarding alcohol and energy drink use has typically collected data only once, asking respondents about their typical or past month/year behavior. The limited work thus far suggests that college students who consume energy drinks tend to consume more alcohol and experience more alcohol-related consequences than students who do not consume energy drinks [4,11,22,23]. Others have questioned the causes underlying such findings, in part because an individual's personality or sensation seeking may lead to both heavier energy drink use and heavier alcohol use [24]. Such studies also typically do not assess whether alcohol and energy drinks are consumed on the same days, nor do they examine the consequences associated with adding energy drinks to alcohol. As a result, little is known about the daily-level consequences of alcohol plus energy drink use. The present study uses repeated measures survey data (i.e., up to 56 daily reports per person), which allows us to compare days an individual consumes energy drinks and alcohol to days he or she consumes only alcohol. This strategy is necessary to identify immediate consequences associated with alcohol plus energy drink use, controlling for stable characteristics of the individual. In addition, we examine the association between energy drink use and alcohol-related consequences after controlling for alcohol use in order to examine whether energy drink use has a direct association with alcohol-related consequences that is independent of the amount of alcohol consumed.

Research questions

The present study was designed to examine whether, on drinking days, the level of alcohol use, subjective intoxication, and consequences differed as a function of energy drink use. Specifically, we hypothesized that on days with greater energy drink use (compared with days of alcohol use alone): (1) alcohol use would be greater (i.e., students would consume a greater number of drinks, spend more time drinking, or reach higher peak levels of intoxication [elevated estimated blood alcohol content; eBACs]); (2) subjective drunkenness would be less likely; and (3) negative alcohol consequences would be greater. In subsequent analyses controlling for eBAC to examine the unique effect of energy drinks above and beyond alcohol consumption, we hypothesized that on days with greater energy drink use: (4) subjective drunkenness would be less likely and (5) negative consequences would be greater.

Methods

Participants

The University Life Study (ULS [25,26]) used a measurement-burst design to capture within-person variation across multiple days and between-person differences in change

across college semesters. Each semester for seven semesters, beginning in the first semester of college, students completed a semester survey followed by 14 consecutive daily surveys. Data on alcohol and energy drinks are available from four 14-day bursts of daily surveys (i.e., 56 days total), from spring of students' second year (spring 2009) to fall of fourth year (fall 2010). Daily surveys were programmed so that the day being reported on was clear on each relevant screen (e.g., "On [Wednesday], did you."). Days were defined as "from the time you woke up to the time you went to sleep" to reflect student schedules rather than calendar dates. Reminder e-mail messages were sent to students who did not complete the surveys. All procedures were approved by the institutional review board.

In total, 744 students (65.6%) completed the semester 1 baseline survey and provided informed consent. Mean age was 18.9 years (standard deviation = .42). A stratified random sampling procedure was used to achieve a diverse sample with respect to gender and race/ethnicity. Sampling groups had response rates from 55.2% to 76.0%. With respect to race/ethnicity, 25.2% of the ULS sample self-reported as Hispanic/Latino American, 27.3% of the sample self-reported as white/European American non-Hispanic, 23.0% Asian American/Pacific Islander non-Hispanic, 15.6% black/African American non-Hispanic, and 8.7% reported more than one race non-Hispanic. Of the initial 744 students, 652 completed semester 4 (88%). There were no differences between those who completed semester 4 and those who did not (n = 92) on age, race/ethnicity, age of alcohol onset, or past month alcohol use at semester 1; however, women were more likely to remain in the study at semester 4 than men. Completion rates of the daily surveys were high, with 79%–86% of each semester's participants completing at least 12 of 14 daily surveys. We focus exclusively on days students reported alcohol use, therefore excluding students who abstained from alcohol on all sampled days (n = 134). In addition, 10 people were excluded because of missing data at levels 2 or 3. The analytic sample included 4,203 days with alcohol use (level 1), 1,135 person semesters (level 2), and 508 people (level 3).

Measures

Each day, students were asked, "On [Friday], how many (1) high energy (caffeinated) drinks like Red Bull, not containing alcohol did you drink? (2) high-energy drinks with alcohol (e.g., Red Bull + vodka, or a premixed drink) did you drink?" A pull-down menu permitted responses of 0–25+. Responses from these two questions were summed and coded as a four-level ordinal variable: 0, 1, 2, or 3+ energy drinks consumed that day.

Each day, participants were asked the number of alcoholic drinks they consumed the prior day and what time they started their first drink and ended their last drink. Gender, body weight, and length of time drinking were used to calculate eBAC [27]. In addition, each day respondents were asked whether they got drunk (yes/no) as a measure of subjective intoxication. Consequences of alcohol use each day were summed based on responses to the prompt, "As a result of drinking on [Friday], did you." with a response of yes or no to each of 10 negative consequences (e.g., have a hangover, get in trouble [28]). Days were coded as weekends (Thursday to Saturday) or weekdays (Sunday to Wednesday), based on alcohol patterns among college students [29–32].

Each semester, students were asked whether they lived in fraternity/sorority housing (yes = 1, no = 0).

Plan of analysis

Research questions examined whether days with more energy drink consumption were associated with (1) increases in alcohol use (i.e., a greater number of drinks, a longer time spent drinking, or higher eBACs); (2) a lower likelihood of reporting subjective intoxication;

and (3) more negative consequences. Two additional models predicting (4) subjective drunkenness and (5) negative alcohol-related consequences controlled for eBAC at level 1.

Three-level hierarchical linear modeling (HLM [33]) was used to separate variance associated with the person (level 3), the semester (level 2), and the day (level 1). Person-level (level 3) variables included gender and the person's mean energy drink use across all assessed days. Semester-level (level 2) controls included the linear effect of semester, fraternity/sorority membership that semester, and the mean energy drink use across days in the semester. Daily-level (level 1) variables included weekend (vs. weekday) and, the primary predictor of interest, the number of energy drinks consumed that day. Interactions between the daily number of energy drinks consumed and gender were also tested (not shown); none was significant. The five dependent variables were number of alcohol drinks consumed, hours spent drinking, eBAC, subjective drunkenness, and negative alcohol-related consequences on a given day. HLM with a Poisson distribution was used for all outcomes except for the dichotomous variable subjective drunkenness, for which HLM with a Bernoulli distribution was used.

Results

Descriptives

In the ULS sample, 80.4% of people used alcohol on at least one of the up to 56 sampled days across four semesters, 51.3% of people used energy drinks at least one time across sampled days, and 30.5% of people used energy drinks and alcohol on the same day at least once across sampled days. On days students used energy drinks, they also used alcohol on 31.6% of days. On days students used alcohol, they also used energy drinks on 9.6% of days. Descriptive statistics for all variables in the analytic sample are shown in Table 1.

Energy drinks predicting number of alcoholic drinks, hours spent drinking, and eBAC

Results for the HLM analyses predicting number of alcoholic drinks, hours spent drinking alcohol, and eBAC are shown in Table 2. Control variables are described first. At the person-level (level 3), men consumed a greater number of drinks but also spent more hours drinking than women and reached lower peak eBACs. Individuals who in general consumed more energy drinks (averaged across all days and semesters) also in general consumed a greater number of alcoholic drinks, and had a trend ($p < .10$) toward spending more time drinking alcohol. At the semester-level (level 2), the number of alcoholic drinks consumed did not change from second to fourth year of college, but there were increases across semesters in hours spent drinking alcohol and decreases in peak eBAC. During semesters students were living in fraternity/sorority housing, they reported higher levels of all three drinking indicators. Fluctuations in energy drink use across semesters (averaged across days within a semester) did not predict variation in the three alcohol-related outcome variables. At the daily-level (level 1), all three indicators of alcohol consumption were higher on weekend days than weekdays.

Consistent with our primary hypotheses for the three indicators of alcohol use, independent of all the associations mentioned previously, on days students consumed more energy drinks they consumed a greater number of alcohol drinks, spent more hours drinking (at trend [$p < .10$] level significance), and reached higher peak eBAC compared with days with only alcohol use.

Energy drinks predicting subjective drunkenness and negative alcohol consequences

Models predicting subjective drunkenness and negative alcohol-related consequences are shown in Table 3. First, models with the same predictors as those in Table 2 examined the

extent to which energy drink use predicted subjective intoxication and negative consequences. Control variables indicated that, at the person level (level 3), men and women were equally likely to report having gotten drunk, but men reported more negative consequences. Students who in general consumed more energy drinks reported more negative alcohol consequences, but had no greater likelihood of reporting that they got drunk. Across semesters (level 2), getting drunk and negative consequences decreased from second to fourth year of college. During semesters that students lived with fraternities/sororities, they reported more subjective drunkenness but no differences in consequences. Students were more likely to report getting drunk in semesters when their energy drink use was higher (averaged across days per semester). At the daily level (level 1), drunkenness was more likely and negative consequences greater on weekends than weekdays.

Addressing our primary hypotheses, students had greater odds of reporting getting drunk and experienced more negative alcohol consequences on days they consumed more energy drinks.

Energy drinks predicting subjective drunkenness and negative consequences, controlling for eBAC

Next, eBAC was added as an additional control at the daily level to isolate the associations between energy drinks and outcomes, independent of the amount of alcohol consumed. Once eBAC was controlled at the daily level, there was no association between energy drink consumption and subjective intoxication, although we had hypothesized there would be a negative association. In support of our hypotheses, students reported experiencing more negative alcohol consequences on days they consumed more energy drinks, even with eBAC on that day included in the model.

Discussion

This study was the first to examine consequences associated with alcohol and energy drink use with daily-level, within-person data. On days when students consumed energy drinks and alcohol, compared with days when they drank alcohol but no energy drinks, they drank more alcoholic drinks, reached a higher eBAC, and showed a trend toward spending more time drinking. Once these differential levels of intoxication (eBAC) were controlled, students did *not* report feeling more intoxicated on drinking days that they consumed energy drinks, but they did report experiencing more negative alcohol-related consequences. That is, consistent with our hypotheses, energy drink use was associated with greater alcohol use and more negative consequences but, contrary to our hypothesis, not with greater subjective intoxication after controlling for actual use.

The intoxicated state resulting from consuming high-caffeine energy drinks with alcohol has been described as “wide-awake drunk” because caffeine is presumed to attenuate some of alcohol’s sedative effects [34]. The present study provides limited support for this phenomenon. However, the increased alcohol consumption on days with energy drink use may also support the process of alcohol priming, such that energy drink consumption may increase motivations to drink more alcohol [35].

Policy and intervention efforts that seek to mitigate harms associated with alcohol and energy drinks may take several approaches. With respect to reducing sales, the United States no longer permits manufacturers to premix high-caffeine products with alcohol [13]; however, energy drinks remain widely available so individuals, hosts, and bartenders (in the United States and many but not all other countries) are free to mix these drinks [15,34]. With respect to packaging, creating common labeling standards for high-caffeine and high-alcohol products similar to those regarding nutritional information on food and/or units on

alcohol (e.g., Federal Trade Commission's new rules for FourLoko high-alcohol beverages [36]) would provide information to consumers wishing to minimize harm. With respect to health education, drinkers could be made aware of the discrepancy between subjective and objective intoxication, and the increased risk for negative consequences when combining alcohol with high doses of caffeine.

These results also need to be interpreted in the context of a number of limitations. First, the sample consisted of a single cohort of students from a single university in the United States, limiting generalizability. Second, no physiological measures of intoxication were available, thus we relied on the calculation of eBAC based on a formula including gender, weight, number of drinks, and time spent drinking [27]. Such measures provide reasonably accurate estimates of breath alcohol concentrations [37] and are necessary in studies designed not to interfere with usual behavior in natural settings, but contain important measurement error [37,38]. Third, the measure of subjective intoxication was dichotomous and thus lacked sensitivity for capturing information about intensity of drunkenness. Fourth, the validity of self-reports of energy and alcoholic drinks depends on accurate recall and willingness to report behavior. Recall was facilitated by asking questions daily, but of course also limited by intoxication—as in all studies—on heavy drinking days. Fifth, the time of day of energy drink consumption was not reported and other caffeinated products were not assessed; however, these limitations likely served to attenuate the effects of energy drinks. In addition, the half-life of caffeine is about 4–5 hours, or longer for higher caffeine consumption [39,40], making it very likely that the pharmacological effects of caffeine and alcohol overlapped on days students used both energy drinks and alcohol, whether or not they were consumed in the same container or sitting. Finally, although the within-person analyses by design control for all time-stable confounding factors (such as family background, precollege drinking history, sensitivity to caffeine), additional fluctuating factors (such as tiredness, food consumed before drinking, goals for the night, drinking partners) remain possible time-varying causes of observed associations.

In a recent editorial, Attwood argued that although the public health concern on this topic may be justified, "we should be careful that preoccupation with the caffeine/alcohol debate does not divert attention from the more pressing issue of harmful alcohol consumption" [34]. Investigating the public health impact of energy drink plus alcohol use, compared with the public health impact of alcohol alone, will be an important step for documenting the scope of the problem. Results here suggest that energy drink consumption is, in fact, a new risk factor for heavier and harmful alcohol consumption that should be examined in the context of other person-level and situational factors that predict dangerous drinking. Future research should build on the strengths of this study–most notably the collection of within-person data comparing different types of drinking days–to replicate and extend the results in samples that are more diverse with respect to age, social role status, drinking culture, and country of origin. More detailed measurement of daily drinking motivations, academic and work demands, and sleep patterns would provide a more nuanced picture of how individuals strategically aim to use both caffeine and alcohol for varied social and achievement goals.

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IMPLICATIONS AND CONTRIBUTION

When late adolescents consume energy drinks and alcohol, they are more likely to consume more alcohol, become more intoxicated, and experience more negative consequences compared with when they consume only alcohol. Prevention programs designed to reduce the risks associated with the consumption of energy drinks and alcohol are needed.

Table 1

Descriptive statistics on days with any drinks

	M	SD	Actual range
Level 3: Person-level constructs			
Male gender	.46	50	0–1
Person mean energy drinks[a]	.08	.16	0–1.19
Level 2: Semester-level constructs			
Fraternity/sorority[b]	.09	.28	0–1
Semester mean energy drinks[c]	.09	.22	0–1.83
Semester mean eBAC[d,e]	.09	.07	0–.50
Level 1: Daily-level constructs[f]			
Energy drinks[g]	.16	.57	0–3
Alcohol drinks, number (all days)	.95	2.76	0–26
Alcohol drinks, number (drinking days)	6.07	4.21	1–26
eBAC[e]	.10	.085	0–.50
Hours spent drinking alcohol	4.33	3.82	0–22.25
Subjective drunkenness	.51	.50	0–1
Negative alcohol consequences	1.01	1.67	0–10

Level 1 N = 4,128–4,203 person days; level 2 N = 1,335 person semesters; level 3 N = 508 people.

eBAC = estimated blood alcohol content; M = mean; SD = standard deviation.

[a] One score per person, averaged across all sampled days and all semesters.

[b] One score per person in each semester, indicating whether a member that semester.

[c] One score per person in each semester, representing the average energy drink use across all sampled days that semester.

[d] One score per person in each semester, representing the average eBAC across all sampled days that semester.

[e] When eBAC was used as a dependent variable, it was multiplied by 100 to facilitate analyses using a Poisson distribution.

[f] All daily-level constructs consist of one score per person per sampled day.

[g] 0 = none, 1 = 1, 2 = 2, and 3 = 3 or more energy drinks.

Table 2

Multilevel models predicting alcohol use based on daily-level energy drink use

	Alcoholic drinks ERR (CI)	eBAC ERR (CI)	Hours drinking alcohol ERR (CI)
Level 3: Person-level			
Intercept	3.22 (2.96–3.51)****	7.32 (6.63–8.09)****	9.86 (8.90–10.92)****
Male gender	1.34 (1.23–1.46)****	.82 (.73–.92)***	1.09 (1.01–1.18)**
Person mean energy drinks	1.49 (1.07–2.08)**	1.41 (.93–2.14)	1.30 (.96–1.76)*
Level 2: Semester-level			
Semester (linear)	.99 (.97—1.01)	.94 (.92–.97)****	1.03 (1.01–1.06)**
Fraternity/sorority	1.16 (1.05–1.28)***	1.16 (1.01–1.32)**	1.15 (1.03–1.28)**
Semester mean energy drinks	1.03 (.92–1.15)	1.05 (.90–1.22)	.99 (.85–1.16)
Level 1: Daily-level			
Weekend	1.42 (1.34–1.51)****	1.33 (1.24–1.42)****	1.54 (1.42–1.66)****
Energy drinks	1.11 (1.07–1.15)****	1.13 (1.07–1.19)****	1.05 (1.00–1.12)*

Level 1 N = 4,128–4,203 person days; level 2 N = 1,335 person semesters; and level 3 N = 508 people. eBAC and time drinking alcohol values were transformed to integer values for analysis to comply with assumptions of the Poisson model that dependent variables be integers representing count variables; raw eBAC values were multiplied by 100 and time spent drinking values were multiplied by 4 (because it was reported in 15-minute increments).

CI = confidence interval; eBAC = estimated blood alcohol content; ERR = event rate ratio (from Poisson hierarchical linear modeling).

* $p < .10$.

** $p < .05$.

*** $p < .01$.

**** $p < .001$.

Table 3

Multilevel models predicting drunkenness and alcohol consequences based on daily-level energy drink use

	Daily-level eBAC not controlled		Daily-level eBAC controlled	
	Drunk OR (CI)	**Negative consequences ERR (CI)**	**Drunk OR (CI)**	**Negative consequences ERR (CI)**
Level 3: Person-level				
Intercept	.45 (.35–.60)***	.52 (.43–.62)***	.65 (.48–.88)**	.52 (.43–.62)***
Male gender	.88 (.67–1.15)	1.25 (1.03–1.52)*	.88 (.64–1.20)	1.27 (1.04–1.55)*
Person mean energy drinks	1.97 (.81–4.75)	2.70 (1.47–4.96)**	2.07 (.70–6.08)	2.60 (1.40–4.81)**
Level 2: Semester-level				
Semester (linear)	.87 (.81–.94)***	.93 (.89–.97)**	.84 (.77–.92)***	.93 (.89–.97)**
Fraternity/sorority	2.46 (1.52–3.99)***	1.07 (.81–1.41)	2.81 (1.57–5.03)**	1.06 (.80–1.42)
Semester mean energy drinks	1.68 (1.07–2.62)*	.98 (.74–1.29)	1.68 (.93–2.99)	.96 (.71–1.30)
Level 1: Daily-level				
Weekend	2.48 (2.00–3.07)***	1.32 (1.16–1.52)***	1.82 (1.47–2.25)***	1.16 (1.02–1.32)*
Energy drinks	1.51 (1.28–1.79)***	1.27 (1.18–1.38)***	1.18 (.97–1.45)	1.14 (1.04–1.25)**
eBAC	—	—	1.24 (1.21–1.27)***	1.07 (1.06–1.08)***

Level 1 N = 4,128–4,203; level 2 N = 1,335 person semesters; and level 3 N = 508 people. eBAC and time drinking alcohol values were transformed to integer values for analysis to comply with assumptions of the Poisson model that dependent variables be integers representing count variables; raw eBAC values were multiplied by 100 and time spent drinking values were multiplied by 4 (because it was reported in 15-minute increments).

CI = confidence interval; eBAC = estimated blood alcohol content; ERR = event rate ratio (from Poisson hierarchical linear modeling); OR = odds ratio (from Bernoulli hierarchical linear modeling).

* $p < .05$.

** $p < .01$.

*** $p < .001$.