Correlates of Alcohol Mixed with Energy Drink Use Among First Year College Students: Clinical and Research Implications

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Background: Alcohol mixed with energy drink (AmED) use among college students is associated with specific adverse effects (e.g., sexual assault, driving while intoxicated). This study offered the opportunity to evaluate correlates of past year AmED use in a large sample of college students.

Methods: In autumn 2010, emails were sent to all first year students ($n = 29,536$) at 11 colleges and universities in North Carolina and Virginia, inviting them to participate in a brief web-based survey to be used to establish a cohort for the parent tobacco use study; 10,340 (35%) students responded to the web-based survey, which elicited items on demographics, past year use of AmED, and other health behaviors.

Results: Past year of AmED was reported by 29.4% of students. Logistic regression analysis revealed that female gender (adjusted odds ratios [AOR] = 1.28, 95% confidence interval [CI] = 1.16–1.42); ever use of smokeless tobacco (AOR = 3.51, 95% CI = 3.00–4.10); current smoking (AOR = 4.97, 95% CI = 4.34–5.69); 2 or fewer days of physical activity per week (AOR = 1.16, 95% CI = 1.04–1.28); and 7 or 8 hours of sleep per day (AOR = 1.12, 95% CI = 1.02–1.24) predicted risk of past year use of AmED.

Conclusions: Nearly a third of first year college students reported past year use of AmED. Our finding of increased past year use of AmED use among women is new and might reflect the changing epidemiology of female college alcohol use. Of additional concern, such use might also reflect targeted marketing to women by the energy drink industry. Findings can guide future research as well as substance counseling to college students.

Keywords: alcohol, college students, energy drink

Introduction

THE CONSUMPTION OF ALCOHOL mixed with energy drinks (AmED) is an increasing phenomenon on college campuses and is associated with high rates of adverse health consequences among young adults.^{1–4} The energy drink component of these beverages virtually always includes caffeine, but may also contain additional ingredients such as taurine, ginseng, ginko biloba, and other stimulants (e.g., guarana or yerba mate).^{1,3,5} Moderate doses of caffeine enhance cognition, vigilance, and reaction time in fatigued individuals, but higher doses can cause renal, cardiovascular, and central nervous system toxicity.⁶ Moreover, lab animal studies indicate that

gender differences exist in the effects of some energy drink ingredients on adolescent mice. For example, among males high doses of taurine added to drinking water decrease cortical dopamine, sociality, and alcohol consumption. In female adolescent mice, high doses of taurine increase alcohol use yet, paradoxically, improve water maze performance. High taurine doses in both genders impair recognition of novel objects and increase hypothalamic serotonin.⁶ Consumed together acutely, caffeine and taurine increase male, but not female, locomotor activity. Binge-like co-administration of alcohol and energy drink (Red Bull®) in male Wistar rats increased alcohol-seeking behavior 1 to 3 weeks after the last alcohol dose.⁷

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As summarized by Weldy,⁸ caffeine use by itself is associated with impulsivity, as well as risky health behaviors such as increased sexual activity, illicit drug use, and tobacco use. Furthermore, Miller⁹ found that energy drink use, even without alcohol, was associated with high-risk behaviors among college students. Medically, a recent review of adverse effects of energy drink use among children, adolescents, and young adults indicated that these products increase the risk of seizures, diabetes, hypertension, cardiac arrhythmias, anxiety, poor nutrition, and sleep disturbance—largely due to caffeine toxicity.¹⁰ Government tracking of caffeine toxicity reports from German poison information and treatment centers since 2002 uncovered liver damage, kidney failure, respiratory disorders, agitation, seizures, psychotic conditions, rhabdomyolysis, tachycardia, cardiac dysrhythmias, hypertension, heart failure, and death.¹¹ In South Carolina recently, a 16 year old collapsed and died in school after consuming three caffeinated beverages within a 2 hour period (a caffè latte, a large caffeinated diet soda, and a popular energy drink).¹²

Combining alcohol with caffeine and other stimulants increases the risk of immediate toxicity and injury.⁸ Concurrently, this combination lessens the subjective feeling of drunkenness¹ and increases the rapidity of drinking.¹³ Thus, inebriated students might continue to drink—and to drink faster—since they lack their typical awareness of their level of intoxication. In a web-based survey of over 4000 college students,¹ consumption of AmED was associated with binge drinking and increased episodes of weekly drunkenness. Additionally, such consumption was associated with a higher rate of alcohol-related consequences (e.g., sexual assault, injuries requiring medical attention, and driving while intoxicated).¹ Despite the increased prevalence of sexual assault with AmED use, a specific focus on gender has been less studied in this field of research. Nonetheless, lab animal data suggest differential gender effects, particularly related to taurine.⁶ The goal of this study was to examine correlates of AmED drink use among first year college students, including associations with gender, sleep and physical activity.

Methods

Sample

Participants in this study were from the initial screening survey of the Smokeless Tobacco Use in College Students study, which has been described previously.¹⁴ The goal of the parent study was to assess trajectories and correlates of smokeless tobacco (SLT) use in a cohort of college students with web-based surveys sent each semester from the fall of their freshman year until the fall of their senior year. For the initial screening survey, email addresses from incoming all first year students ($n = 29,536$) were provided by 11 colleges and universities in North Carolina ($n = 7$) and Virginia ($n = 4$) in fall

2010. There were 10,340 students who responded, for a response rate of 35%. These students were sent a web-based survey from which the final cohort would be drawn. Nine schools are public, two are private, five are in rural communities, four are in suburban communities, and two are in urban communities. Undergraduate enrollment ranges from ~4000 to just over 23,000 students. To encourage participation, participants were eligible for a \$100 gift card raffle (10 students per school).

Measures

The goal of the initial screening survey was to identify correlates of SLT use, while at the same time concealing this goal to respondents so that results would not be biased (e.g., only tobacco users answering). In addition, the survey had to remain brief to encourage participation. Thus, the survey was entitled Assessment of the College Experience, or ACE. Students were asked their age, gender, class year and status (full or part time). Respondents were also asked if they used SLT in the past month, past year, more than a year ago or never; and whether they had smoked a cigarette within the past 30 days. To blind the goal of the survey, we added distractor questions about other important college student health behaviors.^{15–18} We assessed past year of AmED by the question: “Have you ever used alcohol mixed with energy drinks?” Answers were coded as yes within the past year or no. Measures of physical activity were derived from national adult recommendations,¹⁹ and categorized as less than 3 days, 3–4 days and 5 or more days of vigorous activity per week based on the questions: “During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? (Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time).” Sleep is important for college student health and academic success.^{20,21} Therefore, we evaluated sleep by asking: “On an average school night, how many hours of sleep do you get?” Answers were categorized as less than 7 hours, 7–8 hours, and more than 8 hours per night.

Statistics

Alcoholic energy drink use, demographics, and health-risk behaviors were summarized using descriptive statistics. Random-effects logistic regression models were used to fit a multivariable model of past year of AmED. School was treated as a random effect to account for intraschool correlation, since students within a school are likely to be more like one another than they are to be like students in other schools. Adjusted odds ratios (AOR) and their 95% confidence intervals (CI) were calculated for the independent variables. Models were estimated in SAS Version 9.2 and PROC GLIMMIX. A two-sided p -value < 0.05 was considered statistically significant.

TABLE 1. SAMPLE CHARACTERISTICS BY PAST YEAR USE ALCOHOL MIXED WITH ENERGY DRINK

Variable	<i>Past year use alcoholic energy drink</i>		<i>Total (n = 10,340) n (%)</i>
	<i>Yes (n = 3044) n (%)</i>	<i>No (n = 7296) n (%)</i>	
Age			
18 years	2816 (92.51)	6743 (92.42)	9559 (92.45)
>18 years	228 (7.49)	553 (7.58)	781 (7.55)
Gender			
Female	1863 (61.20)	4647 (63.69)	6510 (62.96)
Male	1181 (38.80)	2649 (36.31)	3830 (37.04)
SLT ever use			
Yes	649 (21.32)	362 (4.96)	1011 (9.78)
No	2395 (78.68)	6934 (95.04)	9329 (90.22)
Cigarette past 30-day use			
Yes	872 (28.65)	413 (5.66)	1285 (12.43)
No	2172 (71.35)	6883 (94.34)	9055 (87.57)
Physical activity			
<3 days	854 (28.06)	2226 (30.51)	3080 (29.79)
≥3 days	2190 (71.94)	5070 (69.49)	7260 (70.21)
Sleep (hours)			
>8 hours	98 (3.22)	243 (3.33)	341 (3.30)
<7 hours	1237 (40.64)	2696 (36.95)	3933 (38.04)
7 or 8 hours	1709 (56.14)	4357 (59.72)	6066 (58.67)

SLT, smokeless tobacco.

Results

Sample characteristics and their associations with past year use of AmED use are listed in Table 1. The majority of students were 18 years old (92.4%) and female (63.0%). Almost one-third of the population had used AmED in the past year (29.4%). Nearly one-tenth of students had ever used SLT (9.8%) and just over one-tenth (12.4%) had smoked in the past 30 days. Most students were physically active 3 or more days a week (70.2%) and slept 7 or 8 hours a night (58.7%) over the past 30 days.

In the multivariable model (Table 2), past year use of AmED was associated with: female gender (AOR=1.28, 95% CI=1.16–1.42); ever use of SLT (AOR=3.51, 95% CI=3.00–4.10) cigarette smoking in the past 30 days (AOR=4.97, 95% CI=4.34–5.69); 3 or more days of physical activity per week (AOR 1.16, 95% CI: 1.04–1.28); and >8 hours of sleep per day (compared with 7–8 hours of sleep per day, AOR 1.12, 95% CI: 1.02–1.24).

Discussion

In a large sample of first year college students, we have found that past year AmED use was associated with female gender, SLT use and cigarette smoking, higher levels of physical activity, and more hours of sleep per day. Confirming prior studies,^{22–24} our work shows correlations of past year AmED with tobacco use and physical activity. We also note that any current or prior alcohol use among these first year college students would constitute underage drinking in North Carolina and Virginia because all students were under 21 years old. Further-

more, since this survey was filled out within the first weeks of participants' first year in college, much of this use likely occurred in high school or even earlier.

To our knowledge, we are the first to note the association of past year AmED use with female gender. This

TABLE 2. MULTIVARIATE ANALYSIS USING MIXED EFFECTS LOGISTIC REGRESSION ANALYSIS ADJUSTING FOR CLUSTERING WITHIN-SCHOOLS

Variable	<i>Multivariable analysis</i>		
	<i>Adjusted odds ratio</i>	<i>95% Confidence interval</i>	
Age			
18 years vs. ≥18 years ^a	1.08	0.90	1.28
Gender			
Female vs. male ^a	1.28*	1.16	1.42
SLT ever use			
Yes vs. no ^a	3.51*	3.00	4.10
Cigarette past 30-day use			
Yes vs. no ^a	4.97*	4.34	5.69
Physical activity type (3 or more hours vs. 2 or fewer hours per week)			
Yes vs. no ^a	1.16*	1.04	1.28
Sleep hours per day			
<7 hours vs. 7 or 8 hours ^a	0.99	0.76	1.28
>8 hours vs. 7 or 8 hours ^a	1.12*	1.02	1.24

Outcome = Past year use of alcohol mixed with energy drink (n = 10,340).

^aReference group.

*p < 0.05.

finding is important for at least four reasons. First, as reviewed above, administration to lab animals of caffeine alone, taurine alone, and AmED causes gender-specific differences in cognitive, behavioral, and physiologic effects.^{6,7} Therefore, gender-specific research of effects of AmED use is warranted.⁶

Second, females' use of alcohol has increased over recent years, such that female college students now have the same if not greater prevalence of high risk drinking compared with men.²⁴ Our novel finding of the association of past year use of AmED use with female gender might reflect this change in the epidemiology of women's use of alcohol. While nonalcoholic energy drink use was found predominantly among females in one study,²² AmED use has traditionally been regarded as largely a male phenomenon.²³ It would be important to corroborate whether our female AmED findings reflect the changed epidemiology of alcohol use by college women.

Third, increased prevalence of past year AmED use among women is concerning because it might imply that increased marketing of energy drink products to females could be driving their AmED use. According to Nielsen,²⁵ 5-hour Energy, the maker of popular "shots" of energy drink, are developing a "woman-friendly" energy beverage (pink lemonade flavor) and donating some proceeds to the Avon Foundation Breast Cancer Crusade. Reminiscent of the tobacco industry marketing "slim" cigarettes to women, Monster Energy launched "Zero Ultra," emphasizing its lack of sugar or calories and packaged in white cans with feminine designs.²⁵ In fact, the energy drink industry began targeting women as early as 2009.²⁶ Indeed, Hoyte²⁷ has argued that all healthcare providers should educate patients about unique forms of toxicity involved in energy drink use—for example, adverse reactions to taurine, ginseng, guarana, and caffeine—including use of AmED. The higher female prevalence of AmED use in our sample might indicate that women are more willing to answer questions about energy drink use. Alternatively, the increased use we found among women might indicate the need for health education about the risks of energy drink use when combined with alcohol¹—in particular the potential for fetal harm when used by pregnant women.⁶

Fourth, risk of sexual assault is an additional impetus to be concerned about AmED use among women. Compared with current drinkers who did not drink AmED, O'Brien showed that those students consuming AmED had increased rates of problem drinking and higher rates of alcohol-related consequences (e.g., sexual assault, riding with a driver who was under the influence of alcohol, need for medical treatment).¹ All healthcare providers¹ should inquire about student use of AmED. While this is important for both genders, female students are particularly at risk of AmED. As discussed, additional violent sexual consequences exist for women compared to men (e.g., being physically coerced to have sexual intercourse).²⁸

The correlation of past year AmED use with more hours of sleep per day appears paradoxical, as less sleep, rather than more, among college students has predicted unhealthy behaviors.^{8,9,20,21}

It might be that AmED use causes sleep deprivation on the nights of consumption, which is compensated by increased sleep on other nights. Indeed, students who binge on alcohol and energy drinks have poorer same-night sleep quality and increased next-day tiredness.^{29,30} An overall increase in hours of sleep might simply be compensatory. Alcohol is also a depressant, and students who mix alcohol and energy drinks have higher rates of depressive symptoms³¹—one of which can be insomnia. Further research on the total impact—rather than simply the short term, alcohol- or caffeine-induced impacts^{8,29,30}—of AmED use on sleep is warranted.

Past year use of AmED correlated with increased physical activity. This confirms findings by others that participation in intramural and club sports is associated with increased alcoholic energy drink consumption.³² Student athletes are known to have increased use of AmED, even though the data on athletic performance is conflicting.^{33–35} Tobacco use is a known correlate of AmED use.^{1–3}

These findings are subject to a number of limitations. First, our survey was necessarily very brief, precluding inquiries about premixed or self-mixed beverages, as well as quantity and frequency of AmED use. Such information would be crucial for behavioral counseling. Second, the response rate was 35%, and we do not have information on nonrespondents. However, this response rate is similar to rates achieved by other online surveys among college students.^{36,37} In addition, although almost one-third of the population had used AmED in the past year (29.4%); this is lower than found in other work on use of AmED (44%) among college students.³⁸ The latter study included upperclassmen which likely increased the rate of AmED past year. Still, perhaps our efforts to mask the purpose of the screener survey biased the response rate such that our sample is not fully representative of college students more generally. Indeed, the sample was restricted to first year students and thus is not representative of all college students. Finally, since this initial screening survey was cross-sectional, causality cannot be conferred from these data.

Despite limitations, our results have implications not only for clinicians providing caring for college students, but also for the future. First, substance abuse counseling is solidly within the realm of student health promotion. The U.S. Preventive Services Task Force, for example, recommends screening and brief intervention counseling and referral for treatment for alcohol misuse as part of primary care provision.³⁹ While student health clinicians are usually aware of this need, they often do not provide such counseling because lack of training, time pressure,

and poor reimbursement.³⁹ Second, college healthcare providers should be aware of the increased prevalence of AmED use among women, particularly with recent trends of increased energy drink marketing targeting women. Third, questioning about AmED use could be an additional guide to clinicians to broaden inquiry into types of alcohol use (e.g., beer, wine, mixed drinks, AmED). Finally, the effects of caffeine on sleep and its association with use of other substances including alcohol should be discussed with college students.²¹

Among its many tasks, the prefrontal cortex is responsible for cognition and executive function. This brain region experiences its greatest development from adolescence into young adulthood. Because of energy drinks' multiple ingredients with psychoactive effects, young individuals might be particularly vulnerable to any adverse developmental effects from energy drink use. Batenburg-Eddes *et al.* studied the behavioral and cognitive effects of regular energy drink consumption in Dutch adolescents.⁴⁰ They documented detrimental impacts on behavioral regulation and metacognitive skills with as few as one energy drink serving a day. Parents also recognized these deleterious effects.

Since student health providers are often the "point of entry" into the healthcare system, it is particularly essential that they recognize and are able to counsel on dangers associated with alcoholic energy drink use.³⁹ In addition, these clinicians instructing student-patients on healthy sleep should discuss possible sleep disturbance from AmED which can impact student health and well-being.²¹ From a research perspective, since our study appears to have uncovered previously undetected relationships between AmED use, female sex, and sleep, further research is needed to replicate and more fully describe these new findings regarding energy drink use. From a population health perspective, measures to counteract the marketing of energy drinks to women appear important. Finally, studies need to be carried out evaluating educational needs of clinicians regarding counseling on AmED use, including the adverse reactions to excessive caffeine and other energy drink stimulants.

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Author Disclosure Statement

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