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

Megan E. Patrick, Ph.D.^{a,*}, and Jennifer L. Maggs, Ph.D.^b^a *Institute for Social Research, University of Michigan, Ann Arbor, Michigan*^b *Department of Human Development and Family Studies and Prevention Research Center, Pennsylvania State University, University Park, Pennsylvania**Article history:* Received June 3, 2013; Accepted September 20, 2013*Keywords:* Alcohol; Drinking; Energy drink; Blood alcohol; College; Consequences; Daily

 A B S T R A C T

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.

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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.

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 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.

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* Address correspondence to: Megan E. Patrick, Ph.D., Institute for Social Research, University of Michigan, 426 Thompson Street, Ann Arbor, MI 48106-1248.

E-mail address: meganpat@umich.edu (M.E. Patrick).

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 $\geq .08\%$), 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.

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