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Event-level analyses of energy drink consumption and alcohol intoxication in bar patrons

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ABSTRACT

Aim: To assess event-level associations between energy drink consumption, alcohol intoxication, and intention to drive a motor vehicle in patrons exiting bars at night.
Method: Alcohol field study. Data collected in a U.S. college bar district from 802 randomly selected and self-selected patrons. Anonymous interview and survey data were obtained as well as breath alcohol concentration (BrAC) readings.
Results: Results from logistic regression models revealed that patrons who had consumed alcohol mixed with energy drinks were at a 3-fold increased risk of leaving a bar highly intoxicated (BrAC ≥ 0.08 g/210 L), as well as a 4-fold increased risk of intending to drive upon leaving the bar district, compared to other drinking patrons who did not consume alcoholic beverages mixed with energy drinks.
Discussion: These event-level associations provide additional evidence that energy drink consumption by young adults at bars is a marker for elevated involvement in nighttime risk-taking behavior. Further field research is needed to develop sound regulatory policy on alcohol/energy drink sales practices of on-premise establishments.

1. Introduction

Since the introduction of Red Bull in the U.S. in 1997, the market for high caffeine content energy drinks has grown exponentially (Reissig, Strain, & Griffiths, 2009). The promotional campaigns for energy drinks, which often feature extreme sports, leave little doubt that producers target the young adult market (Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007; Miller, 2008b). The amount of caffeine contained in these drinks as well as other substances—such as amino acids, vitamins, and herbal derivatives (Aranda & Morlock, 2006) included for their real or supposed synergistic effects of increased stimulation (Clauson, Shields, McQueen, & Persad, 2008)—have raised concerns about their potential health risks, particularly when they are used in combination with alcohol (McCusker, Goldberger, & Cone, 2006). Furthermore, the acute and chronic effects resulting from energy drink consumption are not fully understood (Reissig et al., 2009).

Recent studies employing non-probability sampling have found that 73% of an American college sample (Malinauskas et al., 2007) and 85% of an Italian medical school student sample (Oteri, Salvo, Caputi, & Calapai, 2007) had consumed energy drinks mixed with alcohol during the past month. College students are a major market for energy drinks (O'Brien, McCoy, Rhodes, Wagoner, & Wolfson, 2008) and they are a ubiquitous feature of recreational events in many campus communities (Miller, 2008a). The major motivations college students cite for using energy drinks is to compensate for insufficient sleep, increase energy, and mix with alcohol while partying (Malinauskas et al., 2007). In regard to alcohol abuse, concerns have emerged over the increasing popularity of such drinks as "Red Bull and vodka" and "Jager Bombs" (Jagermeister and Red Bull) served at bars and nightclubs (O'Brien et al., 2008).

Clinical studies have found that co-ingestion of caffeine, a central nervous system stimulant, and alcohol, a depressant, reduces subjective perceptions of alcohol-induced impairment in comparison to alcohol alone; however, there is less evidence to suggest that co-ingestion reduces objective measures of impairment (Ferreira, de Mello, Pompeia, & de Souza-Formigoni, 2006; Liguori & Robinson, 2001; Marczinski & Fillmore, 2006). Thus, when mixing energy drinks and alcohol, users may become desensitized to the symptoms of alcohol intoxication, which may increase the potential for alcohol-related harm such as alcohol poisoning, physical injury, impaired

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driving, and sexual victimization. One college study found that in comparison to students who consumed only alcohol, students who consumed energy drinks mixed with alcohol had experienced a higher prevalence of alcohol-related consequences including being taken advantage of sexually, taking advantage of another sexually, riding with a driver who was under the influence of alcohol, being hurt or injured, and requiring medical treatment (O'Brien et al., 2008).

A major limitation of the current published research on the effects of combining energy drinks with alcohol is that these investigations have been conducted in laboratory settings or report findings from retrospective self-report surveys. Missing from the research are event-level analyses of energy drink and alcohol use in naturalistic drinking settings, such as college bars. To examine this popular on-premise drinking practice (Clauson et al., 2008; Miller, 2008b), a carefully designed nighttime field study (Clapp, Holmes, Reed, Shillington, & Freisthler, 2007) was conducted to assess these associations in a sample of college bar patrons.

Two hypotheses were tested in the study. First, we hypothesized that consuming energy drinks mixed with alcohol would be associated with a significant increase in the odds of leaving a bar in a highly intoxicated state [defined as having a breath alcohol concentration (BrAC) $\geq$ 0.08 g/210 L], after adjusting for potential confounders. We expected that consuming energy drinks mixed with alcohol would reduce the sedating effects of alcohol and therefore promote increased alcohol consumption and intoxication. Second, we hypothesized that consuming energy drinks mixed with alcohol would be associated with a significant increase in the odds of intending to drive upon leaving a bar, after adjusting for potential confounders. We anticipated that consuming energy drinks mixed with alcohol would reduce perceptions of impairment and thereby support intentions to drive from a bar district.

2. Methods

2.1. Setting

This institutional review board-approved study was conducted on four consecutive nights in April, 2008 (Wednesday through Saturday). Interview, self-report survey, and BrAC data were collected from patrons exiting seven drinking establishments in a college bar district in Gainesville, Florida. A total of seven establishments in the district served alcohol past 10:00 p.m. Municipal ordinance required them to close at 2:00 a.m. The bar district catered specifically to college students and was adjacent to a public university that enrolls over 51,000 students and is within 5 miles of a public college enrolling an additional 16,000 students. Although it is illegal to serve alcohol to persons under the age of 21, there is no state law banning underage persons from entering these establishments.

2.2. Field procedures

Data were collected each night between 10:00 p.m. and 3:00 a.m. by a team of at least 35 trained graduate and undergraduate students supervised by principal investigators. Recruiters approached every third patron exiting each of the seven drinking establishments, briefly described the purpose of the study and incentives for participation (i.e., free food and non-alcoholic beverages), and solicited verbal informed consent to place a uniquely numbered red bracelet on the patron's wrist. Patrons who agreed to participate were directed to a research station in the center of the bar district. Patrons who were not randomly selected but expressed interest in participating in the study were also directed to the research station (but without a red bracelet). During recruitment, sex and self-reported race/ethnic identity were collected from every third exiting patron to assess the demographic characteristics of patrons in the bar district.

The research station was located within 50 m from the main entrances of all seven drinking establishments in the district. Two university vans were parked parallel to the street, with large signs reading "Alcohol Research" affixed to the vans to identify the project. All research assistants wore uniform t-shirts to identify their affiliation with the research project. In addition to randomly recruiting patrons as they exited the bars, pedestrians passing by the research station were also solicited for participation if they had exited one of the establishments in the district. With consent from these self-selected participants, uniquely numbered green bracelets were placed on their wrists. To maximize their participation, randomly selected participants (noted by red bracelets) were given priority for being interviewed at all times.

The first step in the data collection process was a 3- to 5-minute, structured, face-to-face interview assessing participant demographic characteristics, energy drink consumption, and drinking behavior that night. After the interview was completed, participants used a clipboard to respond to a self-administered questionnaire (also 3–5 min) assessing potentially sensitive items such as age, intention to drive that night, and drinking history. When complete, participants were instructed to deposit their questionnaire in a secure ballot box. Next, participants were then given water to rinse their mouth of any residual alcohol, and breath-tested to assess alcohol intoxication. Previous field research has documented that the water-rinse procedure does not affect the accuracy of BrAC measurement (Thombs et al., 2008). After being breath-tested, participants were provided general feedback about their level of intoxication and given advice about driving risk that night (Thombs et al., 2009). Finally, participants were offered free food, non-alcoholic drinks, and a card with information about the study and sources of help for alcohol problems.

To insure the quality of the data collection procedures, peer confederates who posed as patrons exiting a bar in the district were recruited under the supervision of the principal investigator. Project personnel were informed that confederates would be used, although they were not informed of their identities. After going through the data collection procedures, the confederates reported to a specified location out of visible distance from the research station, where they answered a series of questions designed to assess the fidelity of the data collection process. Results indicated that there was a high degree of project personnel compliance with the data collection protocol.

2.3. Measures

Interview and survey forms with pre-printed matching identification numbers were used to link data collected by both methods. During the face-to-face interview, participants provided information about: demographic characteristics (i.e., sex, race/ethnicity, and current college attendance), energy drink consumption in the past 12 h [two variables coded as "consumption of energy drinks mixed with alcohol" (no = 0, yes = 1), "consumption of energy drinks *not* mixed with alcohol" (no = 0, yes = 1)], time spent drinking that night (in hours), and type, size, and number of alcoholic drinks consumed that night (used to estimate grams of ethanol consumed). After the interview, participants were given the self-administered survey to report particularly sensitive information. Before completing it, they were told that members of research team would not examine their responses and that when finished they were to deposit the survey in a ballot box at the research station. The survey assessed: birth date (to calculate age), intended mode of transportation upon leaving the bar district [coded as "drive a private vehicle" (no = 0, yes = 1)], and quantity and frequency of drinking in the past 12 months using a three-item version of the Alcohol Use Disorders Identification Test (AUDIT-C). The AUDIT-C was designed to assess alcohol dependence risk in situations requiring brevity. The possible

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range of scores for the AUDIT-C is 0 to 12 points with higher scores representing more hazardous patterns of drinking (Dawson, Grant, Stinson, & Zhou, 2005). BrAC readings (g/210 L of breath) were obtained using the Alco-Sensor IV (Intoximeters, Inc., St. Louis, Missouri), a hand-held breath alcohol testing device that meets requirements for traffic safety enforcement and is approved by the U.S. Department of Transportation for evidential use.

3. Results

3.1. Sample representation

Data were collected from 1255 exiting patrons, including 453 randomly recruited non-participants, 227 randomly recruited participants, 575 self-selected participants. Thus, the random selection procedure yielded a participation rate of 33.4% [227/(453+227)]. Among the 802 participants (227 + 575), 71.7% were exiting patrons who self-selected into the study. The proportion of participants recruited on each night of the week was: Wednesday — 25.1%, Thursday — 24.8%, Friday — 28.0%, and Saturday — 22.1%.

"Last bar exited" was the only variable on which a statistically significant group difference was found: randomly recruited *non*-participants were significantly different from that of randomly recruited participants [χ^2 (6, $N = 658$) = 26.94, $p < 0.0001$] and self-selected participants (χ^2 (6, $N = 1014$) = 1.05, $p < 0.0001$). The varying physical distances of the seven bars from the research station most likely accounted for the moderate degree of under- and over-representation observed on "last bar exited." There were no other statistically significant differences ($p > 0.05$) among the three participant groups regarding demographic (e.g., gender) or drinking variables (e.g., BrAC), suggesting that participants overall were representative of the patrons in the bar district on the nights of data collection. Therefore, the observations from the three groups were combined for data analyses.

3.2. Sample characteristics

Analyses were restricted to those cases in which the participant: (a) exited one of the seven establishments in the bar district that night; (b) completed all phases of data collection including breath alcohol test; (c) responded to questions in an accurate and honest manner; and (d) reported consuming alcohol that night. Among these 697 participants, 45 (6.5%) reported consuming energy drinks mixed with alcohol during the past 12 h, 46 (6.6%) reported consuming energy drinks and alcohol (not mixed together), 602 (86.4%) reported consuming alcohol only (no energy drinks), and 4 (0.6%) had missing values. Table 1 summarizes demographic and drinking behavior differences among the three groups defined by energy drink consumption. Chi-square analyses revealed significant sex [χ^2 (2, $N = 687$) = 9.95, $p < 0.007$] and current college attendance [χ^2 ($N = 2693$) = 14.09, $p < 0.001$] differences among the three groups. Non-significant differences ($p > 0.05$) were found for race/ethnicity, age, AUDIT-C score, and night of week. Results from a one-way ANOVA revealed significant group differences in regards to mean time interview began [$F(2, 689) = 3.95$, $p = 0.020$], mean hours engaged in drinking [$F(2, 687) = 5.05$, $p = 0.007$], mean number of drinks consumed [$F(2, 687) = 10.84$, $p < 0.001$], mean grams of ethanol consumed [$F(2, 687) = 14.35$, $p < 0.001$], and mean BrAC [$F(2, 691) = 8.06$, $p < 0.001$]. Student–Newman–Keuls post-hoc analyses indicated that scores on these five drinking measures were significantly greater ($p < 0.05$) in the group who consumed energy drinks mixed with alcohol compared to the other two groups (those who consumed energy drinks and alcohol not mixed together, and those who consumed alcohol only).

Table 1
Characteristics of three groups of college bar patrons ($N = 693$).

Variable	Alcohol only ($n = 602$)	Energy drinks and alcohol — not mixed ($n = 46$)	Energy drinks mixed with alcohol ($n = 45$)	$p <$
Demographic measures				
% male	60.5	82.0	71.1	0.007
% white	81.7	78.3	80.0	ns
% current college attendance	94.0	80.4	86.7	0.001
Mean age	22.6	23.3	22.6	ns
Mean AUDIT-C score	6.7	7.6	6.8	ns
Cross-tabulation by night of week				ns
% on Wednesday	27.1	23.9	11.1	–
% on Thursday	24.8	26.1	20.0	–
% on Friday	27.1	23.9	37.8	–
% on Saturday	21.1	26.1	31.1	–
% total	100.0	100.0	100.0	–
Drinking measures				
Mean interview time (0.00 = noon, 1.00 = 1:00 p.m.)	12.5	12.4	12.9	0.02
Mean hours engaged in drinking	2.9	3.1	3.9	0.007
Mean number of drinks consumed	6.2	7.3	9.0	0.001
Mean grams of ethanol consumed	95.3	108.3	152.2	0.001
Mean BrAC (g/210 L)	0.081	0.078	0.109	0.001

Note: *p*-values are based on Chi-square and *t*-tests. ns = $p > 0.05$.

3.3. Association between energy drink consumption and alcohol intoxication

A multivariable logistic regression analysis was conducted to test the first study hypothesis, i.e., to distinguish patrons who exited bars with BrACs ≥ 0.08 g/210 L from those with BrACs < 0.08 g/210 L. In addition to consumption of energy drinks mixed with alcohol, six potentially confounding variables were entered into the model as well (see Table 2). Among 595 participants who provided complete data (a listwise deletion of cases with missing values resulted in 102 cases being excluded from the analysis), 282 (or 47.4%) had BrAC readings greater than the 0.08 g/210 L cutoff. Peduzzi, Concato, Kemper, Holford, & Feinstein, (1996) recommend in the smaller of the two groups in logistic regression analysis, that there be at least 10 cases per variable to reduce the possibility of an invalid model. Thus, the case-to-variable ratio of 35:1 in the logistic model (282/8) was substantially greater than the threshold needed to establish statistical conclusion validity.

As shown in Table 2, the predictor set accounted for a significant amount of variance in BrAC defined by the 0.08 g/210 L cutting score [model Chi-square = 52.51 ($df = 8$), $p < 0.001$]. In support of the study hypothesis, the results indicated that consuming energy drinks mixed with alcohol was associated with a 3-fold increase in the odds of leaving a bar intoxicated (BrAC ≥ 0.08 g/210 L), after adjusting for potential confounders, including consumption of energy drinks not mixed with alcohol.

3.4. Association between energy drink consumption and intention to drive

A separate regression analysis using a similar set of predictors was conducted to test the second study hypothesis, i.e., to determine whether the predictor set could distinguish patrons intending to drive from bar district from those not intending to do so. In this analysis of driving status, AUDIT-C, a measure of habitual, hazardous drinking,

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Table 2
Multivariable logistic regression analysis of characteristics associated with high intoxication (BrAC ≥ 0.080 g/210 L) among patrons exiting drinking establishments in a college bar district ($N = 595$).

Variable	OR (95% CI)	$p <$	BrAC < 0.080 g/210 L ($n = 311$)	BrAC ≥ 0.080 g/210 L ($n = 284$)
AUDIT-C score	1.16 (1.09–1.24)	0.001	$m = 6.3$ (sd = 2.6)	$m = 7.3$ (sd = 2.7)
Consumed energy drinks mixed with alcohol (no = 0; yes = 1)	2.99 (1.39–6.43)	0.005	3.5%	9.5%
White	1.75 (1.13–2.73)	0.013	76.9%	85.5%
Weekend night (vs. weekday night)	1.72 (1.22–2.43)	0.002	43.9%	56.1%
Female	1.58 (1.09–2.29)	0.015	35.4%	39.2%
Consumed energy drinks and alcohol — not mixed together (no = 0, yes = 1)	1.20 (0.62–2.29)	ns	–	–
Age	0.96 (0.89–1.04)	ns	–	–
College student	0.72 (0.34–1.51)	ns	–	–

was removed and BrAC was included because it was salient to the driving task that night. A total of 623 participants provided complete data (74 cases with missing values were excluded) with 153 (or 24.6%) who indicated they intended to drive from the bar district. The case-to-variable ratio of 19:1 in this logistic model (153/8) also was substantially greater than the threshold needed to establish statistical conclusion validity (Peduzzi et al., 1996). As shown in Table 3, the predictor set accounted for a significant amount of variance in driving intention [model Chi-square = 32.150 ($df = 8$), $p < 0.001$]. Again, in support of the study hypothesis, consuming energy drinks mixed with alcohol was associated with a 4-fold increase in the odds of intending to drive from the bar district (after adjusting for potential confounders).

4. Discussion

This is the first known investigation to assess event-level associations between energy drink consumption and alcohol-related risk behaviors in a natural drinking environment. We hypothesized that consuming energy drinks mixed with alcohol would be associated with significant increases in the odds of: (1) exiting a bar in a highly intoxicated state and (2) intending to drive upon leaving a bar. In support of the first study hypothesis, multivariable analysis found that exiting bar patrons who reported consuming energy drinks mixed with alcohol were 3.32 times more likely to have a BrAC ≥ 0.080 g/210 L, after adjusting for demographic characteristics, alcohol dependence risk, and consumption of energy drinks and alcohol at different times in the same night (not mixed together). Furthermore, analyses indicated that patrons who consumed alcohol mixed with energy drinks, on average, exited a bar later in the evening, engaged in drinking for a longer period of time, consumed more total drinks and more grams of ethanol, and had higher levels of alcohol intoxication, compared to patrons who did not consume energy drinks that night or who consumed energy drinks and alcohol at different times in the same night (not mixed together).

Table 3
Multivariable logistic regression analysis of characteristics associated with intention to drive among patrons exiting drinking establishments in a college bar district ($N = 623$).

Variable	OR (95% CI)	$p <$	Did not intend to drive ($n = 470$)	Intended to drive ($n = 153$)
Consumed energy drinks mixed with alcohol (no = 0; yes = 1)	4.26 (2.14–8.49)	0.001	4.4%	12.3%
Age	1.09 (1.00–1.19)	0.04	$m = 22.5$ (sd = 2.4)	$m = 23.0$ (sd = 2.4)
BrAC	0.99 (0.99–1.00)	0.001	$m = 0.09$ (sd = 0.05)	$m = 0.07$ (sd = 0.05)
College student	1.26 (0.57–2.81)	ns	–	–
Female	1.01 (0.68–1.51)	ns	–	–
Weekend night (vs. weekday night)	1.00 (0.68–1.46)	ns	–	–
White	0.93 (0.58–1.48)	ns	–	–
Consumed energy drinks and alcohol — not mixed together (no = 0, yes = 1)	0.73 (0.34–1.56)	ns	–	–

In support of the second study hypothesis, results from multivariable analysis revealed that bar patrons who reported consuming energy drinks mixed with alcohol were 4.26 times more likely to report an intention to drive a motor vehicle from the bar district. These findings suggest that consuming energy drinks mixed with alcohol may reduce perceptions of alcohol impairment, and thus, increase one's confidence in operating a vehicle under the influence of alcohol. One clinical study found that, compared to consumption of an alcoholic beverage alone, consumption of an energy drink mixed with alcohol did not reduce objective impairment of motor coordination and visual reaction time, but did significantly reduce subjective symptoms of alcohol intoxication such as headache, weakness, dry mouth, and impaired motor coordination (Ferreira et al., 2006). These results are consistent with other studies investigating the combined ingestion of caffeine and alcohol (Liguori & Robinson, 2001; Marczinski & Fillmore, 2006). Thus, consumers of energy drinks mixed with alcohol may misinterpret their level of inebriation and attempt to drive a car or perform other potentially hazardous activities.

These findings corroborate previous studies using different methods and suggest that at the event-level, combining the stimulant effect of energy drinks with alcohol reduces the symptomatic lethargy associated with drunkenness, which may lead drinkers to underestimate their levels of intoxication and consume larger quantities of alcohol (Finnegan, 2003; Reissig et al., 2009). However, a second potential explanation for these findings may involve chronic heavy drinking; that is, over time alcohol tolerance may be increased by habitually consuming energy drinks mixed with alcohol. The possibility that combining energy drinks with alcohol may contribute to a chronic pattern of drinking producing elevated tolerance is supported by one laboratory study which found that a history of combined alcohol and caffeine administration increased alcohol tolerance compared with an exposure history to either drug alone (Fillmore, 2003).

The findings of this study also may be interpreted within the social psychological framework known as Problem Behavior Theory (Jessor & Jessor, 1977). The habitual practice of ordering alcoholic drinks in bars that are mixed with energy drinks may be a manifest feature of an underlying syndrome of problem behavior (Jessor, Donovan, & Costa, 1991). Research on adolescent and young adult development has established that problem behaviors of various types cluster within individuals (Jessor & Jessor, 1977). With respect to energy drinks, Miller (2008a) has found that in college students their consumption is positively associated with marijuana use, sexual risk-taking, fighting, seatbelt omission, taking risks on a dare, smoking, and illicit prescription drug use. Furthermore, O'Brien et al. (2008) found that consuming energy drinks mixed with alcohol was associated with

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increased risk for several alcohol-related consequences, even after adjusting for the amount of alcohol consumed. Therefore, on-premise consumption of energy drinks mixed with alcohol may be a marker of difficulties in psycho-social development.

In both regression models, combined consumption of energy drinks and alcohol was significantly associated with elevated breath alcohol concentrations and intentions to drive from the bar district after adjusting for energy drinks and alcohol consumed at different times in the same night (not mixed together). This finding suggests patrons who consume drinks mixed with energy drinks may have somewhat distinct behavioral or psychological characteristics, and it tends to weaken pharmacological explanations for the observed associations. To address these questions, future approaches to field research on bar patrons should include more comprehensive assessments of patrons and track cohorts through time to establish both event-level associations and patterns of chronic consumption of energy drinks and alcohol. Future field research should use toxicological measures of caffeine and other product ingredients (as well as alcohol) to quantify combined energy drink and alcohol consumption in bars. Finally, to increase our understanding of the appeal young adults have for alcoholic drinks mixed with energy drinks, future research should systematically assess the motivations that support their consumption (e.g., taste, intensify intoxication, to elongate drinking events, etc.).

4.1. Strengths and limitations

The objective measurement of patron intoxication in a naturalistic, nighttime setting and the analysis of event-level relationships between energy drink consumption and alcohol-related risk behavior are the major strengths of the study and bolster its ecological validity. One limitation involves generalizability of findings. Although the study was not designed to establish population parameters of energy drink consumption in on-premise establishments, data were collected in just one college bar district. In field studies, questions often arise about sampling adequacy because of the challenges of collecting data from random samples of intoxicated participants in nighttime settings and because of budget constraints (Dowdall & Wechsler, 2002). Uncertainties about sample representation need to be considered against the quality of the measures (such as BrAC readings) and utility of information generated about event-level associations in naturalistic settings.

A second sampling concern focuses on reasons for non-participation in the bar district. Although it was not possible to collect in-depth interview data from non-participants as they walked away from bars, observations of members of the research team, based on patron comments, suggest that alcohol use was not a likely cause of non-participation in most instances. More likely motivations for patron non-participation were: (1) did not want free food (not hungry), (2) left a bar in a direction that did not take them past the research station, (3) did not want to wait in a line at the research station, (4) preferred to not cross a busy street to get to the research station (one bar only), (5) wanted to leave quickly to be alone with a date, (6) had to leave quickly to meet others at another location, and (7) friends in a vehicle were waiting on the street to take them away.

A third limitation is use of patron self-report to measure intention to drive a vehicle from the bar district. Some participants may not have responded honestly to this questionnaire item because of its legal implications. Although steps were taken to assure participants that their responses would be anonymous and we excluded cases from analyses when the respondent indicated they had not answered all questions honestly, the extent to which driving from the bar district was underreported is not known.

A fourth limitation is that we did not quantify energy drink consumption on the night of the study, i.e., dose of caffeine and other possible psychoactive ingredients. As a result, the present findings provide no information about the extent to which potentially dangerous antagonist effects were produced in the patron sample.

5. Conclusions

This field study of energy drink and alcohol consumption among bar patrons contributes to the growing body of literature indicating that this drinking behavior has negative health and safety consequences in young adults (Miller, 2008b; Reissig et al., 2009). Accordingly, development and implementation of regulations requiring product labeling to fully disclose amounts of caffeine and other ingredients in energy drinks seems to be a sensible (albeit modest) strategy for addressing the problem at this time (Reissig et al., 2009). A further step in product labeling would include a clear warning about risks that might be experienced when combining energy drinks with alcohol. However, at present it may be premature to recommend specific regulatory controls on energy drink and alcohol sales practices in on-premise drinking establishments. Although bars and nightclubs may be the logical target venues for regulating alcohol and energy drink consumption, additional investigation is needed to better understand the consequences of the practice in this setting. Policy seeking to curtail on-premise marketing of alcoholic drinks mixed with energy drinks needs to be informed by research designed specifically for this purpose and should focus on bars and nightclubs that attract young adults.

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Contributors

Authors Thombs, O'Mara, Weiler, Merves, and Goldberger designed the study, wrote the data collection protocol, and supervised night time data collection. Authors Tsukamoto and Rossheim conducted the literature search and wrote the first draft of the Introduction and Discussion. Thombs and O'Mara conducted data analyses and wrote the first draft of the Methods and Results sections. All authors participated in manuscript revisions and approved the final manuscript.

Conflict of Interest

All authors declare that they have no conflicts of interest.

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