

Caffeinated alcoholic beverage consumption is associated with binge drinking among Canadian college students

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ABSTRACT

Introduction: Binge drinking, characterized by a pattern of excessive alcohol intake on a single occasion, is a growing epidemic among college students. Mixing alcohol with caffeinated energy drinks is also increasing in popularity. Caffeine suppresses the user's ability to accurately assess her level of intoxication and, consequently, the user tends to drink more without realizing the effects. Few studies to date, however, have focused on the association between mixing alcohol with energy drinks and binge drinking. **Methods:** Our study surveyed 221 Canadian college students on their mixing and binge drinking behaviours. We expected to find no significant gender differences in the proportions of both mixers and binge drinkers or in the frequencies of mixing and binge drinking. **Results:** Binge drinkers were more likely to mix than non-binge drinkers, and mixers were more likely to binge drink than non-mixers. Additionally, t-test results showed that mixers were more motivated to drink for the sake of getting drunk than non-mixers were. Surprisingly, these two groups did not significantly differ in the degree to which they felt risk-related behavioral states when they consumed, even though mixers reported significantly more drinking-related life interference. **Conclusion:** Our results demonstrate that preventative programs aimed at reducing high-risk alcohol binge drinking need to consider mixing energy drinks and alcohol intake as a risk factor.

KEYWORDS

Alcohol abuse, Binge drinking, Energy drink, Caffeine

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INTRODUCTION

Alcohol abuse by college students is currently recognized as a substantial public health problem (1). This abuse is characterized by heavy patterns of drinking despite recurrent social, interpersonal, physical or legal problems as a result of alcohol use. Binge drinking, relative to other forms of alcohol consumption, has recently received increased attention among both addiction and public health researchers due to its inherently risky nature and its growing popularity among young adults (2). This form of drinking is defined as the consumption of a sufficiently large amount of alcohol to place the drinker at increased risk of experiencing alcohol-related problems and to place others at increased risk of experiencing second-hand effects (3). For the typical adult, this corresponds to the consumption of five or more drinks in a row for men and four or more drinks in a row for women, due to gender

differences in body mass and alcohol metabolism rates (4). Binge drinking is rampant among American college populations, with recent estimates showing that at least 40–45% of college students engage in heavy drinking episodes each year (2). Although men have historically been found to drink more than women, recent data suggests a further narrowing of gender differences in heavy drinking among young adults (5). This change is at least partly explained by period effects, such as rapidly changing gender roles and the related changes in attitudes to women's drinking.

Motivation plays a role in binge drinking as binge drinkers tend to desire a state of intoxication. This motivational state is suggested by the sheer frequency with which binge drinkers engage in binge drinking. Wechsler *et al.*'s College Alcohol Study, which was based on responses from 14,000 American college students, found that when students were divided by drinking pattern, the median number of drinks per week was 0.7 for non-binge drinkers and 3.7 for occasional binge drinkers (i.e., those who binged less than three times in the previous two weeks) (3). For frequent binge drinkers (i.e., those who binged three or more times in the previous two weeks), however, the median was considerably higher: 14.5 drinks per week. Alarming, 20% of college students were frequent binge drinkers. The College Alcohol Study also revealed that 6% of their sample met the DSM-IV criteria for alcohol dependence, while 31% met the criteria for alcohol abuse. Binge drinking and substance-related disorders may thus substantially overlap. Furthermore, the risk of experiencing a negative outcome, such as engaging in unplanned sexual behaviour or getting injured, increases with the frequency of binge drinking (1).

Recent research suggests that college students' binge drinking is facilitated by the practice of mixing alcohol with caffeinated energy drinks (6, 7). Energy drinks are typically a mixture of caffeine, plant-based stimulants (e.g. guarana), simple sugars, amino acids (e.g. taurine), herbs (e.g. ginseng) and vitamins. Not all contain caffeine; however, the more popular ones do, such as *Red Bull*®, *Guru*®, or *Rockstar*®. Indeed, caffeine is the main biologically active component of energy drinks, with content ranging from 50 mg (comparable to one cup of coffee) to an alarming 505 mg per can. These drinks are selectively and aggressively marketed to college students, and recent estimates suggest that 34% of 18–24 year olds are regular users (7). Moreover, the ingestion of energy drinks in combination with alcohol is becoming increasingly popular (6, 7). In a 2007 survey of 496 American college students, a quarter of the sample reported mixing alcohol with energy drinks in the past month (8). Of these mixers, half had consumed more than three energy drinks per occasion. Furthermore, while significantly more females (53%) than males (42%) reported to use energy drinks alone, similar proportions of women and men said that they mix energy drinks with alcohol (57% versus 50%, respectively). These results indicate that gender does not influence college students to mix energy drinks and alcohol.

Finally, mixing is not an exclusively American phenomenon. In a survey of 450 students at the University of Messina in Italy, 56.9% of students reported using energy drinks, and 48.4% of this subpopulation frequently mixed energy drinks with alcohol (9). In addition, 35.8% of mixers had ingested this combination more than three times in the past month. No studies to our knowledge, however, have investigated the combined use of alcohol and energy drinks among college students in Canada.

Mixing alcohol with energy drinks has become increasingly popular due to the widely held belief that the stimulant effects of energy drinks counteract the depressant effects of alcohol. Users reason that mixing allows one to drink more for a longer period of time without feeling the associated negative effects to the same extent as alcohol alone. Since 2000, researchers have conducted several peer-reviewed studies centered on this assumption. These studies concluded that energy drinks do not prevent intoxication (10, 11). Rather, the high levels of caffeine found in energy drinks simply mask the intoxicating effects of excess alcohol intake by lessening how drunk the users perceive themselves to be. As measured by physiological indices, however, these individuals are just as intoxicated as they would have been without concurrent ingestion of caffeine. To illustrate, a double-blind study by Ferreira *et al.* found no significant differences in the blood alcohol levels, physiological parameters (heart rate and blood pressure) or biochemical parameters (glucose, cortisol, dopamine) of volunteers who drank alcohol alone compared to alcohol mixed with energy drinks (10). However, those who ingested the combination reported a reduced perception of motor coordination impairment, as well as a reduced intensity of some subjective symptoms of alcohol intoxication such as headache and dry mouth.

The problem with mixing, therefore, is that caffeine decreases the user's ability to gauge her level of impairment (10), and this can have detrimental consequences. For instance, in a study by Fillmore *et al.*, participants who expected the caffeine in their mixed drinks to compensate for alcohol's depressant effects performed significantly worse on the same psychomotor tests than a second group who were told that the caffeine would have no compensatory effect (11). The latter group seemed to enlist their own compensatory mechanisms whereas the former did not, due to the mistaken belief that caffeine would ameliorate their performance. Thus, mixing energy drinks with alcohol sends the false and dangerous message that the stimulants found in these drinks protect against the effects of alcohol.

Not surprisingly, this false expectation impairs users' assessment of risk and can thereby promote high-risk behaviour, as illustrated by O'Brien *et al.* (6). The authors found that students who mixed energy drinks with alcohol reported nearly double the amount of heavy episodic drinking per month than non-mixers (6.4 days ver-

sus 3.4 days per month), twice as many episodes of weekly drunkenness than non-mixers (1.4 days versus 0.73 days per week), and had a higher prevalence of alcohol-related consequences than non-mixers, including being taken advantage of or taking advantage of another sexually, riding with a drunk driver, being physically injured and requiring medical treatment. Mixers were at a higher risk for these outcomes, even after adjusting for the amount of alcohol consumed.

Although the research community has not fully acknowledged the potential health risks associated with mixing, the aforementioned studies suggest cause for concern. Further research is necessary to understand the mechanisms that relate mixing to an increased risk for alcohol-related consequences. Few studies to date have investigated binge drinking as a potential mediator of this relationship. Moreover, no studies to our knowledge have investigated the association between mixing and binge drinking among Canadian college students. The current study, therefore, investigates the relationship between mixing alcohol with energy drinks and binge drinking among college students at a Canadian university. We hypothesized that no significant gender differences would be found in proportions of mixers and binge drinkers, or in frequency of mixing and binge drinking. We also hypothesized that students who mix would be more likely to binge drink than non-mixers and that binge drinkers would be more likely to mix than non-binge drinkers. Additionally, we expected that mixers would be more motivated to drink for the sake of getting drunk than non-mixers. Finally, we predicted that mixers would feel significantly less risk-related behavioural states (feeling in control, aggressive, daring and sexually uninhibited) when they drink than non-mixers. Paradoxically, we also expected mixers to report significantly more life interference associated with their drinking than non-mixers.

METHODS

PARTICIPANTS

Participants were undergraduate students ages 17–27 (mean age of approximately 20 years), recruited through an advanced undergraduate psychology course at a major metropolitan university in Montreal, Quebec. Age limits were set in order to obtain a sample representative of typical undergraduate populations at North American universities. All participants, except one, met the local legal drinking age of 18 years old. Mature students were excluded because they would likely not exhibit the same drinking behaviours, nor be influenced in the same ways as typical college-aged students. Participants were selected on a voluntary basis, and given course credit for their participation.

MATERIALS

All participants received the Voluntary Anonymous Survey of Drinking Behaviour, which was constructed by the investigators for the purpose of this study. The survey method was chosen because self-reporting is the most common method of data collection used in research on the college student population. Also, past research has demonstrated the accuracy of self-reporting in the assessment of alcohol use (12). The survey contained preliminary demographic questions regarding the participant's age and gender. Next, the definition of 'one drink' was provided (a 12-ounce bottle or can of beer or a 4-ounce glass of wine or a 12-ounce bottle or can of wine cooler or a shot of liquor, either straight or in a mixed drink) to ensure that all of the responses regarding quantity of alcohol consumption were standardized. We then asked 28 questions concerning the participant's: (a) binge drinking behaviour, (b) mixing behaviour, (c) history of alcohol initiation, (d) parents' drinking behaviour and (e) parents' alcohol-specific socialization practices (measures taken to manage or prevent their children's alcohol use). Only items from the first two categories were relevant to our study; the others were used for concurrent studies.

With a slight departure from the traditional definition, our study defines binge drinking as the consumption of five or more drinks per occasion, for both males and females. We asked students to indicate the number of occasions on which they had consumed five or more drinks in the past month. Students who reported at least one occasion of this behaviour were qualified as "binge drinkers" and those that indicated an absence of this behaviour were "non binge drinkers."

The majority of the survey items were based on visual analogue scales (13). This method has been shown to be effective in measuring characteristics or attitudes that range across a continuum of values, making them otherwise difficult to quantify (14). Students were asked to rate on a linear continuum (ranging from never to regularly) how often they drink alcohol in conjunction with energy drinks, how often they drink alcohol with the intention of getting drunk and how often drinking has interfered with important areas of their life. Students were also asked to rate on a linear continuum the extent to which, when they drink, they expect to feel: loss of control to in control, careful to daring, submissive to aggressive and sexually inhibited to sexually uninhibited. We asked students about these behavioural states specifically because the extremes falling to the right end of the spectrum (i.e., feeling in control, daring, aggressive and sexually uninhibited) are all associated with risky behaviour, especially when intoxicated (1).

PROCEDURE

Students were notified a week in advance that the study's survey would be distributed during regular class time, and that their participation would merit course credit. On the day of the study, they were reminded that participation was voluntary and anonymous, and that they could withdraw at any time without consequences. To ensure that students did not feel pressured to participate, the professor (also the study's head researcher) was absent throughout the entire in-class procedure. Research assistants distributed the survey, and gave instructions regarding the visual analogue method. As each survey was handed in, a research assistant separated the last page (containing the participant's identification) from the rest of the survey and placed it in a separate box. This guaranteed both the survey-taker's anonymity and the receipt of course credit given by a third party.

RESULTS

In total, 221 undergraduates participated in the study. The sample comprised 54 males (24.4%), 161 females (72.9%) and six others who did not indicate their gender (2.7%). Ages ($N = 202$) ranged from 17 to 27 years with a mean of 20.32 ($SD = 1.392$).

Table 1. Summary of t-test results for binge drinking frequency between genders

GROUP STATISTICS				
	N	MEAN	STD. DEVIATION	STD. ERROR MEAN
MALES BINGE PAST MONTH	43	3.58	3.81	.580
FEMALES BINGE PAST MONTH	147	2.15	2.43	.201

INDEPENDENT SAMPLES TEST

	t	df	SIG. (2-TAILED)	MEAN DIFFERENCE
BINGE PAST MONTH	2.33*	52.4	.024	1.43

* $p < .05$, therefore significant.

66.1% of students ($N = 146$) were designated as 'binge drinkers' because they reported to have consumed five or more drinks on at least one occasion in the past month. Their mean binge drinking frequency was 3.37 times a month ($SD = 2.91$). Similar proportions of males and females (66.7% versus 65.8%) qualified as binge drinkers. As can be seen in Table 1, t-test results revealed that the genders did significantly differ in their binge drinking frequency, with males binge drinking almost twice as often as females in the past month ($t = 2.331$, $p < 0.05$).

45.7% ($N = 101$) of students said that they had previously mixed alcohol with energy drinks at least once and were therefore categorized as 'mixers'. This group reported that they mixed alcohol with energy drinks on average 32.5% of the time that they drank ($SD = 26.13$). When a history of mixing (yes versus no) was cross tabulated with gender, no significant gender differences were found (Table 2). Similarly, t-test results displayed in Table 3 show that the genders did not significantly differ in their mixing frequency ($t = -1.081$, $p > 0.05$).

When binge drinking in the past month (yes versus no) was cross tabulated with a history of mixing, results showed that 53% of binge drinkers had mixed alcohol with energy drinks, whereas only 35% of non-binge drinkers had, indicating that binge drinkers are statistically more likely to mix than non-binge drinkers are (see Table 4). Conversely, when a history of mixing (yes versus no) was cross tabulated with binge drinking in the past month, 77% of mixers qualified as binge drinkers, whereas only 61% of non-mixers did, indicating that mixers are statistically more likely to binge drink than non-mixers are (Table 5). T-test results were performed to investigate group differences between mixers and non-mixers. Mixers reported a significantly higher motivation to drink for the sake of getting drunk than non-mixers did ($t = 3.516$, $p < 0.01$). No statistically significant differences between the two groups were detected for the degree to which they felt risk-related behavioral states when they consumed (feeling in control, daring, aggressive, sexually uninhibited). Mixers did, however, report significantly more life interference as a result of their drinking than non-mixers did ($t = 2.866$, $p < 0.01$). See Table 6 for a summary of these results.

Table 2. Summary of crosstab analysis for *history of mixing* with *gender*

GENDER			
	MALE	FEMALE	TOTAL
YES MIX ENERGY COUNT	23	75	98
EXPECTED COUNT	24.3	73.7	98.0
ADJUSTED RESIDUAL	-.4	.4	
NO MIX ENERGY COUNT	28	80	108
EXPECTED COUNT	26.7	81.3	108.0
ADJUSTED RESIDUAL	.4	-.4	
TOTAL COUNT	51	155	206
EXPECTED COUNT	51.0	155.0	206.0

Adjusted Residuals are $< |1.3|$, therefore the association between mixing energy (yes versus no) and gender (male versus female) is not statistically significant.

Table 3. Summary of t-test results for mixing frequency between genders

GROUP STATISTICS				
	N	MEAN	STD. DEVIATION	STD. ERROR MEAN
MALES BINGE PAST MONTH	43	3.58	3.81	.580
FEMALES BINGE PAST MONTH	147	2.15	2.43	.201

INDEPENDENT SAMPLES TEST

	t	df	SIG. (2-TAILED)	MEAN DIFFERENCE
MIX ENERGY	-1.08	98.2	.282	-3.92

$p < .05$, therefore significant.

Table 4. Summary of crosstab analysis for *binge drinking past month* with *history of mixing***GENDER**

	MALE	FEMALE	TOTAL
YES BINGE COUNT	78	68	146
EXPECTED COUNT	69.6	76.4	146.0
ADJUSTED RESIDUAL	2.5	-2.5	
NO BINGE COUNT	23	43	66
EXPECTED COUNT	31.4	34.6	66.0
ADJUSTED RESIDUAL	-2.5	2.5	
TOTAL COUNT	101	111	212
EXPECTED COUNT	101.0	111.0	212.0

Adjusted Residuals are $> |1.3|$, therefore the association between binge drinking in past month (yes versus no) and a history of mixing (yes) is statistically significant.

Table 5. Summary of crosstab analysis for *history of mixing* with *binge drinking past month***GENDER**

	MALE	FEMALE	TOTAL
YES MIX COUNT	78	23	101
EXPECTED COUNT	69.6	31.4	101.0
ADJUSTED RESIDUAL	2.5	-2.5	
NO MIX COUNT	68	43	111
EXPECTED COUNT	76.4	34.6	111.0
ADJUSTED RESIDUAL	-2.5	2.5	
TOTAL COUNT	146	66	212
EXPECTED COUNT	146.0	66.0	212.0

Adjusted Residuals are $> |1.3|$, therefore the association between a history of mixing (yes versus no) and a binge drinking in past month (yes) is statistically significant.

Table 6. Summary of t-test results for group differences between mixers and non-mixers**GROUP STATISTICS**

	MIX ENERGY	N	MEAN	STD. DEVIATION	STD. ERROR MEAN
DRINK TO GET DRUNK	YES NO	100 109	59.5 44.4	28.0 34.2	2.80 3.28
CONTROL	YES NO	100 107	47.9 47.6	21.5 21.5	2.15 2.08
DARING	YES NO	100 106	68.4 64.9	20.5 21.2	2.05 2.06
AGGRESSIVE	YES NO	97 103	55.0 53.8	18.7 21.0	1.90 2.07
SEXUALLY UNINHIBITED	YES NO	99 108	71.5 68.5	21.8 20.4	2.19 1.96
LIFE INTERFERENCE	YES NO	101 111	18.9 10.7	23.1 18.1	2.30 1.72

INDEPENDENT SAMPLES TEST

	t	df	SIG. (2-TAILED)	MEAN DIFFERENCE
DRINK TO GET DRUNK	3.52**	204.4	.001	15.16
CONTROL	.111	205	.912	.331
DARING	1.20	204	.230	3.50
AGGRESSIVE	.419	198	.675	1.18
SEXUALLY UNINHIBITED	1.00	205	.318	2.94
LIFE INTERFERENCE	2.87**	189.2	.005	8.23

** $p < .01$, therefore significant.

DISCUSSION

In support of our initial hypothesis, our study did not find significant gender differences in the proportions of binge drinkers as well as mixers within our sample of college students. Mixing frequency not significantly different across genders. We did unexpectedly find that males binge drink significantly more often than females; however, these gender analyses need to be interpreted with caution due to the fact that our definition of binge drinking was the same for both genders (the ingestion of five or more drinks in a row on one occasion). Because past research has shown that women get more intoxicated per gram of alcohol consumed, we likely underestimated female binge drinking

(4). This is certainly a limitation of our study, and future studies should make sure to take this gender specificity into account in their operationalization of binge drinking.

Second, in support of our hypothesis, our study found that binge drinkers would be more likely to mix than non-binge drinkers and that mixers would be more likely to binge drink than non-mixers. We expect that these contingencies can be attributed to the widely held (and false) assumption among college students that the stimulant effects of energy drinks counteract the depressant effects of alcohol, thereby minimizing alcohol-induced impairment (10, 11). Consequently, mixers are more likely to drink heavily, often to the point of bingeing. We suggest that this same rationale could explain our finding that mixers reported a significantly greater motivation to drink for the sake of getting drunk than non-mixers did. We conjecture that mixers use energy drinks as a means of counteracting the unpleasant depressant effects of alcohol intoxication, thereby allowing them to drink in larger quantities for longer periods of time.

Our most surprising finding was the lack of significant differences between mixers and non-mixers on any of the risk-related feelings associated with drinking (feeling in control, daring, aggressive, sexually uninhibited). We had hypothesized that mixers would feel less prone to risk-related behavioural states when they drink due to caffeine's counteracting effect on perceptions of impairment. However, our lack of significant findings could be attributed to how our survey only asked students how they feel when they drink alcohol and not additionally how they feel when they mix. Future studies should investigate differences in students' expectations for when they drink alcohol alone versus in conjunction with energy drinks, as this might reveal more reasons why students are motivated to mix.

We also found that mixers reported significantly more life interference associated with their drinking, supporting another of our hypotheses. This result corroborates past research suggesting that the combination of alcohol and energy drinks, as opposed to alcohol alone, increases alcohol's abuse liability and may lead to more detrimental risk-taking behaviour (6).

In addition to the aforementioned limitation concerning our lack of a gender-specific measure of binge drinking, our study has other limitations that warrant attention. First, our sample size was relatively small ($N = 221$), which of course limits the application of our results in a broader context. Moreover, our sample consisted of three times more females than males, and this female overrepresentation is not representative of the typical college student population. Third, our sample of students came from a single psychology course which makes it, again, not representative of the general college population. Finally, we qualified students with a history of mix-

ing alcohol and energy drinks as "mixers" regardless of whether they had only mixed once or regularly. The same rule applied to our qualification of "binge drinkers." Perhaps surveying the same participants repeatedly over a set period of time (i.e., a longitudinal approach), rather than our method of surveying participants at only one point in time (i.e., a cross-sectional approach), could be used to qualify students as "mixers" or "binge drinkers" while accounting for the frequency of these respective behaviours.

Despite its limitations, our study is nonetheless the first of its kind to investigate the consumption of caffeinated alcoholic drinks and its association with binge drinking among college students at a Canadian university. The concurrent ingestion of energy drinks and alcohol is particularly dangerous because users lose the ability to accurately assess their level of intoxication, thus encouraging them to drink alcohol in larger quantities, often to the point of bingeing. This impairment, in turn, increases their potential for engaging in risky behaviours. Thus, knowledge about the effects of the interaction between alcohol and energy drinks is relevant to preventative programs aimed at reducing high-risk alcohol consumption and alcohol-related injuries resulting from car accidents, assaults and other high risk behaviour. More conclusive research in this area might also have implications for warranted policy measures, such as requiring that energy drinks carry a warning label concerning the danger of consuming these beverages with alcohol.

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