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Short Communication

Effects of caffeinated vs. non-caffeinated alcoholic beverage on next-day hangover incidence and severity, perceived sleep quality, and alertness ☆

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HIGHLIGHTS

- Mitigate hangover after intoxication
- Affect self-reported sleep latency or total sleep time
- Affect next-day mood

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ABSTRACT

Aims: Beliefs about the effects of mixing caffeine and alcohol on hangover or sleep may play a role in motivation to consume these mixtures; therefore, information is needed about actual effects. We investigated whether intoxication with caffeinated vs. non-caffeinated beer differentially affected perceived sleep quality, sleepiness, and hangover incidence and severity the next morning.
Methods: University students (89%) and recent graduate drinkers were randomized to receive: (1) beer with the equivalent of 69 mg caffeine/12 oz glass of regular beer ($n = 28$) or (2) beer without caffeine ($n = 36$), in sufficient quantity to attain a BrAC of 0.12 g%. After an 8-h supervised sleep period, participants completed measures of hangover, sleep quality, sleep latency and time asleep, and sleepiness.
Results: While caffeinated beer improved perceived sleep quality, effect sizes were greater for morning alertness than for quality while sleeping, with no effect on sleep latency or total sleep time. No effects were seen on hangover incidence or severity.
Conclusions: Mixing caffeine and alcohol does not significantly impair amount of sleep or sleep latency, hangover, or sleepiness the morning after drinking to intoxication in this population.

1. Introduction

Caffeinated alcoholic beverage (CAB) includes pre-mixed beverages, drinks mixed in bars or by oneself, or drinking a caffeinated beverage in temporal proximity to drinking alcohol (Howland & Rohsenow, 2013; Howland, Rohsenow, Calise, MacKillop, & Metrik, 2011). Consuming alcohol with caffeinated beverages such as energy drinks is increasingly popular among adolescents and young adults (O'Brien, McCoy, Rhodes, Wagoner, & Wolfson, 2008). While ingredients of energy drinks vary across brands, the primary active component is caffeine, most commonly with about 80 mg of caffeine per 8 ounce (250 ml) beverage (Reissig, Strain, & Griffiths, 2009). Surveys of college students in Australia and the US indicate that 25–65% have consumed CABs in the last 30 days (O'Brien et al., 2008; Peacock, Bruno, & Martin, 2012).

Marketing targeting youth promotes beliefs that CABs increase energy while drinking and counteract unpleasant side effects (Howland et al., 2011). The belief that CAB mitigates hangover symptoms was endorsed by 3–17% of student respondents in three US surveys (MacKillop et al.,

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2012; Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007; O'Brien et al., 2008). This belief may also motivate CAB consumption. The only investigation of whether CAB actually affects hangover was a survey of 1503 Dutch university students; no significant differences were found in hangover severity between those who drank alcohol to intoxication with or without caffeine (Penning, de Haan, & Verster, 2011). No work has compared hangover when drinking to a controlled level of intoxication in the laboratory.

Sleep disruption is a common effect of caffeine (Brezinova, 1974; Hindmarch et al., 2000; Karacan et al., 1976; Nicholson & Stone, 1980). Some people believe that CAB counteracts the sedating effect of alcohol (Malinauskas et al., 2007; Marczinski & Fillmore, 2006; Mintel International Group Ltd, 2005). Due to caffeine content, CABs might result in worse sleep compared to the sleep disruption from the same quantity of alcohol, resulting in greater sleepiness and less alertness the next morning. One survey study reported a fourfold odds of having sleep difficulties with CAB (Peacock et al., 2012); focus groups also reported CAB-related sleep disruptions (Pennay & Lubman, 2012); while another survey study found no effect on self-reported time spent asleep (Penning et al., 2011). Again, no controlled trial has compared the sleep effects of CAB vs. alcohol alone.

The present investigation analyzes data from a previous study of the acute effects of CAB vs. non-caffeinated alcohol (mean BrAC: .12 g%) on a simulated driving task (Howland et al., 2010). We added calibrated amounts of caffeine to beer to produce CAB without confounding caffeine effects with other ingredients often included in energy drinks (e.g., taurine, guarana, and sugar derivatives). We hypothesized that CAB vs. non-caffeinated beer would worsen next-morning hangover incidence and severity, subjective sleep quality, and alertness. The present study is the first to use randomized alcohol administration to compare the effects of intoxication with CAB vs. non-caffeinated alcohol on hangover, sleep quality, and alertness.

2. Methods

2.1. Overview of study

We compared the two groups receiving alcohol (with and without caffeine) on measures the morning after intoxication and an 8-h opportunity. (The placebo beer groups were not studied in the present analyses.)

2.2. Participants and site

Participants were recruited from greater Boston, MA, USA. They were 21 and 30 years of age; had no current or history of drinking problems; and, had had ≥5 drinks on a single occasion (≥4 if female) at least once in the 30 days prior to screening. They were screened for health problems or medication use contraindicated for alcohol; sleep disorders; and pregnancy and nursing, if female. Regular tobacco users were excluded to avoid nicotine withdrawal. A prescribed sleep regimen for three nights prior to the experimental session was confirmed by daily sleep/wake diary and call-in to a time-stamped answering machine. Participants were required to abstain from alcohol, medications not approved by the study physician, sleep aids and recreational drugs for 24-h, and caffeine for 8 h, prior to their experimental session. (See Howland et al., 2010 for further details.)

Participants were paid $150. The study was conducted at the General Clinical Research Center (GCRC) at Boston Medical Center. Institutional Review Boards at Boston Medical Center, Brown University, and the University of Michigan approved this study.

2.3. Beverage administration procedures

Alcoholic beverage administration targeted 0.12 g% BrAC (1.068 g/kg body weight for men and .915 g/kg for women), adjusting for sex as per Friel, Logan, O'Malley, and Baer (1999). Hurricane High Gravity™ (8.1% alcohol by volume) beer (Anheuser Busch, St Louis, MO) was used to reduce the volume required to attain the targeted dose.

Tasteless, anhydrous caffeine powder in solution was added to beer in a quantity equivalent to the caffeine content of a commercially available caffeinated beer (Moonshot ®) (69 ml of caffeine in each 12 ounce bottle).

Beverage administration began 3 h after a standardized meal, served in the lab. Small groups (four to five) consumed beverages from 7:30 until approximately 8:30 p.m. Participants had an 8-h sleep opportunity (11:00 p.m. to 7:00 a.m.), with safety monitoring by an Emergency Medical Technician. Self-report measures of hangover, sleep quality, and sleepiness were completed soon after awaking.

2.4. Measures

2.4.1. Last 30 days alcohol intake

Average daily volume (ADV) of alcohol intake was assessed with two questions: 1) "Considering all your drinking times in the past 30 days, about how often did you have any beer, wine or liquor?," Likert-rated from 1 "once a day" to 7 "did not drink"; and 2) "In the past 30 days, on a typical day that you drank, about how much did you have to drink in one day?," with their actual number of drinks specified. ADV was the product of the quantity by the weighted frequency score.

2.4.2. Subjective sleep quality measure

We used six items from a post-sleep sleep quality questionnaire (Roehrs, Yoon, & Roth, 1991). The scale provides a reliable and valid measure that was significantly lower on mornings after heavy alcohol consumption vs. placebo (Roehrs et al., 1991; Rohsenow, Howland, Minsky, & Arnedt, 2006).

2.4.3. Sleepiness

To measure morning alertness, the 7-item Stanford Sleepiness Scale (SSS; Hoddes, Zarcone, Smythe, Phillips, & Dement, 1973) requires participants to rate their current sleepiness. It was completed three times, at 8:00, 8:30 and 9:00 a.m., with the average of the three ratings used as the dependent variable. (It was not completed in the first hour after waking to avoid sleep inertia effects.)

2.4.4. Acute Hangover Scale (AHS)

The AHS is a psychometrically validated measure of acute hangover symptoms (Rohsenow et al., 2007). The scale consists of self-rated severity of hangover and associated symptoms.

2.5. Data analysis approach

All measures were examined for normality and outliers. Hangover incidence was defined as rating one's hangover as zero (none) vs. any other rating on the first AHS item, "hangover". Hangover severity was the mean score from the nine AHS items. The groups receiving CAB vs. non-caffeinated alcohol were compared on continuous measures using between-groups *t*-tests to compare the differences between mean outcomes, and on dichotomous measures using chi-square tests. Since alcohol administration controlled for sex and weight and was designed to limit range of peak BrAC, and since age range was restricted, there was no need to control for these variables statistically. Alpha was set at .05. Due to the relatively small number of participants, effect sizes were examined to see if non-significance of results was likely due to small statistical effects as opposed to low power to detect medium effects (indicating a promising trend). We used *d* for *t*-tests and *h* for dichotomous variables (a value of .20 – .50 is small, and .50 – .79 is medium in effect size).