



## Combined use of alcohol and energy drinks: Dose relationship with self-reported physiological stimulation and sedation side effects



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### HIGHLIGHTS

- Experience of side effects is positively associated with energy drink (ED) dosage.
- Greater odds of most stimulant side effects when mixing ED with alcohol
- Lower odds of sedation side effects when mixing ED with alcohol

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### ABSTRACT

**Background:** Negative physiological stimulation and sedation side effects are experienced by a significant proportion of consumers who consume alcohol mixed with energy drinks (AmED). Few studies have compared the frequency of side effects between sessions of AmED and sessions of alcohol only within-subject, and none have explored a dose relationship.

**Objectives:** Explore the occurrence of self-reported physiological stimulant and sedative side effects between sessions of AmED and alcohol only, and at varying ED dosage levels within AmED sessions.

**Methods:** A convenience sample of 2953 residents of New South Wales, Australia completed an online survey.  $N = 731$  AmED users reported daily caffeine intake, typical alcohol and AmED consumption, and past 12-month experience of physiological stimulation and sedation side effects during AmED and alcohol only sessions. Within-subject analyses compared occurrence of side effects between session types. Hierarchical binary logistic regression analyses explored the association of ED dose during AmED sessions with the experience of physiological side effects.

**Results:** There were greater odds of most stimulant side effects, and lower odds of sedation side effects, during AmED sessions compared to alcohol only sessions. Compared to one ED, consumption of three or more EDs was significantly associated with the majority of both stimulant and alcohol intoxication side effects after controlling for demographics and consumption covariates.

**Conclusions:** AmED is associated with perceived changes in physiological stimulant and sedation side effects of alcohol. Experience of side effects is positively associated with ED dosage. Future research should account for varying ED dosage, and reflect real world consumption levels.

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### 1. Introduction

Consumption of alcohol mixed with energy drinks (AmED) has become commonplace amongst young adults in the past decade (Brache,

Thomas, & Stockwell, 2012; Pennay et al., 2015a), particularly in night-life and party contexts (Droste, Miller, Pennay, Zinkiewicz, & Lubman, 2016a; Droste et al., 2016b; Peacock, Bruno, & Martin, 2013a; Pettigrew et al., 2015). Self-report data suggests that negative

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physiological stimulation and sedation side effects are experienced by a significant proportion of AmED users (Brache & Stockwell, 2011; Brache et al., 2012; Jones, Barrie, & Berry, 2012; Jones, 2011; Peacock, Bruno, & Martin, 2012; Peacock, Bruno, Martin, & Carr, 2014; Pennay & Lubman, 2011, 2012). The stimulant side effects reported in these studies are typically attributed to the caffeine content of ED, as the symptom profile parallels that evident during caffeine intoxication (Reissig, Strain, & Griffiths, 2009). However, alcohol consumption may also produce stimulation effects at low levels of intoxication on the ascending limb of the blood alcohol curve (BAC), countered by an increased proportion of sedation effects at high levels of intoxication on the descending limb of the BAC, as part of the biphasic nature of alcohol intoxication (Martin, Earleywin, Musty, Perrine, & Swift, 1993). Therefore, alcohol consumption both with and without concurrent ED use may promote stimulant and sedation effects in consumers.

This proposed AmED 'wide awake drunkenness' effect contends that ED use may modify the drinker's perception of alcohol intoxication, or mask potential signs of excessive intoxication that they would normally perceive (Ferreira, Tulio de Mello, Pompeia, & de Souza-Formigoni, 2006; Pennay et al., 2015b). There is a growing body of research to support such a modification or masking effect (Marczinski, Fillmore, Bardgett, & Howard, 2011; Peacock, Pennay, Droste, Bruno, & Lubman, 2013b), but there are limited studies investigating how the experience of physiological sedation and stimulation effects differ between sessions of AmED and of alcohol only, and the relationship between ED dosage and experience of effects has not been explored. Therefore, this study aims to examine:

1. The comparative prevalence of self-reported stimulant and sedation side effects in alcohol only and AmED sessions;
2. The prevalence of self-reported stimulant and sedation side effects within AmED sessions, by typical ED intake in such sessions (dose-relationship), taking into account covariates which could influence symptom presence (e.g., typical daily caffeine consumption, age, gender, frequency of AmED consumption).

## 2. Methods

### 2.1. Participants and procedure

A convenience sample of 2953 participants living in New South Wales (NSW), Australia, completed a self-administered online survey between December 2012–February 2013. The study was advertised as exploring AmED consumption, but participants were invited to participate regardless of whether they had used AmED. Participants were recruited through social media websites, social events websites, press releases, and email snowballing. Participants were excluded if <16 years old or lived outside of NSW. Survey completion took 15–35 min. Participation incentive was provided via a prize draw for one of 10 Apple iPads. To minimise multiple participation by the same respondent, internet protocol (IP) addresses were logged to allow one survey completion per device. IP information was stored separately to survey responses and was deleted at the conclusion of the data collection period.

From the group of 2953, 102 respondents were non-NSW residents and were removed. A further 913 cases were removed due to having completely blank responses, or missing data on essential consumption and demographic items. Four cases were removed due to numerical outliers on consumption measures, and three cases < 16 years were deleted.

After data cleaning the inclusion rate was 65.3%, yielding a sample size of 1931 (from 295 of a possible 961 postcodes in NSW). Only participants who had reported AmED consumption in the past 12 months were retained for analyses ( $n = 731$ , 37.9% of complete responses).

## 3. Key measures

### 3.1. Daily caffeine intake

Participants reported average daily consumption of non-ED products containing caffeine, with a response list of products provided to assist recall. Mean daily non-ED caffeine consumption levels (milligrams) were then calculated, based upon estimated content of these products in Australia (NUTTAB; Food Standards Australia and New Zealand, 2010).

### 3.2. Alcohol and AmED consumption

Participants were asked how often they had a drink containing alcohol in the past 12 months ('never', 'monthly or less', '2 to 4 times a month', '2 to 3 times a week', and '4 or more times a week'). With reference to the past 12 months, the number of standard alcohol drinks consumed during a *typical alcohol only* session, and the number of alcohol drinks and EDs consumed during a *typical AmED session*, was reported. Intake was reported in standardised units for alcohol (10 g ethanol = 1 standard drink; National Health and Medical Research Council, 2009) and ED (250 mL ED containing 80 mg caffeine = 1 standard drink; Australia New Zealand Food Authority, 2009).

Participants who reported alcohol consumption were asked: 'Have you combined alcohol and EDs in the past 12 months?'. If yes, they were asked frequency of consumption ('monthly or less', '2 to 4 times a month', '2 to 3 times a week', and '4 or more times a week'). Visual examples and operational definitions of ED and AmED were placed throughout the survey.

### 3.3. Experience of physiological stimulation and sedation side effects in AmED and alcohol only sessions

Measures of physiological side effects were extracted from the literature, including standardised questionnaires (visual analogue scales (Ferreira et al., 2006); Profile of Mood States (McNair, Lorr, & Droppleman, 1971); and the Biphasic Alcohol Effects Scale (Martin et al., 1993)), as well as recurrent themes emerging in two 30-minute focus group sessions with six AmED users and four alcohol users aged between 21 and 47 ( $M = 26.4$ ;  $SD = 7.6$ ), conducted and validated via iterative application of the Question Appraisal System (Willis & Lessler, 1999) in a previous study (see: Peacock et al., 2012). This combination of measures has been previously evaluated and applied to the exploration of physiological effects amongst AmED consumers (Peacock et al., 2012). The final list of nine stimulation and seven sedation effects is shown in Table 1.

Participants reported the frequency ('never', 'rarely', 'sometimes', 'often', 'always') of their experience of effects in the preceding 12 months following consumption of (i) alcohol only (without ED), and (ii) AmED. Side effects are grouped and presented according to whether they represent typical stimulation or sedation effects in previous literature (Martin et al., 1993; Peacock et al., 2012; Reissig et al., 2009).

### 3.4. Analysis

To avoid transformation of meaningful (but non-normal) data, *daily caffeine intake* was categorised into: *low* (0–39 mg), *medium* (40–139 mg) and *high* (140 mg or more), using population estimates of caffeine consumption (ABS, 2012). *Frequency of AmED use* was dichotomised into *monthly or more*, or *less than monthly* use, due to low frequency of responses '2 to 4 times a month', '2 to 3 times a week', and '4 or more times a week'. Experience of each physiological effect was dichotomised into absence (*never*) versus presence (*rarely*, *sometimes*, *often* and *always*) of these side effects, due to low frequency of responses *sometimes*, *often* and *always*.

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