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Energy drink use frequency among an international sample of people who use drugs:

Associations with other substance use and well-being*

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Highlights

- 74,864 people who use drugs participated in the online Global Drug Survey 2014

- Energy drink, caffeine tablet and spray use was reported by 69.2%, 24.5% and 4.9%

- Greater energy drink use frequency was associated with drug use

- Greater use frequency was associated with hazardous drinking and poorer wellbeing

Abstract

Objective: The study aims were to identify: i.) energy drink (ED), caffeine tablet, and caffeine intranasal spray use amongst a sample who report drug use, and ii.) the association between ED use frequency and demographic profile, drug use, hazardous drinking, and wellbeing.

Method: Participants (n=74,864) who reported drug use completed the online 2014 Global Drug Survey. They provided data on demographics, ED use, and alcohol and drug use, completed the Alcohol Use Disorders Identification Test (AUDIT) and Personal Wellbeing Index (PWI), and reported whether they wished to reduce alcohol use.

Results: Lifetime ED, caffeine tablet and intranasal caffeine spray use was reported by 69.2%, 24.5% and 4.9%. Median age of ED initiation was 16 years. For those aged 16 to 37, median years using EDs increased from 4 to 17 years of consumption, where it declined thereafter. Greater ED use frequency was associated with: being male; under 21 years of age; studying; and past year caffeine tablet/intranasal spray, tobacco, cannabis, amphetamine, MDMA, and cocaine use. Past year, infrequent (1-4 days) and frequent (≥5 days) past month ED consumers reported higher AUDIT scores and lower PWI scores than lifetime abstainers; past month consumers were less likely to report a desire to reduce alcohol use.

Conclusions: ED use is part of a complex interplay of drug use, alcohol problems, and poorer personal wellbeing, and ED use frequency may be a flag for current/future problems. Prospective research is required exploring where ED use fits within the trajectory of other alcohol and drug use.

Keywords: energy drink; caffeine; alcohol; ecstasy, stimulant

1. Introduction

Caffeinated energy drinks (EDs) are stimulant beverages marketed to facilitate performance by reversing fatigue effects and increasing alertness (Heckman et al., 2010). EDs attained popularity following the formation of the Red Bull® brand in Austria in 1987, and the release of their product in the United States in 1997 (Reissig et al., 2009). Estimates of use are generally based on convenience samples within specific regions in the United States, Canada, Australia and Europe, with indications that consumption is normative amongst adolescents (Arria et al., 2014; Azagba et al., 2014; Gallimberti et al., 2013) and young adults (Arria et al., 2010; Berger et al., 2011; Lubman et al., 2013; Rudolph et al., 2014). However, increasing adverse exposure presentations to emergency departments and poison information call centres (Gunja and Brown, 2012; Substance Abuse and Mental Health Service Administration, 2011, 2013), coupled with associations between consumption and risky behaviour (Arria et al., 2014), have generated public debate regarding whether regulation of these beverages would be appropriate.

In regards to risky behaviour, research has indicated that ED consumption is associated with increased alcohol consumption (e.g., Arria et al., 2010; Arria et al., 2011), tobacco consumption (e.g., Friis et al., 2014; Trapp et al., 2014b), nonmedical use of prescription drugs (e.g., Arria et al., 2010; Miller and Quigley, 2011), and illicit drug use (e.g., Terry-McElrath et al., 2014; Trapp et al., 2014b). Based on the pharmacological effects of ED and of alcohol, it has been hypothesised that simultaneous use of EDs with alcohol may promote increased alcohol intake by: i.) delaying onset of fatigue/off-setting the sedating effects of alcohol, ii.) reducing perception of intoxication, iii.) exacerbating disinhibiting effects of alcohol, and iv.) masking the taste of alcohol making consumption more pleasurable. Recent reviews provide mixed support for these assumptions, with consistent evidence of enhanced stimulation and priming effects (i.e., increased desire for more

alcohol), but conflicting findings regarding decreased perception of intoxication (McKetin et al., 2015; Peacock et al., 2014). However, not all consumers of EDs co-ingest, or even use, alcohol (Lubman et al., 2013), meaning that we need to look more broadly for explanations of the association between ED and alcohol and other drug use. Alternative explanations include: i.) common genetic, psychosocial and cultural risk factors which predispose caffeinated ED, alcohol and drug use (Arria et al., 2011; Kendler et al., 2006), ii.) ED marketing promoting the psychoactive effects of the beverage (Reissig et al., 2009), and iii.) caffeinated ED consumption resulting in 'cross-sensitisation' whereby the dopamine system is primed to respond in a rewarding and reinforcing manner to alcohol and other stimulant drugs (Arria et al., 2014; Ferré, 2013; Temple, 2009).

Several of these potential explanations are based on the premise of a dose-response relationship, whereby increased frequency of ED intake inflates risk of reporting hazardous alcohol use and using other drugs. However, few of the aforementioned studies have studied the link between the frequency of ED use and degree of alcohol and drug-related problems. Arria et al. (Arria et al., 2011) found that high frequency ED consumers (≥52 days of use in the past year) were more likely to meet alcohol dependence criteria than low-frequency ED consumers (≤51 days) and Velazquez and colleagues (Velazquez et al., 2012) showed that a one day increase in past month ED use was associated with an increased risk of heavier drinking by 80%. Whilst providing a strong basis to suggest that higher frequency ED use may be associated with greater problems, these analyses did not take into account the potential continuum in ED consumption frequency from lifetime abstinence to daily use.

The majority of our knowledge regarding ED consumption patterns and associated behaviours stems from research with secondary school and university student samples in the US, Australia and Europe (Arria et al., 2014; Velazquez et al., 2012). Given that market-leading ED brands are reportedly available in over 75% of countries worldwide (Red Bull,

2015), it is critical to explore this relationship on a global level. It is also important to place these products in the context of other non-traditional caffeine products marketed as enhancing energy, such as caffeine tablets and more recently caffeine intranasal sprays and sublingual strips. The latter two forms only available since 2013 offer the possibility of a more rapid onset of action and potentially of more intense effects and more unwanted effects related to peak plasma levels (such as headache and heart palpitations). In this study, we draw on a very large global non-probability sample of people who use drugs, including alcohol. The specific objectives were to:

1. Describe ED, caffeine tablet, and intranasal spray consumption patterns amongst a large international sample who report drug use;

2. Identify the demographic and alcohol and drug use correlates of ED use frequency (from lifetime abstinence to regular use); and

3. Assess whether or not frequency of ED consumption is associated with severity of alcohol problems, desire to reduce alcohol use, and subjective wellbeing.

As aforementioned, previous studies have established the link between frequency of ED consumption and hazardous alcohol use. However, there has been no research exploring whether ED consumers are more or less motivated to change their alcohol use (motivation for change being a predictor of reductions in alcohol use; Adamson et al., 2009). As ED consumers are typically more risky, and experience greater negative consequences (Arria et al., 2010; Arria et al., 2011; Malinauskas et al., 2007), we anticipated findings indicating that heavier ED consumers would be less likely to report motivation to change alcohol use. In line with this, we also extended existing research showing a positive association between ED use and depression and anxiety (Richards and Smith, 2016), anticipating greater frequency of use would be associated with poorer overall wellbeing. By studying hazardous alcohol use, desire to reduce alcohol use, and overall wellbeing, we hoped to determine whether greater

frequency of ED use could be a possible flag from a clinical perspective for intervention or treatment.

2. Material and Method

2.1 Design

The Global Drug Survey (GDS) runs the world's biggest drug survey, open to all individuals aged 16 years of age or older. Using an anonymous on-line survey hosted on an encrypted server (https://www.globalrugsurvey.com) GDS uses an international network of media partners (such as Huffington Post, Ziet Online, Fairfax Media, The Guardian and Stuff.co.nz) to promote participation in the survey. The media partners act as hubs with onward promotion through social media (such as Twitter, Facebook and Reddit). This methodology (based on a decade of work by this research group; McCambridge et al., 2007; Winstock et al., 2001) allows for the rapid assessment and identification of alcohol, licit and illicit drugs based on monitoring of large sentinel sample of people who use drugs. Discussion of methods (utility, validity and limitations) has been published elsewhere (Bellis et al., 2015; McCambridge et al., 2007; Winstock et al., 2001; Winstock et al., 2011). Ethical approval was received from the Joint South London and Maudsley and Institute of Psychiatry NHS Research Ethics Committee. In this study, data from the GDS 2014 (open between November 11 and December 29, 2013) was examined.

2.2 Measures

The survey offers a drugs screen that allows subsequent sections of the survey to be tailored based on the individual's recent drug use experience. For all substances including EDs, participants reported lifetime, past year and past month use, days of use in the past month, and age of initiation. In addition to demographics (age, sex, current paid employment,

whether they were currently studying any qualification, and country of origin), participants were asked about their use of alcohol, tobacco, cannabis, 3,4-methylenedioxymethamphetamine (MDMA), amphetamines (excluding MDMA), and cocaine, as well as over 140 other drugs. The 10-item Alcohol Use Disorders Identification Test (AUDIT; Babor et al., 2001) was administered as a measure of alcohol consumption; higher scores are indicative of more problematic use (cut-off score of 8 for harmful alcohol use; Babor et al., 2001). Past year alcohol consumers were also asked if they would like to drink less alcohol over the next 12 months (no/yes). The Personal Wellbeing Index (PWI; ranging from 0 to 80) was administered to assess subjective wellbeing; lower scores are indicative of poorer wellbeing (International Wellbeing Group, 2013).

2.3 Data Analysis

Data were cleaned to remove cases who did not report any alcohol or licit/illicit drug use in their lifetime, cases which had missing data on key variables (e.g., age, sex, drug screen items), data capture glitches, duplicate entries and cases with positive reporting of using a fake drug (*Xenorap*). Given the number of respondents and the extensive number of questions, it is not surprising that non-core items included in the present analyses generated missing responses. Complete-case analyses were used given limited gain from undertaking complex missing-data imputation in such cases (Penny and Atkinson, 2012). Valid *N* is reported for each statistic.

Percentages are reported for categorical data and means and standard deviations are reported for continuous data; median and inter-quartile range (IQR) were reported where continuous data were count or deemed highly skewed. Non-parametric test of trends were performed for demographic and alcohol and drug use variables (i.e., male, <21 years, employed, studying, AUDIT score ≥8, past year caffeine tablet, caffeine intranasal spray,

tobacco, cannabis, MDMA, amphetamine, and cocaine use) across ordered ED consumer frequency groups ('never', 'prior to last year', 'last year', 'last month', 'fortnightly-weekly', 'regular 5-12 days past month', 'frequent 13-30 days past month' consumer) using Stata Statistical Software version 14 (StataCorp, College Station, TX). Hierarchical linear and logistic regression models were performed to determine the unique contribution of ED drinking frequency (entered in Model 2) to AUDIT score and PWI score (linear) and desire to reduce alcohol use (logistic), over and above known demographic risk factors (i.e., age, sex, employment, studying) (Arria et al., 2011; Berger et al., 2011) for ED use (entered in Model 1). Analyses with alcohol-related dependent outcomes (AUDIT and desire to reduce alcohol use) were restricted to those participants who reported past year alcohol use. The aforementioned linear and logistic analyses were adjusted for intra-group correlation by country of origin. Given anticipated divergence in findings across countries, as sensitivity analyses we also ran: i.) multi-level mixed linear and logistic models (Stata commands *mixed* and *meqrlogit*, respectively), including country as a random effect, and ii.) hierarchical linear and logistic regression models separately for the most heavily-represented countries in the sample (Germany, US, UK, and Australia) to demonstrate generalizability of findings (see Supplementary Materials).

3. Results

3.1 Sample Characteristics

The total number of participants was 78,819, of which 3,955 were excluded after the cleaning process (final sample: n=74,864). Over one-quarter of respondents were recruited from Germany (29.7%, n=22,232); other significant nation contributors included the UK (9.6%, n=7,174), US (8.6%, n=6,423), and Australia (7.7%, n=5,789). The majority of the sample was male (67.2%, n=49,293), with a median age of 26 years (IQR 22-35); nearly

three-quarters were employed (72.5%, n=52,184) and two-fifths (43.5%, n=31,700) were

currently studying.

3.2 ED and other Novel Caffeine Product Use

3.2.1 Energy Drink Use

Two-thirds of the sample had ever consumed caffeinated EDs; median age of

initiation was 16 years (Table 1). Past year use was reported by 47.5% of the total sample

(two-thirds of those who had ever used EDs).

Figure 1 provides a breakdown of the percentage of participants within each age

group who reported past year ED use, and median years of ED use amongst consumers within

each age group. A declining percentage reported past year ED use with age; specifically,

three-fifths of 16 year olds reported past ED year use compared to one-tenth or less of those

aged 55 or older. From those aged 16 to 37, median years using EDs increased from 4 to 17

years of consumption, where it declined thereafter. In regards to past year ED use by country,

51.0% (n=11,344) of participants from Germany reported past year ED use, 44.9% (n=3,222)

from the UK, 41.6% (n=2,670) from the US, and 33.8% (n=1,957) from Australia.

Past month ED use was reported by 32.3% of the total sample (nearly half of those

who had ever used EDs) (Table 1). These consumers had ingested EDs on a near weekly

basis in the past month. Figure 2 highlights the distribution of ED consumption within the

past month. Of those who had consumed ED in the past month, 59.7% (n=14,435) had

consumed EDs more than fortnightly (i.e., more than once every two weeks), and 4.1%

(n=995) reported daily use.

3.2.2 Caffeine Tablets and Intranasal Caffeine Spray Use

Caffeine tablets and intranasal caffeine spray were less popular than ED: one-quarter

and one-twentieth of the total sample reported lifetime caffeine tablet and caffeine intranasal

spray use (2.2% and 1.5% of the total sample reported past year use) (Table 1). Past year use of caffeine tablet and intranasal caffeine spray use was typically reported by adolescent and young adult participants (Figure 1), although it is important to note that caffeine spray was only released onto the market in approximately 2013. Whilst participants reported an older age of initiation for tablets and intranasal spray compared to ED (Table 1), frequency of use amongst past month consumers was similar for tablets and ED, but higher in the case of intranasal spray (equivalent to 2-3 times per week). Of those who reported past year use of caffeine tablets and spray, 78.1% (n=3,779) and 68.3% (n=1,119) had also used EDs in the past year, respectively.

3.3 Demographic and Alcohol and Drug Use Correlates of ED Use Frequency

Participants were grouped into seven categories on the basis of ED use:

- *'Non-consumers'*: never used ED in lifetime (30.8%; n=23,029)

- *'Prior consumers'*: used ED in their lifetime but not in the last year (21.8%; n=16,287)

- '*Last year consumers'*: used ED in the last year but not in the last month (15.2%; n=11,375)

- *'Last month consumers'*: used ED one day in the past month (7.2%; n=5,422)

- *'Fortnightly-weekly consumers'*: used ED 2-4 days in the past month (11.3%; n=8,497)

- *'Regular consumers'*: used ED 5-12 days in the past month (8.5%; n=6,372)

- *'Frequent consumers'*: used ED 13-30 days in the past month (5.2%; n=3,882)

Non-parametric test of trends revealed a significant trend for age (<21 years), sex, currently studying, AUDIT score (score ≥8), and past year caffeine tablet, caffeine intranasal spray, tobacco, cannabis, MDMA, amphetamine use according to ED use frequency (ps<.001); there was no significant trend for current paid employment (p=.225).

Inspection of descriptive statistics showed ED consumers were predominantly male, however, the percentage of males was greater amongst those groups who reported past year ED use versus '*prior consumers*' and '*non-consumers*' (Figure 3). The percentage of adolescents within each group generally increased as a function of ED use frequency, with over one-quarter of '*regular consumers*' aged 20 years old or younger. No clear pattern was evident in regards to likelihood of current paid employment on the basis of ED consumption frequency, with the highest percentage of employed persons amongst '*prior consumers*' and '*frequent consumers*'. However, those groups who reported any past year ED use were more likely to report currently studying as compared to '*prior consumers*' and '*non-consumers*'.

In regards to other caffeine use, the percentage of people reporting caffeine tablet use increased as a function of ED use frequency, with 14.3% of '*frequent consumers*' reporting past year caffeine tablet use versus 8.5% of '*last year consumers*', and 2.2% of '*non-consumers*'. Caffeine intranasal spray use followed a similar pattern.

The percentage of people out of the total sample exceeding the AUDIT cut-off indicative of hazardous alcohol use generally increased as a function of ED use frequency. The percentage of people exceeding the cut-off was relatively stable within past month consumer groups, with the exception of a decrease in persons exceeding the cut-off from the '*recent consumers*' group to the *frequent consumers*' group. This was supported by the bivariate correlation between days of past month ED use and AUDIT score (restricted to past month ED consumers), which showed a significant weak negative relationship between the two (r=-.016, p=.014).

Past year tobacco, cannabis, MDMA, amphetamine, and cocaine use followed a similar pattern, with a substantial increase in the percentage reporting past year use from non-past year consumers ('*non-consumers*' and '*prior consumers*') to those past year consumer

groups, with a decrease in percentage of participants reporting use from the *'frequent consumers'* group to the *'regular consumers'* group.

3.4 Frequency of ED Use as a Correlate of Hazardous Drinking

The results of hierarchical regression predicting AUDIT score, desire to cut back alcohol use, and PWI score accounting for age, sex, and education and working in *step 1* and ED consumption in *step 2* (with the reference category non-consumers) are presented in Table 2. For these analyses we combined the *'non-consumer'* and *'prior consumer'* groups (now labeled *'non-consumers'*) and the *'last month consumers'* and *'fortnightly-to-weekly consumers'* (now labeled *'last month consumers'*). As Figure 1 depicts, a curvilinear relationship between age and ED consumption was observed. As such the data were analyzed including a quadratic term for age. However, this quadratic term was not statistically significant and was therefore removed for parsimony.

Frequency of ED use was associated with AUDIT scores. Specifically, in the total sample there was a statistically-significant 1.07 unit increase (indicative of more hazardous drinking) in AUDIT score for the *'last year consumers'* compared to *'non-consumers*; 1.61 unit increase for *'last month consumers'*, and 1.89 unit increase for *'frequent consumers'* relative to *'non-consumers'*. Subsequent contrast analyses revealed that AUDIT score increased with greater frequency of ED use. Specifically, the coefficients for *'frequent consumers'* and *'last month consumers'* were significantly greater than for *'last year consumers'* (ps<.001), with a larger coefficient for *'frequent consumers'* relative to *'last month consumers'*(p=.048). These findings were also evident in the multi-level mixed linear regression sensitivity analyses (see Supplementary Materials[1]).

3.5 Frequency of ED Use as a Correlate of Desire to Reduce Alcohol Use

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[1] Supplementary material can be found by accessing the online version of this paper at http://dx.doi.org and by entering doi:...

Frequency of ED use was also significantly associated with desire to reduce alcohol use in the next 12 months amongst alcohol consumers after controlling for demographics. Specifically, the *'last year consumers'* and *'last month consumers'* had a significantly greater odds ratio of reporting desire to reduce alcohol use compared to *'non-consumers'*. A statistically significant association was not observed for *'frequent consumers'*. Contrasts revealed no significant difference in the odds of reporting desire to reduce alcohol use for *'last year consumers'* and *'last month consumers'* (p=.878), although both had greater odds than *'frequent consumers'* (p=.006 and p=.005, respectively).

AUDIT score was added as a third step in this model to determine whether ED use frequency was associated with desire to reduce alcohol use over and above hazardous alcohol use. In contrast to the previous step, the odds of reporting desire to reduce alcohol use were statistically lower for *'last month consumers'* (OR=0.90, 95%CI 0.86-0.95) and *'frequent consumers'* (OR=0.72, 95%CI 0.64-0.82), compared to *'non-consumers'*, with no statistically significant association for *'last month consumers'* (OR=1.00, 95%CI 0.94-1.06). Contrasts revealed lower odds for *'frequent consumers'* relative to *'last month consumers'* (p<.001), who in turn had lower odds than *'last year consumers'* (p<.001). These findings were evident in the multi-level mixed linear regression sensitivity analyses (see Supplementary Materials[2]).

3.6 Frequency of ED Use as a Correlate of Personal Wellbeing

Frequency of ED use was also associated with higher PWI scores in the total sample (i.e., those who had and had not consumed alcohol) after controlling for demographics. Specifically, there was a statistically significant 0.77 unit decrease (indicative of poorer wellbeing) in PWI score for the *'last year consumers'* compared to *'non-consumers*; 0.66 unit decrease for *'last month consumers'*, and 2.18 unit decrease for *'frequent consumers'*.

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[2] Supplementary material can be found by accessing the online version of this paper at http://dx.doi.org and by entering doi:...

Contrast analyses revealed no statistically significant difference in coefficients for *'last year consumers'* and *'last month consumers'* (p=4.19), although the coefficient for *'frequent consumers'* was significantly greater than that for both these groups (ps<.001). These findings were evident in the multi-level mixed linear regression sensitivity analyses (see Supplementary Materials[2]).

4. Discussion

4.1 ED and other Novel Caffeine Product Use

This research suggests widespread exposure to EDs amongst those who have ever used drugs: over two-thirds of this international sample had tried EDs at some point in their lifetime, and almost half reported past year use. This is consistent with recent research showing that the majority of other high-risk groups for ED use (e.g., adolescents and university students) have consumed these beverages within their lifetime (Arria et al., 2011; Gallimberti et al., 2013; Lubman et al., 2013; Trapp et al., 2014b), with monthly or more frequent use common amongst these populations.

Median age of ED initiation for the total sample was 16 years. However, examination of duration of ED use for past year consumers currently aged 16 showed they had been consuming EDs for a median of four years, suggesting initiation of use around 12 years of age. Qualitative research indicates increasing familiarity with, popularity of, and access to, ED amongst children and adolescents (Costa et al., 2014). However, to the authors' knowledge, this is one of the first studies published to quantitatively assess the age at of ED initiation. While the European Food Safety Authority (2015) were unable to determine a safe level of caffeine intake for children due to insufficient evidence, recent systematic reviews have highlighted that children and adolescents are particularly vulnerable to negative acute physiological side-effects, as well as dependence and withdrawal (Seifert, 2011; Temple,

2009). Relevant to this sample of people who use drugs, children and adolescents may be particularly vulnerable to caffeine's reinforcing effects. Caffeine use may result in cross-sensitisation to alcohol and other drugs, whereby rewarding responses to other psychoactive drugs is enhanced following habitual use of caffeine (Temple, 2009). This growing body of evidence, plus a lack of data regarding long-term outcomes of ED use during childhood and adolescence, reinforces arguments for a precautionary approach to ED use in this period, and discussion of age restrictions on sales, better labelling, and targeted education. We should note that EDs were first introduced in the US in 1997, and the number of countries in which EDs are available has increased considerably in the last decade. Thus, the period of possible exposure may vary by country, and we may see further shifts in patterns of initiation and duration of use with further market expansion.

Normalisation of ED use stands in contrast to use of other 'non-traditional' caffeine products. These non-traditional products, compared to EDs, were generally first used at an older age, and, in the case of intranasal spray, used more frequently. While caffeine tablets have been available for longer than EDs, intranasal caffeine spray is a relatively new product, potentially explaining: i) lower rates of use amongst the total sample, and ii) high rates of past year use amongst lifetime consumers. Large overlap between those reporting ED use and use of these products suggests that use of other non-traditional caffeine products may be strongly related to ED use.

4.2 Demographic and Alcohol and Drug Use Correlates of ED Use Frequency

Over half of past month consumers reported using EDs on a more than fortnightly basis, however less than 5% used EDs every day. These findings suggest that ED use is frequent but not typically part of daily routine, for this sample. The norm of using binary comparisons in this field, often between 'ED consumers' versus 'non-ED consumers'

(Marczinski et al., 2015), may disguise important findings based on a continuum of use from lifetime abstinence to daily use. This is best illustrated when considering past year amphetamine use reported by ED consumption frequency: 4.5% of lifetime ED abstainers, 7.8% of those who had consumed EDs in their lifetime (but not in the past year), 15.5% of those who had consumed EDs in the past year (but not in the past month), and 20.4% of those who had consumed ED on a weekly basis, reported ever using amphetamine. Greater frequency of ED use was also associated with greater likelihood of: being male; being under 21 years of age; currently studying; and past year caffeine tablet, caffeine intranasal spray, tobacco, cannabis, MDMA, and cocaine use.

These findings highlight the importance of conducting analyses that account for heterogeneity in frequency of use. It reinforces calls for prospective research exploring where ED use is positioned within the trajectory of substance use: as a marker of general propensity to engage in potentially hazardous behaviours or a behaviour which directly elevates risk of alcohol and other drug use (Arria et al., 2014). Further, these findings also suggest that greater frequency of ED use could be considered as a marker of current use of alcohol and other drugs, or of individuals at risk of engaging in use of other licit and illicit drugs use in the future.

4.3 Frequency of ED Use as a Correlate of Hazardous Drinking and Subjective Wellbeing

Building on this notion of ED use as an indicator of risk of alcohol and other drug use, previous research with a purposive sample of university students has shown increased likelihood of meeting criteria for DSM-IV alcohol dependence disorder for high frequency ED consumers (≥52 days in past year) versus low frequency (1-51 days) and non-consumers (0 days) (Arria et al., 2011). In contrast, the current study with a purpose sample of people

who use drugs showed that those who had used ED in the last year had a higher AUDIT score indicative of hazardous alcohol use relative to ED lifetime abstainers, with higher scores with increased frequency of use. These findings suggest that knowing the individual's full history of ED use can be important as a potential indicator of problematic alcohol use.

Those who reported both ED use in the past month were less likely to report a desire to cut back on alcohol use relative to ED lifetime abstainers (after controlling for demographics and AUDIT score). It may be that individuals who consume ED have less insight into their drinking behaviours; findings that higher frequency ED use often co-occurs amongst an array of high risk behaviours supports this notion, and previous research has shown higher risk of alcohol dependence amongst higher-frequency ED consumers ($\geq$52 days in the past year) relative to lower-frequency and non-consumers (Arria et al., 2011). It may also be that co-consumption of alcohol with EDs reduce hangover effects, making alcohol use less subjectively problematic. Use to reduce hangover symptoms is flagged by a significant minority of consumers (O'Brien et al., 2008), although these studies have typically focused on university students, with few experimental studies exploring this possible phenomenon (Rohsenow et al., 2014). Regardless, frequency of ED use could serve as flag in clinical settings for potential hazardous alcohol use, important given possible stigma associated with reporting problematic alcohol use (Fortney et al., 2004). Continuing with this premise, evidence from the current and previous studies (Trapp et al., 2014a) showing poorer wellbeing amongst ED consumers suggests that assessing history of use might flag those at greater risk of mental health problems, and in need of help from a mental health professional.

4.4 Strengths and Limitations

This sample for this study is unique compared to existing studies, comprising participants at high risk of ED use recruited from across the globe rather than from homogenous groups such as university students (Arria et al., 2014) or emergency department attendees (Cotter et al., 2013). However, findings should not be seen as representative of all ED consumers more generally or all ED consumers who use drugs as sampling was purposive. Data were self-reported, although evidence points to sufficient validity and reliability of self-report in studies of alcohol and illicit drug use (Darke, 1998; Del Boca, 2003). We were unable to exclude differences in trait impulsivity between consumers as an explanation for greater risk of hazardous drinking (and other outcomes) with increased frequency of ED use, as no such measure was included (Arria et al., 2014). We should also note that, whilst we collected data only on caffeinated EDs, we did not obtain information regarding ingredient profile of products, the typical volume ingested, and whether they were consumed simultaneously with other substances, thus restricting inferences regarding the pharmacological effects of consumption.

4.5 Conclusion

Lifetime exposure to EDs was common amongst the sample, with indications of initiation of use around 12 years of age for young participants. The current results suggest that greater frequency of ED use might form part of an array of complex problems given the interplay between ED use, drug use, alcohol problems, and poorer personal wellbeing. A lack of prospective research exploring where ED use fits within the trajectory of other alcohol and drug use means that we cannot determine whether ED use is causative in elevating likelihood of high risk behaviours, or symptomatic; future research addressing this is critical given the early age of initiation reported here, and concerns that habitual caffeine use in adolescent

may result in cross-sensitisation to other psychoactive substances. Regardless, the current findings indicate that knowledge of history of ED use is important: from a research perspective for understanding and taking into account heterogeneity in frequency of use, and from a clinical perspective for acting as a possible flag of current and/or future hazardous drinking, drug use, and wellbeing.

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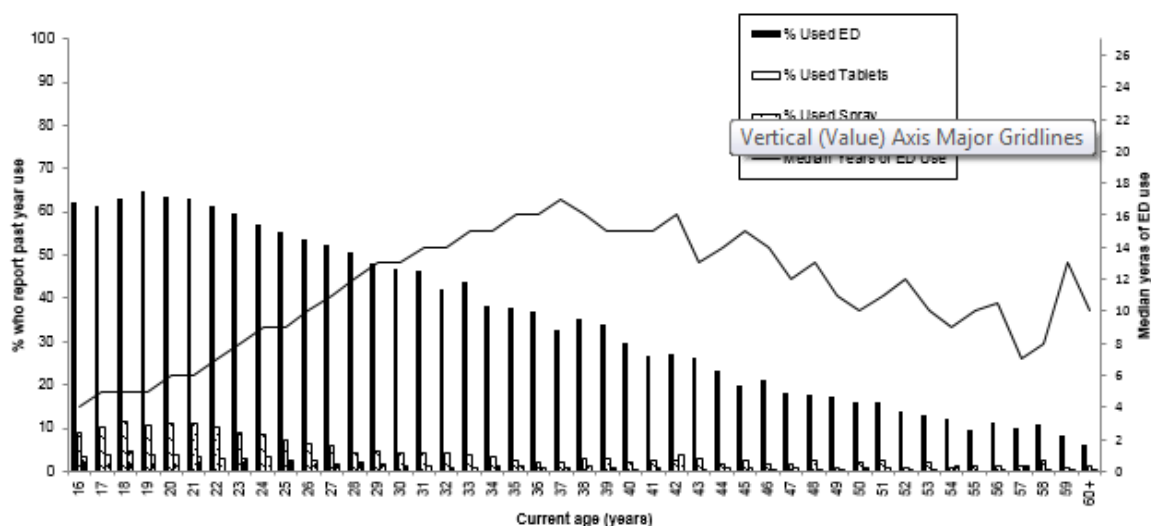
Figure 2. Percentage of past month ED consumers reporting days of ED use in the past month
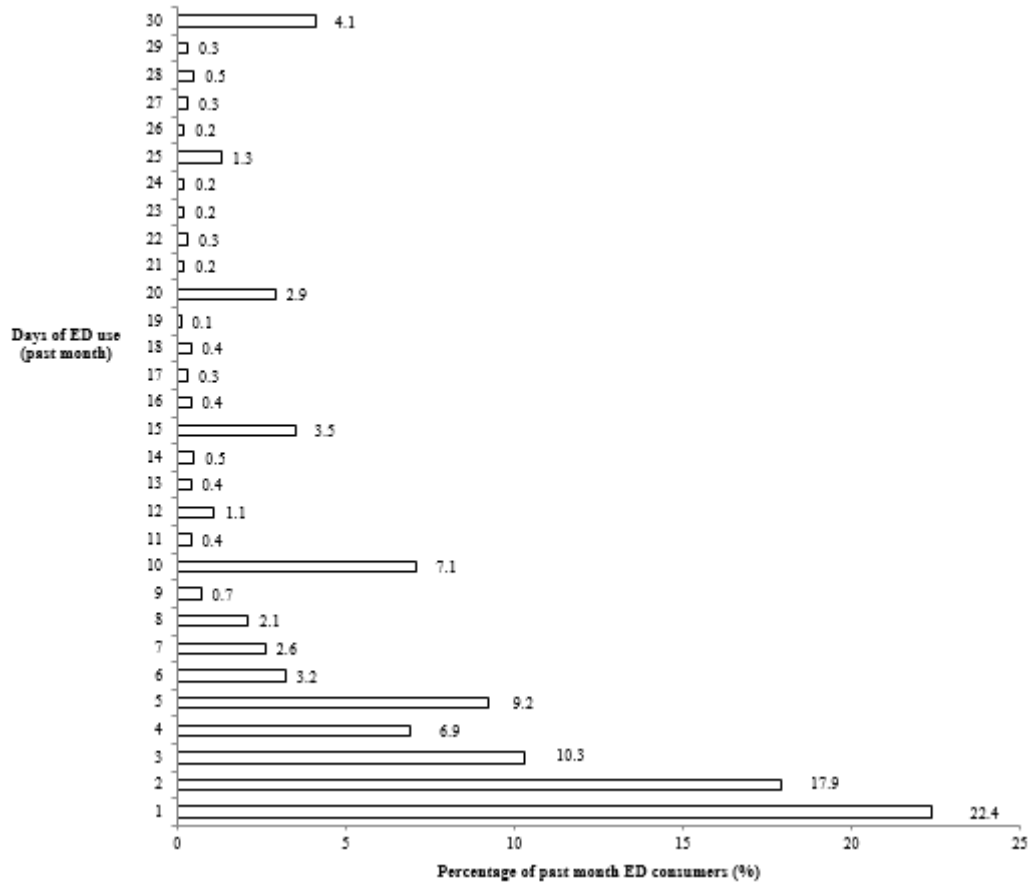(n=24,173).

Figure 3. Percentage of participants who are male (A: n=73,393), younger than 21 years (B: n=73,533), currently employed (C: n=72,020) and currently studying (D: n=72,810) according to ED consumer group. ED: energy drink.
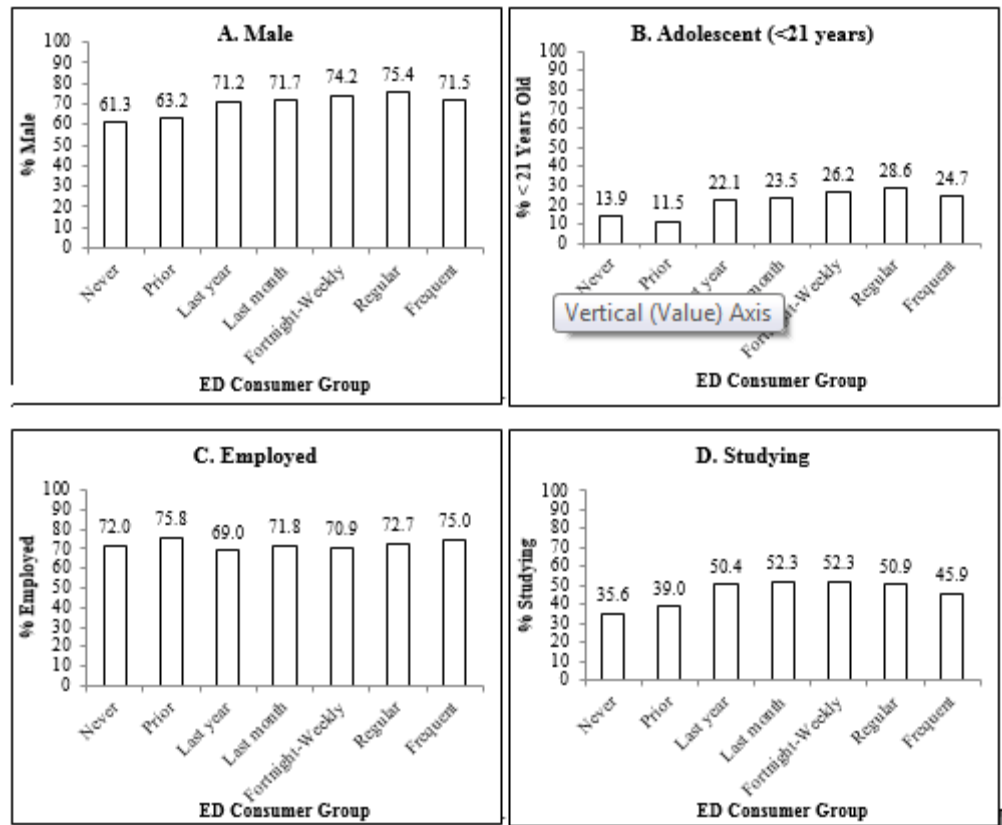
Figure 4. Percentage of participants (n=74,864) who reported past year caffeine tablet use (A); intranasal spray use (B); AUDIT cut-off score indicative of hazardous use (C), tobacco use (D); cannabis (E); MDMA (F); amphetamine (G); and cocaine (H) according to ED consumer group. The total sample was used for all analyses. ED: energy drink.
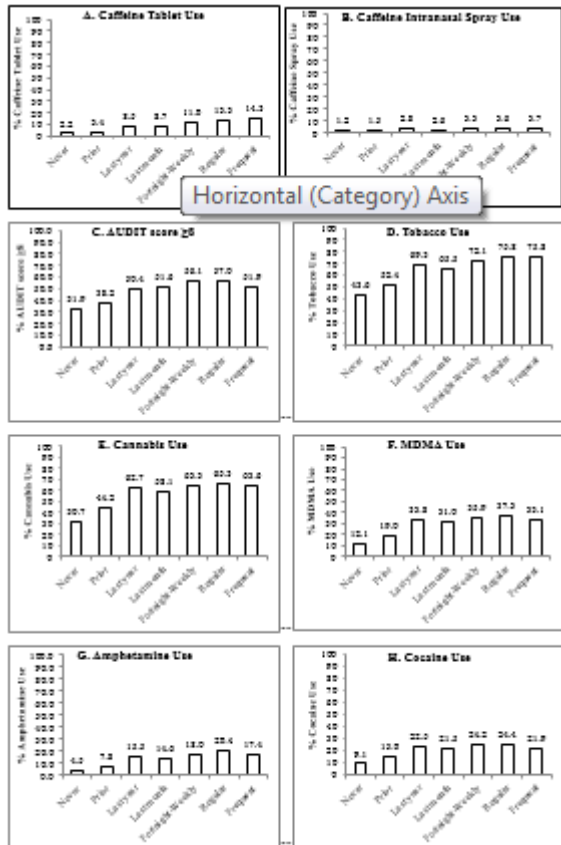
Table 1

Lifetime and Recent Use of Caffeinated Products (n=74,864)

	Energy Drinks	**Caffeine Tablets**	**Intranasal Caffeine Spray**
Ever used % (n)	69.2 (51,835)	24.5 (18,326)	4.9 (3,698)
Of lifetime consumers:			
Median age of first use (IQR)	16 (14-19)	18 (16-20)	17 (15-20)
Used last 12 months % (n)	68.6 (35,548)	26.4 (4,837)	44.3 (1,639)
Used last month % (n)	46.6 (24,173)	12.4 (2,280)	30.0 (1,110)

Table 2

ED Consumption as a Predictor of Alcohol Consumers' AUDIT Score, Desire to Reduce Alcohol Use, and Personal Wellbeing Index Score

	AUDIT Score[1] (n=66,590)		Desire to Reduce Alcohol Use[2] (n=66,237)		Personal Wellbeing Index Score[3] (n=70,361)	
Model	b (SE)	*p*	OR (95% CI)	*p*	b (SE)	*p*
Step 1						
Age (in 5-year groups)	-0.34 (0.03)	**<.001**	1.06 (1.03-1.10)	**<.001**	-0.01 (0.07)	.867
Male	1.73 (0.08)	**<.001**	1.24 (1.16-1.32)	**<.001**	-1.70 (0.24)	**<.001**
Studying	0.18 (0.16)	.264	0.97 (0.85-1.11)	.678	2.58 (0.29)	**<.001**
Employed	0.05 (0.14)	.702	1.14 (1.05-1.25)	**.002**	3.94 (0.51)	**<.001**
Step 2						
Age (in 5-year groups)	-0.22 (0.03)	**<.001**	1.07 (1.04-1.11)	**<.001**	-0.08 (0.08)	.263
Male	1.54 (0.08)	**<.001**	1.22 (1.14-1.31)	**<.001**	-1.57 (0.24)	**<.001**
Studying	0.19 (0.17)	.257	0.97 (0.85-1.11)	.669	2.56 (0.30)	**<.001**
Employed	-0.01 (0.14)	.984	1.14 (1.05-1.25)	**<.001**	4.00 (0.51)	**<.001**
ED Consumer						
Non-Consumer (ref)	-		-	-	-	-
Last Year Consumer	**1.07 (0.08)**	**<.001**	**1.18 (1.13-1.24)**	**<.001**	**-0.77 (0.14)**	**<.001**
Last Month Consumer (1-4 days past month)	**1.61 (0.07)**	**<.001**	**1.19 (1.14-1.24)**	**<.001**	**-0.66 (0.11)**	**<.001**
Frequent Consumer (5+ days past month)	**1.89 (0.17)**	**<.001**	1.04 (0.93-1.16)	.496	**-2.18 (0.27)**	**<.001**
Step 3						
Age (in 5-year groups)	-	-	1.14 (1.10-1.17)	**<.001**	-	-
Male	-	-	0.93 (0.87-1.01)	.087	-	-
Studying	-	-	0.94 (0.84-1.05)	.278	-	-
Employed	-	-	1.19 (1.11-1.29)	**<.001**	-	-
ED Consumer	-	-			-	-
Non-Consumer (ref)	-	-	-	-	-	-
Last Year Consumer	-	-	1.00 (0.94-1.06)	.934	-	-
Last Month Consumer (1-4 days past month)	-	-	0.90 (0.86-0.95)	**<.001**	-	-
Frequent Consumer (5+ days past month)	-	-	0.72 (0.64-0.82)	**<.001**	-	-
AUDIT score	-	-	1.20 (1.18-1.21)	**<.001**	-	-

Note. All demographic variables were categorical with the exception of age, which was treated as a continuous variable. Variables are bolded where statistically significant (*p*<.050). [1]Linear hierarchical regression analyses were restricted to those participants who had

consumed alcohol in the preceding 12 months. Higher AUDIT scores are indicative of more hazardous alcohol use. [2]Logistic hierarchical regression analyses for desire to reduce alcohol use in the next 12 months were restricted to those participants who had consumed alcohol in the preceding 12 months; AUDIT score was added in Step 3 of this model to determine the association between ED use and desire to reduce alcohol use after controlling for hazardous alcohol use. [3]Linear hierarchical regression analyses were conducted using the total sample; lower scores are equivalent to poorer subjective wellbeing.