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An emerging adolescent health risk: Caffeinated energy drink consumption patterns among high school students

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ABSTRACT

Objective. To examine the prevalence, patterns, and correlates of energy drink use among adolescents, and determine whether more frequent use of energy drinks is associated with poorer health and behavioral outcomes.

Methods. Data were from a 2012 cross-sectional survey of 8210 students in grades 7, 9, 10 and 12 attending public schools in Atlantic Canada. Multinomial logistic regression analysis was used to examine correlates of energy drink use patterns, including substance use, sensation seeking, risk of depression, and socioeconomic status.

Results. Nearly two-thirds of survey respondents (62%) reported consuming energy drinks at least once in the previous year, with about 20% reporting use once or more per month. Sensation seeking, depression, and substance use were all higher among energy drink users relative to non-users, and in higher frequency users relative to lower frequency users.

Conclusions. The prevalence of energy drink consumption among high school students was high. The association of energy drinks with other potential negative health and behavioral outcomes suggests that use of these products may represent a marker for other activities that may negatively affect adolescent development, health and well-being.

Introduction

There is a growing concern about the increased consumption of energy drinks — beverages that contain moderate to high concentrations of caffeine as well as taurine, herbal supplements, and sugar or sweeteners, particularly among youth and young adults (Babu et al., 2008; Pennington et al., 2010; Reissig et al., 2009). These beverages contain amounts of caffeine that are substantially higher than what is found in a standard cup of coffee (Arria and O'Brien, 2011; Reissig et al., 2009), but have been cleverly marketed to entice youth and young adults (Reissig et al., 2009). Sales of energy drinks in North America have increased substantially in recent years and are forecasted to approach $20 billion in the U.S. by the end 2013 (Heckman et al., 2010). Although there is no information readily available about how much of this is attributable to youth, it is known that approximately 30 to 50% of adolescents and young adults report regularly consuming such drinks (O'Brien et al., 2008). The appeal of energy drinks to youthful drinkers stems from its temporary benefits of increased alertness and improved mood, and enhanced mental and physical energy (Arria and O'Brien, 2011; Babu et al., 2008; Oddy and O'Sullivan, 2009; Reissig et al., 2009; Seifert et al., 2011; Smith et al., 2004).

Excessive caffeine intake by adolescents has, however, been shown to produce a number of deleterious health effects, such as irritability, cardiovascular symptoms, sleep impairment, and feelings of nausea and nervousness (Iyadurai and Chung, 2007; Nordt et al., 2012; Orbeta et al., 2006; Savoca et al., 2005; Seifert et al., 2011; The American Academy of Pediatrics Committee on Nutrition, and Council on Sports Medicine and Fitness, 2011). A number of studies point to the increasing use of alcohol mixed with energy drinks, which is associated with a number of alcohol-related problems and complications in younger populations, including junior and senior high school students. These include an increased likelihood of alcohol dependence, higher rates of binge drinking, and an increase in the likelihood of alcohol-related accidents and injuries (Azagba et al., 2013; Howland and Rohsenow, 2013; Howland et al., 2011; Marczinski et al., 2011; O'Brien et al., 2008; Patrick and Maggs, in press).

Recent studies point out that a significant number of college students in North America and elsewhere consume energy drinks, and that consumption is typically higher in young males, those who partake in sports, as well as those involved in substance use, prescription drug use and violent conduct (Arria et al., 2010; Buxton and Hagan, 2012; Hoyte et al., 2013; Miller, 2008; Oteri et al., 2007; Velazquez et al., 2012). However, little is known about the prevalence of use of energy drinks, use patterns, and correlates of energy drink consumption

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among junior and senior high school students. Particularly important is an understanding of who consumes energy drinks, how much is consumed, and in what ways these drinks are used. Excessive use of energy drinks has been linked to recent deaths in the United States and Canada (Bailey, 2012; Edney, 2012; Meier, 2012). A more in-depth examination of energy drink consumption in this vulnerable population is therefore warranted. Drawing on a representative sample of junior and senior high school students from three provinces in Atlantic Canada, the main objective of this study is to estimate the prevalence and correlates of energy drink use. Correlates include variables that are generally associated with adolescent health such as socio-demographic indicators as well as measures of depression, sensation seeking, substance use, and educational outcomes. As an additional objective, consumption patterns are assessed to determine whether more frequent use of energy drinks is associated with poorer health and behavioral outcomes.

Methods

Participants

The present study is based on the 2012 Student Drug Use Survey in the Atlantic Provinces (SDUSAP). The SDUSAP is a cross-sectional survey of 9226 students in grades 7, 9, 10 and 12 attending public schools in the three Atlantic Provinces Nova Scotia, New Brunswick, and Newfoundland & Labrador (total population: 2,187,434). Public school students in both Anglophone and Francophone schools were included in the sample; excluded were private schools, schools on reserve, street-youth, school-leavers and students who were absent from school on the designated day of the survey. The sample design was a two-stage stratified cluster sample of randomly selected classes containing at least 20 students in each of the four surveyed grades within each health region in the three participating provinces. The sample allowed for approximately proportional representation of each province, within each region, within each grade; thereafter, the sample was allocated proportionately according to school size. All students who participated in the survey had parental consent. Two weeks in advance of administering the survey, an information package was sent home to parents describing the survey. Parental consent was obtained in one of two ways depending on the school board. Some school boards required active parental consent for their child to take part in the survey, where a signed consent form was to be returned to the school. Other school boards required passive parental consent, whereby parents contacted the school if they did not want their child to take part in the survey. Finally, all students who did participate in the survey also gave individual/personal consent. Ethics approval was granted by the Dalhousie University Health Sciences Research Ethics Board. Ninety percent of students present on the day the survey was administered participated in the SDUSAP. The Nova Scotia instrument was derived from the prototype provided in the Canadian guidelines for self-reported adolescent drug use surveys and the survey was validated prior to its initial use in 1996 (Poulin et al., 1993).

Dependent variable

Energy drink use: a categorical variable was created to represent the consumption of caffeinated energy drinks in the past year: 1) non-use of energy drinks in the past 12 months, 2) consumed energy drinks one or two times in the past 12 months, 3) consumed energy drinks three to eight times in the past 12 months, 4) consumed energy drinks once a month in the past 12 months, and 5) consumed energy drinks more than once a month in the past 12 months. This question draws on similar questions in other surveys of school and college youth (Attila and Çakir, 2011; Berger et al., 2011; Malinauskas et al., 2007; Miller, 2008).

Independent variables

Depression was measured using a 12 item version of the Centers for Epidemiological Studies Depression Scale (CES-D) (range, 0–36, Cronbach's alpha = 0.87) with a higher score indicating increased risk of depressive symptoms. Three categories of depressive symptoms were created using the total CES-D score: very elevated (total score 21 to 36), somewhat (total score 12 to 20) and minimal (total score 0 to 11) (Poulin et al., 2005). Example items included in the 12-item CES-D were "I felt like depressed", "I had trouble keeping my mind on what I was doing", "I had crying spells", and "I felt like lonely".

Sensation seeking was measured according to how students strongly agreed or disagreed with the following 4 statements (scale range, 4–16, Cronbach's alpha = 0.83): "I like new and exciting experiences, even if I have to break the rules", "I prefer friends who are exciting and unpredictable", "I like to explore strange places", and "I like to do frightening things" (Stephenson et al., 2003).

Academic performance was measured according to the question, "So far in the school year, what is your average on all your courses at school?" We grouped the responses into four categories: 80% or above, 70% to 79%, unknown, and less than 70% (reference category).

Substance use was captured by three measures: cigarette, alcohol and marijuana use. Cigarette use represented those who reported smoking more than one cigarette in the past year. Alcohol use represented those that reported drinking other than 'just a sip' in the past year. Marijuana use represented those that reported using marijuana at least once in the past year. An indicator variable was created to represent use of any one of other illicit drugs (e.g. cocaine, MDMA/ecstasy, LSD, non-medical stimulants, non-medical tranquilizers, methamphetamine). These questions have been widely used in previous student surveys, including the preceding five iterations of the current survey (Poulin et al., 1993).

The analysis also controlled for socio-demographic variables including province of residence. Age was represented in continuous form (number of years). Gender was coded 1 for males and 0 for females. Parental (mother) education was categorized as post-secondary education, unknown, and less than post-secondary education (reference category). Due to sample size students' living arrangement was coded as living with both parents vs. not living with both parents.

Statistical analysis

Given the categorical nature of the dependent measure, a multinomial logistic regression analysis was used to examine the correlates of energy drink use patterns. The sample design of the SDUSAP including sample weights was used in the analysis to produce population estimates and adjust for unequal probabilities of selection. Excluded from the analysis were the responses (n = 108) of students who reported using a fictitious drug, which was included in the survey to detect students not responding in a trustworthy fashion. Of the total 9118 students, 76 values were missing for energy drink question, 206 for gender, 298 for sensation seeking, 305 for depression, 145 for marijuana, and 169 for parental education. After omitting missing values, the total sample used in the present study was 8210. We checked for multicollinearity using the variance inflation factor (VIF) and the results showed no multicollinearity problem. All analyses were carried out using Stata version 12.

Results

Table 1 provides descriptive statistics for the sample. The analysis included 8210 students, of whom 51.8% were female. Their average age was 15.2 years. Just over 62% of junior and senior high school students reported having used energy drinks at least once in the past 12 months. Approximately 20% consumed energy drinks once or more per month in the last year. The characteristics of respondents (Table 1) were similar between our analytic sample (n = 8210) and the total sample (n = 9118).

Adjusted odds ratios from the multinomial logistic regression analysis are shown in Tables 2 and 3. In Table 2, the base category was non-energy drink use in the past year while the base category in Table 3 was the consumption of energy drink one or two times in the past year. This approach allows for the comparison of use with non-use, as well as between higher frequency use and lower frequency use. Findings show consistent, statistically significant associations between measures of age, gender, sensation seeking, depressive symptoms, and substance use with energy drink consumption.

In terms of socio-demographic indicators, the likelihood of consuming energy drinks was higher for males relative to females, with an increased odds ratio at higher levels of consumption (three to eight times; odds ratios [OR] 1.23; once a month, OR 1.97; more than once a month, OR 3.26). Moreover, these differences persisted (Table 3) when comparing higher frequency of consumption with lower frequency (once per month vs. one or two times, OR 1.87; more than once per month vs. one or two times, OR 3.09). Age, conversely, was protective with a lower likelihood of consumption among older students. For

Table 1
Sample characteristics (%) of the 2012 Student Drug Use Survey in the Atlantic Provinces.

	Total survey sample (9118)		Study sample (8210)	
	N	%	N	%
Prevalence of energy drink consumption in the past year				
At least once	5523	62.2	5025	62.2
Three or more times	3767	42.0	3416	41.6
Once or more in a month	1812	20.0	1621	19.5
More than once in a month	1165	12.7	1037	12.2
Depressive symptoms				
Very elevated	710	8.4	672	8.5
Somewhat elevated	2063	24.5	1938	24.9
Minimal	6039	67.1	5600	66.6
Gender				
Male	4395	49.2	3974	48.2
Female	4516	50.8	4236	51.8
Age[a]	9094	15.2 (0.06)	8210	15.2 (0.06)
Academic grade				
≥80%	4269	48.3	4008	49.8
70–79%	2241	23.9	2019	24.0
≤69%	1506	16.7	1317	16.0
Not stated	1027	11.1	866	10.2
Living arrangement				
Not with both parents	3159	35.7	2838	35.2
With both parents	5867	64.3	5372	64.8
Parental education				
Post-secondary	4870	56.2	4545	57.1
<Post-secondary	2073	22.8	1913	22.9
Not stated	2005	21.0	1752	20.0
Sensation seeking[a]	8820	10.6 (0.05)	8210	10.6 (0.05)
Substance use				
Cigarette use	1314	14.0	1183	13.7
Marijuana use	2567	31.2	2364	31.8
Alcohol use	4376	48.3	4024	48.8
Other drug use	1861	21.3	1693	21.5
Province of residence				
Newfoundland	2505	22.5	2226	22.1
Nova Scotia	3148	42.6	2856	43.1
New Brunswick	3465	34.9	3128	34.8

The analysis was population weighted, N represent unweighted number.
[a] Values represent mean of a continuous variable with standard deviation in parenthesis.

both gender and age, no differences were observed between those who consumed one or two times compared to those who did not use at all. Parental education, student's living arrangement, and academic grades had limited or no associations with energy drink use. The exceptions were for students whose parents received post-secondary education, who had a lowered likelihood of consuming energy drinks (three to eight times per year or less vs. not at all); not living with both parents was associated with an increased risk of consuming energy drinks at the highest frequency (more than once a month vs. not at all; OR 1.32); and maintaining an average of 80% or higher was protective of moderate (three to eight times vs. not at all) and higher frequency (more than once per month vs. not at all) of energy drink consumption.

In terms of health and behavioral outcomes, results were consistent with two main trends being observed. First, negative health states (heightened sensation seeking, elevated depressive symptoms) and involvement in other risky behaviors (tobacco, alcohol, marijuana, and other drug use) were all associated with an increased likelihood of energy drink consumption. Secondly, in most cases, there was a clear dose–response pattern for these associations whereby higher odds ratios were observed among students who consumed energy drinks more frequently. For example, heightened sensation seeking was associated with an increased OR of 1.09 for consuming energy drinks one or two times per year; an OR of 1.17 for consuming energy drinks three to eight times per year; an OR of 1.17 for consuming energy drinks once per month; and an OR of 1.28 when consuming energy drinks more than once per month. A similar dose–response pattern was observed for the four measures of substance use. The results observed in Table 2 were consistent in Table 3 when comparing higher frequency (once per month or more) with lower frequency energy drink use (one or two times per year).

Discussion

Among a representative sample of junior and senior high school students from Atlantic Canada, nearly two-thirds (62%) report consuming energy drinks at least once in the previous year with about two-in-five reporting use once or more per month. These estimates of energy drink use are similar to prevalence rates reported in a handful of non-probability samples of college students (Arria et al., 2010; Buxton and Hagan, 2012; Hoyte et al., 2013; Miller, 2008; Oteri et al., 2007; Velazquez et al., 2012). As with the college student studies, males were much more likely to report energy drink consumption than female students (Arria et al., 2010; Hoyte et al., 2013; Nordt et al., 2012; Velazquez et al., 2012). Student age also mattered, though not in the direction typically seen with the use of alcohol and other substances. Rates of energy drink use were higher among younger students and the prevalence (and frequency) of consumptions decreased with increasing age. While research on adolescent substance use typically finds a higher prevalence among older youth (Young et al., 2002), a previous study on the consumption of alcohol mixed with energy drinks among Canadian high school students found a similar, inverse relationship (Azagba et al., 2013). Also, results from a community-based probability sample of US adults aged 18 or older found that energy drink users were more likely to be younger (Berger et al., 2011). In addition to the decline in use with age, it is also of note that a minority of students indicated using energy drinks more than once a month. It may be that use of energy drinks by adolescents is an experimental phase through which younger adolescents pass, moving on to other experiences fairly quickly. Parental education, student's living arrangement and academic performance were less clearly related to energy drink use; however,

Table 2
Adjusted multinomial logistic regression results of energy drink use in the past year (odds ratios and confidence interval in parenthesis) using the 2012 Student Drug Use Survey in the Atlantic Provinces (8210).

	One to two times vs. Non-use	Three to eight times vs. Non-use	Once a month vs. Non-use	More than once a month vs. Non-use
Gender				
Male	1.06 (0.87–1.28)	1.23 (1.00–1.51)	1.97 (1.46–2.65)	3.26 (2.57–4.13)
Female	Ref	Ref	Ref	Ref
Age	0.98 (0.93–1.03)	0.91 (0.85–0.97)	0.89 (0.82–0.97)	0.89 (0.81–0.97)
Parental education				
Post-secondary	0.72 (0.57–0.93)	0.77 (0.62–0.97)	0.73 (0.53–1.00)	0.89 (0.68–1.17)
Not stated	0.67 (0.50–0.89)	0.83 (0.63–1.10)	0.79 (0.54–1.16)	0.92 (0.65–1.30)
<Post-secondary	Ref	Ref	Ref	Ref
Living arrangement				
Not with both parents	1.23 (1.00–1.51)	1.15 (0.93–1.42)	1.17 (0.90–1.53)	1.32 (1.05–1.67)
With both parents	Ref	Ref	Ref	Ref
Academic grade				
≥80%	0.75 (0.56–1.01)	0.56 (0.44–0.73)	0.74 (0.52–1.04)	0.53 (0.38–0.74)
70–79%	0.89 (0.64–1.23)	0.91 (0.66–1.26)	1.25 (0.83–1.88)	0.98 (0.70–1.38)
Not stated	1.00 (0.68–1.46)	0.71 (0.48–1.03)	0.88 (0.50–1.54)	1.21 (0.77–1.92)
≤69%	Ref	Ref	Ref	Ref
Sensation seeking	1.09 (1.07–1.12)	1.17 (1.13–1.20)	1.17 (1.11–1.23)	1.28 (1.22–1.33)
Depressive symptoms				
Very elevated	1.40 (1.00–1.97)	1.14 (0.78–1.66)	2.08 (1.23–3.51)	2.73 (1.84–4.06)
Somewhat elevated	1.07 (0.84–1.35)	1.09 (0.85–1.40)	1.20 (0.90–1.60)	1.16 (0.87–1.53)
Minimal	Ref	Ref	Ref	Ref
Substance use				
Cigarette use	1.20 (0.81–1.78)	2.04 (1.42–2.91)	2.70 (1.74–4.19)	3.10 (2.06–4.66)
Non-cigarette use	Ref	Ref	Ref	Ref
Marijuana use	1.55 (1.19–2.03)	2.37 (1.88–2.98)	2.84 (2.11–3.83)	2.91 (2.16–3.92)
Non-marijuana use	Ref	Ref	Ref	Ref
Alcohol use	2.03 (1.66–2.47)	3.15 (2.49–3.99)	4.56 (3.35–6.20)	5.04 (3.77–6.72)
Non-alcohol use	Ref	Ref	Ref	Ref
Other drug use	1.41 (1.06–1.88)	1.59 (1.26–2.00)	2.07 (1.54–2.77)	2.54 (1.91–3.38)
No other drug use	Ref	Ref	Ref	Ref

Ref = reference category.

when associations were observed they were in the anticipated direction (i.e. higher grades were protective).

Of particular concern is the observed link between energy drink consumption, poor mental health, and substance use behavior. Sensation seeking was higher among energy drink users relative to non-users, and in higher frequency users relative to lower frequency users, while elevated depressive symptoms were associated with more frequent energy drink consumptions (monthly use or more). Cigarette, marijuana, alcohol and illicit drug use was all related to energy drink use, with more frequent consumption having a stronger connection with substance uses than less frequent consumption. Our finding of an association of energy drink consumption with substance use is consistent with previous evidence drawn from US college students, particularly as it relates to the consumption of alcohol mixed with energy drinks, where a number of negative health outcomes have been observed (Arria and O'Brien, 2011; Arria et al., 2010; Azagba et al., 2013; Marczinski et al., 2011; Miller, 2008; O'Brien et al., 2008; Velazquez et al., 2012).

That energy drink consumption was strongly linked to a number of other potential adverse health and behavioral outcomes suggest that use may be associated with other activities that may negatively affect adolescent development, health and well-being. Risk behaviors are known to cluster in youth (Alamian and Paradis, 2009; Poulin and Elliott, 1997), and frequent energy drink consumers (monthly or more),are clearly at a heightened likelihood of using alcohol and other substances as well as being more prone to sensation seeking and risk of depression. Whether these associations exist as part of a chain of earlier life events, or as a product of broader disparities in social determinants of health remains less clear (in part due to the cross sectional nature of our data); yet, parents, schools, and other caregivers should recognize excessive energy drink use as a potential warning sign for other problems or difficulties.

This study has several limitations, including most importantly its cross-sectional nature, which limits these findings to associations only; causality in the relationships seen here cannot be inferred. Secondly, while this paper has looked specifically at energy drinks, we are

Table 3
Adjusted multinomial logistic regression results of energy drink use in the past year (odds ratios and confidence interval in parenthesis) using the 2012 Student Drug Use Survey in the Atlantic Provinces (8210).

	Once a month vs. One to two times	More than once a month vs. One to two times
Gender		
Male	1.87 (1.35–2.58)	3.09 (2.33–4.09)
Female	Ref	Ref
Age	0.91 (0.83–0.99)	0.90 (0.82–0.99)
Parental education		
Post-secondary	1.01 (0.73–1.40)	1.23 (0.92–1.65)
Not stated	1.19 (0.80–1.75)	1.37 (0.96–1.97)
<Post-secondary	Ref	Ref
Living arrangement		
Not with both parents	0.96 (0.75–1.21)	1.08 (0.87–1.34)
With both parents	Ref	Ref
Academic grade		
≥80%	0.98 (0.65–1.46)	0.70 (0.49–1.00)
70–79%	1.41 (0.94–2.12)	1.11 (0.77–1.58)
Not stated	0.88 (0.51–1.52)	1.22 (0.77–1.93)
≤69%	Ref	Ref
Sensation seeking	1.07 (1.02–1.12)	1.17 (1.11–1.22)
Depressive symptoms		
Very elevated	1.48 (0.86–2.57)	1.95 (1.36–2.79)
Somewhat elevated	1.12 (0.82–1.54)	1.08 (0.80–1.47)
Minimal	Ref	Ref
Substance use		
Cigarette use	2.25 (1.53–3.30)	2.58 (1.71–3.89)
Non-cigarette use	Ref	Ref
Marijuana use	1.83 (1.37–2.43)	1.87 (1.37–2.56)
Non-marijuana use	Ref	Ref
Alcohol use	2.25 (1.62–3.12)	2.48 (1.83–3.36)
Non-alcohol use	Ref	Ref
Other drug use	1.46 (1.02–2.09)	1.80 (1.26–2.57)
No other drug use	Ref	Ref

Ref = reference category.

unable to consider the potential impact of other, and overall, caffeinated beverage consumption and harm.

Conclusion

In summary, we find that nearly two-thirds of junior and senior high school students in Atlantic Canada report consuming a caffeinated energy drink at least once in the previous year, with one-in-five reporting use once or more per month. Given observed negative effects of caffeine consumption among young people, as well as the link between the use of energy drinks and other negative health behaviors, these trends are a concern that warrants further monitoring and action. Attempts to minimize the potential harms from energy drink consumptions could focus on the suggestion of the American Academy of Pediatrics, among other health and physician groups, to ban the sale of energy drinks to minors and young people under the age of 19 (e.g. Doctor's Nova Scotia, 2012; Meier, 2013). However, it must be recognized that, as seen in this study, many underage youth use tobacco and alcohol, so that this approach, while it may limit access to energy drinks, will not eradicate it. Failing that, at the very least, steps should be taken to reduce the frequency of use among youth, to increase public awareness and education about the potential harms which can result from use of caffeinated energy drinks, and to minimize the amount of caffeine available in each unit (Health Canada, 2011). With respect to limiting use by students in particular schools, health promotion efforts in schools require the concerted efforts of school administration, teachers, parents, and the students themselves. While not eliminating the problem entirely, these approaches may help to mitigate potential harms.

Conflict of interest statement

None.

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