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Evidence Brief: Potential adverse health events following consumption of alcohol mixed with energy drinks

Key Messages

- In 2015, 14 per cent of Ontario youth in grades 7 to 12 consume alcohol mixed with energy drinks (AmEDs).
- Studies comparing persons who consume AmEDs to those who consume alcohol-only have found that persons who consume AmEDs report higher alcohol consumption and more risk-taking behaviours related to driving, sex, and drug use.
- Among AmED users, there was no clear difference in alcohol consumption and risk-taking behaviours during AmED versus alcohol-only drinking sessions.
- Further research is needed to differentiate the risk factors from the consequences of AmED use.

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Glossary

Alcohol mixed with energy drink (AmED): a beverage that contains alcohol and a caffeinated energy drink; hand-mixing typically occurs at the point of consumption.

Caffeinated alcoholic beverage (CAB): pre-mixed and packaged drink containing a caffeinated beverage (e.g., pop) and alcohol. Of note, in the U.S., the preferred term is 'caffeinated alcoholic drink'(CAD).

Caffeinated energy drink (CED): beverages containing caffeine and marketed as being able to boost a person's energy. These may also contain: ginseng, vitamins and minerals, sweeteners, taurine (a non-essential amino acid), and guarana (a supplement that also contains caffeine).

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Issue and Research Question

Combining alcohol with caffeinated energy drinks (CEDs) was a practice that originated in dance clubs.[1] Alcohol mixed with energy drinks (AmEDs) has gained the most popularity with college-aged drinkers.[1]

In addition to the practice of mixing alcohol with an energy drink at the point of consumption, pre-mixed caffeinated alcoholic beverages (CABs) were introduced in the early 2000s.[2] The market for CABs grew in Canada, from combined sales of approximately 300,000 litres in May 2007 in British Columbia, Alberta, Quebec, Manitoba and Ontario, to 500,000 litres in these same jurisdictions in May 2010.[3]

The 2010 Canadian Alcohol and Other Drug Use Monitoring Survey (CADUMS) showed that 11 per cent of young adults aged 18 to 24 in Canada reported consuming alcohol with a CED in the past 30 days.[3] In a survey of university students in British Columbia, 23 per cent of students reported consuming an AmED in the past 30 days.[4] On average, these AmED consumers reported drinking AmEDs on two different occasions in the past 30 days, and drinking two AmEDs during each session.[4] In a survey of 72 young adult CED consumers at Dalhousie University, 76 per cent reported consuming AmEDs in their lifetime and 22 per cent reported consuming their most recent CED mixed with alcohol.[5]

Recent surveys suggested that consumption of AmEDs was also common among Ontario adolescents.[6] A 2015 Ontario survey found that 14 per cent of students in grades 7 to 12 reported consuming at least one AmED in the past year.[6] Unlike CEDs, which are more commonly consumed by male than female students,[6] AmEDs were consumed by a similar proportion of male (15.2 per cent) and female (12.8 per cent) students.[6] Also, consumption rates appeared to increase by grade; 5 per cent of students in grade 8 reported consuming AmEDs in the past year compared to 23 per cent of students in grade 12.[6] This is noteworthy given that evidence suggests that most are aware of the potential risks of AmEDs.[7] A 2015 survey of 2,055 Canadian youth (aged 12 to 17 years) and young adults (aged 18 to 24 years) found 56 per cent of respondents answered that it was “definitely not safe” to mix alcohol with CEDs, and 29 per cent of respondents answered that it was “probably not safe”.[7] Furthermore, Ontario grade 7 to 12 students are not of legal age to drink alcohol.

In Canada, concerns about the safety of CEDs and AmEDs began to emerge when serious adverse events following their consumption were reported to Health Canada.[8] Two systematic reviews of hospital case reports also reported cardiovascular events following AmED consumption.[9,10] In Fall 2010, Health Canada commissioned an independent Expert Panel on Caffeinated Energy Drinks “to provide recommendations on questions relating to the appropriate risk mitigation strategies for energy drink natural health products, as a result of potential safety concerns identified by the Health Products and Food Branch.”[8] The expert panel recommended that labelling of market-authorized CEDs include a statement that these products should not be used with alcohol.[8]

As per current Health Canada regulations, labels on CED containers are required to state that CEDs should not be mixed with alcohol.[8] Health Canada also banned pre-mixed CABs containing added caffeine from an ‘artificial’ source, including some CEDs.[11] However, CABs are still permitted when the caffeine is derived from a

natural source (e.g., guarana, coffee), and are currently available in liquor stores in Ontario.[12] Furthermore, whereas mixing alcohol with CEDs is discouraged on CED labels, CEDs are sold in retail premises (e.g., grocery stores) and establishments (e.g., bars and clubs) where alcohol is also sold.

Some public health units in Ontario are responding to concerns about the potential harms associated with AmEDs by developing information campaigns and creating resources designed to increase public awareness. For example, in 2013 youth leaders from Middlesex-London Health Unit developed short videos illustrating the adverse health events following consumption of CEDs, including one video specifically on AmEDs.[13] Wellington-Dufferin-Guelph Public Health also released a resource titled "Energy Drinks Exposed," which included a presentation and facilitator's guide for grade 7 to 12 teachers focused on the potential adverse health events following consumption of CEDs and AmEDs.[14]

In order to clarify the evidence for local public health, this Evidence Brief asks: What are the potential adverse health events following consumption of AmEDs among youth and young adults?

Methods

Five electronic databases (Ovid MEDLINE; Embase; PsycINFO; CINAHL; and SocINDEX) were searched on April 2, 2015 by Public Health Ontario (PHO) Library Services for articles published between January 2010 and April 2015. This search was updated on March 15, 2016. Articles retrieved by the search were assessed for eligibility using the following criteria: systematic review, meta-analysis or narrative review (primary research studies were excluded); English language; reported on adverse health events following consumption of AmEDs; and included youth and young adults as part of the target population. Grey literature was not included in the search. Reviews that focused solely on caffeine and 'caffeinated beverages with alcohol' (and not specifically on 'energy drinks with alcohol'), or that targeted adults only were excluded. Articles focused on adverse health events associated with consuming CEDs (not necessarily AmEDs) were used to develop an accompanying PHO Evidence Brief.[15]

All titles and abstracts were screened by two reviewers who came to consensus on inclusion decisions. Full-text articles were retrieved and reviewed by two independent reviewers. Relevant information was extracted from each article by one reviewer and doubled-checked by the other. Quality appraisal was conducted independently by two reviewers using the Health Evidence Quality Assessment Tool[16] and disagreements were resolved by consensus. The full search strategy can be obtained by request from PHO.

Main Findings

The search identified a total of 221 reviews, from which 15 unique reviews met the inclusion criteria. Of these, two were meta-analyses: one assessed the effect of drinking AmED compared to alcohol-only on subjective intoxication,[17] the other assessed its effect on alcohol consumption.[18] Two studies[19,20] were systematic reviews; both assessed the effect of AmEDs use on alcohol consumption, risk-taking behaviours and subjective intoxication. The remaining 11 studies[2,21-30] were narrative reviews. The quality of included reviews was rated as moderate[17,19] or weak[2,18,20,21,23-30] using the Health Evidence Quality Assessment Tool for review articles.[16]

The quality appraisal scores are available in a table format upon request from PHO. Our results focus on the nine[17-25] most comprehensive reviews with detailed methods. Results from the six[2,26-30] remaining articles are discussed as necessary. Of note, only one[20] review included in this Evidence Brief formally and systematically appraised the quality of the included primary research studies. Also noteworthy, the same primary research studies were cited by several reviews and their results were sometimes interpreted differently in different reviews. With respect to potential conflict of interest, investigators for both meta-analyses[17,18] had previous ties to CED manufacturers and the Canadian Beverage Association, and investigators for one systematic review[20] had used free samples of CEDs from a manufacturer in a previous primary research study.

The next sections discuss the results of these reviews according to the type of adverse health event studied, including: alcohol consumption, risk-taking behaviour (e.g., drinking and driving, sexual risk-taking) and non-specific physiological events (e.g., tremors, agitation).

Alcohol Consumption

Seven of the nine reviews examined the relationship between AmED use and alcohol consumption. One meta-analysis[18] and three reviews[19,20,25] found that AmED consumers reported higher alcohol consumption compared to alcohol-only consumers. Of note, there was a high degree of overlap in primary research studies[31-34] included in these four reviews. One meta-analysis[18] and three reviews[19,20,25] assessed alcohol consumption within AmED consumers, comparing drinking episodes involving AmEDs to drinking episodes involving alcohol-only. Within included reviews, some primary studies reported higher[31] and others lower[32,34] alcohol consumption during drinking episodes involving AmEDs; the meta-analysis[18] found no difference. As noted in the meta-analysis[18] and three reviews,[19,20,25] a causal relationship between AmED use and increased alcohol consumption has not been established. The three other reviews[21-23] did not consider within-subject and between-group differences in alcohol consumption separately.

Two reviews[22,25] reported that AmED consumers were more likely to report alcohol dependence compared to alcohol-only consumers. However, these findings are based on the results of three primary research studies that did not establish a causal link between AmED use and risk of alcohol dependence.[35-37]

Self-Perceived Intoxication and Desire/Drive to Consume Alcohol

Some attempts to explain the higher alcohol consumption of AmED consumers compared to alcohol-only consumers have focused on the potential for AmEDs to modify self-perceived intoxication and desire/drive to consume alcohol.

Several reviews[17,19,20,22,23,25] assessed self-perceived intoxication following AmED use compared to alcohol-only. A meta-analysis[17] of randomized controlled trials found no significant difference in self-perceived intoxication between healthy volunteers who ingested AmEDs compared to those who ingested alcohol. In contrast, other reviews[19,20,22,23,25] found that AmED consumers were less likely to report feeling intoxicated or being functionally impaired than alcohol-only consumers. Three systematic reviews[19,20,25] cited a randomized controlled trial[38] that found a higher desire rating for alcohol after subjects

were 'primed' with a dose of AmED as compared to being 'primed' with alcohol-only, but this difference did not reach statistical significance. Results from this primary research study were misinterpreted by two of the three reviews as providing conclusive evidence that a priming dose of AmED increases the desire for alcohol longer than a priming dose of alcohol-only.[19,25]

Risk-taking Behaviour

Seven included reviews[19-25] examined the relationship between AmED use and risk-taking behaviours. Comparing AmED consumers to alcohol-only consumers, AmED consumers were more likely to report risk-taking behaviours than alcohol-only consumers in all seven included reviews.[19-25] In contrast, reviews that compared AmED drinking episodes to alcohol-only drinking episodes among AmED consumers found similar or lower risk-taking behaviour during AmED drinking sessions than alcohol-only drinking sessions.[19,20,25] University students who are AmEDs consumers were more likely to report intention to drive intoxicated[19,23-25] and drinking and driving;[19-22,24,25] as compared to alcohol-only consumers, although these results are based largely on the results of three primary research studies.[4,33,39] AmED consumers were also more likely to report being a passenger in a car with an intoxicated driver,[20,21,23,24] and suffering some form of physical injury.[19-21,24,25]

Several reviews commented on the association between AmEDs use and sexual risk-taking behaviours. Four reviews[19,20,22,23] reported that college students who consumed AmEDs in the past 30 days were more likely to report being taken advantage of sexually, as compared to students who drank alcohol-only in the past 30 days; however, this finding is based on only two primary research studies by the same lead author.[33,40] Five reviews[19,20,22-24] reported that college students who consumed AmEDs in the past 30 days were more likely to report taking advantage of another sexually, as compared to students who drank alcohol-only in the past 30 days. Similarly, this finding is based on a single primary research study.[33] Two reviews[19,21] citing two primary research studies[41,42] reported that among college students who are 'hazardous drinkers', those who used AmEDs were significantly more likely than those who used alcohol-only to have had unprotected sex.

Several reviews commented on the association between AmEDs use, smoking and drug use. Three reviews[20-22] citing two primary research studies[32,43] found that that college students who consumed AmEDs were more likely to report cigarette smoking, as compared to those who consumed alcohol-only. Three reviews[21,22,25] citing two primary research studies[42,43] reported that AmED consumers were more likely to use marijuana, as compared to consumers of alcohol-only. One review[25] reported that college students who consumed AmEDs were more likely to use ecstasy and cocaine, compared to students who consumed alcohol-only; this finding is based on a single primary research study.[42] Similarly, one review[20] citing a single primary research study[32] found that college students who consumed AmEDs were more likely to use 'drugs', as compared to students who consumed alcohol-only. In contrast, one review[20] citing a primary research study[44] that used a within-subject comparison design, reported that Australians aged 18 to 35 years who had consumed AmEDs in the previous six months were less likely to smoke cigarettes and consume legal and illegal drugs during AmEDs drinking sessions as compared to alcohol-only drinking sessions.

Non-specific Physiological Events

One of the included reviews[20] considered non-specific physiological events following AmED consumption. This review[20] cites one primary research study[44] that found that AmED consumers were more likely to report agitation, tremors and irregular heartbeat during AmED drinking sessions compared to alcohol-only drinking sessions. This same review[20] also cited another primary research study[34] that found that AmED consumers were more likely to report increased heart rate during AmED drinking sessions compared to alcohol-only drinking sessions. These non-specific physiological events were consistent with known effects of caffeine, and with the findings from PHO's Evidence Brief on CEDs.

Discussion and Conclusions

This review of the literature uncovered evidence that AmED consumers, as compared to alcohol-only consumers, reported higher alcohol consumption and increased risk-taking behaviours, including drinking and driving, unprotected sex, taking or being taken advantage of sexually, cigarette smoking and drug use. In contrast, studies that examined AmED consumers only, found no clear difference in alcohol consumption and risk-taking behaviour during AmED drinking sessions as compared to alcohol-only drinking sessions. Because of the limitations in the design and quality of included reviews, it was not clear whether the observed differences between AmED consumers and alcohol-only consumers were attributable to underlying risk factors for AmED use or whether they represented consequences of AmED use. Therefore, causal inference about the effect of AmEDs on alcohol consumption and risk-taking behaviour is limited. Our findings concur with a systematic review published in 2017 (outside our inclusion period) that addressed AmEDs and the risk of injury specifically.[45] This systematic review stated that no firm conclusion regarding causality between AmED use and injury can be drawn.[45] High-quality primary research studies are needed to determine if consuming AmEDs causes adverse health events.

Implications for Practice

To reduce potential harms from AmEDs, Health Canada issued a formal directive to all provincial/territorial liquor boards in ealy 2010 prohibiting the addition of caffeine from 'artificial' sources to pre-mixed alcoholic beverages.[3] Health Canada also introduced new labeling requirements for CEDs, including the statement 'do not mix with alcohol'.[8] However, current regulations still allow the production and retail of pre-mixed CABs if the caffeine is derived from 'natural' sources (e.g., guarana, coffee). Therefore CEDs, AmEDs and some CABs continue to be available in some retail premises, bars and clubs.

The Ontario Public Health Standards[46] outline the mandate of local public health in assessing, preventing and mitigating the impacts of human health hazards and alcohol-related harms. Given that there is evidence to suggest that AmED consumers drink more alcohol and engage in more risk-taking behaviours than alcohol-only consumers, AmED consumers may be thought of as a high-risk group. Interventions to decrease alcohol consumption and risk-taking behaviours could be targeted and tailored to this group.

Strategies to address the potential harms of AmEDs may draw on the precautionary principle.[47] These strategies may include educating the public about the potential harms

of consuming AmEDs. Public education is important for raising awareness about both the potential adverse health events that follow AmED use and the potential effects of industry promotion on energy drink consumption among youth and young adults. Education efforts could be tailored to meet the needs of different sub-populations (e.g., high-risk youth and young adults). Education could also be provided to specific stakeholders, such as event hosts and bartenders.

Limitations

This Evidence Brief was based on reviews published between January 2010 and March 2016; all of which were assessed as being of moderate or weak quality. Furthermore, there was overlap in the primary research studies cited by the included reviews and some outcomes were investigated by only one to a few primary research studies. Systematic and formal assessment of the quality of the primary research studies included in the reviews was beyond the scope of this Evidence Brief.

Investigators for both meta-analyses[17,18] had previous ties to CED manufacturers and the Canadian Beverage Association, and investigators for one systematic review[20] had used free samples of CEDs from a manufacturer in a previous primary research study. Furthermore, some of the primary reseach studies included in the reviews reported receiving funding from energy drink manufacturers. These are potential conflicts of interest and can be a source of bias.[48] Best practices state that research should be conducted independently from any industry influence.[49,50]

Additional Resources

Boak A, Hamilton HA, Adlaf EM, Mann RE. Drug use among Ontario students, 1977-2015: detailed OSDUHS findings (CAMH Research Document Series No. 41). Toronto, ON: Centre for Addiction and Mental Health; 2015. Available from: https://www.camh.ca/en/research/news_and_publications/ontario-student-drug-use-and-healthsurvey/Documents/2015%20OSDUHS%20Documents/2015OSDUHS_Detailed_DrugUseReport.pdf

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Specifications and Limitations

The purpose of this Evidence Brief is to investigate a research question in a timely manner to help inform decision making. The Evidence Brief presents key findings, based on a systematic search of the best available evidence near the time of publication, as well as systematic screening and extraction of the data from that evidence. It does not report the same level of detail as a full systematic review. Every attempt has been made to incorporate the highest level of evidence on the topic. There may be relevant individual studies that are not included; however, it is important to consider at the time of use of this brief whether individual studies would alter the conclusions drawn from the document.

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