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## RESEARCH ARTICLE

Energy Drink Consumption in Adolescents is Harmful and Everyone Needs to Know Why

**Mohamad Moussa, MD; Miriam Grasso**

[miriam.grasso@rockets.utoledo.edu](mailto:miriam.grasso@rockets.utoledo.edu)

### ABSTRACT

The consumption of energy drinks among adolescents and young adults has escalated tremendously in recent years, with increasing evidence of adverse events related to these beverages resulting in emergency department visits and, at times, catastrophic patient outcomes. While the evidence of harm has grown, little has been done to regulate the advertisement and sales of energy drinks to young people. The regulation of other substances of abuse, such as tobacco and alcohol, serve to similarly protect this young population. These policies should be used as a guide to begin to combat the problem of energy drink consumption among adolescents and young adults.

## Introduction

The consumption of energy drinks over the last two decades has exploded across the United States, with little oversight of the production, advertisement, or distribution of these products. Not only has use skyrocketed among adults, as our lives become ever more fast-paced, energy drink usage by children and adolescents has also surged tremendously in recent years. Among adolescents, energy drink consumption prevalence has increased from 0.2% in 2003 to 1.4% in 2016, where consumption is measured as drinking at least one energy drink daily.<sup>1</sup> With this increase in consumption, we have also seen a surge in emergency department visits related to energy drinks in this young population. The Substance Abuse and Mental Health Services Administration study determined the amount of energy drink-related emergency department visits essentially doubled from 10,068 in 2011 to 20,783 in 2013.<sup>2</sup> The amount of caffeine found in energy drinks of different brands varies substantially from as low as 6 mg to as high as 242 mg per serving.<sup>3</sup> A considerable percentage of energy drinks do not even label the caffeine content.<sup>4</sup> Advertisements target the pediatric and young adult demographic despite growing evidence of the adverse effects of excess caffeine and other supplements which may disproportionately impact young people.

## What is an Energy Drink?

While an energy drink is defined as a drink containing stimulants, such as caffeine and guarana, with fluctuating amounts of carbohydrates, amino acids, protein, sodium, vitamins, and other added minerals, the exact content of different energy drink products varies.<sup>4</sup> Taurine, glucuronolactone, inositol, ginseng, and L-carnitine are all commonly occurring ingredients, several of which exert effects on the cardiovascular system and may play a role in related cardiovascular symptoms and adverse events.<sup>4</sup> Across the population, the majority of side effects reported to the National Poison Data System include nonventricular dysrhythmias, ventricular dysrhythmias, seizures, and tachypnea.<sup>5</sup>

## Adverse Effects of Energy Drinks

The adverse effects of energy drinks in the pediatric and young adult population may cause harm to multiple body systems. Although the high sugar content of many energy drinks, some as high as 31 g per serving, contributes to long-term increased cardiometabolic risk, it is not likely related to most acute adverse events.<sup>4</sup> For

comparison, the sugar content of one 12 fl oz can of Coca-Cola Original is 39 g, while one 20 fl oz bottle of Gatorade Thirst Quencher has 34 g of sugar. A link has also been suspected between caffeine intake and a decrease in insulin sensitivity, further increasing the risk for the development of diabetes in children consuming energy drinks.<sup>6</sup> More acutely, the impact of energy drinks on the renal system, including increased diuresis and natriuresis, leads to a decrease in plasma volume which negatively impacts the cardiovascular system. This is especially concerning while exercising, which is a common time of energy drink consumption in the adolescent and young adult populations.<sup>5</sup> Adolescents also use energy drinks before and during school and study sessions in an effort to increase focus and productivity. Neurologically, caffeine consumption leads to a state of hyperexcitability in the brain, which may contribute to common side effects like headache with daily intake, as well as cerebral edema causing increased intracranial pressure.<sup>6</sup> At least four cases of seizures in adults have also been temporally associated with energy drink consumption.<sup>7</sup> Potential psychiatric concerns of energy drink consumption by children and adolescents include symptoms of caffeine addiction as well as anxiety and sleep disorders.<sup>6</sup> Addiction to caffeine may result in physical manifestations of withdrawal, as well as the need for increased quantities of caffeine over time to reach the desired effects. The anxiety and sleep disorders related to caffeine use, recognized by the Diagnostic and Statistical Manual of Mental Disorders, can be detrimental to sleeping habits, thereby also impacting performance in school and extracurricular activities. Pediatric caffeine use has been associated with a 66% increased risk of hyperactivity and inattention as well, and all of these disturbances may negatively impact academic performance and the developing brain.<sup>8</sup>

## Cardiovascular Complications

Most alarmingly, the cardiovascular effects of energy drink consumption have been called into question with a growing collection of case reports of adverse events such as dysrhythmia, cardiac arrest, and even death in young people. Higgins, Yarlagadda, and Yang compiled a staggering list of case reports of adverse events, most of which have affected young adults and teenagers.<sup>9</sup> One such case was reported of a 22-year-old female who consumed six cans of an energy drink within four hours, after which she suffered an out-of-hospital cardiac arrest where she was found to be in torsade de pointes polymorphic ventricular

tachycardia.<sup>10</sup> Importantly, she was noted to have a prolonged QTc interval which eventually normalized following resuscitation, and was later found to have a genetic long QT syndrome. Reports of significantly increased QTc interval have also been seen in healthy young people without preexisting genetic long QT syndromes after energy drink use.<sup>9</sup> A much younger child in Spain, a 13-year-old healthy boy, developed atrial fibrillation with rapid ventricular response after consuming energy drinks and subsequently participating in a soccer training session.<sup>11</sup> A 23-year-old woman, also with no past medical history, presented to the hospital with symptomatic narrow complex tachycardia with a ventricular rate of 219 beats per minute after drinking a GNC Speed Shot and a Mountain Dew soda.<sup>12</sup> A 24-year-old man, shortly after ingesting an energy drink, developed palpitations, chest pain, and acute respiratory failure with frequent runs of supraventricular and ventricular tachycardia.<sup>13</sup> Following this event, he was diagnosed with Takotsubo cardiomyopathy. Another healthy 28-year-old man lost consciousness secondary to ventricular tachycardia during a basketball game after consuming three cans of an energy drink five hours earlier.<sup>14</sup> While he was resuscitated initially, this patient sadly died on the third day of hospitalization. A second, healthy 28-year-old man developed cardiac arrest after consuming 7-8 cans of energy drink within 7 hours after a day of motocross racing, as a result of diffuse coronary artery vasospasm diagnosed upon cardiac catheterization.<sup>15</sup> The list goes on to describe unmasked Brugada Syndrome in another young adult, several more myocardial infarctions and vasospasm events related to energy drinks alone and in combination with alcohol, and even a case of spontaneous coronary artery dissection in a previously healthy 13-year-old.<sup>16,17</sup> Higgins et al. also reported that the FDA's Center for Food Safety and Applied Nutrition Adverse Event Reporting System Voluntary and Mandatory Reports on 5-h Energy, Red Bull<sup>®</sup>, Monster Energy, and Rockstar energy drinks reported 18 deaths in individuals related to consumption of these products between January of 2004 and October of 2012.<sup>9</sup>

While caffeine's cardiovascular effects have been well studied in adults, there is little research dedicated to examining the direct consequences of caffeine and other energy drink ingredients on the pediatric cardiovascular system. One study of energy drinks containing both caffeine and taurine demonstrated significantly increased myocardial contractility compared with a control group just one hour after consumption.<sup>5</sup> In the same study, energy drinks were also shown to cause a short-term

increase in both systolic and diastolic blood pressure, more so than caffeine alone.<sup>5</sup> The exact mechanism of cardiovascular complications is often difficult to determine due to the unknown composition of many drinks. One study observing the changes in a healthy patient after energy drink consumption noted changes in electrolytes that lead to repolarization abnormalities in the heart, providing a major theory for the development of potential arrhythmias and even the unmasking of heart conditions such as channelopathies in young people using energy drinks.<sup>18</sup> Lastly, complications can arise from interactions between energy drink ingredients and pharmaceutical drugs, such as amiodarone, warfarin, digoxin, corticosteroids, and other potent inhibitors of CYP1A2 which may potentiate the effects of caffeine.<sup>19</sup> The stimulants in energy drinks may also act synergistically with prescription stimulants such as those very commonly used in the treatment of childhood attention deficit hyperactivity disorder, including amphetamines and methylphenidate.

### Energy Drinks in Combination with Alcohol

Still more frightening are the complications which may arise when adolescents or young adults combine energy drinks with alcohol. The combination may precipitate adverse cardiovascular events in particular. This concern disproportionately impacts young people as alcohol is the most abused drug among youth in the United States.<sup>20</sup> The popularity of pre-mixed energy-infused alcoholic beverages led to action banning manufacturers from adding caffeine to these beverages. The most famous example of this was the popular energy drink "Four Loko," which was later associated with many emergency department visits from adolescents and young adults.<sup>21</sup> Several of these cases documented evidence of tachycardia and seizures.<sup>12</sup> The US Food and Drug Administration has never deemed caffeine additives to be safe in combination with alcohol and considers it to be an unsafe food additive. Despite action taken to ban the manufacture of these mixed beverages, both substances are abused simultaneously in youth who mix caffeine and alcohol in homemade cocktails. Upon further investigation, it seems that the greatest potential for harm from the combination of these substances is directly related to the oppositional effects of caffeine and alcohol which enable youth to maintain alertness longer while drinking alcohol, leading to ingestion of greater quantities of both alcohol and caffeine than would otherwise be consumed alone, increasing the cardiovascular risk.<sup>22</sup>

## Marketing and Accessibility of Energy Drinks

With these safety risks disproportionately affecting the pediatric and young adult populations, it is a shame that action has not yet been taken to regulate the advertisement and accessibility of energy drinks to young people. In comparison, the adverse effects of vaping, another recent public health risk that disproportionately affects young people, resulted in significant regulation and reform. Youth use of e-cigarettes was deemed an “epidemic,” which the FDA combatted with prioritization of prevention efforts. Currently in the United States, the purchase, possession, or use of alternative nicotine products, such as e-cigarettes, is not allowed for persons under age 21 unless a parent, spouse, or legal guardian over age 21 accompanies them. Still, tobacco and nicotine advertising to children has been recognized as a substantial barrier to these prevention efforts. Energy drinks are marketed in ways that are accessible to youth and often feature messaging that is meant to appeal to adolescents seeking to increase social status. This pattern is similar to the progression of alcohol and tobacco use in adolescents.<sup>23</sup> The use of various media platforms, including the internet and social media, has tremendously increased the exposure of energy drink advertisements to children. These energy drinks also market on youth-targeted cable networks. A study conducted in 2010 deduced that children in the United States saw as many advertisements for energy drinks as they saw for Capri Sun and Kool-Aid.<sup>24</sup> The top two brands advertising to children and teens were 5-hour Energy and Red Bull<sup>®</sup>.<sup>14</sup> As a society, we recognize the danger that advertising poses with other risky behaviors such as cigarette smoking, and as such we now call for similar regulation with regard to

energy drink marketing. In addition, as much of our marketing now occurs through the internet and social media, regulation around advertising practices for such public health risks affecting our youth should be updated to reflect current trends.

## Conclusion

While evidence on the specific cardiovascular consequences of energy drinks in the pediatric population is still limited, the growing literature provides unequivocal evidence that there is a major health risk associated with energy drink consumption, and that such harm may disproportionately affect young people. More research is needed regarding the specific morbidity and mortality related to pediatric use of energy drinks in order to guide recommendations and policy. The American Academy of Pediatrics does not recommend energy drink use for children or teens. Instead, it is recommended that children improve energy with a proper diet and adequate sleep.<sup>4</sup> At a minimum, children, teenagers, and young adults should be screened for energy drink use with regular preventive care, as we screen for other substances of abuse. Education should regularly be provided to youth and parents on the possible detrimental effects of overuse, including discussions of caffeine and energy drink consumption in health education classes in public schools. In the United States, we have taken action to control the advertisement and accessibility of other substances of abuse to children, and the evidence to date should be enough to call for continued research and similar action in response to energy drinks. In addition, further research should be targeted at understanding the cardiovascular effects of the varying ingredients found within energy drinks to better determine the safety risks for all populations.

**References**

- <sup>1</sup> Vercammen KA, Koma JW, Bleich SN. Trends in energy drink consumption among U.S. adolescents and adults. *Am J Prev Med.* 2019;56: 827–833.
- <sup>2</sup> Mattson ME. Update on emergency department visits involving energy drinks: a continuing public health concern. *The CBHSQ Report.* Rockville (MD). 2013:1–7.
- <sup>3</sup> Consumer Reports Magazine. The buzz on energy-drink caffeine. Consumer Reports Web site. Available at: <https://www.consumerreports.org/cro/magazine/2012/12/the-buzz-on-energy-drink-caffeine/index.htm>. Accessed April 1, 2023.
- <sup>4</sup> Committee on N, the Council on Sports M, Fitness. Sports drinks and energy drinks for children and adolescents: are they appropriate? *Pediatrics.* 2011;127:1182–1189.
- <sup>5</sup> Nordt SP, Vilke GM, Clark RF, et al. Energy drink use and adverse effects among emergency department patients. *J Community Health.* 2012;37:976–981.
- <sup>6</sup> Alsunni AA. Energy drink consumption: beneficial and adverse health effects. *Int J Health Sci (Qassim).* 2015;9:468–474.
- <sup>7</sup> Babu KC, William RL. Energy drinks: the new eye-opener for adolescents. *Clin Pediatr Emerg Med J.* 2008;9:35–42.
- <sup>8</sup> Schwartz DL, Gilstad-Hayden K, Carroll-Scott A, et al. Energy drinks and youth self-reported hyperactivity/inattention symptoms. *Acad Pediatr.* 2015;15:297–304.
- <sup>9</sup> Higgins JP, Yarlagadda s, Yang B. Cardiovascular complications of energy drinks. *Beverages.* 2015;1:104-126.
- <sup>10</sup> Rottlaender, D, Motloch, LJ, Reda, S, Larbig, R, Hoppe, UC. Cardiac arrest due to long QT syndrome associated with excessive consumption of energy drinks. *Int J Cardiol.* 2012;158:e51-52.
- <sup>11</sup> Izquierdo Fos, I, Vazquez Gomis, RM, Vazquez Gomis, C, Piernas, R, Climent Forner, E, Llaguno Salvador, MD, Vargas Torcal, F. Atrial fibrillation after ingestion of a high energy drink. *An Pediatr (Barc).* 2012;77:417-419.
- <sup>12</sup> Nagapradeep, N, Khraisat, A, Velazquez-Cecena JE, Arora, R, Raghunathan, K, Patel, R, Parajuli, R. Energy drink-related supraventricular tachycardia. *Am J Med.* 2008;121:e3-4.
- <sup>13</sup> Kaoukis, A, Panagopoulou, V, Mojibian, HR, Jacoby, D. Reverse Takotsubo cardiomyopathy associated with the consumption of an energy drink. *Circulation.* 2012;125:1584-5.
- <sup>14</sup> Avci, S, Sarikaya, R, Büyükcam, F. Death of a young man after overuse of energy drink. *Am J Emerg Med.* 2013;31:1624.e3-4.
- <sup>15</sup> Berger, AJ, Alford, K. Cardiac arrest in a young man following excess consumption of caffeinated “energy drinks.” *Med J Aust.* 2009;190:41-3.
- <sup>16</sup> Rutledge, M, Witthed, A, Khouzam, RN. It took a RedBull to unmask Brugada syndrome. *Int J Cardiol.* 2012;161:e14-15.
- <sup>17</sup> Solomin, D, Borron, SW, Watts, SH. STEMI Associated with Overuse of Energy Drinks. *Case Rep Emerg Med.* 2015;2015:537689.
- <sup>18</sup> Kozik TM, Shah S, Bhattacharyya M, et al. Cardiovascular responses to energy drinks in a healthy population: the C-energy study. *Am J Emerg Med.* 2016;34:1205–1209.
- <sup>19</sup> Carrillo JA, Benitez J. Clinically significant pharmacokinetic interactions between dietary caffeine and medications. *Clin Pharmacokinet.* 2000;39:127–153.
- <sup>20</sup> Centers for Disease Control and Prevention. Underage Drinking. Alcohol and Public Health Web site. Available at: <https://www.cdc.gov/alcohol/fact-sheets/underage-drinking.htm>. Accessed March 28, 2023.
- <sup>21</sup> Cleary K, Levine DA, Hoffman RS. Adolescents and young adults presenting to the emergency department intoxicated from a caffeinated alcoholic beverage: a case series. *Ann Emerg Med.* 2012;59:67–69.
- <sup>22</sup> Weldy DL. Risks of alcoholic energy drinks for youth. *J Am Board Fam Med.* 2010;23:555–558.

<sup>23</sup> Ruiz, LD, Scherr, RE. Risk of energy drink consumption to adolescent health. *Am J Lifestyle Med.* 2019;13(1):22-25.

<sup>24</sup> Rudd Center for Food Policy and Obesity. Sugary Drink FACTS 2014: Some progress but much

room for improvement in marketing to youth. Available at: [http://www.sugarydrinkfacts.org/resources/SugaryDrinkFACTS\\_Report.pdf](http://www.sugarydrinkfacts.org/resources/SugaryDrinkFACTS_Report.pdf). Accessed April 15, 2023.