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Risk of Energy Drink Consumption to Adolescent Health

Abstract: Energy drinks are beverages marketed to quickly increase alertness and performance of the consumer that typically contain relatively high quantities of caffeine, simple carbohydrates, and a mixture of additional ingredients. The carbohydrate sources, usually glucose and sucrose, found in the beverages supply the substrates needed for physiological energy, while the high caffeine content supplies the perceived energy through enhancing feelings of alertness during fatigued states. Although mean youth caffeine consumption as a whole has decreased over the past 2 decades, adolescent energy drink consumption has significantly increased in the past 10 years. High energy drink consumption of youth is concerning due to the range of reported adverse reactions attributed to excessive caffeine consumption, ranging from mild sleep disturbances to death. Reactions are severe enough to require reporting to the National Poison Data System and may even require emergency medical treatment. Studies have also shown that adolescents who consume energy drinks are likely to also use tobacco, alcohol, and illicit drugs. There is substantial evidence to suggest that

the risk energy drinks pose to health are incredibly hazardous and should not be consumed by children and adolescents.

Keywords: energy drinks; adolescent; adverse reactions; caffeine

Energy drink consumption has been documented as a contributing factor to many accidents and

additional ingredients.⁷⁻¹⁰ The large content of caffeine present in energy drinks is responsible for the advertised stimulatory effects, with many containing well over the amount determined by the Food and Drug Administration (FDA) to be generally recognized as safe (GRAS) for use in cola-type beverages.^{7,9,11,12} Caffeine is structurally similar to the compound adenosine and can bind receptors in its place, thus inhibiting the functionality of adenosine.^{7-9,12-15} This



Although energy drink companies claim that these additional ingredients boost the ergogenic effects of their beverages, evidence is lacking to validate their benefits.



adverse reactions in youth.¹⁻³ Even more concerning, energy drink consumption has been implicated in adolescent death by popular media.^{4,6} Energy drinks are beverages marketed to quickly increase alertness and performance of the consumer.⁷⁻⁹ These beverages are typically carbonated and contain relatively high quantities of caffeine, simple carbohydrates, and a mixture of

blocking results in enhanced catecholamine secretion, which stimulates the central nervous system and results in the consumer having the perception of increased energy.^{7-9,12-15} The effect of caffeine can be felt with only moderate doses and is noticed quickly because it is readily absorbed, within 15 minutes for caffeine-sensitive individuals and within 60 minutes for most individuals.^{9,13,14}

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Energy Drink Ingredients and Adolescent Energy Drink Consumption Rates

The additional ingredients often included in proprietary blends of energy drinks, typically including various B vitamins, herbal supplements, and certain amino acids, are purported to have or enhance the stimulatory effects of the caffeine and sugars.^{7-10,12,14,15} A variety of B vitamins are included in the majority of energy drinks and may be incorporated due to their function as coenzymes in energy metabolism.^{12,14} However, most people consume a sufficient amount of B vitamins through their dietary intake, as B vitamins are found in a wide variety of animal and plant sources.¹² One herbal supplement commonly included in popular energy drinks is guarana, which is a tropical plant that contains highly caffeinated seeds.^{7,12,14,15} Therefore, any energy drinks that contain guarana likely have higher doses of caffeine, compared with those not containing guarana, which is what provides the added enhancement in perceived energy. Although energy drink companies claim that these additional ingredients boost the ergogenic effects of their beverages, evidence is lacking to validate their benefits.¹⁵ The carbohydrate sources, usually glucose and sucrose, found in the beverages supply the substrates needed for physiological energy, while the high caffeine content supplies the perceived energy through enhancing feelings of alertness during fatigued states.⁹

Although energy drinks contain levels well over what is considered GRAS by the FDA for cola-type beverages, they are allowed to be marketed and sold at various locations providing that caffeine is included in the ingredients list on the container.¹⁰⁻¹² The *Dietary Guidelines for Americans 2015-2020* recommends that adults, who are typical caffeine consumers, do not ingest more than 400 mg caffeine per day.¹⁶ Consumption levels that are safe for children and adolescents have not been determined; however, youth are discouraged from

consuming large doses of caffeine and should not exceed 100 mg per day.^{7,17} This is concerning considering that many energy drinks typically contain about 160 mg caffeine in one container and that youth can easily access and purchase energy drinks, as they are predominantly sold at convenience stores and available individually in cold storage areas.¹⁰ Along with convenience, energy drinks are appealing to youth because they are advertised on television channels popular with younger audiences and social media platforms commonly utilized by adolescents.¹⁰ Consumption data collected from the National Health and Nutrition Examination Survey suggest that adolescents consume an average of 61 mg caffeine per day.¹⁸ Although mean youth caffeine consumption as a whole has decreased over the past 2 decades, adolescent energy drink consumption has significantly increased in the past 10 years.¹⁷⁻²¹ Adolescents aged 13 to 19 years tend to have the highest rates of energy drink consumption for youth.^{18,22} While soda remains the main contributor to youth caffeine consumption overall,¹⁸⁻²⁰ about a quarter of regular energy drink consumers reported consuming at least one beverage per day and another quarter of younger adolescents reported consuming 2 or more energy drinks per day.²²

Adverse Reactions Associated With Energy Drink Consumption

The regularity and relatively high consumption of energy drinks in some youth is concerning due to the range of reported adverse reactions attributed to excessive caffeine consumption, ranging from mild sleep disturbances to death.^{1-3,7,10,13-15,23-27} Adverse reactions typically begin to manifest at about 200 mg caffeine and progressively become more severe with larger doses, especially those exceeding 400 mg caffeine.¹⁵ The more mild unfavorable effects include insomnia, mood swings, nervousness, upset stomach, and headaches.^{7,13-15} Severe harmful effects of excessive

caffeine consumption include cardiovascular problems, such as atrial fibrillation, palpitation, and tachycardia; seizures; and renal and liver diseases.^{7,14,15} Incidents cataloged in the National Poison Data System for 2011 showed that children under 6 years old had the highest incidence of unintentional energy drink overconsumption and that adolescents aged 13 to 19 years had the highest incidence of intentional energy drink overconsumption.¹ The 131 cases reported in connection with intentional energy drink consumption for adolescents also had the highest incidence of minor to moderate reactions with about 90% of individuals experiencing mild to more exasperating symptoms.¹ In line with these figures, about 1500 adolescents aged 12 to 17 years visited emergency departments in 2011 with energy drink-related adverse reactions.² This number was an increase compared to the 1145 energy drink-related emergency department visits for this age range recorded in 2007.² Death from consuming energy drinks is very rare, but has been reported and is usually brought on by ingesting another substance with energy drinks or results from complications from underlying cardiovascular conditions.^{10,14} Individuals on certain medications or those with chronic cardiovascular diseases are discouraged from consuming energy drinks.^{9,10}

Reasons for Energy Drink Consumption and Potential Behavioral Consequences

Costa et al²⁵ and Nordt et al²³ sought to better understand adolescents' reasoning for consuming energy drinks. Costa et al²⁵ conducted focus groups with Australian adolescents aged 12 to 15 years and found that energy drinks were primarily used to help alleviate fatigue to better perform sports and daily activities. Nordt et al²³ surveyed adolescent emergency department patients aged 13 to 19 years and found that energy drinks were commonly used as ergogenic and

study aids. These results are interesting considering that adolescents who frequently consume caffeinated beverages do not meet recommendations for sleep duration and commonly experience sleep disturbances.^{26,27} This likely results from the adenosine-blocking capacity of caffeine, which decreases feelings of tiredness and can ultimately interrupt normal sleep cycling.^{7,9,12-15,26,27} This presents a vicious cycle of adolescents feeling tired and resorting to energy drink consumption to feel more awake, but then simultaneously positioning themselves for initiating the fatigued state by consuming high levels of caffeine and interrupting their normal sleep patterns.

When assessing influence on the choice of energy drinks, both aforementioned studies^{23,25} found that marketing and peers influenced adolescents' decision to select and consume energy drinks. Energy drinks are marketed in ways that are accessible to youth and typically feature messaging that is appealing to adolescents desiring to increase social status.^{10,25} Unfortunately, this context encourages energy drinks to follow a similar pattern and progression of alcohol and tobacco use in adolescents.²⁵ Studies have shown that adolescents who consume energy drinks are likely to also use tobacco, alcohol, and illicit drugs.^{23,28-31} Leal and Jackson²⁸ used nationally representative data through the Monitoring the Future Survey to assess whether energy drink consumption was associated with illicit drugs use. Results from over 7500 surveyed adolescents in 8th, 10th, and 12th grades found that energy drink consumption was significantly positively correlated with use of soft drugs, which in turn was significantly positively correlated with hard drug use.²⁸ Soft drugs were identified as cigarettes, alcohol, and marijuana, while hard drugs included heroin, methamphetamine, and hallucinogens, among others.²⁸ The most substantial impact of energy drink consumption was anticipated for 8th-grade adolescents, who were over twice as likely to try soft drugs at least

once if they also consumed energy drinks.²⁸

Conclusion

Energy drinks are predominantly carbohydrate beverages that provide an increase in perceived energy by supplying large doses of caffeine, which prevent adenosine from initiating the sleep cycle.^{7-9,12-15} Disruption of the sleep cycle thus creates a false dependency on energy drinks to combat the resulting fatigue, particularly for youth who reported consuming energy drinks to counteract feelings of tiredness.^{23,25-27} Energy drinks are marketed on popular television channels and websites that are commonly viewed by adolescents and thus may encourage youth to consume energy drinks.¹⁰ While adolescent caffeine consumption from other beverages has decreased over time, caffeine consumption from energy drinks has generally increased in recent years.¹⁷⁻²¹ Although a recommended limit on caffeine exists for adults,¹⁶ there currently is no established recommendation for youth.¹⁷ Youth should be discouraged from consuming energy drinks because mild to moderate adverse reactions have been observed with the level of caffeine provided in these beverages.^{1-3,7,10,13-15,23-27} Reactions are severe enough to require reporting to the National Poison Data System and may even require emergency medical treatment.¹⁻³ In addition to immediate health concerns, energy drink consumption is also associated with behavioral concerns that can drastically affect adolescent health, including the use of alcohol, cigarettes, and various illicit drugs.^{23,28-31} Therefore, there is substantial evidence to suggest that the risk energy drinks pose to health are incredibly hazardous and should not be consumed by children and adolescents.

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Ethical Approval

Not applicable, because this article does not contain any studies with human or animal subjects.

Informed Consent

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Trial Registration

Not applicable, because this article does not contain any clinical trials. **AJLM**

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