



Caffeinated Energy Drinks/Energy Shots Among Young Adults

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There are more than 300 energy drink and energy shot products available in the United States, and of these, Red Bull, Monster, Rockstar, 5-Hour Energy, Stacker 2 6-Hour Power, and private labels are the top-selling brands. Manufacturers have now shifted their marketing focus from athletes to young adults, and these drinks are being aggressively marketed on college campuses. Thirty-four percent of 18- to 24-year-olds use energy drinks regularly as a means of improving performance, endurance, and alertness before and during exercise; staying awake in demanding situations; and compensating for loss of sleep, especially during exams.

The consumption of alcoholic beverages mixed with caffeine is increasing and becoming a public health problem among college students. A major concern is that mixing energy drinks with alcohol can lead to “wide-awake drunkenness,” where caffeine masks the drunkenness but does not decrease alcohol-related impairment. Research has shown the dangers of adding caffeine to alcoholic drinks, and numerous health problems have been reported. In November 2010, the U.S. Food and Drug Administration issued a letter to manufacturers advising that adding caffeine to some alcoholic beverages makes the products unsafe (FDA 2010). As a result, some products were removed from the market, and other companies agreed to stop making the beverages. However, there are still no regulations for the amount of caffeine and no requirements related to labeling the contents or the possible health risks of these drinks.

What Are Caffeinated Energy Drinks and Shots?

Energy drinks are beverages that contain, besides calories, caffeine in combination with other presumed

energy-enhancing ingredients such as taurine, herbal extracts, B vitamins, etc. They first appeared in Europe and Asia in the 1960s in response to consumer demand for a dietary supplement that would result in increased energy. Energy drinks were not introduced into the U.S. market until 1997 (Reissig, Strain, and Griffiths 2009).

Some energy drinks and shots have been labeled as dietary supplements and others as conventional foods. The FDA regulates both dietary supplements and conventional foods under the Federal Food, Drug, and Cosmetic Act, but the requirements for them are different (FDA 2012). As dietary supplements, the energy drinks and shots are supplemented with vitamins and/or phytochemicals as well as caffeine. The caffeinated shots tend to have as much caffeine in smaller volume as caffeinated energy drinks. Energy shot makers are not required to disclose the content of supplemented ingredients. These ingredients require no FDA preapproval to be used in dietary supplements.

Energy drinks are nonalcoholic beverages containing stimulants such as caffeine, herbal extracts (guarana, ginseng, yerba mate, ginko biloba), glucuronolactone, taurine, inositol, carnitine, and B vitamins to enhance physical and mental endurance.

Energy shots are a specialized form of energy drinks that contain the same amount of caffeine in a small amount of liquid, typically 60-90 ml in small bottles or cans.

Major Ingredients in These Products

Most of the kick from these drinks comes from caffeine and sugar, but other stimulants are often added.

- **Caffeine:** Caffeine content varies from 75 to 150 mg per serving (2 to 15.5 fl oz) of energy drink (1 cup of coffee contains 80-120 mg of caffeine, 1 cup of tea contains 60 mg). After the energy drink is ingested, the caffeine is rapidly absorbed from the intestinal tract, and it is ready to be used by the body within 30-45 minutes (Rein et al. 2013). Table 1 shows the total content of caffeine in selected energy drinks and energy shots.
- **Sugars:** Most energy drinks contain sugars or sweetener in the form of sucrose, glucose, or high-fructose corn syrup. The World Health Organization recommends a maximum of 25 g (6 teaspoons) of sugar per day, and the American Heart Association recommends 20-36 g (5-9 teaspoons) per day. One can or bottle of an energy drink contains more than twice as much sugar as the Recommended Dietary Allowance (table 2). Their intake poses a risk for obesity and diabetes (Pereira 2014).
- **Guarana (*Paullinia cupana* Kunth var. *sorbilis* (Mart.) Ducke):** Also known as Brazilian cocoa, guarana has been traditionally consumed by indigenous communities of the Amazon region (Schimpl et al. 2013). It contains stimulant properties because of its high caffeine content (approximately four times as much caffeine per weight as coffee; Smith and Atroch 2010). The seeds contain about twice the concentration of caffeine found in coffee beans (1 g of guarana is contains approximately 40 mg of caffeine; Marczynski and Fillmore 2014).
- **Ginseng (*Panax ginseng*):** Ginseng has been used for its potential performance-enhancing attributes; however, no scientific evidence supports this claim.
- **Yerba mate (*Ilex paraguariensis*):** Yerba mate tea has been a commonly consumed beverage in South American countries for centuries. Yerba mate has

Table 1. Total content of caffeine in energy drinks sold in the United States.

Energy drink brand*	Volume/bottle or can (fl oz)	Total caffeine content (mg/can or bottle)	Caffeine content per fluid ounce (mg/fl oz)
AMP Energy Lightning	16	160	10
Bomba	8.4	75	9
Cocaine	8.4	280	33
Fixx	20	500	25
Full Throttle	16	144	9
Monster Energy Assault	16	160	10
Monster Energy XXL	24	240	10
Red Bull	16	160	10
Rockstar	16	160	10
Vitaminwater Energy (citrus)	20	50	2.5
Wired X505	24	505	21

Source: Chrysant and Chrysant, 2015.

*Examples of energy drinks drawn from hundreds of marketed drinks in the United States listed alphabetically.

been known for its anti-inflammatory, antidiabetic, and antioxidative properties. It is a central nervous system stimulant due to its high caffeine concentrations (one cup of yerba mate tea contains 78 mg of caffeine; Sorkin and Coates 2014).

- Taurine: Taurine is one of the most abundant amino acids in the human body; the body of a 70-kg (154.3 lb) person can contain up to 70 g of taurine, primarily in the eyes and the skeletal and heart muscle tissue. Taurine supports neurological development and helps regulate the level of water and minerals in the blood. It is also thought to have detoxification and antioxidant properties. Antioxidants are manmade or natural substances that

may prevent or delay some types of cell damage. Taurine is present in meat, seafood, and milk. Normal dietary taurine consumption varies from 4 to 400 mg per day. The amount of taurine ingested by regularly consuming energy drinks (2,000-3,000 mg per 16 fl oz) far exceeds the amount in a normal diet.

- Other ingredients: B vitamins, carnitine, glucuronolactone, and inositol are other ingredients found in energy drinks. The scientific evidence is lacking for the safety of these ingredients and their claims of improving endurance. The quantities of these ingredients found in energy drinks are often so low or high that their effects on humans have not yet been studied (table 2).

Table 2. Comparison of ingredients in energy drinks.

	Full Throttle (16 fl oz)	Monster Energy (16 fl oz)	Red Bull (16 fl oz)	Rockstar (16 fl oz)
Caffeine (mg)	144	160	160	240
Sugar (g)	57	54	54	65
Taurine (mg)	3,000	2,000	2,000	2,000
Ginseng extract (mg)	Listed as part of 3,000 mg "energy blend"	400		50 mg as part of a 1.35 g "energy blend"
Guarana extract (mg)	Listed as part of 3,000 mg "energy blend"	Listed as part of 5,000 mg "energy blend"		50 mg as part of a 1.35 g "energy blend"
Ginkgo biloba leaf extract (mg)				300 mg as part of a 1.35 g "energy blend"
Niacin (B-3)	200% RDA*	100% RDA	200% RDA	200% RDA
Inositol (B-8)		Listed as part of 5,000 mg "energy blend"		50 mg as part of 1.35 g "energy blend"
Pyridoxine hydrochloride (B-6)	200% RDA	200% RDA	200% RDA	200% RDA
Cyanocobalamin	200% RDA	200% RDA	160% RDA	200% RDA
Riboflavin (B-2)	200% RDA			400% RDA
Pantothenic acid (B-5)			100% RDA	200% RDA

*Recommended Dietary Allowance.
Source: Higgins, Tuttle, and Higgins, 2010.

Alcohol Mixed With Energy Drinks Among Young Adults

Young adults are a population at great risk for problematic health behaviors. The consumption of alcohol mixed with energy drinks has become a relatively common trend in alcohol consumption behavior among college students; between 24 and 40 percent of college students reported consumption in the prior month (Snipes and Benotsch 2013; Velazquez et al. 2012).

Drinking alcohol mixed with an energy drink has become a health risk behavior among young adults, and an association has been demonstrated with other alcohol and drug use, high-risk sexual behavior, and sexual victimization (Marczinski and Fillmore 2014; Marzell et al. 2014). The consumption of alcohol mixed with energy drinks may also be a risk factor for a pattern of alcohol dependence. It has also been shown to increase the desire for more alcohol, more so than alcohol-only beverages (Snipes et al. 2015).

Although the FDA banned prepackaged alcohol mixed with energy drinks in 2010, mixing alcohol with energy drinks is popular and widely prevalent among young adults. Given the concerning prevalence of this trend, stronger regulation of energy drinks may be needed.

Recent Research Studies Conducted in Young Adults

Health Effects

- Symptoms of caffeine intoxication in young adults include nervousness, palpitations, anxiety, insomnia, nausea, vomiting, restlessness, tremors, gastrointestinal complaints, tachycardia (a faster-than-normal heart rate at rest), cardiac arrhythmias (irregular heartbeat), and, in rare cases, death (Kerrigan and Lindsey 2005; Avci, Sarikaya, and Büyükcem 2013). Energy drink consumption is associated with weight loss attempts, poor personal appearance, and disordered eating behaviors (Jeffers, Hill, and Benotsch 2014).
- Energy shots increase blood pressure (both systolic and diastolic) in healthy young adults (Kurtz et al. 2013).

- Most energy drinks contain citric acid, which lowers pH (pH 3-4). This acidic range is associated with enamel demineralization and dental problems (Jain et al. 2012).
- Consumption of energy drinks is associated with sleep disturbance and poor sleep quality among college students (Sanchez et al. 2013).

Performance/Endurance

- Research on the influence of energy drinks on athletic performance is limited. A few studies showed a small improvement in athletic performance; other studies showed no difference.
- The precompetition ingestion of caffeinated energy shots did not affect performance in six trained male runners (Schubert, Astorino, and Azevedo 2013). The pre-exercise ingestion of caffeinated energy drinks was effective in enhancing some aspects of the physical performance of elite junior tennis players (Gallo-Salazar et al. 2015).
- Caffeine-containing energy drinks (less than 70 mg caffeine for a 70-kg [154.3 lbs] adult) did not improve muscle performance. Caffeine content greater than 210 mg per 70-kg adult improved upper and lower body muscle power (work/time) and strength (force output); however, these doses induce side effects, including increased heart rate and blood pressure (Del Coso et al. 2012).
- Ingesting energy drinks containing sugar, taurine, caffeine, and several B vitamins 40 minutes before cycling improved performance on a one-hour cycling trial (Ivy et al. 2009).

Alcohol Mixing

- Consuming energy drinks mixed with alcohol can make an individual more likely to (1) underestimate impairment from alcohol, (2) consume a greater number of alcoholic drinks, and (3) drink to higher blood-alcohol concentrations than alcohol-only drinkers (O'Brien et al. 2008; Thomas et al. 2010).
- Mixing alcohol with caffeinated beverages showed that caffeine had no effect on the judgment of subjective intoxication (Benson et al. 2014).
- Frequently mixing alcohol with caffeinated beverages by college students was associated with

serious alcohol problems and an increased risk of alcohol-related accidents (Patrick, Evans-Polce, and Maggs 2014).

- Students who mixed alcohol and energy drinks had double the risk of being hurt or injured and requiring medical attention (Azagba, Langille, and Asbridge 2013), driving with an intoxicated driver (Flotta et al. 2014), being taken advantage of sexually, or taking advantage of another sexually (Snipes et al. 2014; O'Brien et al. 2011). Students whose motor skills, visual reaction times, and judgment are impaired by alcohol may not perceive that they are intoxicated as readily when they have also ingested a stimulant.

High-Risk Groups

- People with Attention Deficit Hyperactivity Disorder: Energy drinks can be very harmful for those already taking stimulant medications. Combining stimulants and energy drinks may create a euphoric effect (an exaggerated feeling of well-being; Franke et al. 2014).
- People with heart disease: A combination of excessive caffeine- and taurine-containing energy drinks can trigger serious cardiovascular events including hypertension, arrhythmias, stroke, and sudden death (Kaoukis et al. 2012).
- People with anorexia: An eating disorder is a disorder of liquid intake as well as food intake. It has been reported that patients with anorexia drink excessive quantities of caffeinated drinks to suppress appetite, boost energy level without consuming calories, restore energy, eliminate hunger, relieve fatigue, control weight, and increase the effect of laxatives (Hart et al. 2011). These patients have a higher risk for heart disease and electrolyte imbalance. Therefore, intake of high-caffeine energy drinks can trigger arrhythmias (Chrysant and Chrysant 2015).

Summary

Energy drinks are becoming increasingly popular, and when consumed in moderation, most are considered safe. Overconsumption can induce potential adverse effects attributed to the high caffeine content.

- Energy drinks contain large doses of caffeine and other legal stimulants like guarana and ginseng. The

amount of caffeine in an energy drink can range from 75 mg to more than 200 mg per serving.

- Overconsumption of caffeine is associated with a variety of health effects, such as palpitations, anxiety, insomnia, digestive problems, hypertension, dehydration, and more.
- Caffeine is the major ingredient in most energy drinks, but none of the drinks state the exact caffeine content. Top-selling energy drinks may contain an amount of caffeine equivalent of two or three cups of coffee and more caffeine than FDA-regulated alertness pills.
- There is great concern over the safety and negative health effects regarding mixing energy drinks or energy shots with alcohol among young adults. Although caffeinated alcoholic beverage products are no longer allowed on the market, self-mixing energy drinks with alcohol can be very dangerous.

High doses of caffeine, often in combination with ingredients of unknown safety profiles, require research on the safety of energy drink use in young adults, and more awareness is required regarding their appropriate intake. Although energy drinks and energy shots may have pleasant short-term effects, they can be harmful, especially in young adults.

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