Today's Dietitian
The Magazine for Nutrition Professionals
CE Learning Library
TODAY'S DIETITIAN

The Truth About Energy Drinks
By Densie Webb, PhD, RD

Suggested CDR Learning Codes: 2000, 2010, 2100, 3000, 3070, 3100; Level 2

According to market researcher Packaged Facts, the US energy drink/shot market was worth $12.5 billion in 2012 and is predicted to be worth $21.5 billion by 2017.[1] However, Packaged Facts also state that energy drinks and shots account for only 3% of nonalcoholic beverage sales,[1] and according to BeverageDaily.com, manufacturers are looking for ways to boost sales by increasing consumption among existing users and attracting new consumers.[2]

Surveys have found that 30% to 50% of adolescents and young adults consume energy drinks.3 Energy drink manufacturers that sponsor events often highlight extreme or thrill-seeking sports that appeal to teens and young adults. Red Bull sponsors a competition for the longest rally car jump, while Monster Energy supports the AMA Motorcycle Supercross.[4]

The long-term safety of the unique combinations of ingredients found in increasingly popular energy drinks is unknown. As the popularity of these products has grown, so have concerns about their safety. Most reports of negative effects are believed to be due to excessive consumption of the caffeine these products contain.

This continuing education course explores the increasing presence of energy drinks and shots in the marketplace; the potential consequences of overconsumption, especially in combination with alcohol; labeling issues; and the misconceptions about these products' function and efficacy.

What Are Energy Drinks and Shots?
Although calories can provide energy, the energy these products promise derives from the stimulant caffeine.[5] Energy drinks are flavored beverages containing varying amounts of caffeine and, typically, other additives, such as vitamins, taurine, theanine, carnitine, herbal supplements, creatine, sugars, and guarana, a plant product that naturally contains concentrated caffeine.

Energy drinks are readily available in cans or bottles at grocery stores, in vending machines, and at convenience stores as well as at bars and other outlets where alcohol also is sold.[6] The iconic energy drink Red Bull, introduced in the United States in 1997, and Monster, which appeared in 2002, now account for the overwhelming majority of energy drink sales in the United States.[7]

Energy drinks are promoted to improve concentration and alertness and to help both mental and physical performance. They've been advertised to "pump up the beast"; "vitalize body and

mind"; "fuel your brain"; provide "focus, energy, and determination"; and help consumers "get animated."

Energy shots, compared with energy drinks, contain more concentrated sources of caffeine, have fewer ingredients and fewer calories, and generally are sold in small 50-mL containers. 5-Hour Energy makes up nearly 89% of the energy shot category.[2]

Sports drinks aren't the same as energy drinks and energy shots, and the terms shouldn't be used interchangeably.[5] Sports drinks are flavored beverages that often contain carbohydrates, minerals, electrolytes, and sometimes vitamins or other nutrients. They're designed to replenish rather than energize.[5]

Labeling Issues

Energy drink manufacturers choose whether to label their products as a beverage or liquid dietary supplement, though the FDA regulates beverage labels. Manufacturers that designate their energy drinks as beverages must comply with the Nutrition Labeling and Education Act of 1990 (NLEA) and label the drinks with conventional Nutrition Facts panels.[8] Manufacturers of energy drinks designated as dietary supplements must comply with the labeling requirements of the Dietary Supplement Health and Education Act of 1994, which are significantly more lax. Instead of the Nutrition Facts panels, these products are labeled with Supplement Facts panels. Manufacturers can list on Supplement Facts panels ingredients that aren't permitted on beverage labels under the NLEA.[9] Thus, labeling is inconsistent across companies.

Though the manufacturers choose the type of label, the FDA still can challenge companies' labeling decisions, and the agency has done just that.[8,10] In addition, several energy drink/alcohol combinations and stimulant ingredients have been removed from the market because of inaccurate labeling and charges of marketing to minors.[11]

The Food, Drug, and Cosmetic Act, which sets mandates for the safety of items falling into these three categories, doesn't require caffeine disclosure for beverages or supplements. American Beverage Association member companies and some independent companies voluntarily disclose caffeine content.[12] But many manufacturers don't provide this information, and consumers who wish to know the caffeine content must call the companies to get it. Also, several energy drink brands don't belong to the American Beverage Association.[8] However, Monster's manufacturer recently joined the association and now discloses its products' caffeine contents on their labels.[13]

Consumer Reports found that 8-oz energy drinks such as Monster (92 mg of caffeine) and Red Bull (83 mg of caffeine) are comparable in caffeine levels to a typical 8-oz cup of coffee (100 mg), but the drinks often come in much larger 24- or 32-oz cans. Of the 16 products tested that provided caffeine content on labels, five contained 20% more caffeine per serving than the amount stated on the label. The so-called caffeine wars—in which producers vied for the highest caffeine content—produced a product with 505 mg per 23.5-oz can, which has since been discontinued.[14] The same line of energy drinks now includes a maximum of 344 mg per 16-oz can.

In March 2013, two major energy drink companies, Monster and Rock Star Energy, announced that they would disclose caffeine content for the first time and, instead of marketing their products as dietary supplements, they would begin marketing them as beverages, which will change the way they're regulated.[13]

Although they all feature caffeine, over-the-counter products, energy drinks and shots, and coffee drinks containing the stimulant are subject to different labeling regulations and restrictions. NoDoz tablets, for example, one of the most widely recognized of several caffeine-containing over-the-counter stimulants, has been on the market for 50 years. It contains 200 mg of caffeine per caplet, and the dosage is $^1/_2$ to one caplet no more than every three to four hours. None of the caffeine pills on the market provides more than 200 mg per dose.[7] The FDA requires that over-the-counter caffeine product labels contain the following warnings and directions[15]:

• The recommended dose of this product contains about as much caffeine as a cup of coffee. Limit the use of caffeine-containing medications, foods, or beverages while taking this product because too much caffeine may cause nervousness, irritability, sleeplessness and, occasionally, rapid heart beat.

• For occasional use only. Not intended for use as a substitute for sleep. If fatigue or drowsiness persists or continues to recur, consult a physician.

• Do not give to children under 12 years of age.

• Directions: Adults and children 12 years of age and over: Oral dosage is 100 to 200 mg not more often than every three to four hours.

No such warnings, however, are required for energy drinks, energy shots, or coffee drinks, despite the fact they sometimes contain even more caffeine per serving.

Questionable Ingredients

The most common added ingredients in energy drinks are sodium compounds, guarana, sugars, and taurine.[16] However, it's difficult to determine the amounts contained in these products. Other ingredients that may be found in energy drinks include glucuronolactone, B vitamins, ginseng, gingko biloba, antioxidants, and trace minerals.[16]

While both the positive and negative effects of caffeine have been proven, the purported positive effects of many of the other common ingredients, such as taurine and glucuronolactone, remain unproven as energy boosters, as do the combined effects of these ingredients in energy drinks.[16] Other unproven ingredients found in some energy drinks include white tea extract, inositol, aloe vera leaf extract, resveratrol, and coconut water.

Caffeine

Caffeine is the world's most widely consumed central nervous system stimulant. It's been a component of the human diet for centuries, primarily through the consumption of coffee and tea and, more recently, sodas, but it's also naturally present in cocoa beans and guarana. The

average amount of caffeine consumed in the United States remained relatively constant at 300 mg per person per day between 2003 and 2008.[7] Those who drink coffee consume an average of 3.3 cups per day, an amount that has been unchanged since 2003.[7]

In healthy adults, a caffeine intake of 400 mg/day or less is considered safe. Acute clinical toxicity begins at 1 g, and 5 to 10 g can be lethal.[3] A cup of coffee can contain anywhere from 100 mg to 400 mg or more, depending on the brew and the size of the drink. However, some researchers have found that doses of more than 300 mg can cause anxiety and panic attacks, especially for individuals under stress.[17]

The March of Dimes in the United States and the Food Standards Agency in the United Kingdom have suggested an upper limit for pregnant women of 200 mg of caffeine per day from all sources.[18,19] In its 2008 position paper, the Academy of Nutrition and Dietetics recommended an upper limit of 300 mg/day for pregnant women.[20]

Adults who consume low to moderate amounts of caffeine (1 to 3 mg/kg or 12.5 to 100 mg/day) have improved exercise endurance, cognition, reaction time, and mood.[3] Consuming 4 to 12 mg/kg, however, has been associated with anxiety and jitteriness, according to a double-blind, placebo-controlled study on 26 children.[21] Headache and fatigue can occur after short-term, high-dose use (six to 15 days of 600 mg/day or more).[22] Caffeine intoxication can cause insomnia, tremors, tachycardia, heart palpitations, and upset stomach. At the highest levels (5 to 10 g), it can induce vomiting and abdominal pain, hypokalemia, hallucinations, increased intracranial pressure, cerebral edema, stroke, paralysis, altered consciousness, rigidity, seizures, arrhythmias, and death.[3,22-25]

The effects of chronic high-dose caffeine intake in children and adolescents are unknown, but the American Academy of Pediatrics recommends that, because of caffeine's potentially harmful effects, intake should be discouraged for all children.[1] A limit of 100 mg/day for children and 2.5 mg/kg/day for adolescents has been suggested.[3]

During the 20th century, the consumption of carbonated soft drinks with added caffeine became commonplace. While most soft drinks and colas contain about 30 to 40 mg of caffeine per 12-oz serving,[7] the FDA allows as much as 71 mg per 12 oz. The FDA doesn't regulate the caffeine content of energy drinks and shots, and the amount of caffeine they contain varies greatly, from as little as 38 mg for a 16.9-oz serving to as much as 350 mg in a 2.5-oz serving.[7] However, in the population as a whole, energy drinks make only a small contribution to caffeine intake.[7]

The amount of caffeine in energy products varies, depending on the serving size, the type of product, and the preparation method. The Yale-Rudd Center for Food Policy & Obesity examined energy drink products and found that slightly more than one-half fully disclosed both product ingredients and caffeine content.[4]

Consumer Reports measured the amount of caffeine in 27 top-selling energy drinks and shots, and the organization found caffeine ranged from about 6 mg to 242 mg per serving, with some containers providing more than one serving.[26] To put that into perspective, according to

Starbucks' website, a venti (20 oz) caffé Americano has 300 mg of caffeine and a venti Pike Place roast has 415 mg of caffeine, more than any energy drink currently on the market. However, because coffee most commonly is enjoyed hot, it's likely to be consumed more slowly than an energy drink and certainly more slowly than an energy shot, so it's less likely to have a negative effect.

Caffeine may raise blood pressure, disrupt adolescent sleep patterns, exacerbate psychiatric disease, cause physiologic dependence, and increase the risk of subsequent addiction.[27] A recent review concluded that energy drinks have no therapeutic benefit and both the known and unknown pharmacology of various ingredients, combined with reports of toxicity, suggest that these drinks may put some children at risk of serious adverse health effects.[3]

Health Canada's scientific assessment supported the establishment of an initial maximum limit for total caffeine in energy drinks of 400 mg/L (34 oz), with a maximum amount of caffeine of 180 mg per single-serve container.[25]

Sugar and Calories

The median sugar content of sugar-sweetened energy drinks was found to be 25 g (107 kcal) per 8-oz serving, which is comparable with sodas and fruit drinks but higher than sports drinks and flavored waters.[28] However, some containers provide as many as 32 oz and 108 g (400 kcal) of sugar. It's been suggested that young people may substitute energy drinks for other beverages, which could boost both their sugar and caffeine intakes.[8]

Although it's been suggested that energy drinks may promote weight loss, they're high in sugar and actually can contribute to weight gain. A small study of 10 healthy young women found that energy drink consumption increased carbohydrate oxidation and reduced lipid oxidation relative to a lemonade drink with an equivalent amount of sucrose.[29] The researchers suggested that energy drinks could cause lipogenesis and contribute to obesity. They also recommended that the longer-term effects of combined caffeine and sucrose intake, particularly in sedentary individuals, on the promotion of lipogenesis and insulin resistance in relation to frequency of consumption needs to be studied.

Sodium

Some energy drinks contain surprisingly high levels of sodium. The median level of 123 mg per 8-oz serving or shot is more than three times the amount found in soda. Several have more extreme levels, with one product containing 340 mg per 8-oz serving.[4]

Guarana, Taurine, Carnitine

Although the FDA considers guarana as Generally Recognized as Safe (GRAS) up to a specific amount, it's unclear exactly how much guarana energy drinks contain and how much would be considered safe when added to a product that already is highly caffeinated.[8]

Taurine is an amino acid normally present in foods and produced by the human body. While the FDA hasn't conducted a formal assessment of taurine or approved it as a food additive for use in conventional foods, it's considered GRAS for flavor use by the Flavor and Extract Manufacturer's Association.[10] The European Commission assessed the use of taurine in

energy drinks but, thanks to limited information, couldn't reach a conclusion regarding its safety.

Taurine is known to influence various physiological functions, including blood pressure, growth hormone production, and hypothalamus stimulation. Based on the European Commission's review, the average daily intake of taurine from omnivore diets ranged from 40 to 400 mg/day. The intake of individuals following strict vegan diets would be low or negligible.

Also based on the European Commission's estimates, consuming 0.5 L/day of some energy drinks can result in a taurine intake five times greater than the highest estimated intake of 400 mg/day from naturally occurring sources. The European Commission stated that further studies will be required to establish an upper safe intake level for taurine and determine whether the combination of taurine and caffeine may result in any harmful interactions. Some energy drinks provide information about the taurine content on their product labels.[30]

A recent study suggested that carnitine intake may promote hardening of the arteries and increase the risk of cardiovascular disease, which may be predicted by blood levels of the compound and its metabolite trimethylamine-N-oxide.[31] Though more research is needed to prove a cause and effect, there appears to be no benefit to consuming energy drinks that provide additional carnitine to the diet, and such consumption may present a health risk.

Effect on Athletic Performance

Though caffeine is a proven ergogenic aid, evidence regarding the effect of energy drinks on athletic performance has been inconsistent.[32] It has been suggested that consuming energy drinks may produce diuretic and natriuretic (excessive sodium in the urine) effects, mainly because of the caffeine they contain, and may cause dehydration during and after exercise.[16,33] However, research suggests consuming no more than 500 mg of caffeine daily generally doesn't cause dehydration.[34,35]

In addition, the International Society of Sports Nutrition has concluded that while energy drinks and shots contain several nutrients that are purported to affect mental and/or physical performance, the primary ergogenic nutrients in most energy drinks and shots appear to be carbohydrate and/or caffeine.[32] The society also concluded that consuming a caffeine-containing energy drink 10 to 60 minutes before exercise can improve mental focus, alertness, anaerobic and/or endurance performance, but that indiscriminant use of energy drinks or shots, especially if more than one serving per day is consumed, may lead to harmful side effects.[32]

Safety Concerns

Safety determinations for energy drinks are made solely by the manufacturers, and there are no requirements for testing, warning labels, or restriction on sales to minors.[3]

According to one study, while no clinically relevant adverse cardiovascular effects have been reported after combining energy drinks and alcohol use in healthy people,[36] the number of emergency department visits involving energy drinks doubled between 2007 and 2011.[6] Visits

were more common among males than females and among those aged 18 to 25. However, the most dramatic increase in visits has occurred in patients aged 40 or older.

Among the biggest safety concerns associated with energy drinks involves consumers who believe “more is better,” whether for staying alert or enhancing physical performance. Also, high doses of caffeine may exacerbate cardiac conditions for which stimulants aren’t recommended,[3] and those with known cardiovascular disease should avoid the use of energy drinks and shots or any product with known cardiostimulant effects.[32]

In one study, 15 healthy people aged 18 to 40 consumed two cans (500 mL or 16.9 oz) daily of a commercially available energy drink containing 1,000 mg of taurine and 100 mg of caffeine as well as vitamins B_5, B_6, and B_{12}; glucuronolactone; and niacinamide for one week, with measurements taken regarding the drink’s effects on their blood pressure, pulse, and heart rate.[37] The authors concluded that although no clinically important electrocardiogram changes occurred, there were significant increases in heart rate and blood pressure, and thus patients with hypertension shouldn’t consume this type of drink.

The majority of reports on energy drinks’ harmful effects have involved either excessive intakes of several energy shots or drinks over a short period of time and/or combining them with alcohol.[38-43] Moreover, some people are more sensitive than others to caffeine, which may be due to genetic differences.[44-46] How individuals are affected also depends on their tolerance (ie, how much caffeine they normally consume from all sources).[23]

Daily consumption of high doses of caffeine can result in complete tolerance to its effects. Children and adolescents who don’t consume large amounts of caffeine daily are at greater risk of caffeine intoxication from energy drink consumption than are regular caffeine consumers.[23] Most studies about caffeine intoxication have examined coffee consumption. However, there’s no reason to believe that the delivery of caffeine via energy drinks would produce significantly different results.[23]

While caffeine from energy drinks will temporarily increase alertness and cognitive functioning, studies show that excessive daytime sleepiness may occur the day following energy drink consumption.[47] A study of US military service members found that those who drank three or more energy drinks per day were significantly more likely to report sleeping four or fewer hours per night than were those consuming two drinks or fewer daily. In addition, they were more likely to report sleep disruption related to stress and illness and were more prone to fall asleep during briefings or while on guard duty.[48]

There are no long-term studies on the effects of the combination of caffeine, taurine, and glucuronolactone on the body. Norway, Denmark, and France initially banned the sale of Red Bull, which contained glucuronolactone, partly in response to reports of adverse effects in animals but later reinstated it for consumption.[16]

Alcohol Consumption

Consuming one can of an energy drink is safe for most healthy people. However, excess consumption and consumption with other caffeine-containing beverages or alcohol may lead to adverse effects and possibly death.

Consuming alcohol and energy drinks together is common, especially among college students.[49,50] Some students report mixing energy drinks with alcohol so they can drink more and feel less drunk.[51] The high caffeine levels can mask alcohol's sedative effects, thereby reducing the feeling of drunkenness without reducing alcohol-related impairment,49 which creates a dangerous combination.

While consuming energy drinks along with alcohol significantly reduces subjective sensations of intoxication, objective effects on motor coordination and visual reaction time as well as breath alcohol concentration are unchanged.[52] Surveys have found that between 25% and 81% of college students experiment with mixing energy drinks and alcohol and that those who do mix the two consume more alcohol and participate in more binge drinking than those who don't.[24,50,51,53]

While it's common for college students to consume energy drinks and alcohol, surveys have shown it's common among high-school students as well. A recent Canadian survey found that about 20% of high school students reported consuming alcohol mixed with energy drinks in the previous year.[54] The FDA and Health Canada warn against mixing of energy drinks with alcohol, and the FDA has moved to eliminate such "premixed" beverages from the market. However, self-mixing is common.[54] Part of Health Canada's labeling proposal for energy drinks is including the statement "Do not mix with alcohol."[25]

There are several outcomes, both proven and potential, for consuming energy drinks and alcohol together, whether they're purchased premixed or mixed after being purchased individually[55]:

• Caffeine blunts the sedative effect of alcohol without improving reaction time.

• Lengthened time awake from caffeine consumption theoretically allows for greater alcohol consumption.

• At low blood alcohol levels, caffeine appears to decrease some of the physical and mental impairments caused by the alcohol. At higher blood alcohol levels, caffeine doesn't appear to have a modifying effect on either.

• Energy drink ingredients may give the consumer a false sense of physical and mental competence as well as decrease the awareness of impairment.

The FDA announced in 2010 that caffeine is an unsafe food additive to alcoholic beverages, which effectively prohibited premixed alcoholic energy drinks.49 However, some products still are available.

Recommendations for Practice
When counseling clients who consume energy drinks and/or shots, share the following information with them[16]:

• Limit energy drink consumption to no more than 1 can (500 mL or 16.9 oz) per day.

• Don't mix energy drinks with alcohol, as this can mask intoxication and may be extremely dehydrating.

• Rehydrate with water or an appropriately formulated sports drink after exercise or intense physical activity.

• If you experience an adverse reaction to an energy drink, report it to your health care professional or organization.

• If you're being treated for hypertension, avoid consuming energy drinks.

• If you have a serious underlying medical condition, including coronary artery disease, heart failure, or arrhythmia, consult with your physician before using energy drinks.[15]

A major concern is consuming energy drinks with other caffeinated beverages and products, such as caffeinated gum (2 pieces = 1 cup of coffee), caffeinated water (60 to 120 mg per bottle), caffeinated maple syrup (84 mg caffeine per tablespoon), caffeinated popcorn snack (2-oz serving = 70 mg of caffeine), and espresso bean candy covered in dark chocolate (1.3-oz box = as much caffeine as 6 cups of coffee). It's important to note that while the caffeine amounts of these beverages and products are common, they may vary significantly by brand than what's mentioned above.

A caffeine-laced maple syrup product in particular can pose a real risk for children and adolescents. The 1-T serving is small, and it's not uncommon for children and adolescents to generously cover pancakes, French toast, and waffles with copious amounts of syrup.

Over-the-counter caffeine pills and pain relief medications are additional sources of caffeine that shouldn't be consumed with energy products.

Be sure to ask clients and patients about energy drink consumption as well as their intake of alcohol and other sources of caffeine when taking a diet history. Explain that perceived health benefits largely are due to marketing techniques rather than scientific evidence.6

Putting the Issue in Perspective
Most energy drinks contain relatively low levels of caffeine, similar to that of soft drinks, and much lower than many commonly consumed coffee drinks. There appears to be little or no risk for healthy individuals consuming single servings of most energy drinks or energy shots. Neither is there evidence that the ingredients in energy drinks or shots provide any benefits over and above what would be gained from consuming a cup of coffee or 1 or 2 cups of tea.

However, the greatest concern is for children, adolescents, and young adults who drink several energy drinks or shots in a short period of time, mistakenly believing that the extra “boost” will lessen the effects of alcohol, increase their mental acuity, or improve athletic performance. If consumed along with any other products that contain caffeine, such as coffee, caffeine pills, soft drinks, tea, over-the-counter pain relievers, caffeine-infused energy gum, or espresso bean candy, they easily can reach a toxic caffeine dose.

For information on the content and caffeine levels in energy drinks, visit www.energyfiend.com. Drinks are rated by their caffeine levels: low, moderate, high, very high, extreme, and dangerous.

—Densie Webb, PhD, RD is a freelance writer, editor, and industry consultant based in Austin, Texas.

References

1. Packaged Facts. ***Energy Drinks and Shots: US Market Trends***. Rockville, MD: Packaged Facts; 2013.

2. Watson E. The evolution of energy drinks: what next for Monster, Red Bull and 5-Hour Energy? Beverage Daily.com website. http://www.beveragedaily.com/Sectors/Energy-Sports/The-evolution-of-energy-drinks-What-next-for-Monster-Red-Bull-and-5-Hour-Energy. February 4, 2013.

3. Seifert SM, Schaechter JL, Hershorin ER, Lipshultz SE. Health effects of energy drinks on children, adolescents, and young adults. ***Pediatrics***. 2011;127(3):511-528.

4. Energy drinks fact sheet, November 2011. Yale Rudd Center for Food Policy & Obesity website. http://www.yaleruddcenter.org/resources/upload/docs/what/policy/SSBtaxes/SSB_EnergyDrinks.pdf. November 2011.

5. Committee on Nutrition and the Council on Sports Medicine and Fitness. Sports drinks and energy drinks for children and adolescents: are they appropriate? ***Pediatrics***. 2011;127(6):1182-1189.

6. Update on emergency department visits involving energy drinks: a continuing public health concern. Substance Abuse and Mental Health Services Association website. http://www.samhsa.gov/data/2k13/DAWN126/sr126-energy-drinks-use.htm. January 10, 2013.

7. Somogyi LP. Caffeine intake by the US population. http://www.fda.gov/downloads/AboutFDA/CentersOffices/OfficeofFoods/CFSAN/CFSANFOIAElectronicReadingRoom/UCM333191.pdf. Revised August 2010.

8. Pomeranz JL, Munsell CR, Harris JL. Energy drinks: an emerging public health hazard for youth. ***J Public Health Policy***. 2013;34(2):254-271.

9. Draft guidance for industry: factors that distinguish liquid dietary supplements from beverages, considerations regarding novel ingredients, and labeling for beverages and other conventional foods. US Food and Drug Administration website. http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/DietarySupplements/ucm196903.htm. December 2009.

10. Letter to US Sen Richard Durbin. US Sen Dick Durbin website. http://www.durbin.senate.gov/public/index.cfm/files/serve?File_id=17eadaa1-85e7-4ceb-a827-be244fbddfa5. August 10, 2012.

11. Weldy DL. Risks of alcoholic energy drinks for youth. ***J Am Board Fam Med***. 2010;23(4):555-558.

12. ABA guidance for the responsible labeling and marketing of energy drinks. American Beverage Association website. http://www.ameribev.org/files/339_Energy Drink Guidelines (final).pdf. Accessed April 28, 2013.

13. Meier B. In a new aisle, energy drinks sidestep some rules. The New York Times website. http://www.nytimes.com/2013/03/20/business/in-a-new-aisle-energy-drinks-sidestep-rules.html?pagewanted=all. March 19, 2013.

14. Wiredx505: 505 mg of caffeine in a can. Energyfiend website. http://www.energyfiend.com/wired-x505-500mg-of-caffeine-in-a-can.

15. Code of Federal Regulations: Stimulant drug products for over-the-counter human use. 21 CFR Sect 340.50 (2007).

16. Higgins JP, Tuttle TD, Higgins CL. Energy beverages: content and safety. ***Mayo Clin Proc***. 2010;85(11):1033-1041.

17. Persad LA. Energy drinks and the neurophysiological impact of caffeine. ***Front Neurosci***. 2011;5:116.

18. Eating and nutrition: caffeine in pregnancy. March of Dimes website. http://www.marchofdimes.com/pregnancy/nutrition_caffeine.html. Last reviewed June 2012.

19. High caffeine energy drinks and other foods containing caffeine. Food Standards Agency website. http://www.food.gov.uk/policy-advice/additivesbranch/energydrinks - .UX65po6Z9hN.

20. Kaiser L, Allen LH; American Dietetic Association. Position of the American Dietetic Association: nutrition and lifestyle for a healthy pregnancy outcome. ***J Am Diet Assoc***. 2008;108(3):553-561.

21. Heatherley SV, Hancock KM, Rogers PJ. Psychostimulant and other effects of caffeine in 9- to 11-year-old children. ***J Child Psychol Psychiatry***. 2006;47(2):135-142.

22. Griffiths RR, Woodson PP. Caffeine physical dependence: a review of human and laboratory animal studies. ***Psychopharmacology (Berl)***. 1988;94(4):437-451.

23. Reissig CJ, Strain EC, Griffiths RR. Caffeinated energy drinks—a growing problem. ***Drug Alcohol Depend***. 2009;99(1-3):1-10.

24. Malinauskas BM, Aeby VG, Overton RF, Carpenter T, Barber-Heidal K. A survey of energy drink consumption patterns among college students. ***Nutr J***. 2007;6:35.

25. Health Canada's proposed approach to managing caffeinated energy drinks. Health Canada website. http://www.hc-sc.gc.ca/fn-an/alt_formats/pdf/legislation/pol/energy-drinks-boissons-energisantes-eng.pdf. October 2011.

26. The buzz on energy-drink caffeine. Consumer Reports website. http://www.consumerreports.org/cro/magazine/2012/12/the-buzz-on-energy-drink-caffeine/index.htm. December 2012.

27. Wolk BJ, Ganetsky M, Babu KM. Toxicity of energy drinks. ***Curr Opin Pediatr***. 2012;24(2):243-251.

28. Harris JL, Schwartz MB, Brownell KD. Evaluating sugary drink nutrition and marketing to youth. Yale Rudd Center for Food Policy & Obesity website. http://www.sugarydrinkfacts.org/resources/SugaryDrinkFACTS_Report.pdf.

29. Rush E, Schultz S, Obolonkin V, Simmons D, Plank L. Are energy drinks contributing to the obesity epidemic? ***Asia Pac J Clin Nutr***. 2006;15(2):242-244.

30. Opinion on caffeine, taurine and d-glucurono-g-lactone as constituents of so-called "energy" drinks (expressed on 21 January 1999). European Commission website. http://ec.europa.eu/food/fs/sc/scf/out22_en.html

31. Koeth RA, Wang Z, Levison BS, et al. Intestinal microbiota metabolism of l-carnitine, a nutrient in red meat, promotes atherosclerosis. ***Nat Med***. 2013;19(5):576-585.

32. Campbell B, Wilborn C, La Bounty P, et al. International Society of Sports Nutrition position stand: energy drinks. ***J Int Soc Sports Nutr***. 2013;10(1):1.

33 Riesenhuber A, Boehm M, Posch M, Aufricht C. Diuretic potential of energy drinks. ***Amino Acids***. 2006;31(1):81-83.

34. Armstrong LE. Caffeine, body fluid-electrolyte balance, and exercise performance. ***Int J Sport Nutr Exerc Metab***. 2002;12(2):189-206.

35. Armstrong L, Pumerantz A, Roti M, et al. Fluid, electrolyte, and renal indices of hydration during 11 days of controlled caffeine consumption. ***Int J Sport Nutr Exerc Metab***. 2005;15:252-265.

36. Verster J, Aufricht C, Alford C. Energy drinks mixed with alcohol: misconceptions, myths and facts. ***Int J Gen Med***. 2012;5:187-198.

37. Steinke L, Lanfear DE, Dhanapal V, Kalus JS. Effect of “energy drink” consumption on hemodynamic and electrocardiographic parameters in healthy young adults. ***Ann Pharmacother***. 2009;43(4):596-602.

38. Berger AJ, Alford K. Cardiac arrest in a young man following excess consumption of caffeinated “energy drinks.” ***Med J Aust***. 2009;190(1):41-43.

39. Terlizzi R, Rocchi C, Serra M, Solieri L, Cortelli P. Reversible postural tachycardia syndrome due to inadvertent overuse of Red Bull. ***Clin Auton Res***. 2008;18(4):221-223.

40. Trabulo D, Marques S, Pedroso E. Caffeinated energy drink intoxication. ***BMJ Case Rep***. 2011;2011.

41. Benjo AM, Pineda AM, Nascimento FO, Zamora C, Lamas GA, Escolar E. Left main coronary artery acute thrombosis related to energy drink intake. ***Circulation***. 2012;125(11):1447-1448.

42. Kaoukis A, Panagopoulou V, Mojibian HR, Jacoby D. Reverse Takotsubo cardiomyopathy associated with the consumption of an energy drink. ***Circulation***. 2012;125(12):1584-1585.

43. Usman A, Jawaid A. Hypertension in a young boy: an energy drink effect. ***BMC Res Notes***. 2012:5:591.

44. Byrne EM, Johnson J, McRae AF, et al. A genome-wide association study of caffeine-related sleep disturbance: confirmation of a role for a common variant in the adenosine receptor. ***Sleep***. 2012;35(7):967-975.

45. Landolt HP. “No thanks, coffee keeps me awake”: individual caffeine sensitivity depends on ADORA2A genotype. ***Sleep***. 2012;35(7):899-900.

46. Yang A, Palmer AA, de Wit H. Genetics of caffeine consumption and responses to caffeine. ***Psychopharmacology (Berl)***. 2010;211(3):245-257.

47. Ishak WW, Ugochukwu C, Bagot K, Khalili D, Zaky C. Energy drinks: psychological effects and impact on well-being and quality of life—a literature review. ***Innov Clin Neurosci***. 2012;9(1):25-34.

48. Centers for Disease Control and Prevention. Energy drink consumption and its association with sleep problems among U.S. service members on a combat deployment—Afghanistan, 2010. ***MMWR Morb Mortal Wkly Rep***. 2012;61:895-898.

49. Arria AM, O’Brien MC. The “high” risk of energy drinks. ***JAMA***. 2011;305(6):600-601.

50. Marczinski CA. Alcohol mixed with energy drinks: consumption patterns and motivations for use in U.S. college students. ***Int J Environ Res Public Health***. 2011;8(8):3232-3245.

51. O'Brien MC, McCoy TP, Rhodes SD, Wagoner A, Wolfson M. Caffeinated cocktails: energy drink consumption, high-risk drinking, and alcohol-related consequences among college students. ***Acad Emerg Med***. 2008;15(5):453-460.

52. Ferreira SE, de Mello MT, Pompéia S, de Souza-Formigoni ML. Effects of energy drink ingestion on alcohol intoxication. ***Alcohol Clin Exp Res***. 2006;30(4):598-605.

53. Price SR, Hilchey CA, Darredeau C, Fulton HG, Barrett SP. Energy drink co-administration is associated with increased reported alcohol ingestion. ***Drug Alcohol Rev***. 2010;29(3):331-333.

54. Azagba S, Langille D, Asbridge M. The consumption of alcohol mixed with energy drinks: prevalence and key correlates among Canadian high school students. ***Can Med Assoc J Open***. 2013;1(1):E19-E26.

55. Liguori A, Robinson JH. Caffeine antagonism of alcohol-induced driving impairment. ***Drug Alcohol Depend***. 2001;63(2):123-129.

Examination

1. During physical activity, energy drinks can be used as a substitute for sports drinks.
A. True
B. False

2. Which of the following is the most common ingredient found in energy drinks and shots?
A. Ginseng
B. White tea
C. Caffeine
D. Creatine

3. Which of the following is considered a clinically toxic dose of caffeine for adults?
A. 100 mg
B. 300 mg
C. 400 mg
D. 1 g

4. Which of the following is considered a safe level of caffeine intake for children?
A. 100 mg/day
B. 200 mg/day
C. 300 mg/day
D. 400 mg/day

5. Energy drinks and shots are not recommended for which of the following groups?
A. Athletes
B. Personal trainers
C. Individuals with cardiac problems
D. Individuals who are obese

6. Which of the following are symptoms of caffeine intoxication?
A. Low blood sugar
B. Insomnia
C. Restless leg syndrome
D. Depression

7. Which of the following statements is true based on this article?
A. All energy drinks are low in sodium.
B. Most energy drinks are artificially sweetened.
C. The unique combination of ingredients in energy drinks is what provides an energy boost.
D. Many ingredients in energy drinks have not been proven to enhance energy or cognitive function.

8. Mixing alcohol and energy drinks can result in which of the following?
A. Enhanced effect of caffeine
B. Reduced breath alcohol concentration
C. Improved visual reaction time
D. Lengthened time awake compared with consuming alcohol alone

9. Energy drink consumption should be limited to which of the following?
A. No more than 32 oz over a 24-hour period
B. No more than one 500-mL can per day
C. No more than two 500-mL cans per day
D. As a replacement for coffee

10. It's unlikely that someone can reach a toxic level of caffeine by combining energy drinks with other caffeine-containing products.
A. True
B. False