Looking Beyond the Marketing Claims of New Beverages

Health Risks of Consuming Sports Drinks, Energy Drinks, Fortified Waters and Other Flavored Beverages

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Introduction

Consumption of several new categories of beverages has increased significantly in recent years. Sold in cans and bottles in many venues and heavily marketed as health and strength enhancing, these beverages have become popular among children and adolescents as well as adults.

Energy drinks, sports drinks, fruit drinks, flavored waters, and sweetened teas and coffees are known collectively as fortified beverages due to the natural and artificial ingredients that are added in the processing of their main ingredient, water. In view of their rising popularity, it is important to assess the healthfulness of these beverages and the implications of their consumption by the general public. Consumption by youth, to whom marketing is often targeted, is of particular interest in view of children's potentially increased vulnerability to chemicals and other added substances. Further, the possible contribution of these beverages to the high prevalence of childhood obesity merits attention.

This report will discuss the major categories of fortified beverages, presenting data on their nature, their ingredients, their similarities and differences, the possible effects on children of their consumption, and areas for further research.

Executive Summary

Background

Sugar sweetened beverages are a growing market sector and are common in the diets of both adults and youth. These beverages are often fortified with added nutrients that are advertised as providing health benefits, including vitamins, minerals and other herbals. However, the sugar content and potential adverse effects of some additives outweigh any potential benefit these ingredients may provide, especially among youth.

Fortified beverages that are commonly advertised to and consumed by youth and adolescents include energy drinks, sports drinks, fruit drinks, flavored waters and sweetened teas or coffee. In this analysis, compiled their nutritional information and performed an extensive literature review of the beverage categories and their fortified ingredients to identify any risk they pose in the diet of young people.

Methods

Beverage Identification

In 2011, the Yale Rudd Center completed an extensive marketing analysis to identify beverage types that are commonly advertised to children and adolescents (Harris, Schwartz, & Brownell, 2011). Beverage categories identified included energy drinks, sports drinks, fruit drinks, flavored water, and sweetened teas or coffees. Among these beverage categories they also identified which brands were most commonly advertised to youth, including Kool-Aid®, Capri Sun®, Sunny D®, Gatorade®, Red Bull®, Vitamin Water®, Amp®, Sobe®, Snapple®, and Powerade®. To supplement the Rudd Center analyses, we took beverage inventories of eight convenience stores located near secondary schools in Berkeley, Los Angeles, Grass Valley, and Sacramento, California, and in New York City, between April and June 2012. We identified common brands according to amount of shelf space occupied in each store and common brand flavors based on their availability in distinct geographical locations. Using the Rudd Center marketing analysis and our store inventories we identified a total of 21 (fortified) beverages in the beverage categories listed below.

Table 1. Common fortified beverages marketed and sold to youth

Beverage Type	Brand and Flavor Identified
Energy Drinks	Monster® Energy RockStar® Energy Drink AMP® Energy (Boost Original) Red Bull® Starbucks® Doubleshot® Energy
Sports Drinks	Gatorade G® Perform 02 (Lemon Lime) Gatorade G2® Low Calorie (Glacier Freeze) Gatorade G® Recover 03 (Mixed Berry) Powerade® Fruit Punch Advanced Electrolyte System
Fruit Drinks	Sobe® Strawberry Banana V8 Splash® Berry Blend Sunny D® Orange Tampico® Mango Punch Capri Sun® Sunrise Kool Aid®
Flavored Water	Vitamin Water® XXX Vitamin Water® Revive Sobe® Lifewater® Yumberry Pomegranate
Sweetened Teas and Coffee	Arizona® Green Tea Snapple® Peach Tea Starbucks® bottled Mocha Frappuccino®

Nutrient Analysis

The nutrient content of each beverage was gathered from the nutrition or supplement facts on the package labels. If the amounts were written as percent Daily Values, these were converted to gram amounts or International Units (IUs). In some cases, beverage companies were contacted by phone to gather the content of nutrients or other additives listed on the label. The vitamin and mineral content was compared to the Recommended Daily Allowances and Upper Limits for youth.

Literature Review

A literature review was performed using PubMed to identify published articles over the last 10 years, between 2002 and 2012. Human studies in English publications were sought when they included the terms—energy drinks and caffeine; caffeine consumption; caffeine (or guarana, taurine, L-carnitine, gingko biloba, ginseng, milk thistle, ginger, dandelion, glucuronolactone, inositol) use as a dietary supplement. The preceding ingredients were also used as search terms alone. The studies were limited to those completed with youth age 18 and younger; in the absence of adequate numbers of results, the limits were expanded to include adult studies.

Additional searches limited to youth age 18 and younger were completed using the following terms—sports drinks, fruit drinks, flavored water, sweetened teas, and sweetened coffee.

Articles were excluded based on the following criteria—the ingredient of interest was not the primary dependent variable; the ingredient was not used as a supplement or as an additive in a beverage or food, or was used as part of a medication complex; the ingredient was provided as a combined (multinutrient) supplement; the study was based only on animal or in vitro studies; or subjects exhibited a disease state. Additionally, studies were identified that were referenced in the primary articles found, and case reports were identified in national news reports (Business Week, New York Times) released in 2012.

In our review of sugar substitutes, we included both human and animal studies following the aforementioned search criteria and used the following terms—artificial sweeteners; sucralose; acesulfame potassium; stevia; neotame; and erythritol.

Main findings

The popular fortified beverages identified are a major source of sugar and can contribute a significant amount of calories to the diets of children. The consumption of sugar sweetened beverages is associated with overweight and obesity among youth and has been shown to lead to obesity in adulthood along with related chronic diseases including type 2 diabetes and cardiovascular disease (Hu & Malik, 2010). Other potential concerns related to the consumption of each beverage type are highlighted below, and Table 2 highlights the additives contained in each beverage type that have been shown to pose risk to children or young adults. More detailed information is provided in the chapters on each beverage type.

Table 2. Fortified ingredients found in each beverage type and identified risks

Beverage Type	Fortified Ingredients	Main Areas of Concern
Energy Drinks	B Vitamins, Taurine, L-Carnitine, Caffeine, Guarana, Gingko Biloba, Ginseng, Milk Thistle, Glucuronolactone, Inositol	Sugar, Caffeine, Guarana, Ginseng, Taurine, Gingko Biloba
Sports Drinks	Potassium, Sodium, Magnesium, B Vitamins	Sugar
Fruit Drinks	Vitamins A, B1 (Thiamin), C, and E, Ginseng, Yerba Mate	Sugar, Vitamin A, Ginseng, Yerba Mate
Flavored Water	Manganese, Magnesium, Potassium, B Vitamins, Vitamins A, C and E, Ginger and Dandelion Extract	Sugar, Vitamin B3
Sweetened Teas and Coffee	Vitamin C, Ginseng	Sugar, Caffeine, Ginseng

Energy Drinks

Energy drinks are among the fastest growing beverage industries, and are heavily marketed and consumed among young adults and adolescents. Energy drinks are a major source of sugar and caffeine—a can of a typical energy drink contains more caffeine than a cup of coffee, and exceeds the amount recommended that youth not exceed—2.5 mg per kg of body weight daily (Nawrot et al. 2003). Recent case reports have highlighted concerns regarding youth consuming excess amounts of energy drinks; deaths from cardiac arrest attributed to excess caffeine intake from energy drinks have been documented (Gunja & Brown, 2011; Meier, 2012). Research shows additional concerns related to caffeine intake from energy drinks including seizure activity, heart arrhythmia, increased blood pressure, attention and behavior problems, sleep disturbances, jitteriness and nervousness (Higgins, Tuttle, & Higgins, 2010; Seiffert et al., 2011). Caffeine may exhibit synergistic effects in combination with other stimulants contained in energy drinks, including Guarana, which is another source of caffeine, Ginseng, Gingko Biloba and Taurine, an amino acid. These additives have been shown to have similar effects on the nervous and cardiovascular system, especially in combination with caffeine (Russo et al., 2011; Torbey, et al., 2011; Franks et al., 2012; Rath, 2012).

An additional risk associated with energy consumption among adolescents and young adults is the practice of mixing energy drinks with alcohol. Mixing energy drinks with alcohol during partying is a common practice among college students and is found to lead to greater alcohol consumption and risky behavior practices including driving under the influence and sexual assault (Howland & Rohsenow, 2013).

Sports Drinks

The consumption of sports drinks has also grown in the past decade. The percentage of 6 to 11 year olds that regularly consume sports drinks has grown from 2 to 12 percent between 1989 and 2008, and the daily calorie contribution of these beverages to children's diets has increased from 1 to 9 calories (Lasater, Piernas, & Popkin, 2011). Although sports drinks were originally developed as a carbohydrate replacement for athletes, there is a common misconception of their proper use and they are now more commonly marketed and consumed by (often sedentary) youth in general. Those that consume sports drinks are not engaging in activity that expends the additional calories provided by the drinks and are at risk of becoming overweight (Park et al., 2012; Schneider & Benjamin, 2011). The Academy of Pediatrics encourages the use of water as a superior hydration source and advises against the use of sports drinks for youth engaging in everyday activities (Schneider & Benjamin, 2011). Sports drink consumption may only be necessary for young athletes participating in prolonged vigorous activity lasting more than an hour in extreme conditions (hot, cold or high altitude conditions), when electrolyte losses and dehydration are a significant concern. The Institute of Medicine advises against schools providing sports drinks to students, except to those participating in vigorous athletic events (IOM Report on School Food, 2007).

Fruit Drinks

Fruit drinks are most commonly consumed by young children aged 2 to 5, and are commonly marketed to parents of young children (Harris, Schwartz, & Brownell, 2011). Fruit drinks are a significant source of calories in the diets of young children and may influence overweight—national data from 2004 NHANES indicate that pre-school age children on average consume 176 calories a day from sugar sweetened beverages and fruit drinks contribute over half of these calories (Wang et al., 2008). Additional data show that fruit drink consumption is associated with overweight in preschool children and may lead to obesity as children grow older (Sanigorski et al., 2007; Lim et al., 2009).

Although fruit drinks have been shown to be a large contributor of vitamin C in the diets of youth, their consumption has been shown to displace natural sources of vitamins and minerals. The consumption of fortified beverages among youth is associated with lower intakes of vital nutrients including fiber, iron and calcium, Vitamins A, B6, B12 and D, magnesium, potassium and zinc (Frary, Johnson, & Wang, 2004; Sacco & Tarasuk, 2011).

Flavored Water

Like fruit drinks, flavored waters are heavily fortified with vitamins, and may displace other natural sources of vitamins and other nutrients in the diet of youth (Frary, Johnson, & Wang, 2004; Sacco & Tarasuk, 2011). Another concern is that flavored waters are gaining popularity over plain water; their names make them appear to be "water" with added benefits. However, flavored waters can contribute excess sugar and calories in the diet that can increase risk for overweight and obesity, making plain water the best fluid choice for children and adolescents (IOM 2007 Report on Food in Schools). Data show that children who consume more plain water on a daily basis are less likely to be overweight. A survey of 6th-8th grade students in Florida showed that low water drinkers are substituting less healthful (high calorie, high sugar) beverages in their diets (Park et al., 2011). Marketing sugar sweetened beverages as "water" may only exacerbate this trend.

Sweetened Teas and Coffee

Sweetened teas and coffee are also widely consumed among youth, especially among older adolescents. About 20% of youth report regularly consuming sweetened teas or coffee (Lasater, Piernas, & Popkin, 2011). Sweetened teas and coffees are a great source of sugar and can lead to excess calorie consumption among youth. In addition, these beverages are a natural source of caffeine. Although they contain low amounts of caffeine in comparison to energy drinks, even modest amounts of dietary caffeine (50 g or more) have been shown to be associated with sleep disturbances, and nervous and behavior problems among youth (Temple, 2009; Warzak et al., 2011; Martin & Cook, 2008). Caffeine has further been shown to impart a reinforcing effect in combination with foods and beverages, and this effect may encourage excess consumption of caffeinated sugar sweetened beverages (Temple et al., 2010). Some teas are also fortified with Ginseng, an herbal stimulant that can exhibit physiological effects similar to those seen with caffeine administration, including tachycardia, headache and insomnia (Higgins, Tuttle, & Higgins, 2010; Torbey et al., 2011).

Conclusion

Energy drinks, sports drinks, fruit drinks, flavored waters and sweetened teas and coffees are growing in popularity among youth. These beverages are heavily fortified with herbals, vitamins, minerals and other stimulants that provide energy enhancing and other health benefits, but these benefits do not outweigh risks identified among youth consuming these beverages or fortified nutrients. All beverages identified are major sources of sugar, which contributes excess calories in the diets of youth and has been shown to lead to obesity. Although some beverages, including fruit drinks and flavored waters, may be a significant source of vitamins in the diets of youth, it has been shown that these beverages displace other natural dietary sources of vitamins and minerals, and youths who consume them are then less likely to meet recommended intakes of additional nutrients. Of growing concern, in addition, are caffeinated sugar sweetened beverages, including energy drinks, which have been related to many physiological and behavioral problems among youth. It is recommended that youth do not consume fortified sugar sweetened beverages to avoid risks related to their consumption, and consume water as an optimal source of hydration and other natural food sources, such as fruit, vegetables and low fat milk products, that offer the same vitamins and minerals contained in these beverages in addition to other health-enhancing nutrients, including phytochemicals, calcium and fiber.

Chapter 1. Energy Drinks

What are energy drinks?

The sugar sweetened beverages known as energy drinks are a rapidly growing component of the beverage industry (Reissig, Strain, & Griffiths, 2009). Sales of Monster Energy®, for example, have tripled since 2006 (Edney, 2012). A typical energy drink comes in a 16 ounce can and contains 200 calories; 54 grams of sugar; B vitamins (Riboflavin, Niacin, Vitamin B6 and Vitamin B12; amino acids (Taurine and L-carnitine); herbal supplements (Ginseng); and other “energy enhancing” ingredients, including caffeine, guarana, inositol, and glucuronolactone (Table 3).

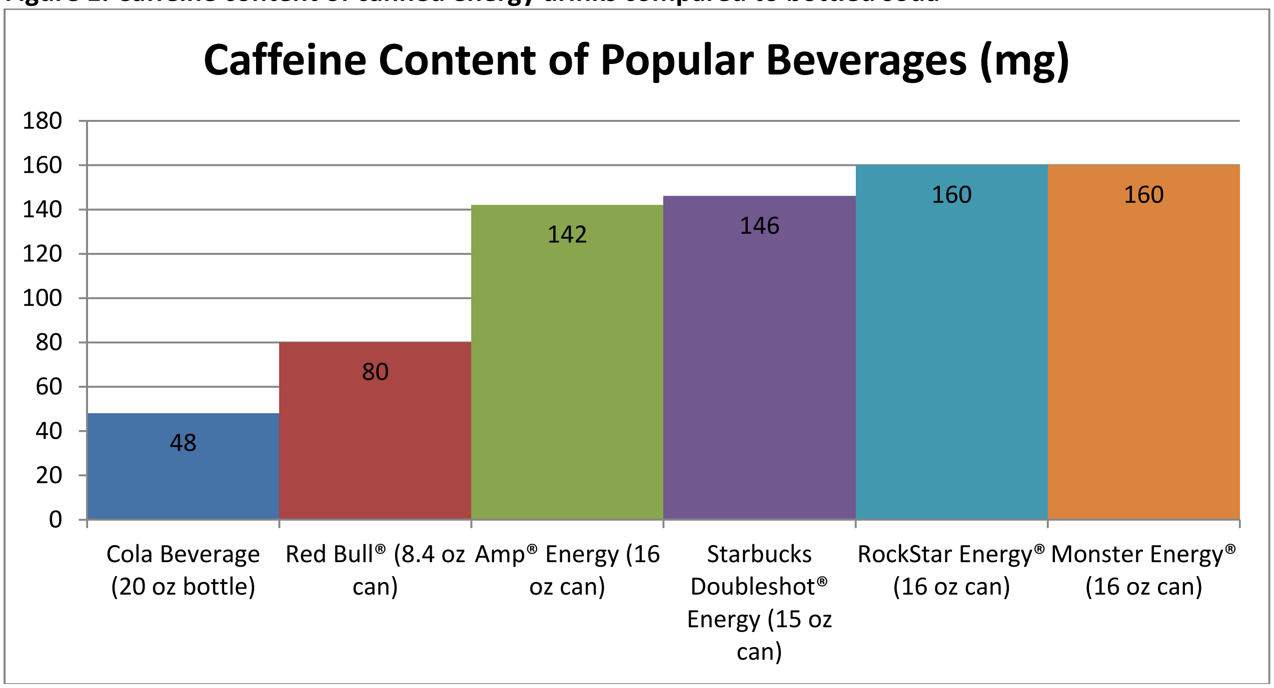
Table 3. Nutritional content per can of popular energy drinks vs. caffeinated soda

Beverage	Bottle Size (fl oz)	Calories	Sugar (g)	Caffeine (mg)	Guarana (mg)	Added Vitamins and Minerals	Other Additives
Monster Energy®	16	200	54	160*	Not provided	Riboflavin (Vitamin B2), Niacin (Vitamin B3), Vitamin B6, Vitamin B12	Taurine, L-Carnitine, Ginseng, Inositol, Glucuronolactone
Amp Energy®	16	220	58	142	295	Riboflavin (Vitamin B2), Niacin (Vitamin B3), Pantothenic Acid (Vitamin B5), Vitamin B6, Vitamin B12	Taurine, Ginseng
Starbucks® Doubleshot® Energy	15	200	26	146*	90	Vitamin A, Riboflavin (Vitamin B2), Niacin (Vitamin B3), Vitamin B6	Taurine, Ginseng, Inositol
Rockstar®Energy Drink	16	280	62	160	50	Riboflavin (Vitamin B2), Niacin (Vitamin B3), Pantothenic Acid (Vitamin B5), Vitamin B6, Vitamin B12	Taurine, L-Carnitine, Gingko Biloba, Ginseng, Milk Thistle Extract, Inositol
Red Bull®	8.4	110	27	80	None	Niacin (Vitamin B3), Pantothenic Acid (Vitamin B5), Vitamin B6, Vitamin B12	Taurine, Inositol, Glucuronolactone
Coca-Cola®	20	240	65	58	None	None	None

*Caffeine content not listed, provided through customer service phone line of beverage company
Sources: Nutrition and Supplement Facts, Starbucks.com, the coca-colacompany.com, Monster and Starbucks customer service hotline

Although energy drinks are required to follow FDA nutrition and supplement labeling law standards for foods and beverages sold in the U.S. (FDA Register), the FDA does not set limits on the amounts of nutrients allowed in energy beverages, such as caffeine, while it does enforce limits on the amount of caffeine allowed in sodas (71 mg per 12 fluid ounces) (Food and Drug Administration, 2003). The amount of caffeine contained in popular energy drinks exceeds this amount, averaging 107 mg per 12 fluid ounces. In fact, canned energy drinks contain about triple the amount of caffeine contained in a bottled soda (Figure 1). Further, current FDA labeling laws allow beverage companies to aggressively market energy drinks to young people by citing their alleged "energy" and "performance" enhancing benefits (Temple, 2009). A TV advertisement exposure analysis showed that youth, aged 12 to 17 years, had a 32% higher exposure to energy drink ads than adults (Harris, Schwartz, & Brownell, 2011). The American Academy of Pediatrics strongly discourages the inclusion of energy drinks in the diets of youth due to potential negative effects of caffeine (Schneider & Benjamin, 2011). However, adolescents are drawn by the drinks' purported benefits, including taste, energy boost, and improved performance (Rath, 2012).

Figure 1. Caffeine content of canned energy drinks compared to bottled soda



Energy drink consumption patterns

Energy drink consumption patterns among youth are under-reported; however, a few observational studies indicate regular energy drink use is common among adolescents and has increased in the past decade. Adolescents are at risk of over-consuming high calorie energy beverages due to marketing claims that they enhance performance and increase energy (Reissig, Strain, & Griffiths, 2009). According to a consumer research study using National Simmons Teen Survey data, 28 percent of 12 to 14 year-olds and 31 percent of 12 to 17 year-olds regularly consumed energy drinks in 2006 (Simon & Mosher, 2007). These rates have increased significantly since 2002 when 18 percent of 12 to 17 year olds reported consuming energy drinks regularly. A 2011 study of 136 undergraduate students in the southern plains states indicated that more than half (59%) consumed energy drinks at least once in the past week. Respondents most commonly reported drinking 1 to 2 energy drinks on one occasion (66%), while 8% reported to drinking 4 to 6 drinks at maximum (Pettit & DeBarr, 2011). Data on 11,209 students in grades 9 to 12 from the 2010 National Youth Physical Activity and Nutrition Survey indicated that 5 percent of high school students drank energy drinks at least once daily. Being male, Hispanic or non-Hispanic black was associated with greater odds of drinking energy drinks at least once per day (Park et al., 2012).

Caffeine and energy drink consumption

Currently, the U.S. has no dietary guidelines for caffeine consumption by adults or children. However, Canada has set guidelines for both adults and children based on research showing adverse health effects related to high levels of caffeine consumption (Nawrot et al., 2003). Healthy Canada currently recommends that adults consume no more than 400 mg caffeine daily, and that children up to age 18 consume no more than 2.5 mg per kg of body weight per day. The upper level of intake according to these recommendations for a child weighing 34 kg or 75 lb would be 85 mg, while a typical 16 oz. canned energy drink contains 160 mg of caffeine, almost twice the recommended limit (Table 4).

Table 4. Caffeine in Monster Energy® and Canadian caffeine recommendations

Monster Energy® (16 oz can)	Healthy Canada Recommendations for Adults	Healthy Canada Recommendations for Children (up to age 18)
160 mg	400 mg daily	2.5 mg per kg of body weight or 85 mg for a child weighing 75 pounds

Sources: Monster Energy®, Health Canada

According to the 1998 Continuing Survey of Food Intakes by Individuals (CSFII), soft drinks were the highest source of caffeine in the diets of youth, contributing an average of 36.5 mg and 51.3 mg of caffeine to the daily diets of 12 to 17 year old females and males, respectively (Frary, Johnson, & Wang, 2005). The percentage of youth consuming caffeine (82%) almost doubled since 1977 when 43% of children aged 6 to 17 who completed the Generally Recognized as Safe (GRAS) survey consumed caffeine. This trend is thought to result from the increase in soft drink consumption by children and teens since the 1970s (Frary, Johnson, & Wang, 2005). Data from the 2009-2010 NHANES survey showed caffeine intake higher than in 1998; average caffeine consumption among a national sample of 12 to 19 year olds was 66.3 mg daily among males and 50.2 mg daily among females. This increase, while significant, may not reflect the recent rapid rise in popularity of caffeine-containing energy drinks among youth (Edney, 2012).

Blood pressure and tachycardia

Controlled trials have shown that both energy drinks and caffeine elevate blood pressure and alter heart rate in children and young adults. In a controlled trial, college students who consumed only one can of Red Bull® energy drink experienced decreases in heart rate and increased blood pressure (Ragsdale et al.). Another trial with 9 adult subjects aged 18-45 showed the effects of Red Bull® on blood pressure to be more pronounced than consuming the same dose of caffeine (80 g) by itself (Franks et al., 2012). The effect on blood pressure is thought to be explained by the synergistic effect of other compounds found in Red Bull®, including 1000 mg of taurine, an amino acid. Similar patterns are seen in controlled trials looking at the effects of caffeine consumption on heart rate and blood pressure (Turley and Gerst; Temple et al.; Savoca, C. D. Evans, et al.; Savoca, MacKey, et al.). In a controlled trial of 12 to 17 year olds, caffeine provided in 0 to 200 mg doses was found to increase diastolic blood pressure and decrease heart rate in a dose-dependent manner (Temple et al.). The dose-dependent effects of caffeine on blood pressure were shown to be more pronounced in African American children in controlled trials where 15 to 19 year old youth were provided 0 to 100 mg of caffeine from beverages and chocolate (Savoca, C. D. Evans, et al.; Savoca, MacKey, et al.).

Neurological problems

Youth with higher caffeine intake commonly report neurological symptoms, including nervousness and anxiety, jitteriness, dizziness, headache, muscle twitching and tremors (Higdon and Frei; Temple). In one review, jitteriness and nervousness were reported in youth consuming 100 to 400 mg of caffeine from dietary sources (Temple), while an observational report saw increased neurological complaints after lower doses of 50 to 75 mg daily (Temple, Dewey, and Briatico). In a controlled trial, 9 to 11 year olds asked to abstain from caffeine displayed symptoms of withdrawal, including headache, which were rapidly reversed with the re-introduction of a fruit drink containing 50 mg of caffeine (Heatherley, Hancock & Rogers, 2006).

Sleep problems

Multiple observational studies have shown dietary caffeine intake to be associated with reduced sleep and sleep quality in youth (Drescher et al., 2011; James, Kristjánsson, and Sigfúsdóttir, 2011; Calamaro, Mason, and Ratcliffe; Ludden & Wolfson, 2010; Warzak et al., 2011; Pollak & Bright, 2003). A survey of 9th and 10th graders showed a positive relationship between dietary caffeine consumption and daytime sleepiness, and a strong negative relationship with academic achievement (James, Kristjánsson, & Sigfúsdóttir, 2011). In this sample energy drinks followed soda as the most commonly reported dietary source of caffeine.

Individual case reports of caffeine induced symptoms

A few cases have been reported of new-onset seizures among youth aged 15 to 20 attributed to energy drink consumption (Calabrò et al., 2012; Babu and Zuckerman, 2011; Iyadurai & Chung, 2007). In all of these cases, seizures ceased after the individuals abstained from energy drinks. Gunja & Brown (2011) reported signs of caffeine toxicity including gastrointestinal upset, hallucinations, seizures and cardiac ischemia after energy drink consumption by Australian subjects who contacted a poison information center. In this study, symptoms were reported even among subjects who limited consumption to manufacturer-recommended quantities. A more recent report detailed the death of a 14 year old girl that was attributed to cardiac arrhythmia caused by caffeine intoxication after consuming two- 24 oz Monster Energy® beverages over 2 consecutive days (Edney, 2012). Poison control records in Ireland reported 2 deaths related to over-consumption of energy drinks between 1999 and 2005, and deaths have been reported in Germany since 2002 (Seifert et al., 2011). Energy drink consumption was implicated in the deaths of five people within one year in the U.S. (Meier, 2012). Twenty cases of caffeine intoxication from energy drink consumption in children and young adults up to age 24 were reported in New Zealand from 2005 to 2009 (Seifert et al., 2011).

Additional energy drink concerns

Relationship with obesity

The American Academy of Pediatrics finds that the consumption of excessive carbohydrate calories from energy drinks increases risk of pediatric overweight and that energy drinks have no place in the diet of youth (Schneider & Benjamin, 2011). Energy drinks increase risk of obesity due to their high calorie and sugar content (Schneider & Benjamin, 2011; Clauson et al., 2008). Another hypothesis is that caffeine's influence on sleep quality may increase energy consumption during the day; one cross-sectional study showed that adolescents aged 12 to 17 who reported higher consumption of caffeinated beverages reported less sleep and had higher BMIs, compared to those reporting lower consumption (Drescher et al., 2011).

Academics and behavior

Studies have shown a relationship between energy drink or caffeine intake and academic performance. A survey of college students found higher energy drink users displayed higher levels of stress and poorer academic performance (Pettit & DeBarr, 2011). This relationship may be explained by caffeine's negative impact on sleep quality (Calamaro, Mason, and Ratcliffe, 2009; James, Kristjánsson, and Sigfúsdóttir, 2011), as well as caffeine's negative impact on student behavior. In a survey of 12 to 19 year olds whose caffeine intake ranged from 23mg to 1458 mg per day, those who reported falling asleep in school had 76% higher caffeine intake than those who did not report falling asleep (Calamaro, Mason, and Ratcliffe, 2009). A survey of 11 to 16 year olds found that youth reporting higher intake of caffeinated beverages showed more aggressive behavior as well as social and attention problems (Martin & Cook, 2008). A review written by nursing professionals found energy drinks can negatively impact youth behavior and cause jitteriness, anxiety and dizziness, which may play a role in students' ability to stay on task, focus and perform well (Pennington et al., 2010).

Relationship with alcohol consumption

Alcohol consumption is associated with energy drink consumption in adolescents and young adults, and those that consume energy drinks with alcohol commonly consume more alcohol. A study released in 2007 of 496 college students in the mid-Atlantic, with a mean age of 21 years, indicated that about half (51%) consumed one or more energy drinks per month, and that energy drink users most commonly reported drinking one drink on 1 to 4 days during the month (Malinauskas et al., 2007). About half (54%) of the energy drink users reported mixing energy drinks with alcohol and also reported drinking more energy drinks at once—49% commonly drank 3 or more at one time. Similar patterns were shown in another study released in 2008 of 795 undergraduate students in New York—39% reported consuming at least one energy drink in the past month and 26% reported mixing energy drinks with alcohol. Those that reported mixing energy drinks with alcohol were more likely to consume energy drinks more than once or twice per month (Miller, 2008b). When mixing alcohol with energy drinks, users may drink more since the caffeine in energy drinks reduces the sedative effect of alcohol (Howland & Rohsenow, 2013). This phenomenon, called "wide awake drunkenness," can also influence risk taking behaviors, including driving under the influence and sexual assault. Another survey of college students found greater energy drink use in this population to be associated with drinking and alcohol problems (Miller, 2008a). A similar survey showed that college students who were considered high frequency energy drink users (having energy drinks more than 52 days in the past year) reported drinking alcohol more frequently, and drinking higher quantities of alcohol. Students reporting a higher frequency of energy drink usage were further found to be at risk of alcohol dependence (Arria & O'Brien, 2011).

Other Additives in Energy Beverages

Very little research has been done on the effects of youth consuming supplemental herbals, amino acids, B vitamins and other ingredients found in energy drinks. Since many side effects are unknown, it is generally recommended that youth not consume supplements or herbals, unless they are naturally present in foods (Institute of Medicine, *Dietary Reference Intakes* (DRIs)). Additives that have shown risks among adults or children consuming them are discussed below.

Guarana

Guarana is a component in energy drinks that contains caffeine and is known to produce similar stimulating effects (Rath, 2012). Little research has been completed on the effects of guarana on adults, and none has been completed on youth. While one review found that there are no reported negative effects in adults associated with the amount of guarana found in energy drinks (Clauson et al., 2008), there is concern due to its caffeine content—each gram of guarana can contain 40 to 80 mg of caffeine and since food and beverage manufacturers are not required to list its caffeine content, the caffeine listed on ingredient labels may exceed the actual amount if the product contains guarana (Seifert et al., 2011). Consuming high amounts of guarana has shown to cause adverse effects in adults including insomnia, nervousness, restlessness, tachycardia, tremors, anxiety, chest pain, and dysrhythmias (Rath, 2012). Two studies saw risks similar to caffeine intoxication in adults consuming guarana. A review looking at the use of guarana as a supplement among adults noted various adverse effects at doses of 0.1 to 15 grams including irritability, heart palpitations, and anxiety (Pittler, Schmidt, & Ernst, 2005). One case was noted in which a woman experienced tachycardia from consuming 1 gram of guarana daily. A case study of women admitted to a hospital found central nervous system manifestations including headache and dizziness attributed to guarana use (Cuzzolin, Zaffani, & Benoni, 2006).

Taurine

No studies on youth have been completed looking at the health effects of Taurine. One controlled trial looking at the effects in nine adults consuming Red Bull® energy drink containing 1000 mg Taurine and 80 mg caffeine compared to consuming 80 mg caffeine alone, saw significantly higher increases in blood pressure, suggesting a synergistic effect when Taurine is combined with caffeine. (Franks et al., 2012). Based on available data, one review concluded that up to 3 g/day is a safe consumption rate for Taurine. Although studies have tested higher levels of Taurine without finding adverse effects, the data for higher levels is not sufficient for a confident conclusion of long-term safety (Shao & Hathcock, 2008).

Ginseng

No studies on youth have been completed looking at the health effects of ginseng. There is insufficient evidence to support ginseng supplementation in adults, and risks have been reported in adults consuming high doses of ginseng including increased blood clotting time and interference with anti-coagulant medication at doses of 120 to 200 mg (Stanger, 2012). Ginseng may exhibit synergistic effects when combined with caffeine—one case study reported on a woman who experienced multiple events of cardiac arrhythmia from taking a combination of 70 centiliters of caffeine and 4 liters of ginseng, and reported no events once she stopped taking ginseng (Torbey, 2011). Other adverse effects shown to be related to high doses of ginseng supplementation include hypotension, edema, heart palpitations, cerebral arteritis, vertigo, headache, insomnia, mania, fever, appetite suppression, pruritus, cholestatic hepatitis, mastalgia, and neonatal death (Higgins, Tuttle, & Higgins, 2010).

Gingko Biloba

No studies on youth have been completed looking at the health effects of gingko biloba, but risks have been noted in adults including an adverse effect on blood flow and platelet activity, especially in patients taking gingko in combination with anticoagulant medications who experience bleeding (Stanger, 2012). In one case study, a female patient experienced hemorrhage from cerebral bleeding attributed to taking 240 mg of gingko biloba daily for four years (Pedroso, 2011). In another case, a female who was taking 240 mg of gingko daily experienced cardiac arrhythmias that ceased once she stopped taking the supplement (Russo, 2011).

Chapter 2. Sports Drinks

What are sports drinks?

Sports drinks were developed in the 1970s as a source of hydration and carbohydrate replacement for athletes. The first commercially available sports drink, Gatorade®, was developed for this reason (Cohen, 2012). Currently, sports drinks are marketed not only to athletes, but also to a broader audience that does not necessarily engage in physical activity. Sports drinks, including Gatorade® and Powerade®, are highly marketed to adolescents (Harris, Schwartz & Brownell, 2011). Gatorade® is now widely available in three different varieties—G 02 Perform®, G 03 Recovery®; and G2®, a low calorie alternative. Data from the 2010 National Youth Physical Activity and Nutrition survey data of high school students indicate that 16% of students drink sports drinks at least once daily and that Hispanic and non-Hispanic black students are more likely than white students to consume sports drinks daily (Park, 2012).

Table 5. Nutritional content of sports drinks per bottle

Beverage	Bottle Size	Calories	Carbohydrate (grams)	Sugar (grams)	Sodium (mg)	Potassium (mg)	Other additives
Gatorade G® Perform 02	20 oz	150	35	35	268	75	None
Gatorade G2® low calorie	20 oz	50	12.5	12.5	268	75	Sucralose, acesulfame potassium
Gatorade G® Recover 03	16 oz	230	41	41	220	85	Protein, Calcium
Powerade® Fruit Punch Advanced Electrolyte System	30 oz	200	52	50	375	87	Vitamins B3, B6, B12

Data from the 2010 National Youth Physical Activity and Nutrition survey showed that high school students who are *not* physically active for at least 60 minutes per day 5 days per week are more likely than their active peers to drink sports drinks at least once per day, which implies *less* active students were more likely to drink sports drinks (Park, 2012). There is a lack of knowledge on the proper use of sports drinks among youth—a survey of high school rugby players in Ireland showed little awareness on their part of the proper use of these beverages (Walsh, 2011). Similarly, adolescents surveyed in the US did not differentiate their use of sports drinks for varying levels of intensity of physical activity, and reported consuming sports drinks for good taste, to quench thirst, and to gain extra energy needed to improve sports performance (Schneider, 2011).

Sports drinks as a superior source of hydration?

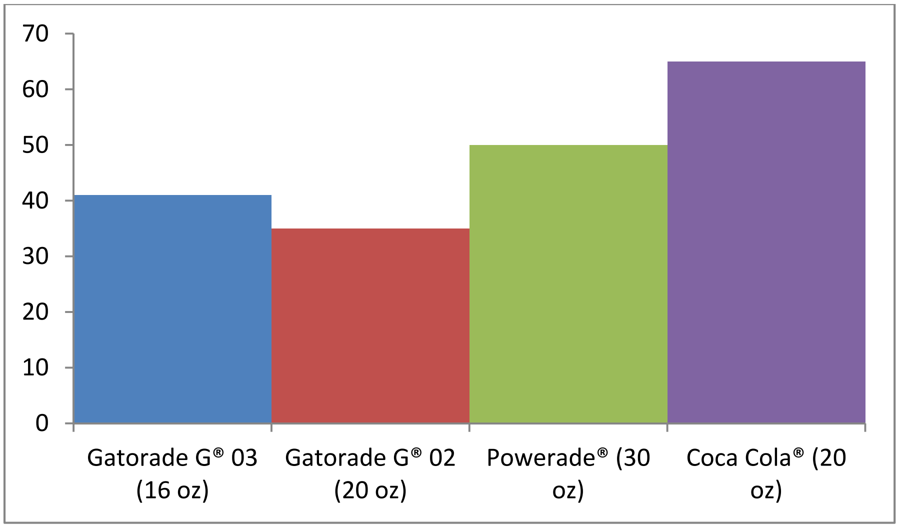
Sports drink companies have aimed their marketing outreach at the general public (Cohen, 2012; Harris, Schwartz, & Brownell, 2011), claiming that the sodium and carbohydrate content in sports drinks maintain the body's hydration status and performance during endurance exercise better than water. However, the Institute of Medicine finds that the evidence supporting this statement is inadequate and does not apply to children playing football or another sport or game for an hour at a time (Cohen, 2012). The few studies that show any benefit from consuming sports drinks have been done using trained athletes rather than ordinary people or children engaging in everyday activities or sports, and are often funded by beverage companies (Cohen, 2012; Thompson, Heneghan, & Cohen, 2012; Unnithan & Goulopoulou, 2004).

The Academy of Pediatrics does not recommend sports drinks as a hydration source for children and adolescents and finds that water is the best source of hydration for ordinary children engaging in routine physical activity (Schneider, 2011). The only instance when sports drinks may be indicated is for child athletes that engage in prolonged, continuous vigorous activity for more than one hour in hot weather conditions (Schneider; Meadows-Oliver; Unnithan). The Academy of Pediatrics advises against the use of sports drinks among children due to their contribution of excess carbohydrate calories in the diet that can increase risk of becoming overweight or obese (Schneider). The Institute of Medicine recommends against providing sports drinks in schools for regular consumption and even advises against providing sports drinks to student athletes unless they are participating in prolonged, vigorous sports activities (IOM Report on Standards for School Foods, 2007).

Sports drink consumption and childhood obesity

Although the amount of sugar in sports drinks is lower per volume than in soda, they still contribute a significant amount of sugar, ranging from 35 to 52 grams per bottle (Figure 2). The sugar content in sports drinks can be a significant source of calories in children's diets and can therefore contribute to excess weight gain (Schneider; Meadows-Oliver). Longitudinal evidence shows that sports drinks have contributed to an increase in calories in children's diets between 1989 and 2008—national data from CSPII and NHANES indicate that daily calories consumed by 6 to 11 year olds from sports drinks increased from 1 to 9 calories, and the percent of children regularly consuming sports drinks increased from 2% to 12% (Lasater, Piernas, & Popkin, 2011). This trend parallels the increasing prevalence of childhood obesity in the US. A meta-analysis of epidemiological studies showed that the higher consumption of sugar sweetened beverages (which includes sports drinks) among children contribute to excess energy intake and weight gain, and can lead to weight gain in adulthood. There is also some epidemiological evidence that shows the consumption of sugar sweetened beverages during adolescence can lead to type 2 diabetes and cardiovascular disease in adulthood (Hu & Malik, 2010).

Figure 2. Grams of sugar in sports drinks compared to a 20 oz bottle of Coca Cola®



Low calorie sports drinks

G2, marketed as the low calorie version of Gatorade®, uses acesulfame and sucralose in place of sugar and contains 40 calories per 16 ounces, fewer than half the calories in the same quantity of sugar-sweetened Gatorade®. While choosing G2® might appear to be appropriate for obesity prevention, some studies with adults and children show that non-nutritive sweeteners may alter hunger-signaling pathways and encourage compensatory energy intake (Foreyt et al., 2012; Fowler et al., 2008). There is observational evidence that children consuming diet beverages containing artificial sweeteners are more commonly obese than children that do not consume diet beverages (Ledoux, 2011; Foreyt et al., 2012). However, individuals consuming nonnutritive sweetened beverages may already be aware of weight issues and may be choosing them to decrease caloric intake. One animal study showed that rats consuming acesulfame experienced weight gain without increasing their calorie intake, which questions the effect of regular aspartame consumption on metabolism and weight maintenance (Polyak, 2010). Some studies have shown acesulfame and sucralose to have potential side effects in humans. When taken in high amounts, sucralose and acesulfame have shown to cause migraines; and high intakes of sucralose have resulted in diarrhea (Whitehouse, 2008). Further research in this area is warranted.

Sports drink consumption and dental health

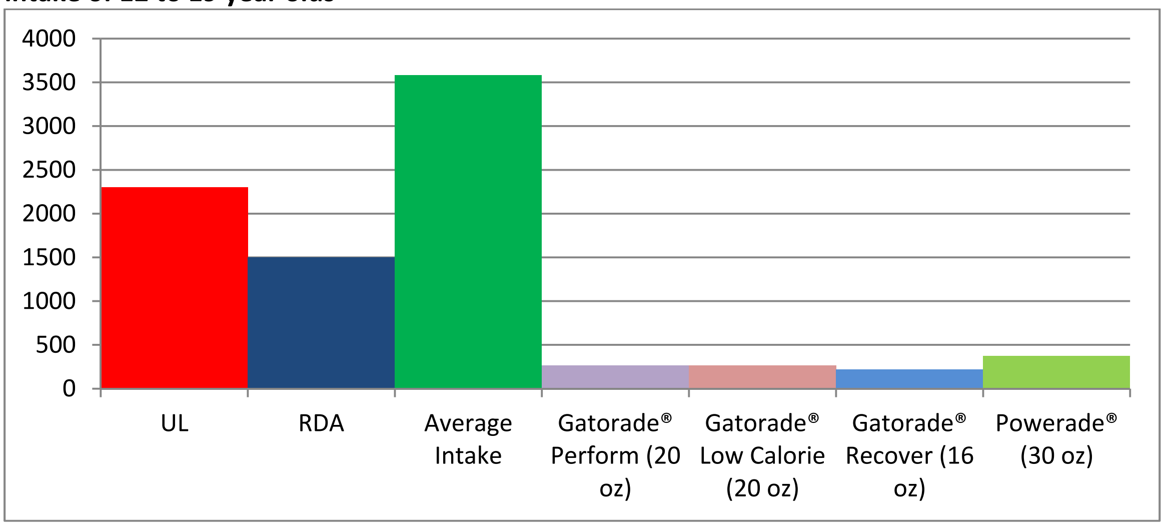
The high sugar and citric acid content of sports drinks erodes tooth enamel and can cause dental caries in children (Meadows-Oliver & Ryan-Krause, 2011; Schneider & Benjamin, 2011). Three-year-old children in Japan who frequently consumed sports drinks were more likely to have dental caries (Kawashita et al, 2011). This same association has been shown in adult athletes who consume a greater amount of sports drinks (Bryant et al., 2011).

Other ingredients in sports drinks

Electrolytes- Sodium and Potassium

The sodium and potassium in sports drinks are designed to replenish losses that may occur during sweating. However, youth engaged in physical activity do not need the extra electrolytes contained in sports drinks since electrolytes are adequately provided by a well-balanced diet (Schneider). Further, most youth do not engage in activity for prolonged periods in extreme heat conditions, the only situation that may indicate the need for extra electrolytes during activity (Unnitham & Goulopoulou, 2004). Excessive amounts of sodium, in particular, are typically ingested by both adults and children consuming the average American diet. The average sodium intake of children exceeds established upper limits that are based on concerns about the adverse effect that high sodium intake has on blood pressure, which is an independent risk factor for cardiovascular and renal disease (DRIs for sodium). Figure 3 compares the average sodium intake of 12 to 19 year olds, according to 2009-2010 NHANES data, with the Upper Limits and Recommended Daily Allowance of sodium intake for children, and the sodium content in sports drinks. These figures suggest that the additional sodium from sports drinks may pose further risk since youth already consume sodium in excess of current recommendations.

Figure 3. Sodium content per sales volume of sports drinks compared to RDA, UL and average sodium intake of 12 to 19 year olds



Chapter 3. Fruit Drinks

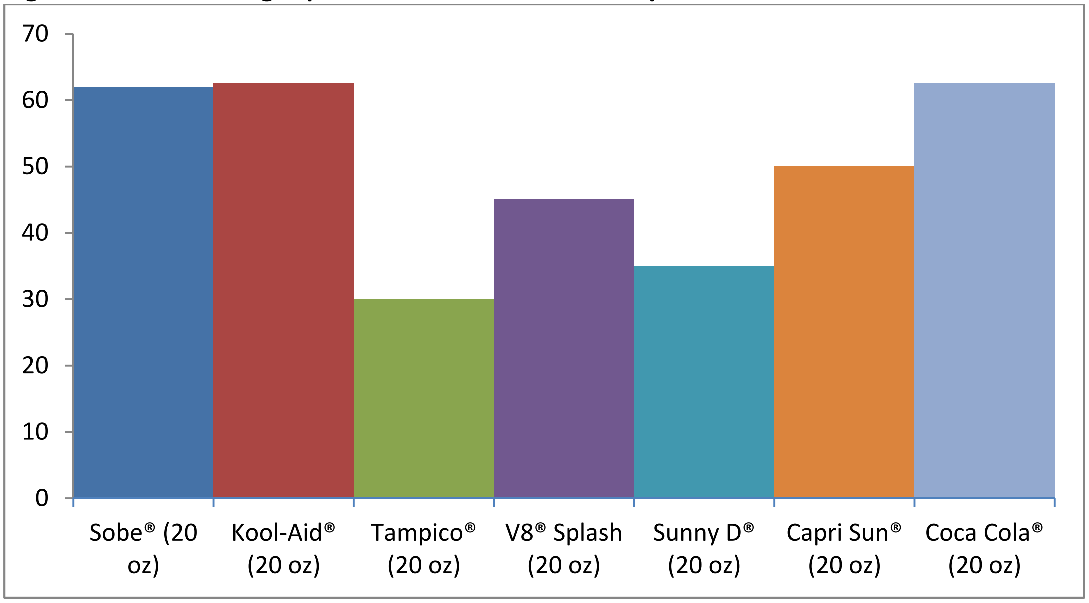
What are fruit drinks?

Fruit drinks, not to be confused with fruit juice, are sugar sweetened beverages flavored with fruit, fruit flavors, sugar, and/or sometimes sugar substitutes. Fruit drinks that are heavily marketed to children and adolescents include Kool Aid®, Tampico® Punch, V8 Splash®, and Sobe® (Harris, Schwartz, & Brownell, 2011). Fruit drinks are deceptively marketed for their "fruit content" even though they may not contain fruit—Kool Aid® contains artificial fruit flavors and Tampico® Punch contains less than 1% fruit juice. These beverages are also commonly advertised as good sources of Vitamins A and C, which are added to the beverages but can be naturally found in whole fruit (Table 6). Fruit drinks can contribute significant amounts of sugar and calories to the diets of children and adolescents, adding to the risk of childhood obesity (Wang, 2008). The sugar content per bottle of popular fruit drinks ranges from 15 to 66 grams, and many contain as much sugar per volume as Coca Cola® (Figure 4).

Table 6. Nutritional content of fruit drinks per bottle

Beverage	Bottle Size (oz)	Calories	Carbohydrate (g)	Sugar (g)	Vitamin C (mg)	Other ingredients
Sobe® Smoothie Strawberry Banana	20	250	62	62	60	Ginseng, Yerba Mate
Kool-Aid® (prepared with 1/8 cup sugar)	8	97	25	25	6	None
Tampico® Mango Punch	20	125	32.5	30	150	Sucralose, Acesulfame potassium, Neotame
V8 Splash ® Berry Blend	16	140	36	36	120	Sucralose, Thiamin (Vitamin B1), Vitamin A, E
Sunny D® Orange	16	110	30	28	120	Sucralose, Thiamin (Vitamin B1), Vitamin E
Capri Sun® Sunrise	6	60	16	15	60	Calcium

Figure 4. Grams of sugar per 20 oz of fruit drinks compared to a 20 oz bottle of Coca Cola®



Fruit drink consumption and childhood obesity

Sugar sweetened fruit drinks are a significant source of calories in the diets of youth, especially in pre-school children aged 2-5 (Wang, 2008). Data from the 2004 NHANES indicate that pre-school age children, on average, consume 176 calories a day from sugar sweetened beverages, and fruit drinks provide over half of these calories. Daily calorie consumption from fruit drinks increased by about 10 calories among pre-school children drinking sugar sweetened beverages since 1988-1994. Among all youth aged 2 -19 years, fruit drinks contributed about 37% of an average daily 224 calories from sugar sweetened beverages in 2004. Data show that fruit drink consumption may lead to obesity in children. A longitudinal study of low income African American preschool children showed the odds of normal weight children becoming overweight at follow-up increased by 4% for each additional ounce of fruit drinks consumed at baseline (Lim, 2009). A similar study with Australian school children showed those who regularly drink more than 2 servings of fruits drinks daily are almost twice as likely to be overweight or obese as those that drink fruit drinks once or less per week (Sanigorski, 2007).

Vitamins from fruit drinks in children’s diets

Fruit drinks are marketed for their added vitamin content, and the claims that fruit drinks are good sources of vitamin C often appeal to parents (Harris, Schwartz, & Brownell, 2011). National data show that fortified fruit drinks may be a significant source of vitamin C in the diet of children (Berner, Clydesdale, & Douglass, 2001). However, more evidence indicates that the consumption of vitamin-fortified sweetened beverages (including fruit drinks) is associated with lower intakes of other essential nutrients, including fiber, iron and calcium (Frary, Johnson, & Wang, 2005), vitamins A, B6, B12 and D, magnesium, potassium and zinc (Sacco, 2004). A national survey of children and adolescents (the Continuing Survey of Food Intakes by Individuals from 1998) showed children with higher intake of sugar sweetened beverages (including soft drinks, non-diet fruit drinks and sport drinks) are less likely to meet Adequate Intakes of vitamins and minerals, since they displace natural forms of nutrients in their diets, including whole fruits and dairy products like milk (Frary, Johnson & Wang, 2005).

The Academy of Nutrition and Dietetics recommends following a balanced-diet with a variety of nutrient-dense foods that are natural sources of vitamins and minerals instead of eating fortified products (JADA, 2005). Natural food sources contain additional nutrients that cannot be added to food products and offer added health benefits, and the vitamins and minerals they contain are more readily absorbed by the body compared to supplements or fortified ingredients.

Vitamins and minerals in fruit drinks with established upper limits- Vitamin A

It is further recommended that children and adolescents obtain vitamins from natural food sources in the diet (as oppose to supplemental forms or fortified products) to prevent any risk of over-consumption (Institute of Medicine, DRIs). Vitamins A, C and E, the most common added nutrients in fruit drinks, have established upper limits for children, based on some animal and human research described in Appendix E. The content of Vitamin C and E in fruit drinks is minimal compared to their established upper limits, but the Vitamin A content in a 20 oz bottle of V8 Splash® (1500 mg) almost meets the established upper limit of 1700 mg. The established upper limit is based on the critical adverse effect of teratogenicity of newborns of women consuming Vitamin A in excess amounts. Other identified adverse effects include liver abnormalities in adult populations and intracranial and skeletal abnormalities in children (DRIs, Vitamin A). It would be advisable that in order to avoid possible adverse side effects children avoid V8 Splash® and consume natural food sources of vitamin A instead.

Chapter 4. Flavored Waters

What are flavored waters?

Flavored waters are sugar sweetened beverages that may appear to be "water" with added benefits, but are a significant source of sugar and calories and can increase risk for overweight and obesity. Flavored waters that are marketed to children and adolescents include Vitamin Water® and Sobe® Lifewater® (Harris, Schwartz, & Brownell, 2011). The sugar content per bottle of Vitamin Water® is about 32 grams, which is 8 teaspoons of sugar (Table 7). In addition, flavored waters are heavily fortified with vitamins, which are better derived from natural sources including fruits and vegetables in the diet. The Institute of Medicine recommends that flavored waters should not be available for normal fluid consumption in schools (IOM 2007 Report on Food in Schools).

Table 7. Nutritional content of Flavored Waters per bottle

Beverage	Bottle Size (oz)	Calories	Carbohydrate (grams)	Sugar (grams)	Vitamin C (mg)	Other ingredients
Vitamin Water® XXX	20	120	33	32	60	Vitamins A, B3, B5, B6, B12, Manganese
Vitamin Water® Revive	20	120	32	31	60	Vitamins B3, B5, B6, B12, Potassium
Sobe® Lifewater® Yumberry Pomegranate	20	0	7.5	0	150	Stevia, Erythritol, Vitamins B3, B5, B6, B12

Flavored water consumption and childhood obesity

Epidemiological data suggest that the consumption by youth of sugar sweetened beverages including flavored waters can contribute to childhood overweight and obesity, and even lead to obesity into adulthood (Hu and Malik, 2010). Additional data show that children who consume more plain water on a daily basis are less likely to be overweight (Park, 2011). A survey of 6th-8th grade students in Florida showed that low water drinkers were substituting less healthful (high calorie, high sugar) beverages in their diets (Park, 2011). Marketing sugar sweetened beverages as "water" may only exacerbate this trend.

Low calorie flavored waters

Sobe® Lifewater® contains zero calories and zero sugar, but is sweetened with erythritol and Stevia, which are sugar substitutes. Evidence to support the effectiveness of artificially sweetened flavored waters, as well as other artificially sweetened beverages is lacking, and some studies with adults and children show that non-nutritive sweeteners may alter hunger-signaling pathways and encourage compensatory energy intake (Foreyt et al., 2012; Fowler et al., 2008). Further research in this area is warranted.

Other ingredients in flavored waters

Vitamin water® marketing and labeling highlight vitamin content (i.e. as an "excellent source of C and B vitamins"). However, consumption of flavored water and other sugar sweetened beverages may displace better sources of these vitamins in children's diets, including fruits and vegetables that also provide fiber and other vital nutrients. A US national survey of children and adolescents (the Continuing Survey of Food Intakes by Individuals from 1998) showed children with higher intake of sugar sweetened beverages are less likely to meet Adequate Intakes of vitamins and minerals, since they displace other natural forms of nutrients in their diets, including whole fruits and dairy products like milk (Frary, Johnson, & Wang, 2004). Those that consumed the highest amount of sugar sweetened beverages, had lower intakes of essential nutrients, including calcium, folate, iron, and fiber. A Canadian study found that individuals with higher intakes of vitamin fortified foods, including beverages, showed lower intake of vegetables and fruit, milk products, meat and meat alternates, Vitamins A, B6, B12 and D, magnesium, potassium and zinc than those who consumed fewer fortified foods (Sacco, 2004).

The Academy of Nutrition and Dietetics recommends following a balanced-diet with a variety of nutrient-dense foods that are natural sources of vitamins and minerals instead of eating fortified products (JADA, 2005). Natural food sources contain additional nutrients that cannot be added to food products and offer added health benefits, and the vitamins and minerals they contain are more readily absorbed by the body compared to supplements or fortified ingredients.

Vitamins and minerals in flavored waters with established upper limits- Vitamin B3

It is recommended that children and adolescents obtain these vitamins from natural food sources in the diet (as oppose to supplemental forms or fortified foods) to prevent any risk of over-consumption (DRIs, Institute of Medicine). Although there is limited evidence on the risks associated with children over-consuming vitamins, some vitamins have established upper limits based on data of adverse effects occurring in adults or animals. Flavored waters contain Vitamins A, C, E, B3, B6 and Manganese, which have established upper limits (see appendix E for further information). Although most vitamin and mineral quantities in flavored waters do not nearly approach upper limits established for children, the content of Vitamin B3 (or Niacin) in Vitamin Water® (20 mg) is equivalent to the established upper limit (DRIs, Institute of Medicine), so it would be recommended that children not consume Vitamin Water® to avoid any adverse effects association with excess consumption of Vitamin B3. The upper limit for Vitamin B3 has been established based on the critical adverse effect—red flushing—which is seen in patients taking nicotinic acid as a therapeutic agent (at oral doses of 30 to 1,000 mg)(DRIs, Vitamin B3).

Chapter 5. Sweetened Teas and Coffee

What are sweetened teas and coffee?

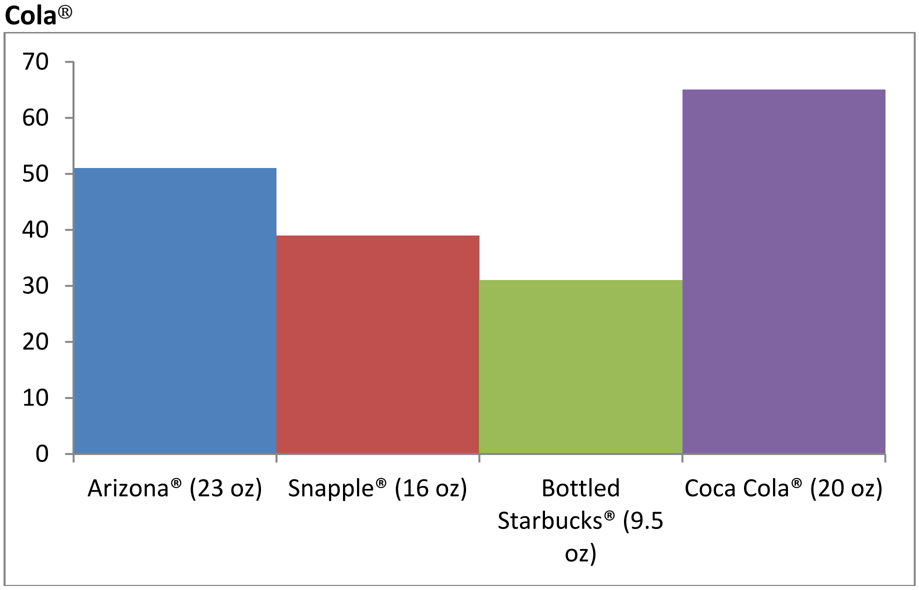
Although sweetened teas and coffee are not as commonly consumed as other sugar sweetened beverages, they are marketed to adolescents and contribute calories to their diets. Commonly marketed brands include Snapple®, Arizon®a and Starbucks®. Arizona® Green tea is fortified with Vitamin C and Ginseng, while canned Starbucks® coffees and Snapple® are not usually fortified (Table 8). Bottled sweetened teas and coffee contain as much sugar as a bottle of Coke® and can have more sugar per volume (Figure 5), and are a natural source of caffeine.

Table 8. Nutritional content of Sweetened Teas or Coffee per bottle

Beverage	Bottle Size (oz)	Calories	Carbohydrate (grams)	Sugar (grams)	Vitamin C (mg)	Caffeine* mg (natural content)	Other ingredients
Arizona® Green Tea	23	210	54	51	45	22	Ginseng, Vitamin C
Snapple® Peach Tea	16	160	40	39	None	8	None
Starbucks® bottled Mocha Frappuccino®	9.5	180	33	31	None	80	None

**Caffeine content from beverage manufacturers*

Figure 5. Grams of sugar in bottled sweetened teas and coffees compared to a 20 oz bottle of Coca Cola®



Caffeine in sweetened teas and coffee

National data show that about 20% of youth are regular consumers of sweetened tea or coffees (Lasater, Piernas, & Popkin, 2011). Ready packaged coffees and teas can contribute 8 to 80 mg of caffeine per can or bottle, and even modest amounts of caffeine (greater than 50 mg) have been shown to cause behavioral symptoms among youth including reduced sleep quality, attention problems, jitteriness, acute changes in blood pressure and heart rate, and headache and withdrawal symptoms (Temple, 2009; Higdon & Frei, 2006). Furthermore, controlled trials show that caffeine can have reinforcing properties when associated with foods, which may influence excess intake of caffeinated sugary beverages (Temple, 2010). It is recommended that youth consume no more than 2.5 mg per kg of body weight caffeine daily (Nawrot, 2003). The recommended limit for caffeine intake would be 85 mg for a child weighing 34 kg or 75 lb, which is equivalent to fewer than 4 cans of Arizona® Iced tea and one bottle of Starbucks® coffee (Table 8).

Contribution to obesity

Sweetened teas and coffee contribute excess sugar and calories to the diet of youth, and their sugar and caffeine content may influence youth to drink these beverages in excess. Nationally representative dietary data from 6 to 11 year olds indicate that the percentage of youth consuming sweetened teas or coffee increased from 13% to 19% between 1989 and 2008. Those reported drinking sweetened teas or coffee consumed an average of 63 calories from these beverages daily (Lasater, Piernas, & Popkin, 2011). A large survey of 10 year old school children in Los Angeles indicated that the mean gram amount of tea with sugar consumed significantly increased from 54 g to 120 g between 1973 and 1994, resulting in an increase in the total gram amount of sweetened beverages consumed (Rajeshwari, 2005). Sugar sweetened beverage consumption as a whole (which includes soda, fruit drinks, flavored water, energy drinks and sweetened teas or coffee), contributes to excess calorie intake and weight gain in children. There is evidence that the consumption of sugar sweetened beverages (soda, fruit drinks, flavored water, energy drinks and sweetened teas or coffee) is associated with childhood excess weight gain that is maintained into adulthood and is associated with chronic conditions including type 2 diabetes and cardiovascular disease (Nicklas et al., 2003; Hu & Malik, 2010).

Fortified ingredients with potential adverse effects-Ginseng

No studies have been completed looking at the effects of Ginseng in youth, but risks have been identified among adults including hypotension, edema, heart palpitations, cerebral arteritis, vertigo, headache, insomnia, mania, fever, appetite suppression, pruritus, cholestatic hepatitis, mastalgia, and neonatal death (Higgins, Tuttle, & Higgins, 2010). There is also some evidence that ginseng may have synergistic effects when taken in combination with caffeine. In one case report, a woman experienced multiple events of cardiac arrhythmia from taking a combination of 70 centiliters of caffeine and 4 liters of ginseng, and reported no events once she stopped taking ginseng (Torbey, 2011). Youth should not be consuming ginseng since there is not sufficient evidence to establish safety levels and risks have been noted in adults.

Conclusion

It appears that the marketing of fortified beverages as beneficial or health-enhancing is premature at best and deceptive at worst. All of the beverages discussed in this report—energy drinks, sports drinks, fruit drinks, flavored waters, and sweetened teas and coffees—supply natural and artificial ingredients in quantities that are not at this time proven safe and have not been shown to provide the benefits that are claimed for them. Their names may be designed to convey a promise of healthfulness and bodily benefit, as in “energy” drinks or “sports” drinks but, unfortunately, these suggested promises are unfulfilled.

The sugar sweetened beverages add significant calories to children’s and adolescents’ diets, with consequent risk of obesity, without providing the nutritive values found in 100 percent fruit juice or milk, without exceeding the hydration effect of plain water, and without providing the fiber that a fruit snack would offer. The artificially sweetened beverages provide fewer calories, but supply a plethora of chemical and herbal additives of dubious value and questionable safety. Although the beverages are required to follow FDA nutrition and supplement labeling law standards for foods and beverages sold in the U.S., the FDA does not at this time set limits on the amount of various ingredients that are introduced into these drinks. This omission is not due to generally acknowledged safety of the additives, particularly for children, since adequate research on their effects is often lacking. Instead, it appears to be a matter of researchers and regulators not yet having caught up with assessment of manufacturers’ new products.

For example, while the FDA enforces limits on the amount of caffeine allowed in sodas, there is no limit on the caffeine allowed in energy drinks or sweetened teas. High doses of caffeine are known to produce negative symptoms in youth, yet while Canada has set guidelines for both adults and children based on research showing adverse health effects of high caffeine consumption, the U.S. currently has no dietary guidelines for caffeine consumption. One 16-ounce energy drink available to a child in the U.S. provides more than twice the caffeine level recommended in Canada. Information on the effect of more exotic ingredients, such as ginseng, gingko biloba, and amino acids, as well as high levels of various vitamin and mineral supplements, is also lacking, particularly for children and adolescents.

Further research is needed on the impact of fortified beverages on children who are drinking them in increasing amounts. The effects of their ingredients must be assessed and recognized. Further, serious considerations should be given to the extent in which these beverages replace more nutritious foods and drinks in the diets of children and adolescents, ultimately adding to the potential for both pediatric obesity and malnutrition.

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Appendices

Appendix A. Added ingredient content of Fortified Beverages

	Sugars						Sugar Substitutes					Added Vitamins									Added Minerals					Amino Acids			Stimulants			Herbals					Other	
	Sucrose	Glucose or Dextrose	Fructose	Corn Syrup	High fructose corn syrup	Maltodextrin	Sucralose	Acesulfame potassium	Reb A (Stevia Extract)	Neotame	Erythritol	A	B1 (Thiamin)	B2 (Riboflavin)	B3 (Niacin)	B5 (Pantothenic Acid)	B6	B12	C	E	Calcium	Manganese	Magnesium	Potassium	Sodium	Taurine	L-Carnitine	L-Proline	Caffeine	Yerba Mate	Guarana	Ginkgo Biloba	Ginseng	Milk Thistle Extract	Ginger Extract	Dandelion Extract	Glucuronolactone	Inositol
Energy Drinks																																						
Monster Energy®	✓	✓				✓	✓							✓	✓			✓							✓	✓	✓		✓		✓		✓				✓	✓
Amp® Energy					✓									✓	✓	✓	✓	✓							✓	✓			✓		✓		✓					
Starbucks® Doubleshot® Energy		✓				✓	✓					✓		✓	✓		✓		✓		✓			✓	✓	✓			✓		✓		✓					✓
Rockstar® (original)	✓	✓												✓	✓	✓	✓	✓							✓	✓	✓		✓		✓	✓	✓	✓				✓
Redbull®	✓	✓													✓	✓	✓	✓							✓	✓											✓	✓
Sports Drinks																																						
Gatorade G® Recover 03	✓	✓					✓	✓													✓			✓	✓													

	Sugars						Sugar Substitutes					Added Vitamins									Added Minerals					Amino Acids			Stimulants			Herbals					Other	
	Sucrose	Glucose or Dextrose	Fructose	Corn Syrup	High fructose corn syrup	Maltodextrin	Sucralose	Acesulfame potassium	Reb A (Stevia Extract)	Neotame	Erythritol	A	B1 (Thiamin)	B2 (Riboflavin)	B3 (Niacin)	B5 (Pantothenic Acid)	B6	B12	C	E	Calcium	Manganese	Magnesium	Potassium	Sodium	Taurine	L-Carnitine	L-Proline	Caffeine	Yerba Mate	Guarana	Ginkgo Biloba	Ginseng	Milk Thistle Extract	Ginger Extract	Dandelion Extract	Glucuronolactone	Inositol
Gatorade G® Perform 02	✓						✓	✓																✓	✓													
Gatorade G2® low cal	✓						✓	✓																✓	✓													
Powerade® Fruit Punch					✓										✓		✓	✓	✓		✓		✓	✓	✓													
Flavored Waters																																						
Vitamin Water® XXX		✓	✓									✓			✓	✓	✓	✓	✓			✓		✓														
Vitamin Water® Revive		✓	✓												✓	✓	✓	✓	✓				✓	✓														
Sobe® Lifewater®									✓		✓				✓	✓	✓	✓	✓	✓	✓			✓	✓										✓	✓		
Fruit Drinks																																						
Sobe® Smoothie Strawberry Banana	✓								✓										✓		✓				✓					✓			✓					
Kool-Aid® (prepared w/ 1/8 c sugar)																			✓						✓													

	Sugars						Sugar Substitutes					Added Vitamins									Added Minerals					Amino Acids			Stimulants			Herbals					Other	
	Sucrose	Glucose or Dextrose	Fructose	Corn Syrup	High fructose corn syrup	Maltodextrin	Sucralose	Acesulfame potassium	Reb A (Stevia Extract)	Neotame	Erythritol	A	B1 (Thiamin)	B2 (Riboflavin)	B3 (Niacin)	B5 (Pantothenic Acid)	B6	B12	C	E	Calcium	Manganese	Magnesium	Potassium	Sodium	Taurine	L-Carnitine	L-Proline	Caffeine	Yerba Mate	Guarana	Ginkgo Biloba	Ginseng	Milk Thistle Extract	Ginger Extract	Dandelion Extract	Glucuronolactone	Inositol
Tampico®, mango punch					✓		✓	✓		✓									✓																			
Sunny D® Orange				✓			✓	✓		✓			✓						✓						✓													
Capri Sun® Sunrise					✓														✓		✓				✓													
V8 Splash® – Berry Blend					✓		✓					✓							✓	✓				✓	✓													
Sweetened Teas																																						
Arizona® Green Tea		✓	✓		✓														✓														✓					
Snapple® Peach Tea	✓																								✓				✓									
Starbucks® bottled Frappuccino®	✓																				✓				✓				✓									

Appendix B. Ingredient Glossary

The information below provides information on the physiological roles and derivation of ingredients in beverages, natural food sources (if applicable), and safety of supplementation (if applicable and if established by the National Institute of Health).

Ingredient	Definition (physiologic role)	Effectiveness and safety of supplementation evaluated by NIH*	Natural Food Sources**
Added Sugars			
Glucose (also known as Dextrose)	Simple carbohydrate; single molecule sugar. Supplies 4 calories of energy per gram. Primary energy source for the body. Produced in plants via photosynthesis.[9]	Not applicable.	All plants.
Maltodextrin	Simple carbohydrate; made up of multiple molecules of glucose, and readily absorbed as glucose in the body. Supplies 4 calories of energy per gram.[9]	Not applicable.	Manufactured as a food additive from corn sugar.
Fructose	Simple carbohydrate; single molecule of sugar. Supplies 4 calories of energy per gram.[9]	Not applicable.	Honey, saps and fruit.
Sucrose	Simple carbohydrate; double molecule of sugar made of glucose and fructose. Supplies 4 calories of energy per gram. Also known as "table sugar" or "cane sugar."[9]	Not applicable.	Sugar cane, fruits, vegetables and grains.
Corn syrup	Syrup sweetener manufactured from corn starch; contains mostly glucose. Supplies 4 calories of energy per gram.[9]	Not applicable.	Manufactured as a food additive from corn sugar.
High fructose corn syrup	Syrup sweetener manufactured from corn syrup; contains mostly fructose. Primary sweetener used in processed foods and beverages. Supplies 4 calories of energy per gram.[9]	Not applicable.	Manufactured as a food additive from corn sugar.
Sugar Substitutes			
Sucralose	Zero calorie sweetener. Chlorinated sugar.[10]	Not applicable.	Manufactured as a food additive from sucrose (a sugar type).
Aspartame	A peptide based sweetener. Supplies 4 calories of energy per gram, but its calorie	Not applicable.	Manufactured as a food additive from the amino acids aspartic acid and

Ingredient	Definition (physiologic role)	Effectiveness and safety of supplementation evaluated by NIH*	Natural Food Sources**
	contribution is low in food products due to its use in minimal quantities.[9, 10]		phenylalanine.
Acesulfame Potassium	Zero calorie sweetener. Derived from a potassium salt.[10]	Not applicable.	Manufactured as a food additive from the mineral potassium.
Reb A (Stevia Extract)	An herbal non-caloric sweetener.[10]	Not applicable.	Extracted from Stevia leaves for use as a food additive.
Neotame	A peptide based sweetener. Provides no calories since the human body cannot digest it.[10]	Not applicable.	Manufactured as a food additive from the amino acids aspartic acid and phenylalanine.
Erythritol	Naturally occurring sugar alcohol. Supplies 0.2 calories per gram.[10]	Not applicable.	Manufactured by fermenting sugar.
Added Vitamins			
Vitamin A	Fat soluble vitamin; involved in vision, the immune system and reproduction.[1]	Supplementation is *effective* in treating and preventing Vitamin A deficiency, and *possibly effective* in reducing disease complications in children with a deficiency, including malaria, measles, HIV and diarrhea. It is *possibly effective* in preventing breast cancer in post-menopausal women and cataracts. Supplementation is *likely safe* for adults and children taking Vitamin A in recommended amounts (less than 9300 units for children aged 14-18 years, and less than 5700 units in child aged 9-13 years). When taking more than the recommended doses, side effects include irritability, sleepiness, vomiting, diarrhea, loss of consciousness, headache, vision problems, peeling skin, increased risk of pneumonia and diarrhea.[2]	Carrots, sweet potato, pumpkin, collard greens, spinach, lettuce, kale, winter squash, cantaloupe, apricots
Thiamin (Vitamin B1)	B vitamin required for the formation of a coenzyme (TPP) involved in metabolizing derivatives from carbohydrates and	Supplementation is *effective* for preventing and treating deficiency, and *possibly effective* in preventing kidney disease in people with type 2	Oat bran, oats, cornmeal, whole wheat flour products, peas, meat. poultry, fish, beans

Ingredient	Definition (physiologic role)	Effectiveness and safety of supplementation evaluated by NIH*	Natural Food Sources**
	amino acids for the production of energy in the body.[6]	diabetes and cataracts. Supplementation is *likely safe* when taken in appropriate amounts. Rare side effects include allergic reactions and skin irritations.[2]	
Riboflavin (Vitamin B2)	B vitamin required for the formation of coenzymes (FAD, FMN) that are involved in the metabolism of glucose, fatty acids, ketone bodies, and amino acids that yield energy in the body.[6]	*Effective* in treating or preventing deficiency and conditions related to deficiency and *possibly effective* in preventing cataracts and migraine headaches. Supplementation is *likely safe* for most people. High doses may cause increased urine and diarrhea.[2]	Yogurt, soybeans, ricotta cheese, milk, spinach, mushrooms, meat, poultry, fish, eggs
Niacin (Vitamin B3/ Niacinamide)	B vitamin essential for the formation of coenzymes (NAD and NADP) involved in the metabolism of glucose, fatty acids, ketone bodies and amino acids that yield energy in the body.[6]	Supplementation is *likely effective* for preventing and treating deficiency and disorders related to deficiency, including pellagra; and *likely effective* in lowering cholesterol. Low levels of supplementation are *likely safe* for most adults and *possibly safe* for children. A common side effect includes a flushing reaction that may involve burning, tingling, itching, and redness of the face, arms, and chest, and headaches. Large doses of over 3 grams per day may cause serious side effects, including liver problems, gout, ulcers of the digestive tract, loss of vision, high blood sugar, and irregular heartbeat.[2]	Meat, poultry, fish, tomato, barley, brown rice, mushrooms, cornmeal, whole grain wheat products
Pantothenic Acid (Vitamin B5)	Is a component of enzyme cofactors (CoA, ACP) involved in many metabolic pathways in the body; including the synthesis and metabolism of fatty acids, and the metabolism of amino acids, ketone bodies and glucose.[6]	*Effective* for treating or preventing pantothenic acid deficiency. Supplementation is *likely safe* for adults and seems to be safe for children when used appropriately. Higher doses can result in diarrhea.[2]	Meat, poultry, fish, mushrooms, milk and yogurt, corn, peas, lentils, sweet potato, tomatoes
Vitamin B6 (pyridoxine)	Part of a coenzyme (PLP) involved in protein and fat	*Effective* for treating a Vitamin B6 deficiency, and	Meat, poultry and fish, nuts, bananas, dried plums,

Ingredient	Definition (physiologic role)	Effectiveness and safety of supplementation evaluated by NIH*	Natural Food Sources**
	metabolism, immune function and brain development during infancy.[1,6]	deficiency-related anemia. *Possibly effective* for behavior disorders in children with low levels of serotonin. Supplemental use is *likely safe* for most people. In some people, pyridoxine might cause nausea, vomiting, stomach pain, loss of appetite, headache, tingling, sleepiness, and other side effects. Long-term use of high doses is *possibly unsafe* because it might cause certain brain and nerve problems.[2]	cornmeal products, barley, whole wheat flour products, spinach, peppers, beans
Vitamin B12	Cofactor for biological enzymes involved in the metabolism of fats and protein, and synthesis of amino acids, DNA and RNA, and hemoglobin (the oxygen carrying component in red blood cells). [6]	*Effective* for treatment and prevention of vitamin B12 deficiency, and treatment of vitamin B12 deficient anemia (pernicious anemia). Supplemental vitamin B12 is *likely safe* for most people. In some people, vitamin B12 might cause diarrhea, blood clots, itching, or serious allergic reactions.[2]	Meat, poultry, fish, nuts, bananas, dried plums, barley, whole wheat flour products, spinach, red peppers
Vitamin C	Acts as an antioxidant and prevents damage of body components from free radicals. Required for the synthesis of collagen, a component of connective tissue found in blood vessels, bone, tendons and ligaments.[6]	Is *effective* for preventing and treating deficiency; *likely effective* improving iron absorption; and *possibly effective* in shortening cold duration, preventing atherosclerosis and reducing lead in blood (in the form of food only). Supplemental vitamin C is *likely safe* for most people when taken at recommended doses. Larger doses of Vitamin C may result in nausea, vomiting, heartburn, stomach cramps and headache. Consuming more than 2000 mg daily is *possibly unsafe* and can result in serious side effects including kidney stones and severe diarrhea.[2]	Red peppers, oranges, papaya, strawberries, Brussels sprouts, grapefruit, broccoli, mango, cabbage
Vitamin E	A fat-soluble vitamin. Acts as an antioxidant; prevents cellular damage from free radicals, most notably in	Is *effective* for treating and preventing deficiency. Is *possibly effective* for treating sunburns. Supplementation	Nuts and seeds, avocado, fish, plant oils (canola), peppers, collard greens, spinach, carrots, sweet

Ingredient	Definition (physiologic role)	Effectiveness and safety of supplementation evaluated by NIH*	Natural Food Sources**
	structures made of fats (lipids), including lipoproteins. Vitamin E's capacity to prevent LDL (lipoproteins) from radical damage can preserve cardiovascular function and decrease the onset of cardiovascular disease.[6]	is *likely safe* when taken at recommended doses. Supplementation is *possibly unsafe* when daily intake is greater than 400 IU. Serious side effects include hemorrhagic stroke (bleeding in the brain), and contraindications in people with heart disease or diabetes. Other side effects include nausea, diarrhea, stomach cramps, fatigue, weakness, headache, blurred vision, rash, and bruising and bleeding.[2]	potato
Added Minerals			
Calcium	Maintains bones; involved in muscle movement, nerve and hormone transmission.[2]	*Effective* for raising calcium levels or preventing low calcium levels. *Likely effective* in preventing bone loss and osteoporosis. Supplemental calcium is *likely safe* for most people. Minor side effects include belching or gas. Some research suggests that adults taking more than the recommended dose can have increased risk of heart attack.[2]	Dairy products such as milk and yogurt, canned fish with bones, spinach, collard greens, Chinese cabbage
Manganese	Component of an antioxidant enzyme that protects cellular mitochondria from oxidative damage from free radicals produced in metabolic pathways. Also a component of enzymes involved in the metabolism of carbohydrates, amino acids and cholesterol. Acts as a cofactor in processes required for bone and collagen development.[6]	*Effective* for preventing and treating deficiency. Supplementation is *likely safe* if daily consumption does not exceed 11 mg. Amounts over 11 mg may not be safe and can result in serious side effects including tremors.[2]	Whole wheat flour products, oat bran, barley, nuts, seeds, spinach, pineapple, beans, sweet potato, collard greens
Magnesium	Component of protein complex that produces ATP—the main energy source produced from macronutrients (carbohydrates, protein and fat) in the body. Required in	*Effective* for treating and preventing deficiency and conditions related to a deficiency; and for use as an antacid or laxative. Is *possibly effective* in reducing cholesterol and reducing risk	Whole wheat flour and cornmeal products, whole corn, spinach, beans, brown rice, nuts, fish, okra, potatoes, tomatoes, papaya

Ingredient	Definition (physiologic role)	Effectiveness and safety of supplementation evaluated by NIH*	Natural Food Sources**
	the production of DNA and RNA. Component of enzymes involved in carbohydrate and lipid synthesis. Facilitates the transport of ions involved in nerve conduction, muscle contraction and heart rhythm.[6]	of heart disease or diabetes (when taken from both food and supplemental forms). Supplementation is *likely safe* when daily amounts do not exceed 350 mg. Some side effects include stomach upset, nausea, vomiting, and diarrhea. Supplementation is *possibly unsafe* when taken in high amounts; serious side effects include irregular heartbeat, low blood pressure, confusion, slowed breathing, coma, and death.[2]	
Potassium	An electrolyte. Its concentration is tightly regulated inside and outside of cells to control to create a cell membrane potential that controls many processes including the transmission of nerve impulses, muscle contraction and heart function. Its presence is required for enzymes that are involved in carbohydrate metabolism and maintaining cell membrane potential.[6]	No supplement information provided.	Tomatoes, potatoes, spinach, broccoli, orange juice, milk, yogurt, beans, plantains, bananas, pumpkin, fish
Sodium	An electrolyte. Its concentration is tightly regulated inside and outside of cells to control to create a cell membrane potential that controls many processes including nerve impulse transmission, muscle contraction, and cardiac function. It is primarily present in extracellular fluid, in which its presence helps regulate blood volume and blood pressure.[6]	No supplement information provided.	Salt, canned foods including soups, bread, cheese, deli meats, canned and smoked fish, soy sauce
Amino Acids			
Taurine	Nonessential amino acid (synthesized by the body from essential amino acids found in food protein); involved in neurological and retinal development and	No supplement information provided.	Animal protein. Synthesized in the human body from other amino acids.

Ingredient	Definition (physiologic role)	Effectiveness and safety of supplementation evaluated by NIH*	Natural Food Sources**
	function [6]		
L-Carnitine	Nonessential amino acid; involved in fat metabolism.[6]	No supplement information provided.	Animal protein. Synthesized in the human body from other amino acids.
L-Proline	Nonessential amino acid; required for collagen synthesis.[6]	No supplement information provided.	Animal protein. Synthesized in the human body from other amino acids.
Stimulants			
Guarana	Herbal; Similar to caffeine; acts as a stimulant.[2]	No supplement information provided.	Guarana plant.
Caffeine	Stimulates the central nervous system, increases alertness.[1]	No supplement information provided.	Coffee and cacao beans, tea leaves.
Herbals and other additives			
Ginseng	Herb from a root; used to reduce stress, to boost immunity and as a general tonic and stimulant.[5]	Is *possibly effective* in preventing respiratory tract infections and lowering blood sugar after a meal in adults with type 2 diabetes. Side effects may include diarrhea, itching, trouble sleeping (insomnia), headache, and nervousness. Temporary use is *possibly safe* for adults and children.[3]	Not applicable.
Ginkgo Biloba	An herb; extracts are made from the Ginkgo leaf. Commonly used to treat memory disorders, which are thought to be alleviated by Ginkgo's ability to increase blood flow to the brain.[3]	Is *possibly effective* in improving thinking skills in both young and older people, and improving thinking and memory skills in adults with memory loss. Supplementation is *likely safe* for adults and *possibly safe* for children. Minor side effects include stomach upset, headache, dizziness, constipation, forceful heartbeat, and allergic skin reactions; other side effects include increased risk of bruising and bleeding.[2]	Not applicable.
Milk Thistle Extract	A plant; the seeds and above ground parts are used to make medicinal extract. It is most commonly used in the treatment of liver disorders.[2]	There is *insufficient evidence* to rate the effectiveness of milk thistle in treating various health issues. Its use is *likely safe* for most adults. It can commonly have a laxative effect. Other less	Not applicable.

Ingredient	Definition (physiologic role)	Effectiveness and safety of supplementation evaluated by NIH*	Natural Food Sources**
		common side effects include nausea, diarrhea, indigestion, intestinal gas, bloating, fullness or pain, and loss of appetite.[2]	
Ginger Extract	Herb from a stem; traditionally used to treat nausea, arthritis and muscle aches.[2]	Is *possibly effective* in reducing nausea and dizziness, and pain associated with osteoarthritis. Is *likely safe* for most people. Minor side effects include heartburn, diarrhea, and general stomach discomfort[2].	Not applicable.
Dandelion Extract	An herb. The ground parts and stem are used to make medicinal extract. Common uses include treating loss of appetite, upset stomach, intestinal gas, gallstones, joint pain, muscle aches, eczema, and bruises.[2]	There is *insufficient evidence* to rate its effectiveness in treating health complications. It is *likely safe* when eaten as a naturally occurring substance in food; and *possibly safe* when used in medicinal amounts.[2]	Not applicable.
Other			
Inositol	Serves as a messenger molecule; component of cell membranes.[6]	No supplement information provided.	Not applicable.
Glucuronolactone	Glucose metabolite synthesized in the liver. Structural component of mammalian tissues.[6]	No supplement information provided.	Not applicable.

* *Natural Medicines Comprehensive Database* rates effectiveness based on scientific evidence according to the following scale: Effective, Likely Effective, Possibly Effective, Possibly Ineffective, Likely Ineffective, Ineffective, and Insufficient Evidence to Rate. Effective and possibly effective uses are highlighted. Ratings of effectiveness and safety are based on adult studies unless otherwise noted.[2]
**From USDA "What's in your food" Nutrient Database (edition 24).[7]

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Appendix C. Fortified Ingredient Research Summaries

There is little research available on the effects of youth consuming the various additives in sugar sweetened beverages, and research among adults is also sparse. Risks and benefits identified in the research on adults or youth consuming these additives are highlighted below.

Taurine

No studies on youth have been completed looking at the health effects of taurine. A few small trials identified found taurine supplementation may improve blood lipid profiles in adults (Wójcik, 2010; Ahn, 2009) although most articles identified reported inconclusive evidence to support taurine supplementation in adults (Wójcik, 2010; Galloway, 2008; Zembron-Lacny, 2009; Jeukendrup, 2011). Based on available data, one article concluded that up to 3 g/day is a safe consumption rate for Taurine. Although studies have tested higher levels of Taurine without adverse effects, the data for higher levels is not sufficient for a confident conclusion of long-term safety (Shao, 2008). One controlled trial looking at the effects of nine adults consuming Red Bull energy drink containing 1000 mg taurine and 80 mg caffeine compared to consuming 80 mg caffeine alone, saw significantly higher increases in blood pressure, suggesting a synergistic effect when taurine is combined with caffeine. (Franks et al., 2012).

L-Carnitine

No studies on youth have been completed looking at the health effects of L-carnitine. While no risks have been identified for adults taking carnitine, mixed results have been found for L-carnitine's ability to increase exercise endurance or performance or attenuate oxidative muscle damage following exercise (Cherniack, 2011; Spriet, 2008; Smith, 2008; Ho, 2011; Spiering, 2008; Bloomer, 2009). Insufficient evidence exists to support L-carnitine supplementation for improving fatty acid (Broad, 2011; Wall, 2011; Gonzalez, 2011; Jeukendrup, 2011; Sahlin, 2011; Spriet. 2008) or protein or carbohydrate utilization (Broad, 2008). Two trials were identified that may support L-carnitine's ability to reduce atherosclerotic markers and cardiovascular stress in combination with exercise by elevating nitric oxide levels (Bloomer, 2011)or improving endothelial function (Volek, 2008).

L-Proline

No studies on youth or adults have been found looking at the health effects of L-proline supplementation. However, patients that have extremely high plasma proline concentrations do not appear to be adversely affected (Watford, 2008).

Guarana

No studies on youth have been completed looking at the health effects of guarana, but risks have been identified in adults consuming guarana. Although two studies completed with adults found guarana supplementation can increase mental alertness and cognitive performance at doses of 37 to 300 mg (Haskell, 2007; Kennedy, 2004), two other studies saw risks similar to caffeine intoxication in adults consuming guarana. A review looking at the use of guarana as a supplement among adults noted various adverse effects at doses of 0.1 to 15 grams including irritability, heart palpitations, and anxiety (Pittler, 2005). One case was noted in which a women experienced tachycardia from consuming 1 gram of guarana daily. A case study of women admitted to a hospital found central nervous system manifestations including headache and dizziness attributed to guarana use (Cuzzolin, Zaffani & Benoni, 2006).

Milk Thistle

No studies on youth have been completed looking at the health effects of milk thistle, and no studies have been identified reporting adverse effects in adults (Chen, 2011; Loguerico, 2011; He, 2011; Vaid, 2010). A review that analyzed studies of the effects of a purified product of milk thistle, silybin, noted that a well-defined finding is the absence of adverse events at high doses (Loguerico, 2011). Benefits for adults include antioxidant effects and detoxification properties (Loguerico, 2011; Vaid, 2010).

Ginger

No studies on youth have been completed looking at the health effects of ginger. Studies have found several beneficial effects of ginger consumption in adults (Mansour, 2012; Al-Suhami, 2011; Black, 2010). However, in one case study and one review, nausea was found as a serious side effect after high doses of ginger consumption (Gul, 2012; Stanger, 2012). In this case study, a woman suffered from an episode of nausea and a sudden loss of consciousness. Tests revealed sinus bradycardia and first-degree atrioventricular block. She had been consuming one cup of ginger, 3 times daily for 5 days as medication for the flu (Gul, 2012). The review notes that consuming ginger at amounts exceeding four grams a day may cause stomach discomfort and nausea (Stranger, 2012).

Dandelion Extract

No studies on youth have been completed looking at the health effects of dandelion extract. Two studies have found anti-inflammatory effects in adults (Gonzalez-Castejon, 2012; Rodriguez-Fragoso, 2008). However, risk of allergic reaction has been identified in people who ingest dandelion pollen. When taken orally, dandelion pollen can cause severe allergic reactions, including anaphylaxis (Rodriguez-Fragoso, 2008).

Ginseng

No studies on youth have been completed looking at the health effects of ginseng. There is insufficient evidence to support ginseng supplementation in adults, and risks have been reported in adults consuming high doses of ginseng. Some studies show that ginseng may improve cognition and memory at doses of 100-400 mg (Scholey, 2010). Other benefits reported include ginseng's effect on mood enhancement, anti-inflammatory and anti-oxidant activity, pulmonary function, glucose metabolism and insulin sensitivity in doses ranging from 200 mg to 2 g daily (Chan, 2012; Jia, 2009; Lee, 2011; Kim, 2011). Risks that have been seen with supplementation include ginseng's ability to increase blood clotting time and to interfere with anti-coagulant medication at doses of 120 to 200 mg (Stanger, 2012). One case reported a woman that experienced multiple events of cardiac arrhythmia from taking a combination of 70 centiliters of caffeine and 4 liters of ginseng, and reported no events once she stopped taking ginseng (Torbey, 2011). Other adverse effects shown to be related to high doses of ginseng supplementation include hypotension, edema, heart palpitations, cerebral arteritis, vertigo, headache, insomnia, mania, fever, appetite suppression, pruritus, cholestatic hepatitis, mastalgia, and neonatal death (Higgins, Tuttle, & Higgins, 2010).

Gingko Biloba

No studies on youth have been completed looking at the health effects of gingko biloba. Some studies report benefits of improved mood, memory and cognition in adults taking 80 mg to 240 mg of the supplement (Clemet, 2011; Dodge, 2008; Gorby, 2010; Kaschel, 2009, 2011). Gingko's effect on cognition may be related to its ability to increase blood flow (Mashayekh, 2011), which is also thought to promote antioxidant activity (Sutter, 2011) and decrease diseases of aging (Wu, 2008). However research shows that gingko's effect on blood flow and platelet activity can be dangerous, especially in patients who experience bleeding while taking gingko in combination with anticoagulant medications (Stanger, 2012). In one case study, a female patient experienced hemorrhage from cerebral bleeding attributed to taking 240 mg of gingko biloba daily for four years (Pedroso, 2011). In another case, a female who was taking 240 mg of gingko daily experienced cardiac arrhythmias that ceased once she stopped taking the supplement (Russo, 2011).

Yerba Mate

No studies on youth have been completed looking at the health effects of yerba mate. One clinical study (done on healthy adult females) and one review reported benefits such as antioxidant and weight management properties (Matsumoto, 2009; Heck, 2007). However, a majority of the studies reported strong associations with yerba mate consumption and specific cancers (Stefani, 2011; Szmanska, 2010; Dasanayake, 2010; Loria, 2009; Garavello, 2009; Abnet, 2007; De Stefani, 2007; Pittler, 2005; Goldenburg, 2004,2003). Several case-control studies in Latin America submitted cancer patients to interviews about their diet, smoking habits and alcohol consumption (Stefanie, 2011; Szmanska, 2010; De Stefani, 2007). They all found strong positive associations between habitual mate consumption and risk for various cancers. Associated cancers include oral, oropharyngeal, head and neck, and esophageal cancers. Studies found that the associations remained after controlling for smoking and alcohol consumption (Szmanska, 2010; Goldenburg, 2004). Cancer risk increased with duration, daily quantity and temperature at drinking (Loria, 2009; Abnet. 2007). The association between yerba mate consumption and cancer risk is strong, but researchers are unsure of the cause. Some studies speculate that the increased cancer risk is caused by "chronic thermal injury", as patients in the studies prefer to drink the mate at very hot temperatures (Pittler, 2005). Other researchers propose that carcinogenic contaminants are introduced during the processing of yerba mate (Loria, 2009).

Gluronolactone

No studies have been identified on the effects of consuming gluronolactone in adults or children.

Inositol

No studies on youth have been completed looking at the health effects of inositol. One study identified showed inconclusive evidence on its effect on glucose metabolism in adults (Stull, 2009). Older non-diabetic adults who took 1000 mg of inositol (provided in a beverage as 1000 mg of pinitol) showed no changes in indices of whole-body glucose tolerance and insulin sensitivity, or the activation of the skeletal muscle insulin receptor.

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Appendix D. Sugar Substitute Research Summaries

Research on the effects of artificial sweeteners in the human body is very sparse. Although some animal studies exist, further research is warranted to assess whether ingesting artificial sweeteners is beneficial or harmful to the human body.

Sucralose (Splenda®)

Some human research studies have looked of the effects of sucralose ingestion on glucose signaling and the insulin response, and how sucralose may help regulate glucose homeostasis. While studies show that sucralose has no effect on the insulin response, one study showed that when taken after ingesting glucose, sucralose might act synergistically with glucose in activating insulin-dependent pathways (Brown 2011). The FDA has set the acceptable daily intake level of sucralose for humans to be 5 mg per kg daily (Whitehouse, 2008).

Aspartame (Equal® and NutraSweet®)

At high doses, aspartame has been shown to cause headache, dry mouth, dizziness, mood change, nausea, vomiting, and reduced seizure threshold in humans (Whitehouse, 2008). Individuals with phenylketonuria, who are not able to metabolize phenalanine, an amino acid in aspartame, should not ingest it or they can experience altered brain function. The FDA has set the acceptable daily intake of aspartame for humans to be 40 mg per kg daily (Whitehouse, 2008).

Multiple rat studies have shown increased incidence of malignant tumors and cancer in rats given high doses of aspartame ranging from 400 to 100,000 ppm and 40 to 2500 mg per kg (Belpoggi, 2006; Gombos, 2007; Soffritti, 2006, 2010). In addition, aspartame has been shown to alter brain receptors and function (provided at 250 mg per kg) (Christian, 2009) and produce liver damage (at 500 and 1000 mg per kg) in rats (Abhulash, 2011). One study found rats consuming aspartame at acceptable daily intake levels for humans gained weight without increasing their food intake (Polyak, 2010), which raises questions on the effect of regular aspartame consumption on metabolism and weight maintenance.

Acesulfame

Few studies were identified looking at the effect of acesulfame in humans or rats. The FDA has established the acceptable daily intake to be 15 mg per kg daily (Whitehouse, 2008). When consumed in large amounts, acesulfame can cause headaches in adults. A laboratory study has demonstrated that acesulfame may cause DNA damage and thyroid tumors in rats at high doses of 60, 450, 1,100, and 2,250 mg per kg (Whitehouse, 2008). One study found rats consuming acesulfame at acceptable daily intake levels for humans gained weight without increasing their food intake (Polyak, 2010), which questions the effect of regular acesulfame consumption on metabolism and weight maintenance.

Saccharin (Sweet 'N Low®)

The acceptable daily intake of saccharin is established to be 5 mg per kg daily. At high doses, saccharin can cause nausea, vomiting and diarrhea in humans. Rat studies have demonstrated saccharin to potentially cause bladder cancer, liver toxicity, and low birth weight of offspring (Whitehouse, 2008). Two studies were identified that saccharin may influence weight gain in rats. In one study, a group of rats was given saccharin and another group was given glucose in equivalent amounts. Those given saccharin increased their caloric intake and gained weight, suggesting that sacharrin does not provide the same satiation effect of regular sugar and may influence compensatory calorie intake (Swithers, 2008). Another study found rats consuming saccharin at acceptable daily intake levels for humans gained weight without increasing their food intake (Polyak, 2010), which questions the effect of regular saccharin consumption on metabolism and weight maintenance.

Neotame

Neotame has an established acceptable daily intake of 2 mg per kg of body weight. At high doses, Neotame may cause headache and liver toxicity in humans (Whitehouse, 2008). Some rat studies have demonstrated that a diet containing neotame may result in decreased food intake and weight loss due to the low palatability of neotame (Whitehouse, 2008; World Health Organization, 2004).

Stevia®

Some reviewed benefits of stevia use in rats show anti-oxidant and blood pressure lowering effects (Gayal, 2010), and anti-hyperglycemic, anti-inflammatory, anti-tumor, anti-diarrheal and immune enhancing effects (Chatsudthipong, 2009; Sehar, 2008). Few rat studies have demonstrated stevia to improve insulin function (given at .5 and 5 mg per kg) (Chen, 2005; Chan, 2005). In one study, rats given a high fat diet had lower cholesterol when given 1 ml per kg of stevia daily compared to rats given a high fat diet with water or sucrose (Park, 2010). However, some rat studies have demonstrated toxicity—one rat study showed stevia produces metabolites in the gut that are capable of inducing developmental toxicity (Brahmachari, 2011); and another study demonstrated an oral solution of 4 mg per ml may result in lesions in the brain, spleen and liver (Nunes, 2007). Other animal studies have shown that Stevia may increase calorie intake or weight—one study showed that rats given a 12.5 to 15% stevia solution compensated by consuming extra calories when stevia was not available (Figlewicz, 2010); another study showed that chickens given 130 ppm stevia demonstrated increased abdominal fat and greater weight gain when consuming the same amount of feed as other chickens (Atteh).

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Appendix E. Establishment of Upper Limits of Vitamins and Minerals

Information on the establishment of upper limits of vitamins and minerals added to sugar sweetened beverages was synthesized from the *Dietary Reference Intakes* published by the Institute of Medicine. Human and animal studies used to establish the upper limits are highlighted below.

Vitamins and Minerals with Upper Limits Not Determinable

Thiamin (Vitamin B1)
Riboflavin (Vitamin B2)
Pantothenic Acid (Vitamin B5)
Vitamin B12

The Upper Limits (ULs) of the above vitamins have yet to be established due to lack of data on adverse effects and concern with regard to lack of ability to handle excess amounts. It is thus recommended that the source of intake be from food only (natural forms and not supplemental forms) to prevent high levels of intake.

Vitamins and Minerals with established Upper Limits

Upper limits of the following vitamins and minerals have been established on the basis of reports looking at the intake of large doses from mainly supplemental forms. The research on children and adolescents is limited; most upper limits have been defined according to risk assessments completed on adults. See table below for the established upper limits for children.

Age group	Vitamin A (as preformed) mg	Niacin (Vitamin B3) mg	Vitamin B6 (mg)	Vitamin C (mg)	Vitamin E (as alpha-tocopherol) mg	Calcium (mg)	Magnesium (mg)	Manganese (mg)	Phosphorus (g)	Sodium (g)
4-8	900 (2997 IU)	15	40	650	300 (450 IU)	2500	110	3	3	1.9
9-13	1700 (5661 IU)	20	60	1200	600 (900 IU)	3000	350	6	4	2.3
14-18	2800 (9324 IU)	30	80	1800	800 (1200 IU)	3000	350	9	4	2.3

IU= International Units

Vitamin A

Upper limits are based on the intake of preformed Vitamin A from food, fortified food, and/or supplements. In women of childbearing age, teratogenicity is the critical adverse effect. The critical adverse effect seen in other adult populations is liver abnormalities. Children given high doses of Vitamin A have shown intracranial and skeletal abnormalities[4].

Niacin (Vitamin B3)

No adverse effects have been associated with a high intake of niacin from food sources. The upper limit was established based on reports of high doses of niacin as a supplement, food fortificant, or pharmacological agent. The most critical adverse effect—red flushing--is seen in patients taking nicotinic acid as a therapeutic agent (at oral doses of 30 to 1,000 mg). Red flushing is accompanied by symptoms of burning, tingling and itching in the face, arms and chest. No data has been reported on the adverse effects of excess niacin intake in children or adolescents, so the UL for adults is adjusted for children[1].

Vitamin B6

No adverse effects have been associated with a high intake of vitamin B6 from food sources. The upper limit was established based on clinical research of patients taking large oral supplemental doses of pyridoxine. Severe sensory neuropathy has been described in multiple reports of patients who were given 1 to 6 grams of pyridoxine daily[1]. Due to the absence of reports on children, the UL for adults is adjusted for children[1].

Vitamin C

The upper limit of Vitamin C is based on reports from children and adults taking high doses (up to 3 g/day). The most common side effect, from which the UL is derived, is gastro-intestinal stress, including diarrhea[6].

Vitamin E (as supplemental alpha-tocopherol)

No adverse effects have been reported from ingesting vitamin E from natural food sources. The UL is based on adverse hemorrhagic effects seen in adults taking large dose supplements. The information on the toxicity of vitamin E supplementation is limited; the UL for children and adolescents is adjusted based on the UL for adults[6].

Calcium

The upper limit is based on the intake of calcium supplements. The most widely studied adverse effects of excessive calcium include kidney stone formation, hypercalcemia and renal insufficiency, and the interaction of calcium with other essential minerals. The upper limit for adults is based on reports of excess calcium intake and kidney stone formation, and the upper limit for children is based on reports of hypercalciuria, or excess calcium excretion occurring from excess intake[3].

Magnesium (represents intake from a pharmacological agent)

No adverse effects have been reported from consuming magnesium from natural food sources. Upper limits were established based on adverse effects from consuming magnesium salts from pharmacological agents. The most common side effects from excessive intake include diarrhea, nausea and gastrointestinal discomfort. One case of an infant who suffered severe diarrhea, dehydration and metabolic alkalosis after taking magnesium salts was reported. An adult in a reported case suffered metabolic alkalosis and hypokalemia from taking daily doses of 30 grams. More severe cases have been reported in adults taking larger doses of magnesium, including paralytic ileus, and cardiac arrest, especially in patients with renal insufficiency[2].

Manganese

Research on the intake of manganese is sparse in adults and non-existent in children. Upper Limits have been established based on a no-observed-adverse-effect level for Western diets. Some evidence is based on cases of occupational hazards of inhaling manganese dust and other ecological studies. Elevated blood levels of manganese are associated with neurotoxicity, and supplemental manganese is discouraged[4].

Phosphorus

The UL of phosphorus is based on animal studies, as there are no reports of adverse effects attributable to high phosphorus intake in adults or children. The UL is based on the adverse effects of high phosphorus blood levels on calcium homeostasis, the most harmful being the calcification of non-skeletal tissues[2].

Sodium

The UL of sodium is based on the major adverse effect that increased sodium intake is positively correlated with increased blood pressure. Increased blood pressure is an independent risk factor for cardiovascular and renal disease. This effect has been seen in adults, but has not been extensively studied in children. Thus, the UL for children has been extrapolated from the UL established for adults[5].

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2) National Academy of Sciences. Institute of Medicine. Food and Nutrition Board. *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D and Flouride* (1997).
3) National Academy of Sciences. Institute of Medicine. Food and Nutrition Board. *Dietary Reference Intakes for Calcium and Vitamin D* (2010)
4) National Academy of Sciences. Institute of Medicine. Food and Nutrition Board. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc (2001)*
5) National Academy of Sciences. Institute of Medicine. Food and Nutrition Board. *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate (2004)*
6) National Academy of Sciences. Institute of Medicine. Food and Nutrition Board. *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*(2000).

Appendix F. Nutrient Marketing and Functional Claims

Nutrient Marketing

Beverage companies more commonly market beverages as containing certain nutrients or being good sources of vitamins or minerals. It is more common to see the nutrients written on the beverage without any statement of what it does (a functional claim, described further) or how much is contained. Fruit drinks and flavored waters more commonly indicate that they are "good sources of" or provide 100% of the daily value of certain nutrients, including Vitamin C, calcium and B vitamins. Although these beverages may be good sources of these nutrients, it is known that children that drink more fortified beverages, such as fruit drinks, are more likely to displace other natural food sources of these nutrients, including fruits, vegetables, and dairy products and have lower intakes of other vital nutrients, such as fiber (Frary et al. 2004; Sacco & Tarasuk 2011). Examples of nutrient marketing are shown below.

Beverage Type	Beverage	Nutrient Marketing
Sweetened Tea	Arizona® Green Tea	Vitamin C Green tea with ginseng and honey Antioxidant
	Snapple® Peach Tea	140mg of natural antioxidants
Fruit Flavored	Capri Sun® Sunrise	100% Daily Value Vitamin C Good Source of Calcium
	Tampico® Mango Punch	100% DV Vitamin C
	Kool Aid® Fruit Punch	Good source of Vitamin C
Flavored Waters	Vitamin Water® Fruit Punch Revive	Excellent source of C and B vitamins 100% vitamin C Potassium 100% vitamins B5 B6 B12 Electrolytes but it's definitely stacked…with vitamins, that is.
	SoBE® Lifewater® Yumberry Pomegranate	Nutrient enhanced hydration beverage Ginger and dandelion root extract
Sports Drinks	Gatorade G2-Perform	Electrolytes + carbs
	Gatorade G3-Recover	Post-game protein
	Powerade Fruit Punch	Sports Drink & Vitamins B3, B6, B12
Energy Drinks	Monster Energy®	L-Carnitine + Taurine + Ginseng + B-vitamins Energy Supplement
	RockStar®	Caffeine * Guarana * Ginseng * B-vitamins * Taurine
	Amp® Energy	Caffeine B-vitamins

	Starbucks® Doubleshot Energy	A premium energy drink enhanced with ginseng, guarana, B vitamins and creamy mocha flavor, perfectly blended with rich, bold Starbucks® coffee. B Vitamins Guarana Ginseng Fortified energy coffee drink

Nutrient Functional Claims

Other beverage package marketing tactics seen are "functional" claims where companies state how certain nutrients (or combinations of) contained in beverages may optimize health. Examples of these are shown below, and research disclaiming the package content is provided in the footnotes. Some of the functional claims are indirect or implied. For example, "Vitamin C" is written with "Antioxidant" on both fruit flavored drinks and flavored waters, but does not explicitly state that Vitamin C acts as an antioxidant. The beverage types containing the most functional claims include flavored waters, sports drinks and energy drinks.

Beverage Type	Beverage (# claims)	Nutrient Functional Claims			
Sweetened Tea/coffee	Arizona® Green Tea (1)	Vitamin C Antioxidant[1]			
Beverages showing no functional claims	Snapple® Peach Tea Starbucks® Frappuccino®				
Fruit Flavored	Sobe® Strawberry Banana (1)	Naturally sweetened and lizzle-drizzle with a nice peaceful[2] blend of ginseng and yerba mate.			
	V8 Splash® Mixed Berry (1)	Vitamins A, C & E Antioxidant[1] Plus			
Beverages showing no functional claims	Tampico® Mango Punch Capri Sun® Sunrise Kool Aid®				
Flavored Waters	Vitamin Water® Fruit Punch Revive (1)	It's got B vitamins and potassium, some of your body's friends[3].			
	Vitamin Water® XXX (1)	We only named this drink XXX because it has antioxidant vitamins A & C[1] to help fight free radicals and help support your body.			
	SoBE® Lifewater ® Yumberry Pomegranate (2)	Antioxidants Vitamins C and E[1]	Vitamins C & E are antioxidants that help protect the body from damaging free radicals[1]. We're just psyched they're on our side!		
Sports Drinks	Gatorade G2®-Perform (regular and low calorie) (4)	Replenish vital nutrients and energy[4].	Drink to help rehydrate[5], replenish and refuel[4] and savor the sweat.	Thirst quencher[5].	For athletes. For performance[6].

Beverage Type	Beverage (# claims)	Nutrient Functional Claims			
	Gatorade® G3-Recover (4)	Take as soon as possible after your workout to help restore tired muscles[7] and rehydrate.	Recovery beverage[7].	Restore your body after working so hard. And then go do it again[7].	For athletes. For performance[6].
	Powerade® Fruit Punch (1)	Advanced Electrolyte System Helps Replenish 4 Electrolytes lost in sweat: sodium, potassium, calcium, magnesium4			
Energy Drinks	Monster Energy® (1)	It's a wicked mega hit that delivers twice the buzz[8] of a regular energy drink			
	RockStar® (2)	Double Strength, Double Size Bigger. Better. Faster. Stronger. Rockstar is the world's most powerful8 energy drink.	Enhanced with the potent herbal blend of Guarana, Ginseng and Milk Thistle, Rockstar is scientifically formulated to provide an incredible energy boost8 for those who lead active and exhausting lifestyles- from athletes to rockstars.		
	Amp® Energy (1)	With B vitamins to help kick you into high gear[9].			
	Red Bull® (4)	Improves performance especially during times of increased stress or strain. Increases endurance[10].	Increases concentration and improves reaction speed[11].	Stimulates the metabolism9.	With Taurine. Vitalizes body and mind[12].
Beverages showing no functional claims	Starbucks® Frappuccino®				

[1] **Vitamins A, C and E as antioxidants**
Vitamins A, C, and E do act as antioxidants, but are best obtained from natural sources—whole fruits and vegetables are high in vitamins A and C and plant oils (found in nuts and cooking oil) are high in vitamin E. Youth that drink more fortified fruit drinks and other beverages containing these vitamins have been shown to displace natural food sources of these vitamins in their diet(Sacco & Tarasuk 2011; Frary et al. 2004). Many professional health associations including the National Institutes of Health, Academy of Nutrition and Dietetics, and American Heart Association discourage the use of supplemental forms since there may be unknown risks associated with ingesting excess supplemental antioxidants, and that natural forms obtained from plant sources offer additional health benefits, including fiber and phytochemicals that also act as antioxidants in the body(JADA 2005; NIH).

[2] **Ginseng and Yerba Mate as peaceful**
Ginseng and Yerba Mate may be traditionally taken individually for their calming properties, but some research suggests their intake, especially in combination with other stimulants, including caffeine, can be harmful. Yerba mate, consumed regularly, has been shown to be associated with some cancers (Pittler et al. 2005; Loria et al. 2009). Ginseng, when taken in conjunction with caffeine, may have synergistic effects, including heart arrhythmia and increased blood pressure (Torbey et al. 2011; J. Higgins et al. 2010; National Institutes of Health). The NIH advises against the intake of the combination of caffeine and ginseng due to known adverse side effects.

[3] **B vitamins and potassium as our "body's friends"**
This claim seems to imply that B vitamins and potassium are essential for body functions, which is true. However, B vitamins and potassium are plentiful in the food supply and in the diets of youth(Bailey et al. 2012). Potassium and B vitamins are best obtained from natural food sources, which are high in additional nutrients (JADA 2005). Foods high in vitamin B include meat and dairy products, beans, nuts and grains; Foods high in potassium include fish, dairy products, beans, fruits and vegetables. Further, the Institute of Medicine recommends obtaining B vitamins and potassium from food sources, rather than supplemental forms to reduce any risks that may occur if they are ingested in excess(IOM 1998).

[4] **Use of sports drinks to replenish "vital" nutrients and energy**
Sports drinks are not necessary to replenish nutrients and energy, especially if not engaging in continuous, vigorous activity for more than one hour in hot weather. Only under these extreme conditions may the body lose enough electrolytes and deplete blood glucose to warrant replacement from a sports drink, and the majority of children do not engage in activity under these conditions. The nutrients contained (calories, potassium, sodium, calcium, magnesium) are sufficient in the diet for ordinary day-to-day activities(Unnithan & Goulopoulou 2004).

[5] **Use of sports drinks to rehydrate**
Water is the optimal beverage of choice for rehydrating for everyday activities. Only if doing prolonged, vigorous activity for more than one hour in extreme conditions, when the body is more prone to dehydration, may sports drinks better rehydrate(Unnithan & Goulopoulou 2004). The majority of youth do not engage in this type of activity where a sports drink may be warranted for hydration purposes(Schneider & Benjamin 2011).

[6] **Sports drinks designed for athletes and performance**
This claim is supported by the fact that athletes engaging in prolonged vigorous activity may be the one population that may benefit performance-wise from sports drinks(Cohen 2012). For the ordinary population, a

balanced diet that provides sufficient calories and nutrients from a variety of food sources can sufficiently support exercise activities(Unnithan & Goulopoulou 2004).

[7] **Protein-enhanced sports drinks for muscle recovery**

The average American diet is high in protein and well supports the needs for muscle rebuilding and growth in adolescents engaging in activity. The average protein requirement for adolescents is about 1 g per kg and most adolescents take in protein well above this requirement from food sources(Unnithan & Goulopoulou 2004).

[8] **Energy drinks providing boost, power or a buzz**

These statements may refer to the stimulants contained in energy drinks, including caffeine and guarana, which do stimulate the cardiovascular and nervous system, and can have detrimental effects (such as tachycardia) when consumed in large quantities, as they are present in some energy drinks(J. Higgins et al. 2010; Seifert et al. 2011).

[9] **B vitamins providing an energy-enhancing element**

B vitamins are involved in metabolic pathways in the body but do not provide energy. There is **no** conclusive scientific evidence that supports the intake of additional B vitamins to speed up these metabolic pathways, increasing the efficiency of energy production in the body(NIH). Energy is obtained from food calories in the diet, and beverages (including energy drinks) provide excess energy that is not needed in the diets of youth(Schneider & Benjamin 2011). Both energy (calories) and B vitamins are plentiful in the diets of youth(Bailey et al. 2012). B vitamins are plentiful in the American food system and found in a variety of food sources including meat and dairy products, beans, nuts and grains.

[10] **Energy drinks enhancing performance and endurance**

Energy drinks companies mislead consumers by advertising these drinks as a performance-enhancing product, and they can be mistaken for sports drinks. Energy drinks should not be used for endurance activities, as they can pose risk on the body during performance due to the dehydrating and cardiovascular effects of their high caffeine content(Meadows-Oliver & Ryan-Krause 2007).

[11] **Energy drinks improving concentration and reaction speed**

The few studies that have been completed exploring this concept were conducted by beverage companies themselves, which are incredible sources (Smit et al. 2004; Scholey & Kennedy 2004). Other studies show mixed results and show intake may even slow reaction speed(Anderson & Horne 2006). Also, youth consuming caffeine in their diets show to have reduced ability to focus and concentrate in a learning environment(Pennington et al. 2010), which contra-indicates the use of caffeine or energy beverages for this purpose.

[12] **Taurine producing vitality**

Taurine has been shown to be a stimulant, but can also pose risks in the body similar to that of caffeine, and may produce synergistic effects when consumed with caffeine, such as increased blood pressure(Franks et al. 2012). Taurine is a non-essential amino acid, so is synthesized in the body from other amino acids ingested from protein-containing foods that are plentiful in the American diet (Shao & Hathcock 2008). Therefore, supplemental taurine is unneccesary.

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