OXFORD JOURNAL
OF STUDENT
SCHOLARSHIP

Performance Enhancements: Can Fruit Juice Replace Energy Drinks?

Amanda Kaplan
amandakaplan2026@gmail.com

ABSTRACT

Energy drink consumption has become increasingly common among adolescents and athletes seeking performance enhancement. While studies have shown benefits such as improved stamina and strength, energy drinks pose significant health risks, primarily due to high caffeine content. Fruit juice has been studied for its long-term recovery effects; however, research on its acute impact on athletic performance is limited. This study aimed to compare the effects of 100% fruit juice versus energy drinks on performance and perceived exertion in high school students.

Two surveys were included in the experimental design: a general survey assessing energy drink use and an athlete survey evaluating perceived exertion and willingness to substitute fruit juice. Celsius was selected as the energy drink for testing based on survey results. In the experimental phase, 12 South Florida high school students consumed, on separate days, either a placebo, tangerine juice, or Celsius. After 120 minutes, participants completed a 40-yard sprint, maximum leg press, and leg extension. The second experimental phase consisted of nine female soccer players who consumed the same drinks before four games, with varied supplementation methods.

Fruit juice showed greater performance improvements compared to energy drinks, with average percent changes of +5.9% (sprint), +13.2% (leg press), and +16% (leg extension) over placebo. Perceived exertion ratings were lower with fruit juice versus energy drinks for all supplementation methods.

Overall, this study found that fruit juice demonstrated superior acute performance benefits compared to energy drinks while avoiding caffeine-related health risks. Athletes should consider fruit juice as a safer alternative, though further research should examine mixed juices, whole fruits, and broader demographics.

INTRODUCTION

According to Statista, one of the world's most renowned statistics portals, energy drink sales in the United States reached 18.5 billion dollars in 2023 (Statista 2023). The significant value associated with the energy drink industry has led to extensive research on these drinks' overall composition and effects on the human body. These beverages are readily available, as the Journal of Nutrition and Metabolism,

establishes that over 500 varieties exist, present in the majority of grocery stores or gas stations, which has resulted in "an extensive increase in the consumption of [energy drinks], especially among younger populations (Mohammed et al. 2022). Easy accessibility has caused the extensive success and popularity of this industry. This widespread availability increases routine exposure and convenience for consumers, normalizing energy drink use and significantly contributing to the industry's rapid growth. Moreover, Noni Macdonald et al. from the National Library of Medicine explain, "Energy drinks are often targeted toward children and youth through carefully designed advertising campaigns as well as sponsorship of events such as snowboarding and skateboarding competitions" (Macdonald et al. 2010). The elaborate marketing schemes have been proven successful, as the Centers for Disease Control and Prevention reveal, "Between 30–50% [of adolescents] reported consuming energy drinks" (CDC 2024). The prevalence of energy drinks is only increasing, but other alternatives have been introduced. Specifically, fruit juices have been used instead as a natural supplement. Consequently, this paper will discuss the components, performance enhancements, and dangers of energy drinks, along with fruit juice ingredients and their effect on physical performance.

Energy Drinks: Components

The main component thought to be attributed to the positive effects of energy drinks is caffeine, which is combined with other ingredients to form the "energy blend". According to Jorge Gutiérrez-Hellín et al., from the Department of Exercise and Sport Sciences of Universidad Francisco de Vitoria, caffeine is a "socially acceptable drug... [that] stimulates the central nervous system... generating a delay in the onset of fatigue" (Gutierrez-Hellin et al. 2021). The average concentration ranges, as demonstrated by clinical psychiatry professor Rajnish Mago, from 80 to 505 mg, which is up to 6 cups of coffee (Mago 2025). While caffeine on its own is an extremely strong stimulant, combining it with other ingredients, such as taurine, which occurs naturally in food sources, constitutes the majority of the "energy blend."

Energy Drinks: Effects on Performance

To preface the enhancement of physical performance, Raul Dominguez et al., from the College of Health Sciences of the University Alfonso X El Sabio, explain, "In competitive sports, 0.5%–1.5% improvements in performance are considered a critical difference" (Dominguez et al. 2017). Improvements beyond this percentage have been exhibited by subjects consuming energy drinks. A study revealed that trained cyclists experienced a 23-25% increase in work during a ride after consuming an energy drink (Gutierrez-Hellin et al. 2021). This dramatic increase encourages people to consume energy beverages, as the ergogenic effects experienced are substantial. To display these effects in another sport, a study conducted by Juan Del Coso et al., from the Exercise Physiology Laboratory at Camilo José Cela University, consisting of semiprofessional soccer players who consumed Red Bull (the most popular commercially available energy drink) revealed an increase in total distance covered at a speed higher than 8 mph during a simulated match by about 200 meters (Del Coso et al. 2012). This drastic increase in distance covered at a sprint reveals that energy drinks improve players' performance and endurance. These studies display similar statistics supporting athletic improvements, focusing mainly on endurance-based activities, leaving questions as to whether these improvements can be evidenced across a range of events.

Overall, energy drinks have repeatedly proven to be a beneficial supplement across multiple sports by supporting endurance levels, mainly due to the effects of caffeine.

Energy Drinks: Benefits Beyond Athletic Performance

To display benefits of energy drinks beyond ergogenic and athletic standpoints, the Mayo Clinic Health System begins to describe that energy drinks can lead to "improved reaction time, alertness and ability to concentrate… [along with] reduced risk of Parkinson's disease [and] Alzheimer's disease" (Padilla 2025). These various improvements are likely attributed to the various ingredients that combine to create the "energy blend". To further support these improvements, Ahmed Alsunni, from the National Library of medicine, found that "both cognitive function and mood were significantly improved in partially sleep-deprived individuals who consumed energy drinks. They were able to preserve their initial levels of attention for a period of six hours, whereas the placebo group failed" (Alsunni 2015). Beyond the more commonly recognized athletic improvements, Alsunni provides findings regarding cognitive improvements as a result of regulated energy drink consumption, especially among those affected by sleep-deprivation. Together, these findings show that energy drinks may offer meaningful cognitive benefits beyond physical performance, particularly in enhancing attention, alertness, and mental function when consumed in moderation.

Energy Drinks: Dangers

While these beverages induce benefits, several severe dangers are unfamiliar to the general public. An alarming statistic provided by the Centers for Disease Control and Prevention puts these dangers into perspective: "In 2011, 1,499 adolescents aged 12 to 17 years went to the emergency room for an energy drink-related emergency... [including] irregular heartbeat and heart failure" (CDC 2024). This aspect of energy drinks is commonly overlooked and is why society needs to take extreme caution before consuming. While not all of these hospital visits were met with extreme outcomes, there are many deaths directly related to energy drink consumption. Diana Cao et al., from the Department of Pharmacy Practice at Ketchum University, reveal that 34 deaths were linked to energy drink consumption in a single decade, but that amount is bound to rise with increased consumption patterns (Cao et al. 2021). Further, Andrea Costantino et al., from the Institute of Legal Medicine, found that in a study with subjects ranging in age who consumed energy drinks, 41.5% resulted in arrhythmias, or irregular heartbeats (Costantino et al. 2023). To understand the severity of this diagnosis, Lin Chen et al., from the University of Minnesota Medical School, found that arrhythmias increase the risk of death by almost double (Chen et al. 2021). Due to the extensive research correlating energy drink consumption with lethal consequences, paired with the trend of adolescents being constantly targeted in the marketing of energy drinks, regulations must be put in place regarding caffeine dosages. Currently, the Food and Drug Administration does not have a "regulation specific to 'energy drinks.' All of the general regulations about the safe use of ingredients apply to these beverages" (FDA 2024). The lack of regulations is highly responsible for the lethal aspects of this industry, as the supposed "safe use of ingredients" has continuously resulted in harm. The deleterious side of energy blends is commonly overlooked, and, with this information, society must be more concerned with the high consumption patterns. To view this issue from an athlete's perspective,

Mathew Mayer, a professional basketball player, explains, "I had caffeine poisoning. I had six Monsters the day of the game...because I like a caffeine-induced euphoria... I could barely get out of bed the next day. It was basically like a caffeine hangover" (Lauletta and Landsverk 2023). Mayers' story illustrates the threat people face when over-relying on energy drinks for fuel, resulting in immediate and lasting health effects when the "euphoria" wears off. Mayer relates his sluggishness to a hangover, which demonstrates how powerful the effects truly are. Conclusively, energy drinks are an imminent threat to human health in various forms that are unknown to society, displaying the industry's unethical facets due to the lack of caffeine dosage control.

Fruit Juice: Components

Recent studies have sought to discover if fruit juice could provide a safer and more efficient alternative to energy drinks. As caffeine was determined as the main component in energy drinks, in fruit juice, polyphenol and antioxidant contents are the main components that correlate to performance. Abdel-Majeed Safer, a professional researcher in cell biology, states that polyphenols are "plant-derived dietary compounds" (Safer, 2013). These compounds are found in various fruits, ranging in amounts from 400-800 mg per 100 grams of fruit, according to Ali Redha et al., experts in sports sciences (Redha et al. 2022). While there is minimal evidence of these contents directly affecting immediate performance, they are essential to post-workout recovery. Sarah Valder et al., from the Department of Rehabilitative Sports Medicine., state, "The consumption of polyphenol-rich juices improves the regeneration of skeletal muscles [which are in action during sports and physical activities] by up to 13% and can reduce muscle soreness by up to 29%" (Valder et al. 2024). These improvements far surpass the previously mentioned improvement percentage range that was deemed critical. Continuing with the aspect of recovery, Redha et al. further address that "the most common side effect of intensive exercise across all sports fields is oxidative stress... [which is] a result of an imbalance of the RONS," or reactive oxygen and nitrogen species, and "a high level of RONS... leads to cellular damage and dysfunction" (Redha et al. 2022). The importance of this revolves around the capability of antioxidants in fruits to reverse these effects. Redha et al. state, "Natural antioxidants [found in fruits] can scavenge RONS and eliminate their harmful effects that could negatively influence the athlete's performance" (Redha et al. 2022). Redha et al. reveal critical information to explain the improvements that Valder et al. displayed regarding muscle regeneration, a critical aspect of post-workout recovery. Most importantly, various components within fruits have repeatedly been proven to improve recovery and prevent muscle damage, which are some of the most important and overlooked aspects that determine an athlete's consistent performance.

Fruit Juice: Acute Supplementation

Existing studies about acute supplementation of fruit juices directly affecting athletic performance have produced results revolving around endurance improvements. Dominguez et al., previously mentioned, analyzed an experiment that administered a single dose of beetroot juice before exercise, resulting in "improvements close to 20% in the number of repetitions performed" (Dominguez et al. 2017). These improvements were attributed to the high levels of nitrites in beets that speed up muscle rebuilding, delaying the depletion of energy in the muscles after intense exercise and allowing one to perform more

high-intensity repetitions with shorter rest periods required. Additionally, the high levels of inorganic nitrates in beets promote vasodilation, or enhanced blood flow, leading to a faster muscle shortening velocity, which allows muscles to contract and change length more quickly (Dominguez et al. 2017). This reveals an extensive performance improvement in the aspect of acute stamina.

Fruit Juice: Supplementation Over Time

Comparing energy drinks and fruit juice, differences are present in athletic improvements from repeated supplementation. Beginning with energy drinks, John Higgins et al., from the Division of Cardiology, revealed that "the human body develops a tolerance to caffeine quickly, usually 3 to 5 days after regular use" (Higgins et al. 2010). Along with the previously mentioned dangers, this further proves that energy drinks cannot be a reliable source of energy for athletes, as their efficiency diminishes. Contrastingly, Julien Aucouturier et al., with a Ph.D., experimented with 3-day supplementation of beetroot juice on young men. The results revealed a difference of about 5 repetitions greater with supplementation before reaching the point where participants felt unable to continue (Aucouturier et al. 2015). Contrary to energy drinks, Aucouturier provides evidence that the body improves with recurring juice supplementation, proving to be substantially more effective than energy drinks. To view a different aspect of increased performance or recovery, the ingestion of tart cherry juice was experimented with. Kerry Kuehl et al., from the Journal of the International Society of Sports Nutrition, provided participants with "bottles of tart cherry juice or placebo cherry drink twice daily for 7 days prior to" a race to view the subsequent measure of increased pain after the event (Kuehl et al. 2010). The results revealed that "the cherry juice group reported a significantly smaller increase in pain (12 ± 18 mm) compared to the placebo group (37 ± 20 mm)" (Kuehl et al. 2010). Kuehl et al.'s experiment proves that supplementation over time can not only increase performance but can also reduce pain by over double the amount, which is an extremely important facet for athletes who play multiple games and train daily.

Fruit Juice: Potential Hazards

While the wide range of potential benefits of fruit juice is substantial, the hazards and potential dangers must also be adressed. Michelle Nguyen from the Department of Nutritional Sciences at the University of Toronto begins describing the potential danger of weight gain, stating that "1 serving per day of 100% fruit juice was associated with [a 0.03] BMI gain among children" (Nguyen et al. 2024). This suggests a subtle but statistically significant link between juice intake and gradual weight gain, as although a 0.03 BMI increase is negligible in the short term, small cumulative changes over many years can contribute to classification as overweight or obese. Another potential side effect of fruit juice consumption is the onset of Type II Diabetes. The American Heart Association found that regular consumption of 100% fruit juice during childhood and adolescence was associated with higher HbA1c levels (a measure of average blood sugar levels over time) in late adolescence, with each daily serving corresponding to a 0.07% increase among boys and a smaller 0.02% increase among girls ("Sugary Drinks, Fruit Juices Linked to Higher Risk of Developing Type 2 Diabetes among Boys" 2024). This information is significant because HbA1c shows how high someone's blood sugar has been over time, so an increase means the body may be having more trouble controlling blood sugar. Even though the increase is small, it suggests that drinking fruit

juice often can negatively affect blood sugar levels, showing that too much fruit juice may not be as harmless as it seems. However, when consumed in moderation, the positive effects previously mentioned likely outweigh the potential negative side effects.

Gap In Existing Literature

Overall, athletes seek various ways to improve their performance and recovery, leading to the use of supplements. While many have reverted to energy drinks due to their drastic increase in performance across a range of events, the reported dangers pose imminent threats. An obstacle arises, though, as stated by Kuehl: "Professional players are more susceptible to the ergogenic effects of caffeine when compared to younger players" (Kuehl et al. 2010). Due to this information, newer evidence reveals that pure fruit juice can act in similar ways but lacks a dangerous nature. Yet, the existing literature lacks evidence discussing the effect of acute supplementation of fruit juice on high school student-athletes or the effects on maximum strength, speed, and in-game improvements in this age cohort. This research paper will seek to answer these gaps.

Hypothesis

I hypothesize that acute supplementation of 100% fruit juice (FJ) will improve speed, maximum strength, and post-game perceived exertion more than energy drinks (ED). Further, I hypothesize that repeated supplementation throughout games (during warm-ups, half-time, and water breaks) will further improve efficiency.

METHODS

The methods of this research consist of 2 parts: surveys and test experiments with high school volunteers.

1.1 General Survey

A survey was sent to high-school students in grades 9-12, with 100 respondents. The following questions were asked:

1. Approximately how many energy drinks do you drink per week?
2. What energy drink brand do you most often resort to?
3. Have you ever tried to drink fruit juice instead of energy drinks before a workout/game/practice?

These questions evaluated the general consumption rates of energy drinks and determined which brand would be used in the experimental portions of this research. This survey also determined the presence of fruit juice as a supplement for performance.

1.2 Athlete Survey

A second survey was sent to only high school athletes in grades 9–12, with 50 respondents. The following questions were asked in a Google Forms questionnaire and submitted by participants on the same day of the game in question:

1. On a scale of 1-5, how tired/exhausted do you feel after playing in a school sports game?
2. Have you ever drunk an energy drink to try to increase your stamina/energy?

3. Would you purchase and supplement with fruit juice over an energy drink if you discovered they were equally effective?

These questions examined energy drink consumption rates specifically in athletes. This survey also evaluated average perceived exertion rates to compare to later experimental results.

2.1 Participant Experiment: Maximum Strength

Using information gathered from the surveys, I conducted an experiment focusing on maximum strength and speed. A consent form was signed by the parents of each subject prior to testing for both parts of the participant experiment. 3 different drinks were involved:

1. Placebo: 1 full disposable water bottle with flavor-enhancing drops that did not contain any ingredients that would hinder results.
2. Fruit juice: Tangerine Juice (8 oz/1 serving) containing approximately 106 mg of polyphenols, according to Polyphenol-Explorer, the first comprehensive database on polyphenol content in foods ("Showing All Polyphenols Found in Tangerine, Juice from Concentrate—Phenol-Explorer" 2015). Tangerine juice was chosen as the fruit juice comparator due to its wide availability in grocery stores.
3. Energy drink: Celsius, a commercially available energy drink (12 oz/1 serving) containing 200 mg of caffeine. The flavor selected was fizz free peach mango green tea to ensure uniformity throughout the test beverage's appearances.

The preparation method involved combining 1 serving of the drink into a disposable water bottle and filling the rest with water to make all drinks appear nearly identical. The fluid content of all 3 drinks were exactly the same when mixed: 16.9 fluid ounces.

Beverage Composition Table (Table 1)

Experiment Drink	Placebo	Tangerine Juice (FJ)	Celsius (ED)
Volume per serving (fluid ounces)	0.06	8	12
Caloric content (kcal)	0	110	10
Carbohydrate content (grams)	0	25	0
Sugar content (grams)	0	25	0
Caffeine content (milligrams)	0	0	200
Total polyphenol content (milligrams)	0	~106	0
Full ingredient list	Water, Citric Acid, Malic Acid, Natural	100% Tangerine Juice	Filtered Water, Citric Acid, Taurine, Guarana

	Flavors, Potassium Citrate, Gum Acacia, Sucralose, Sucrose Acetate Isobutyrate, Acesulfame Potassium, Medium Chain Triglycerides, Potassium Benzoate (To Protect Taste), Red 40, Potassium Sorbate (To Protect Taste), Yellow 6.		Seed Extract, Green Tea Extract, Caffiene, Sucralose, Ascorbic Acid, Glucuronolactone, Vegetable Juice (color), Ginger Root Extract, Natural Flavor, Calcium Pantothenate, Niacinimide, Pyridoxine Hydrochloride, Riboflavin, Chromium Chelate, Biotin, Cyanocobalamin

When considering active ingredients in the respective drinks, sugar content and varieties must be addressed. For the placebo drink, the flavor-enhancing drops do not contain sugar, only the artificial sweeteners sucralose and acesulfame potassium (Table 1), which are known as non-nutritive sweeteners, absent from calories and nutritional value. This is similar to the energy drink, as the sweetener used is sucralose (Table 1). Although lacking real sugar, artificial sweeteners do raise health concerns. The National Library of Medicine overviews these health concerns, including gastrointestinal and gut-related side effects, along with an increased cardiovascular disease correlation from long-term consumption of these artificial sweeteners (Ghusn et al. 2023). However, the fruit juice contains 25 grams per cup of naturally occurring sugars called fructose, glucose, and sucrose, which are all simple sugars/carbohydrates (Table 1). The Harvard Health publishing staff, reviewed by the Chief Medical Editor at Harvard Health Publishing, state that "consuming natural sugars in foods such as fruit is not linked to negative health effects, since the amount of sugar tends to be modest and is 'packaged' with fiber and other healthful nutrients" (Malik 2023).

Next, twelve South Florida high school students, one male and eleven females, ingested these drinks on separate days. For participants to be included in this experiment, they must have met the following criteria: currently a high school student and committed to participating throughout the entire duration of testing. Upon first recruitment of subjects, 15 possible subjects volunteered. Of these 15, three dropped out as a result of not being able to commit to testing throughout the entire duration of the experiment. This resulted in 12 subjects fully completing the maximum strength portion of the experiment. Subjects were told not to change their diets, hydration levels, or sleep levels to accurately measure results. The order of drink supplementation (placebo, fruit juice, energy drink) was randomized but consistent throughout all subjects. Each subject consumed all 3 drinks on separate days and repeated each test for all drinks on separate days. A control group was not used because each participant was compared only to their own results, not to other participants. Previous research methods in this topic commonly supplemented subjects with either 60 or 120 minutes before testing. To be able to compare to

previous research and ensure that the drinks were fully consumed before testing, this experiment paralleled this timeline. Thus, 120 minutes subsequent to ingestion, subjects performed a 40-yard sprint test, a maximum leg press test, and a maximum leg extension test. Three days separated each test visit and washout periods between trials consisted of this entire 3-day period. All participants did fully refrain from caffeine and strenuous exercise in the days between trials. The sprint test was measured using an iPhone stopwatch, and both the leg press and leg extension were measured using equal standard gym equipment. The leg press and leg extension tests were performed by increasing the weight in 10-pound increments until the subject could not complete the full movement. Results analyze the percent change in sprint times and maximum weight of the energy drink and fruit juice individually compared to the placebo drink.

2.2 Participant Experiment: Perceived Exertion

For the second portion, nine South Florida high school female soccer players ingested the exact same energy drink and fruit juice drinks mentioned earlier, with the same preparation methods. This portion required 4 games:

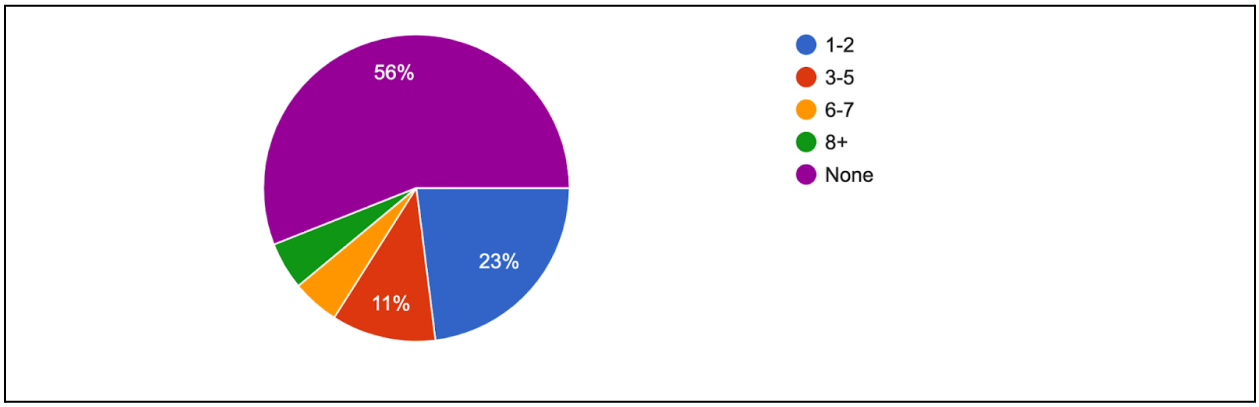
1. One-time supplementation 120 minutes before a match
2. Supplementation throughout the entire match (warm-ups, water breaks, halftime)

This method was used for the energy drink and fruit juice, two games for each drink. Each subject was asked about their perceived exertion level after every game. Each subject's perceived exertion was recorded, and the average rating for each game and supplementation method was assessed. Subjects were told not to change their diets, hydration levels, and sleep levels in order to accurately measure results.

RESULTS

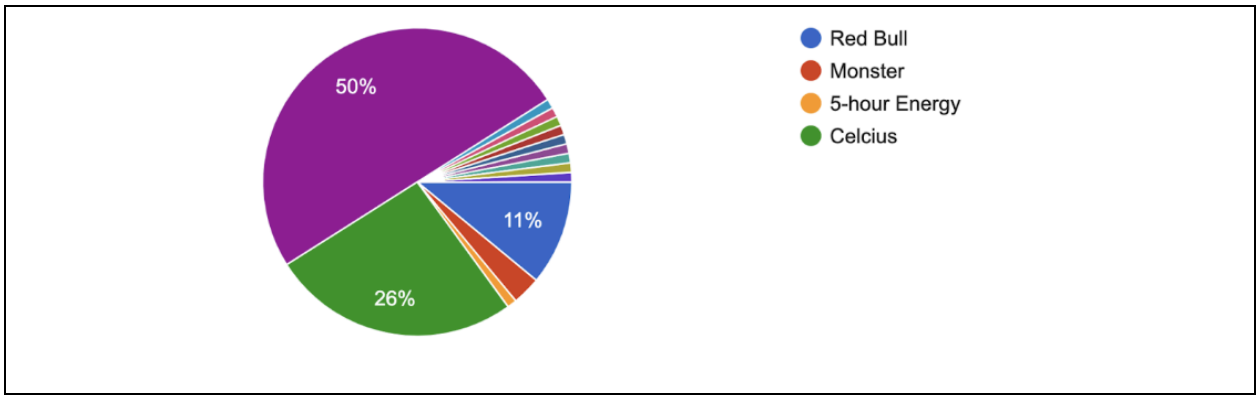
1.1 General Survey Responses - 100 respondents

Figure 1 - Approximately how many energy drinks do you drink per week?



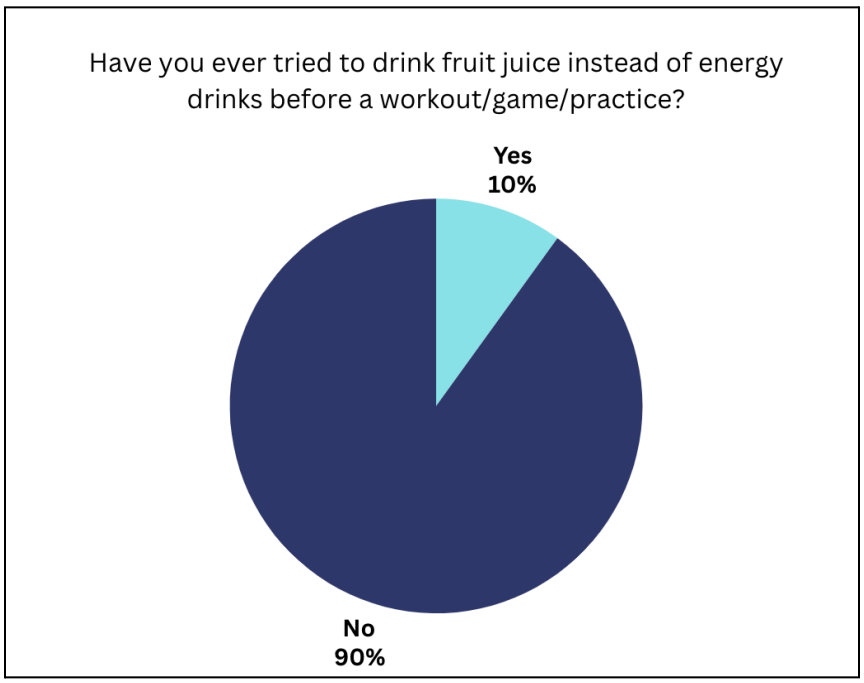
Out of 100 high school respondents, 44% demonstrated that they drink energy drinks. Of this population, 53.2% consume these 1-2 times per week, 25% consume these 3-5 times per week, 11.4% consume these 6-7 times per week, and 11.4% consume these 8 or more times per week (Fig. 1). Notably, about 23% of respondents in this group consume energy drinks 6 or more times per week (Fig. 1).

Figure 2 - If you drink energy drinks, what brand do you most often resort to?



The most commonly selected energy drink was Celsius (26%), a commercially available energy drink with 200 mg of caffeine (Fig. 2). The other 50% of respondents were those that selected "None" (Fig. 2). With this information, Celsius was the energy drink used in the experimental portions of this research.

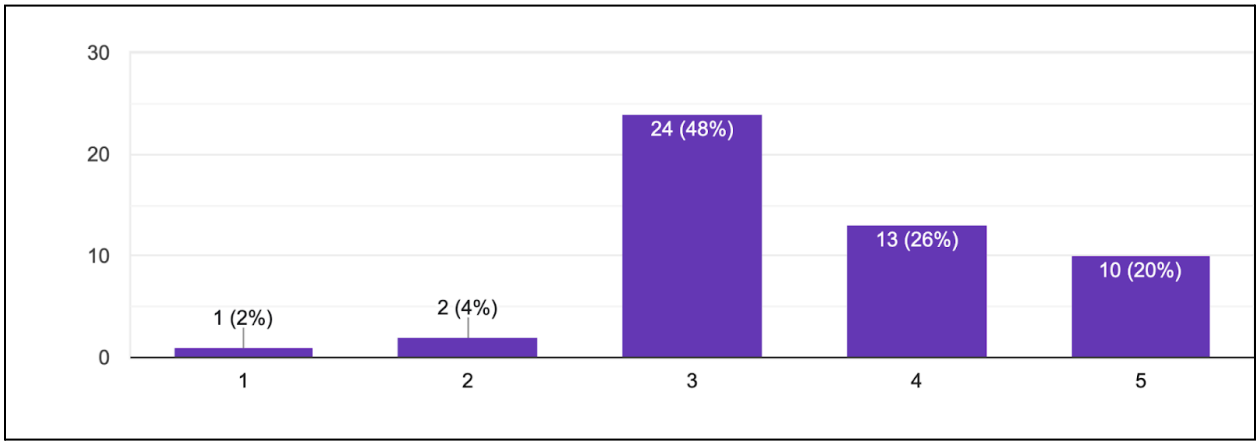
Figure 3 - Percentage of respondents who have consumed fruit juice over energy drinks



When observing fruit juice consumption rates as a pre-workout performance enhancement, it can be seen that 90% of the respondents selected "No" to ever consuming fruit juice over an energy drink, with only 10% selecting "Yes" (Fig. 3). This result shows that fruit juice is rarely used as a pre-workout option, since the overwhelming majority of participants reported never choosing it over an energy drink.

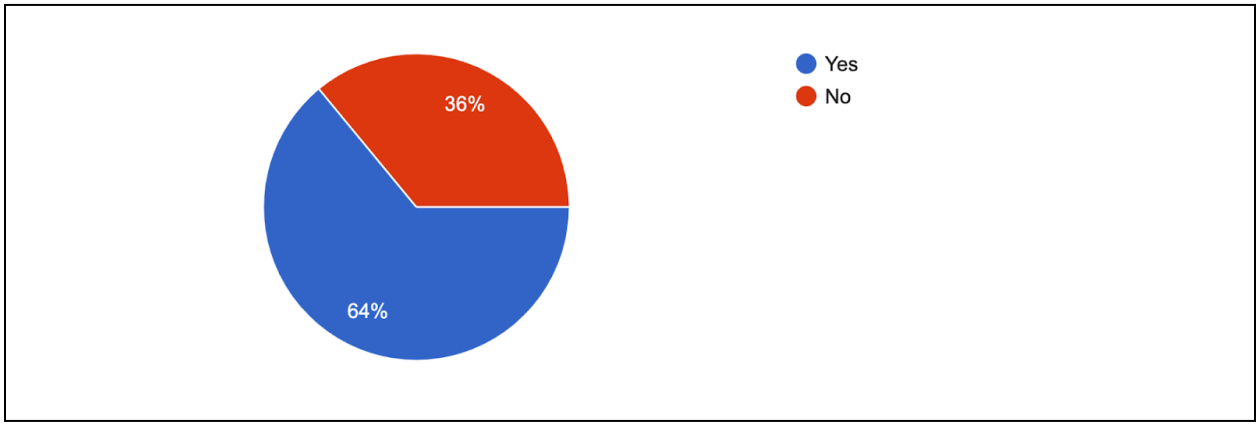
1.2 - Athlete Survey - 50 respondents

Figure 4 - On average, how tired/exhausted do you feel after playing a school sports game? (1 = not tired; 5 = exhausted)



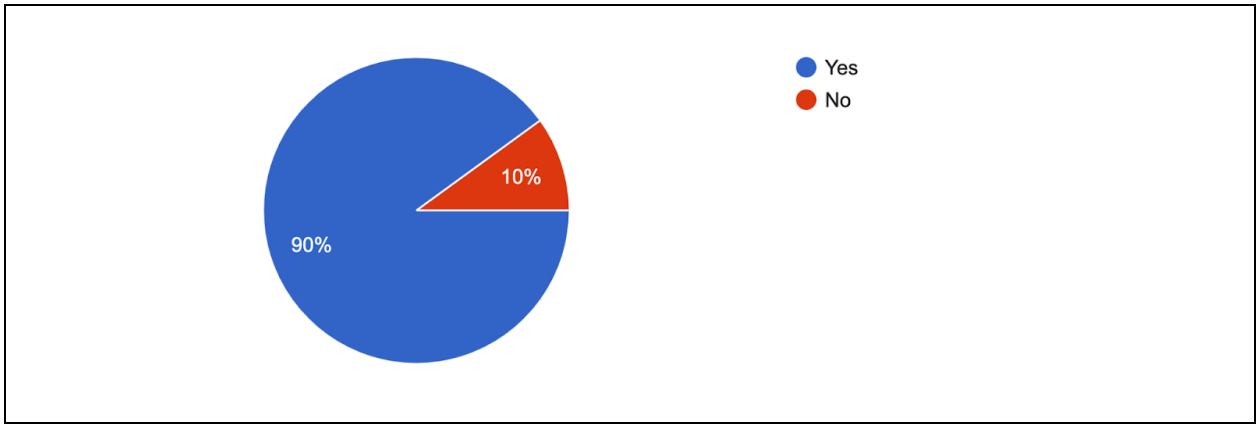
Of the 50 high school student-athletes that responded, 94% displayed their average perceived exertion rates after a game as a 3 or above (Fig. 4). On this scale, only 1/50 (2%) selected "1", 2/50 (4%) selected "2", 24/50 (48%) selected "3", 13/50 (26%) selected "4", and 10/50 (20%) selected "5" (Fig. 4).

Figure 5 - Have you ever drunk an energy drink to try to increase your stamina/energy?



The vast majority, 64% of highschool athletes selected "Yes" to drinking energy drinks in attempt to increase stamina or energy, while only 36% selected "No" (Fig. 5). This demonstrates the higher consumption rate of energy drinks among athletes when compared to the earlier revealed 44% of high school non-athletes who consume energy drinks (Fig. 1).

Figure 6 - Would you purchase and supplement with fruit juice over an energy drink if you discovered they were equally effective?



2.1 - Participant Experiment: Maximum Strength

Table 2 - Maximum Strength Output Values

Participant	Placebo (sprint, leg press, leg extension)	ED (1 time) (sprint, leg press, leg extension)	FJ (1 time) (sprint, leg press, leg extension)	Percent Change (Sprint)	Percent Change (Leg press)	Percent Change (Leg extension)
1	6.01 s 130 lbs 100 lbs	6.27 s 110 lbs 110 lbs	5.55 s 110 lbs 110 lbs	ED: -4% FJ: +7%	ED: -15% FJ: -15%	ED: +10% FJ: +10%
2	10.72 s 90 lbs 60 lbs	10.63 s 110 lbs 60 lbs	11.04 s 110 lbs 70 lbs	ED: +0.8% FJ: -3%	ED: +22.2% FJ: +22.2%	ED: 0% FJ:+16.7%
3	7.43 s 150 lbs 60 lbs	7.41 s 160 lbs 70 lbs	7.05 s 180 lbs 80 lbs	ED: +0.3% FJ: +5%	ED: +6% FJ: +20%	ED: +16% FJ: +33%
4	7.01 s 130 lbs 70 lbs	6.73 s 140 lbs 70 lbs	5. 98 s 140 lbs 80 lbs	ED: +3% FJ: +14%	ED: +7% FJ: +7%	ED: 0% FJ: +14%

5	8.05 s 130 lbs 90 lbs	7.59 s 130 lbs 90 lbs	6.11 s 150 lbs 100 lbs	ED: +5% FJ: +24%	ED: 0% FJ: 15%	ED: 0% FJ: +11%
6	10.55 s 70 lbs 30 lbs	9.47 s 70 lbs 60 lbs	8.93 s 80 lbs 60 lbs	ED: +10% FJ: 15%	ED: 0% FJ: +14%	ED: +100% FJ: +100%
7	6.58 s 120 lbs 60 lbs	6.41 s 130 lbs 70 lbs	6.44 s 140 lbs 50 lbs	ED: +2.6% FJ: +2.1%	ED: +8.3% FJ: +16.7%	ED:+16.7% FJ: -16.7%
8	6.31 s 90 lbs 50 lbs	6.28 s 100 lbs 50 lbs	6.11 s 110 lbs 60 lbs	ED: +0.5% FJ: +3.2%	ED: +11.1% FJ: +22.2%	ED: 0% FJ: +20%
9	7.63 s 80 lbs 50 lbs	7.55 s 90 lbs 60 lbs	7. 59 s 90 lbs 40 lbs	ED: +1% FJ: +0.5%	ED: +12.5% FJ: +12.5%	ED: +20% FJ: -20%
10	8.73 s 80 lbs 60 lbs	8.82 s 90 lbs 50 lbs	8.71 s 90 lbs 70 lbs	ED: +1% FJ: +0.2%	ED: +12.5% FJ: +12.5%	ED: -16.7% FJ: +16.7%
11	7.04 s 90 lbs 70 lbs	7.13 s 100 lbs 60 lbs	6.91 s 100 lbs 70 lbs	ED: -1.3% FJ: +1.8%	ED: +11.1% FJ: +11.1%	ED: -14.3% FJ: 0%
12	7.31 s 50 lbs 150 lbs	7.42 s 60 lbs 150 lbs	7.28 s 60 lbs 160 lbs	ED: -1.5% FJ: +0.4%	ED: +20% FJ: +20%	ED: 0% FJ: +6.7%
Avg.				ED: +1.5% FJ: +5.9	ED: +8% FJ: +13.2%	ED: +11% FJ: +16%

For the outputs displayed in the table for each participant, values go in the order of sprint time, leg press weight, and then leg extension weight. Out of 12 participants, after consuming the fruit juice in comparison to the energy drink, 8/12 (66.7%) showed faster sprint speeds by at least 0.5%, 2/12 (16.7%) showed slower speeds by at least 0.5%, and 2/12 (16.7%) displayed no significant change (Table 2). For the leg press, the fruit juice, when compared to the energy drink, improved maximum strength by at least 0.5% for 5/12 (41.7%), decreased strength for 0/12 (0%), and displayed no significant change for 7/12 (58.3%) (Table 2). For the leg extension, the fruit juice, when compared to the energy drink, noticeably improved maximum strength for 8/12 (66.7%), decreased maximum strength for 2/12 (16.7%), and remained relatively unchanged for 2/12 (16.7%) (Table 2). When comparing the fruit juice and energy drink results to the placebo drink, the average percent change across all 3 activities was greater for the fruit juice by an average of 4.9% (Table 2).

2.2 - Participant Experiment: Perceived Exertion

Table 3 - Perceived Exertion Rates

Participant	Game 1 (1-time ED)	Game 2 (1-time FJ)	Game 3 (ED throughout)	Game 4 (FJ throughout)
Average	3.1	2.3	3	2.1

Perceived exertion rates across all 4 games were relatively similar, with slight improvements in the fruit juice trials. The average perceived exertion rates for the games in the supplementation order of 1-time energy drink, 1-time fruit juice, energy drink throughout, fruit juice throughout: 3.1, 2.3, 3, 2.1 (Table 3). Rates slightly varied between repeated and 1-time supplementation of the same drink. While the differences were not drastic, fruit juice was more effective than the energy drink in both sets of trials.

DISCUSSION

Prior to conducting this research, I hypothesized that acute supplementation of 100% fruit juice would improve speed, maximum strength, and post-game perceived exertion. The findings of this research fully support this portion of my hypothesis. Further, I hypothesized that repeated supplementation throughout games - during warm-ups, halftime, and water breaks - would further improve efficiency. The results displayed that the repeated supplementation trials yielded relatively equal results to the 1-time supplementation trials, but ultimately were deemed more effective. The general survey supported previous research discussing high rates of energy drink consumption in high schoolers, with 44% of respondents displaying that they consume these harmful drinks (Fig. 1). With the experimental portions of this research, consuming fruit juice prior to a workout or game displayed a positive effect on speed, strength, and perceived exertion. Relating to caffeine tolerance, Higgins et al., previously mentioned, describe the tolerance that the human body builds to caffeine when regularly consumed (Higgins et al. 2010). This evidence further supports the benefits of replacing caffeinated drinks, as fruit juice leaves a sustained effect, along with the newly evidenced acute effects. This evidence would be beneficial for high school athletes to be aware of, as fruit juice overall improved performance more than energy drinks. As previously discussed, there are a variety of dangers that are associated with the consumption of energy drinks, so the findings of this paper could work toward the shift from energy drinks to fruit juice as a supplement to increase performance. As displayed in the results, at least 58% of participants increased performance in speed and maximum strength when consuming fruit juice compared to energy drinks, which could be due to the high concentration of polyphenols positively acting on muscle groups throughout the body (Table 2). However, it is important to note that nutritional confounders, such as sugar and carbohydrate content, were not analyzed in this research and could also be responsible for the evident ergogenic benefits of the fruit juice. As previously determined when discussing the various beverage compositions, the tangerine juice has a significantly higher sugar and carbohydrate content compared to both the placebo and energy drink (Table 1). The National Library of Medicine describes that

"carbohydrate is the substrate most efficiently metabolized by the body and the only macronutrient that can be broken down rapidly enough to provide energy during periods of high-intensity exercise when fast-twitch muscle fibers are primarily relied upon" (Kanter 2018). To support this information, the World Sugar Research Organization explains the process in which carbohydrates supply energy: The body stores carbohydrates in the muscles and liver as glycogen, which can be broken down into glucose to supply energy and maintain stable blood sugar levels. Because these glycogen stores are limited, the body must rely more on fat for energy as they are depleted, which provides energy at a slower rate (Wittekind 2024). With a carbohydrate count of 25 grams per serving (Table 1), tangerine juice is a quick source of carbohydrates that can help replenish glucose and support higher-intensity performance. Moving forward, the results displayed a more significant increase for fruit juice in comparison to energy drinks for the maximum speed and strength tests compared to perceived exertion. It is also important to note that 5 subjects reported stomach pains or undesirable feelings of anxiousness when consuming the energy drink for the perceived exertion portion of the experiment. Moreover, out of the 50 high school athletes surveyed, 64% have attempted to increase performance by supplementing with an energy drink. This displays how high school athletes actively seek ways to improve their energy levels and can benefit from a safe and effective supplement. Further, out of the 50 high school athletes surveyed, 90% displayed that they would choose fruit juice over an energy drink if they were found to be equally effective. With the findings of this paper concluding that fruit juice has been deemed more effective across a range of events, along with the immense recovery aspects and minimal presence of health hazards, the transition between supplements is very likely if made aware to athletes. In conclusion, the implications of the results and findings of this research paper are that consuming fruit juice before a workout or game would have an even greater benefit on performance aspects when compared to the more commonly consumed, yet extremely harmful, energy drinks.

Upon analyzing this research, acknowledging its limitations is important. While my research began with almost 30 participants for the volunteer experimental portions, only 12/30 of the participants completed the experiments in the end. For the maximum strength portion of the experiment, 11/12 of the participants were female, with only 1 male. Similarly, for the perceived exertion portion, all participants were female. It is important to note that the female cycle could have impacts on performance, as fluctuations in hormones across the female menstrual cycle can influence energy levels, strength, coordination, and recovery. In addition, for the perceived exertion trials, participants had to actively participate in a school sport, which made it difficult to gather a larger group of volunteers. These aspects limit the pool of results, as the deviation of results between genders, if any, could not be determined. It is also important to acknowledge that the subjects were all from the same school and consisted of a short range of athleticism. Yet, due to the consistency of the research results, a larger volunteer pool is likely to produce results consistent with this research.

Moreover, supplement variety throughout the experiment was limited to only one source of caffeine and one source of fruit juice, even though there is a wide variety of both available. Different types of fruits are likely to react differently with muscles and performance. There are a variety of different sugars, antioxidants, polyphenol contents, electrolytes, and vitamins that are found throughout different

fruits, which could likely yield various results. Some of these components better support recovery, immediate performance, immunity, repair, or growth and function. In addition, everyone reacts differently and has a different caffeine tolerance, which should be more closely researched in the future. Further, the maximum strength portion of this research focused heavily on lower-body compound lifts. Thus, a wider range of subjects and supplements, along with a longer time frame to perform a variety of upper body lifts, could provide a more cohesive review of the various effects of fruit juice and energy drinks on performance. However, these limitations do not prevent the hypothesis of this paper from being proved through effective evidence.

As previously discussed, the diversity in the participant pool was limited in the aspects of demographics—mainly gender, age, and a short but varied range of athletic abilities. In order to fully understand the effects of fruit juice and energy drinks on performance, further research should be conducted to fill these existing gaps. Similar methods and procedures should be carried out, but should include a variety of males and females, professional athletes, and various age groups. Various sources of supplementation should also be tested, including a mix of fruit juices, whole fruits, freeze-dried fruits, and different caffeinated energy drinks. Fruit juice can also be compared to electrolyte-based sports beverages, which are designed to improve performance but were not tested in this research. Regarding the events tested, future research should also focus on assessing the effects of these multiple supplements on upper-body compound lifts, as these movements may yield different results. To further implicate the findings of this research, fruit juice, while a slight additional cost, should be more widely available at sports games on all levels for athletes. For example, the findings of this research can be used to create a powder supplement that is added to water to allow for easier accessibility and wider use. This research can be presented to corporations that sponsor athletes in the field of performance supplements to raise their popularity. Similarly, fruit juice can be marketed in more appealing ways to young athletes, such as featuring sporting events, similar to the way energy drinks and sports drinks currently do. With the support of professional athletes and businesses, funding, and advertising, the transformation to fruit juice can be fully implicated in the realm of sports, saving lives, improving overall health, and improving performance across a wide athletic spectrum.

CONCLUSION

This extensive research has established that athletes seek ways to improve their performance, commonly resorting to energy drinks. These caffeinated energy beverages have displayed significant beneficial effects on athletic performance through a range of events. However, these drinks have proven to pose several health hazards, mostly attributed to the high caffeine dosages. As previously discussed, serious dangers are associated with the consumption of energy drinks, including life-threatening arrhythmia and, in some cases, lethal consequences. But, due to the extensive performance-enhancing effects, athletes of all ages continue to consume these.

Another supplement that has been severely underutilized is 100% fruit juice. There exists a wide variety of fruit juices that contain compounds known as polyphenols and antioxidants that react with several parts

of the body to enhance recovery and performance when supplemented over a period of time. Due to the lower consumption of fruit juice for performance enhancement, many gaps exist in this area of research. A substantial gap that presented itself was the acute, 1-dose supplementation effects of fruit juice. This research sought to fill this gap, focusing on the high school cohort.

The results of this research solidified the athletic enhancements that fruit juice provides by displaying its effects through acute supplementation on high school students. Through various exercises—sprints, leg press, leg extension, and post-game exertion—the results have proven that fruit juice is even more effective than energy drinks, on top of being a healthier and safer supplement. Hence, athletes seeking to improve their performance should be cautious of the supplements they consume and should highly consider the transition from caffeine-based energy drinks to 100% pure fruit juice.

To further enhance research on this topic, future experiments should be tested with mixed fruit juices, whole fruits, and dried fruits, along with broadening the age and demographics of the subjects to create a holistic review of the performance effects.

REFERENCES

Ali Redha, Ali, et al. "Blackcurrants: A Nutrient-Rich Source for the Development of Functional Foods for Improved Athletic Performance." *Food Reviews International*, 31 Dec. 2022, pp. 1–23, https://doi.org/10.1080/87559129.2022.2162076.

Alsunni, Ahmed Abdulrahman. "Energy Drink Consumption: Beneficial and Adverse Health Effects." *International Journal of Health Sciences*, vol. 9, no. 4, 9 Oct. 2015, pp. 468–474, pmc.ncbi.nlm.nih.gov/articles/PMC4682602/.

American Heart Association. "Sugary Drinks, Fruit Juices Linked to Higher Risk of Developing Type 2 Diabetes among Boys." *American Heart Association*, 2024, newsroom.heart.org/news/sugary-drinks-fruit-juices-linked-to-higher-risk-of-developing-type-2-diabetes-among-boys. Accessed 9 Jan. 2026.

Aucouturier, Julien, et al. "Effect of Dietary Nitrate Supplementation on Tolerance to Supramaximal Intensity Intermittent Exercise." *Nitric Oxide*, vol. 49, Sept. 2015, pp. 16–25, https://doi.org/10.1016/j.niox.2015.05.004. Accessed 26 Jan. 2020.

Cao, Diana X., et al. "Energy Drink-Associated Electrophysiological and Ischemic Abnormalities: A Narrative Review." *Frontiers in Cardiovascular Medicine*, vol. 8, 1 July 2021, https://doi.org/10.3389/fcvm.2021.679105.

Chen, Qi, et al. "The Dose Response of Taurine on Aerobic and Strength Exercises: A Systematic Review." *Frontiers in Physiology*, vol. 12, 18 Aug. 2021, https://doi.org/10.3389/fphys.2021.700352.

Costantino, Andrea, et al. "The Dark Side of Energy Drinks: A Comprehensive Review of Their Impact on the Human Body." *Nutrients*, vol. 15, no. 18, 9 Sept. 2023, p. 3922, www.mdpi.com/2072-6643/15/18/3922, https://doi.org/10.3390/nu15183922.

Del Coso, Juan, et al. "Effects of a Caffeine-Containing Energy Drink on Simulated Soccer Performance." *PLoS ONE*, vol. 7, no. 2, 14 Feb. 2012, p. e31380, https://doi.org/10.1371/journal.pone.0031380.

Domínguez, Raúl, et al. "Effects of Beetroot Juice Supplementation on Cardiorespiratory Endurance in Athletes. A Systematic Review." *Nutrients*, vol. 9, no. 1, 6 Jan. 2017, p. 43, www.ncbi.nlm.nih.gov/pmc/articles/PMC5295087/.

---. "Effects of Beetroot Juice Supplementation on Intermittent High-Intensity Exercise Efforts." *Journal of the International Society of Sports Nutrition*, vol. 15, no. 1, 5 Jan. 2018, www.ncbi.nlm.nih.gov/pmc/articles/PMC5756374/, https://doi.org/10.1186/s12970-017-0204-9.

Ghusn, Wissam, et al. "The Impact of Artificial Sweeteners on Human Health and Cancer Association: A Comprehensive Clinical Review." *Cureus*, vol. 15, no. 12, 29 Dec. 2023, https://doi.org/10.7759/cureus.51299.

"Energy Drink Sales | Statista." *Statista*, Statista, 2023, www.statista.com/statistics/558022/us-energy-drink-sales/.

Gutiérrez-Hellín, Jorge, and David Varillas-Delgado. "Energy Drinks and Sports Performance, Cardiovascular Risk, and Genetic Associations; Future Prospects." *Nutrients*, vol. 13, no. 3, 24 Feb. 2021, p. 715, www.ncbi.nlm.nih.gov/pmc/articles/PMC7995988/, https://doi.org/10.3390/nu13030715.

Higgins, John P., et al. "Energy Beverages: Content and Safety." *Mayo Clinic Proceedings*, vol. 85, no. 11, Nov. 2010, pp. 1033–1041, www.mayoclinicproceedings.org/article/S0025-6196(11)60094-3/pdf, https://doi.org/10.4065/mcp.2010.0381.

Kanter, Mitch. "High-Quality Carbohydrates and Physical Performance." *Nutrition Today*, vol. 53, no. 1, 2018, pp. 35–39, www.ncbi.nlm.nih.gov/pmc/articles/PMC5794245/, https://doi.org/10.1097/NT.0000000000000238.

Kuehl, Kerry S, et al. "Efficacy of Tart Cherry Juice in Reducing Muscle Pain during Running: A Randomized Controlled Trial." *Journal of the International Society of Sports Nutrition*, vol. 7, no. 1, 7 May 2010, https://doi.org/10.1186/1550-2783-7-17.

Landsverk, Tyler Lauletta, Gabby. "A College Basketball Player Drank 6 Monster Energy Drinks While Chasing "Caffeine-Induced Euphoria." a Dietitian Explains Why That's a Bad Idea." *Business Insider*, www.businessinsider.com/matthew-mayer-he-suffered-caffeine-poisoning-after-drinking-6-monsters-2023-3.

MacDonald, N., et al. ""Caffeinating" Children and Youth." *Canadian Medical Association Journal*, vol. 182, no. 15, 26 July 2010, pp. 1597–1597, https://doi.org/10.1503/cmaj.100953.

Malik, Vasanti. "Are Certain Types of Sugars Healthier than Others? - Harvard Health Blog." *Harvard Health Blog*, 20 Oct. 2023, www.health.harvard.edu/blog/are-certain-types-of-sugars-healthier-than-others-2019052916699.

Mohammed, Ali, et al. "Knowledge, Consumption Pattern, and Adverse Effects of Energy Drinks among Asian Population: A Cross-Sectional Analysis from Malaysia." *ProQuest*, 2022, www.proquest.com/docview/2651414928/abstract/59879F50D50A486FPQ/1?accountid=50218, https://doi.org/10.1155/2022/3928717.

Nguyen, Michelle, et al. "Consumption of 100% Fruit Juice and Body Weight in Children and Adults: A Systematic Review and Meta-Analysis." *JAMA Pediatrics*, vol. 178, no. 3, 16 Jan. 2024,

jamanetwork.com/journals/jamapediatrics/article-abstract/2813987, https://doi.org/10.1001/jamapediatrics.2023.6124.

Padilla, Roxanna. "What's the Latest Buzz on Energy Drinks?" *Mayo Clinic Health System*, Mayo Clinic Health System, 18 Sept. 2025, www.mayoclinichealthsystem.org/hometown-health/speaking-of-health/the-buzz-on-energy-drinks.

Mago, Rajnish. "Caffeine Content of "Energy Drinks."" *Simple and Practical Mental Health*, simpleandpractical.com/caffeine-content-energy-drinks/#:~:text=Monster%20Energy%20comes%20in%20a.

"More Bang for Your Buck: Caffeine Content of Bang Energy Drinks." *Cafely, Cafely*, 5 Sept. 2024, cafely.com/blogs/info/caffeine-in-bang-energy-drink.

Safer, Abdel-Majeed. "Polyphenol - an Overview | ScienceDirect Topics." *Www.sciencedirect.com*, 2013, www.sciencedirect.com/topics/food-science/polyphenol.

"Showing All Polyphenols Found in Tangerine, Juice from Concentrate - Phenol-Explorer." *Phenol-Explorer.eu*, 2015, phenol-explorer.eu/contents/food/21.

"Spilling the Beans: How Much Caffeine Is Too Much?" *U.S. Food and Drug Administration*, 28 Aug. 2024, www.fda.gov/consumers/consumer-updates/spilling-beans-how-much-caffeine-too-much.

"Sugary Drinks, Fruit Juices Linked to Higher Risk of Developing Type 2 Diabetes among Boys." *American Heart Association*, 2024, newsroom.heart.org/news/sugary-drinks-fruit-juices-linked-to-higher-risk-of-developing-type-2-diabetes-among-boys?utm. Accessed 9 Jan. 2026.

"The Buzz on Energy Drinks." *School Nutrition*, 4 Dec. 2024, www.cdc.gov/school-nutrition/energy-drinks/?CDC_AAref_Val=www.cdc.gov/healthyschools/nutrition/energy.htm.

Valder, Sarah, et al. "The Influence of a Polyphenol-Rich Red Berry Fruit Juice on Recovery Process and Leg Strength Capacity after Six Days of Intensive Endurance Exercise in Recreational Endurance Athletes." *Nutrients*, vol. 16, no. 10, 1 Jan. 2024, p. 1428, www.mdpi.com/2072-6643/16/10/1428, https://doi.org/10.3390/nu16101428.

Wittekind, Anna. "Sugars and Sports Performance." *World Sugar Research Organisation*, 2024, wsro.org/sugars-health/sugars-and-sports-performance.