Female High School Athletes Regularly Consume Energy Drinks with Moderate and High Caffeine Content

Original Research

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Abstract

Introduction: The consumption of energy drinks can result in unhealthy caffeine intake for children. The objective of this study was to better understand energy drink consumption in young female athletes.

Methods: A cross-sectional questionnaire-based study on self-reported energy drink prevalence and perception of a convenience sample (n=203) of U.S. female high school athletes (age 15.9±1.1 years).

Results: Of the athletes responding, 64.5% reported use of an energy drink at some time during the last 12-months. Of this group, >25% reported using energy drinks 3-4 times a week or more. Roughly half of the athletes reported using energy drinks with a high caffeine content (~150-300 mg/serving), and they reported more positive opinions about caffeine's potential (negative) side effects compared to athletes not using energy drinks.

Conclusions: A majority of female high school athletes reported the regular use of energy drinks, including those with a high caffeine content, and athletes that reported higher dose usage expressed more positive opinions about the side effects of energy drinks. High schools should include discussion about energy drinks as part of healthy lifestyle education, allowing athletes to make safe choices about the use of such products.

Key Words: Dietary supplements, sports nutrition, caffeine intake

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Introduction

Energy drinks are beverages, with or without sugar, that usually contain caffeine and other ingredients, such as taurine, glucuronolactone, and a variety of B vitamins.[1] The main active ingredient in most energy drinks is caffeine, which is suggested to boost physical and mental performance, increase alertness, and reduce fatigue.[2,3] As the market has seen an increase in energy drinks with a high caffeine content (150-300 mg per 250 mL serving), the athlete's consumption might easily exceed the safe upper limit of 2.5 mg/kg bodyweight [1,4], or about 140 mg per day for a young female athlete weighing about 124 lbs. For children, the American Medical Association suggests a lower limit of 100 mg per day.[5–7] This age group is highly susceptible to advertising campaigns [8], and based on a study gathering consumption data for energy drinks in 16 countries of the European Union, it was concluded that young people aged 10–18 years had the highest reported consumption prevalence (68%) when compared with adults older than 18 years (30%) and children under 10 years (18%).[9] Overall, the total caffeine intake in the US for the age group 12-19 years between 1999 and 2010 did not increase [10], and a stable percentage for caffeine containing beverages has been reported at ~75% with average caffeine intake among users

ranging between 41-110 mg/day as shown in Table 1.[10–13] At the same time, the prevalence of energy drink consumption in the U.S. has increased significantly between 2003 and 2016 [14], with numbers ranging from ~5-16% of U.S. high school students reporting the consumption of energy drinks at least once a week.[15–18] Participating in competitive sports can be an important reason for athletes to consume energy drinks [9], and especially the sugar free energy drinks with a high level of caffeine that are marketed to females.[19] It is often assumed that boys consume more energy drinks than girls [19], but specifically not much is known about the consumption level of young females participating in competitive sports.

Table 1. Overview of caffeine intake (mg/day) in high school age kids and adolescents in the US.

Age (years), or type	Percentage consuming caffeine	Mean intake among consumers	Mean intake including non-consumers	Source	Reference
12-19	75±2	41 (Mdn)	14 (Mdn)	NHANES 2009-2010	Ahluwalia et al. 2014[11]
12-16	75±1	68±2	--	NHANES 1999-2010	Branum et al. 2014[10]
17-18	76±1	110±7			
13-17	83 (Avg)	83±2	--	7-day beverage diary 2010-2011	Mitchell et al. 2014[12]
Female Adolescents	--	47 (Avg)	--	NHANES 2005-2006	Somogyi 2010[13]
Male Adolescents		70 (Avg)			

Results are presented as average ± standard deviation (sd) or as Avg= average or Mdn= median only; -- reflects not reported data or results that could not be retrieved.

Although sports nutrition guidelines promote evidence-based practice, and studies on self-reported food and fluid intake help to create a better understanding how to apply current guidelines, females have been inadequately included in sports science research.[20,21] This warrants a look closer at energy drink in young female athletes for several reasons. 1) Energy drinks are popular among teens and adolescents [14], but energy drink consumption in female athletes may be higher than previously reported in normal U.S. high school students because of their athletic focus. 2) Energy drink consumption may result in high caffeine intake exceeding the recommendations and safety guidelines established by health organizations. 3) Because they might consider some of the negative side effects (e.g., sleep deprivation) as positive, for example, when more focused cognition is desired (e.g., for high exam scores and passing courses). 4) Despite clear mandatory label regulations stating that energy drinks are not intended or recommended for children under the age of 18, they can freely be sold at places targeting adolescents. 5) Little is known about the potential health risks for the general population, as well as adolescents, associated with the combination of multiple bioactive ingredients, such as caffeine, taurine, glucuronolactone, sugar, and other components when consumed under published safe upper limits.[22]

We therefore aimed to explore the self-reported use of energy drinks with varying levels of caffeine among female high school athletes to better understand their perceptions of energy drinks in relation to their preferred level of caffeine content. This is a unique perspective, as earlier studies questioned only about energy drink frequency in general.[23,24]

Scientific Methods

Participants

A convenience sample was collected by targeting ~750 female high school athletes from three public high schools in Long Island, NY, U.S.A., from February 8 to March 13 in 2021. We used a mixed recruitment approach via email and social media. Based on a confidence level of 95%, with a margin of error of 10% and a population proportion of 50%, we aimed for a minimum sample size of n=96 student-athletes.

Sayville School Research IRB Committee from Sayville High School, Long Island, NY, approved the study (2022-APR100010200). No personally identifiable information was collected, and before completing the survey, respondents were required to affirm that they were given parent or guardian consent to complete the survey by checking a box marked, "Yes." No incentive was provided. The IRB at Arizona State University approved the final protocol for data analysis (STUDY000016238).

Protocol

During the development of the questionnaire, two sports nutrition experts were consulted to ensure content validity. The questionnaire was then pilot tested by six high school students. Feedback was specifically sought on the length (duration was approximately 4 min) and content. The 13 questions included in this study, with the number of questions per category in parenthesis, were organized as follows: Demographics, such as age, sport, and sport activity intensity (#3); energy drink consumption of moderate or high caffeine-based drinks, and number of energy drinks on a consumption day over the past 12 months (#3); consumption of other caffeine holding beverages, including coffee (75-95 mg/serving), black or green tea (47 or 25 mg/serving), soda with caffeine (20-37 mg/serving) and kombucha (10-15 mg/serving) (#1) [25], all listed in Table 2; and perceptions of energy drinks (#6) that have been listed in Table 3. The questionnaire, using Google Forms, was distributed directly to students via email, and by using social media (i.e., Facebook, Snapchat, and Instagram). This research aimed to investigate energy drink consumption and perceptions of female student-athletes, and what type of energy drink they preferred to use over the past year. For this purpose, energy drinks were classified as "moderate" when they contained 80 mg of caffeine per 250 mL serving, reflecting traditional energy drinks (such as Red Bull and Monster) or as 'high" when holding ~150-300 mg of caffeine per 250 mL serving (such as Bullet and Celsius). Based on their answers, respondents were divided in four categories: non-users, users of energy drinks primarily with a moderate caffeine content, users of both energy drinks with a moderate and a high caffeine content, and users of energy drinks with a high caffeine content.

Statistical Analysis

For data analysis, data were exported from Google Forms (Google LLC, Mountain View, CA, USA) into SPSS (version 28, IBM SPSS Statistics, Armonk, NY, USA) for analysis. Participants were excluded if they did not fit into the inclusion criteria (i.e., not checking the box for parental consent, not being a female student-athlete, not attending high school in the Long Island area, or if they answered the survey incompletely). The categorical data were checked for normality and presented as total or grouped data as average and standard deviation or number (n) and percentage (%). Differences between subgroups were analyzed using a Kruskal-Wallis, resulting in reporting the test statistic H, degrees of freedom (3), and significance, and pairwise comparisons using Dunn's test. P-values for significance were set at ≤ 0.05.

Results

Two hundred thirteen high school students participated in the survey. A total of 10 respondents were excluded due to not being an athlete, not obtaining parental consent, or not completing the full survey. A total of 203 female high school athletes, age 15.9±1.1 years, completed the full survey. Most of them (72%) exercised 5-7 days a week and performed vigorous exercise (81%), as shown in Table 2. A total of 65% (n=132) of the female high school athletes reported the use of energy drink(s) during the last 12 months. Female athletes reporting the use of energy drinks exercised more frequently on a weekly basis ($H(3)=13.688$, $P=0.003$), while also more frequently reporting vigorous exercise ($H(3)=9.036$, $P=0.029$) compared to those not reporting the use of energy drinks.

Regardless of the type of energy drink (with a moderate or a high caffeine content) and the frequency of energy drink use, half of the athletes' reported using coffee (51%), soda with caffeine (46%), and/or black or green tea (31%). Notably, coffee use was reported more frequently in female athletes who reported the use of energy drinks with a high amount of caffeine ($H(3)=9.775$, $P=0.021$). A total of 35% (n=71) of athletes reported not consuming energy drinks. The consumption of moderate ($H(3)=183.327$, $P<0.001$) or highly caffeinated ($H(3)=135.895$, $P<0.001$) beverages differed between each of the four categories listed in Table 2. The number of respondents that consumed energy drinks at least once a week or more (≥1-2 times a week) differed between the three stratifications for energy drink consumption (i.e., users of energy drinks with a moderate caffeine content, users of both energy drinks with a moderate and a high caffeine content, and users of energy drinks with a high caffeine content), as shown in Table 2. In the group that reported only the use of "moderate caffeine energy drink," 16% reported consuming these drinks 1-2 times a week, and an additional 5% reported consumption 3-4 times a week. In the group that reported using both moderate and highly caffeinated energy drinks a total of 38% consumed energy drinks with moderate caffeine content 1-2 times a week, while 6% reported consuming these drinks 3-5 times a week. Additionally, 29% reported the use of energy drinks with high caffeine 1-2 times a week, 19% used them 3-4 times a week, and 5% consumed them 5-7 times a week. Finally, the group using only "high caffeine energy drink," a total of 34%, reported drinking high caffeine drinks 1-2 times a week, whereas 6% reported drinking them 3-4 times a week, and 8% consumed them 5-7 times a week.

We asked how many energy drinks they consumed when they decided to consume energy drink(s). They reported consuming 1.1±0.4 energy drinks per day, ranging from 1-3 drinks total, with a significant majority of athletes (88%) consuming only 1 drink on a consumption day ($H(3)=111.070$, $P<0.001$).

Overall, roughly half of the female athletes (50.5%, n=103) thought that an energy drink with a high caffeine content provides more energy compared to a drink with moderate caffeine content (Q1). Respondents that reported consuming primarily moderate caffeinated energy drinks were less sure about this proposition, than those reporting the use of energy drinks with a high caffeine content, driving the significant difference between groups ($H(3)=9.273$, $P=0.026$). However, self-reported perceived effects of energy drinks differed between users and non-users of these drinks (Table 3). The general perception of half of the females (50.5%, n=103) was that side effects of energy drinks with a high caffeine content are worse than that of energy drinks with a moderate caffeine content (Q2). In contrast users of high caffeine energy drinks (n=103) less often reported that they feel that these highly dosed energy drinks have more side effects (i.e., 36% for users of both types of energy drinks, and 41% for users of energy drinks with a high caffeine content alone, respectively), resulting in a significant difference between groups ($H(3)=16.069$, $P=0.001$). When asked if energy drinks with a moderate (Q3) or high (Q4) caffeine content have a positive effect on performance, the users of highly caffeinated energy drinks (i.e., a combination of moderate and high caffeinated and high caffeine drinks alone) reported in the affirmative ($H(3)=38.660$, $P<0.001$, and $H(3)=20.377$, $P=0.002$, respectively). Finally, when asked if energy drinks with a moderate (Q5) or high (Q6) caffeine content have a positive effect on cognition, again the users of highly caffeinated energy drinks report the highest percentage for a positive effect ($H(3)=14.502$, $P=0.002$, and $H(3)=11.912$, $P=0.008$, respectively).

Discussion

This study shows that 65% of this group of female high school athletes reported the use of energy drink(s) at some point during the last 12 months. One-fifth of the athletes frequently used energy drinks with moderate amount of caffeine alone, whereas roughly half of the athletes reported using energy drinks with a high amount of caffeine or a combination of moderate and high caffeine content, and that they consumed energy drinks at least once a week. A unique finding of this reporting is that those who reported using energy drinks with a high caffeine content also more often reported a higher frequency of use on a weekly basis. Most athletes reported consuming one energy drink on a consumption day, but 1 out of 10 high school athletes reported drinking two or three beverages on days they consumed an energy drink. Users of energy drinks with a high caffeine content were more positive, or less concerned, about caffeine's potential (negative) side effects or its impact on their athletic or cognitive performance than athletes who reported not using energy drinks.

The reported frequency of combined energy drink use was substantially higher than the earlier reported range of 5-16% in U.S. high school students [15–18], but consistent with European data reporting a 63% female energy drink use [9], and previously reported 54% in a mix of male and female collegiate U.S. athletes.[26] This study adds to our knowledge showing that 31% of the full sample (or 47% of all energy drink users) reported the use of energy drinks at least once a week, which is much higher than earlier reported by non-student athlete boys, reporting values ranging from 7%[18] up to 22%.[16]

The average caffeine consumption in this age group has previously been estimated to be 14 mg/day and 41 mg/day for consumers of caffeine containing products [11], up to even 110 mg/day.[10] The majority of athletes reporting energy drinks in this study also reported the use of a wide range of caffeine containing beverages, with the average reported coffee (51%), and caffeine containing soda (46%) that was higher, but tea (31%) in a similar range than previously reported in children and adolescents reporting coffee in a range of ~10-25%, soda ~25-30%, and tea in a range of 40-60%.[10] Important is to state that the actual prevalence of other caffeine containing drinks was higher in the high school athletes that also reported the use of highly caffeinated energy drinks. As a result, when adding up the regular daily caffeine intake and the consumption of an energy drink during the day, the daily caffeine intake in the current sample of high school athletes could easily increase to a range of ~120-340 mg depending on the type and number of energy drinks consumed.

Due to the high caffeine content per serving of energy drinks (ranging from 80 mg in traditional "moderate" toward 150-300 mg in the higher dose drinks per 250 mL), the actual caffeine consumption in this sample, on days that they consume energy drink(s), may be higher than the previously discussed 41-110 mg/day caffeine consumption in the high school athletes in the current sample. Despite the fact that low to moderate consumption is part of the young athletes' diet, the consumption of (multiple or high dosed) energy drinks may be a subject of concern. The literature consistently reports two safe upper limits (UL) for caffeine in children that are substantially lower than the recommended UL for adults of 400-500 mg/day.[6,7] The most conservative UL suggest a caffeine consumption in children ≤100 mg/day.[27]

Table 2. Participant demographics and consumption of (energy) drinks for all (n=203) and stratified groups based on type of energy drink(s) consumed.

	All	No energy drink [a]	Moderate caffeine energy drink[b]	Both moderate and high caffeine energy drink[c]	High caffeine energy drink[d]	P-value
Demographics						
Participants (n)	100% (203)	35% (71)	9% (19)	32% (64)	24% (49)	
Age (years)	15.9±1.1	15.8±1.0	15.9±1.3	16.0±1.2	16.1±1.1	
Sports frequency						
1-2 days a week	5% (10)	6% (4)	11% (2)	6% (4)	0% (0)	
3-4 days a week	23% (47)	34% (24)[c,d]	28% (5)[d]	16% (10)[a]	14% (7)[a,b]	**0.003**
5-7 days a week	72% (146)	60% (43)	61% (12)	78% (50)	86% (42)	
Sports intensity						
Light	1% (2)	3% (2)	--	--	--	
Moderate	18% (37)	27% (19)[d]	21% (4)	16% (10)	8% (4)[a]	**0.029**
Vigorous	81% (164)	70% (50)	79% (15)	84% (54)	92% (45)	
Energy drink consumption						
Moderate caffeine (n=192)						
Never	59% (120)	100% (71)	--	--	100% (49)	
Once a year	9% (18)	--	37% (7)	18.5% (12)	--	
Once a month	16% (33)	--[b,c]	42% (8)[a,c,d]	37.5% (24)[a,b,d]	--[b,c]	**<0.001**
1-2 times a week	13% (26)	--	16% (3)	38% (24)	--	
3-4 times a week	3% (6)	--	5% (1)	6% (4)	--	
5-7 times a week	0% (0)	--	--	--	--	
High caffeine (n=200)						
Never	39.5% (80)	100% (71)	100% (19)	--	--	
Once a year	13% (26)	--	--	19% (12)	29% (14)	
Once a month	17% (35)	--[c,d]	--[c,d]	28% (18)[a,b]	23% (11)[a,b]	**<0.001**
1-2 times a week	19% (39)	--	--	29% (19)	34% (17)	
3-4 times a week	8% (16)	--	--	19% (12)	6% (3)	
5-7 times a week	3.5% (7)	--	--	5% (3)	8% (4)	
Number of drinks at an energy drink consumption day*						
Energy drinks/day (#)	1.1 ±0.4 (range 1-3)	0±0 (range 0-0)[b,c,d]	1.2±0.5 (range 1-3)[a]	1.2±0.4 (range 1-3)[a,d]	1.1±0.2 (range 1-2)[a,c]	**<0.001**
Other beverages with caffeine consumption						
Coffee	51% (104)	32% (23)	37% (7)	72% (46)	57% (28)	
Black or green tea	31% (63)	25% (18)	26% (5)	36% (23)	35% (17)	
Soda with caffeine	46% (93)	49% (35)	53% (10)	56% (36)[a,d]	27% (13)[c]	**0.021**
Kombucha	7% (14)	3% (2)	5% (1)	11% (7)	10% (5)	
Other	1% (2)	--	--	--	2% (1)	

Energy drinks were classified as "moderate" when they contained 80 mg of caffeine per 250 mL serving, reflecting traditional energy drinks (such as Red Bull and Monster) versus energy drinks classified as 'high" when they contained ~150-300 mg of caffeine per 250 mL serving (such as Bullet and Celsius). *The average of the number of energy drinks per consumption day is based on n=132 athletes reporting energy drink consumption; 88% stated they consumed 1 drink per day, 10.5% consume two drinks per day, and 1.5% consume three drinks per day at a "regular" energy drink consumption day.
Kruskal-Wallis Tests indicate significant differences between groups with P≤0.05 as significant; pairwise comparisons are indicated between columns using [a,b,c,d] in which "a" matches "no energy drink", and "b" matches "moderate caffeine energy drink", c matches "both moderate and high caffeine energy drink" that will be abbreviated below as COM, from combination, followed by d "high caffeine energy drink". Individual Dunn's pairwise comparisons per question with P≤0.05:
Sports frequency: MOD vs. HIGH: P=0.010, NO vs. MOD: P=0.034, NO vs. HIGH: P=0.001; Sports intensity: NO vs. HIGH: P=0.03; Moderate caffeinated energy drink consumption: NO vs. MOD: P<0.001, NO vs. COM: P<0.001, HIGH vs. MOD: P<0.001, HIGH vs. COM: P<0.001; High caffeinated energy drink consumption: NO vs. MOD: P=0.007, NO vs. HIGH: P<0.001, NO vs. COM: P<0.001, MOD vs. HIGH: P<0.001, MOD vs. COM: P<0.001; Number of drinks on an energy drink consumption day: NO vs. HIGH: P<0.001, NO vs. MOD: P<0.001, NO vs. COM: P<0.001; Other beverages with caffeine consumption: HIGH vs. COM: P=0.009, NO vs. COM: P=0.006.

Table 3. Perceived effect of energy drinks (ED) on energy availability, side effects, and athletic and cognitive performance for all (n=203) and stratified groups based on type of energy drink(s) consumed.

Question	Answer	All	No ED[a]	Moderate caffeine ED[b]	Both high and moderate caffeine ED[c]	High caffeine ED[d]	P-value
		n=203	n=71	n=19	n=64	n=49	
1) Do you think an energy drink with a high caffeine content provides more energy compared to an energy drink with a moderate caffeine content?	Yes	50.5% (103)	50% (36)	16% (3)	61% (39)	51% (25)	**0.026**
	No	15% (30)	18% (13)[b]	21% (4)[a,c,d]	16% (10)[b]	8% (4)[b]	
	Not sure	34.5% (70)	32% (23)	63% (12)	23% (15)	41% (20)	
2) Do you think an energy drink with high caffeine content has better or worse side effects compared to an energy drink with a moderate caffeine content?	Better	21% (43)	15% (11)	11% (2)	28% (18)	24% (12)	**0.001**
	Worse	50.5% (103)	66% (47)[c,d]	68% (13)[c,d]	36% (23)[a,b]	41% (20)[a,b]	
	Maybe	28.5% (58)	19% (13)	21% (4)	36% (23)	35% (17)	
3) Do you think the effects of an energy drink with a high caffeine content on athletic performance are positive or negative?	Positive	55% (112)	29.5% (21)	31.5% (6)	73% (47)	76% (37)	**<0.001**
	Negative	19% (39)	32.5% (23)[c,d]	31.5% (6)[c,d]	6% (4)[a,b]	12% (6)[a,b]	
	Not sure	26% (53)	38% (27)	37% (7)	21% (13)	12% (6)	
4) Do you think the effects of an energy drink with a moderate caffeine content on athletic performance are positive or negative?	Positive	42.5% (86)	30% (21)	47% (9)	61% (39)	35% (17)	**0.002**
	Negative	24% (49)	35% (25)[c]	21% (4)	16% (10)[a,d]	20% (10)[c]	
	Not sure	33.5% (68)	35% (25)	32% (6)	23% (15)	45% (22)	
5) Do you think the effects of an energy drink with a high caffeine content on cognitive performance are positive or negative?	Positive	26% (53)	10% (7)	22% (4)	41% (26)	31% (15)	**<0.001**
	Negative	49% (99)	68% (48)[c,d]	45% (9)	33% (21)[a]	45% (22)[a]	
	Not sure	25% (51)	22% (16)	33% (6)	26% (17)	24% (12)	
6) Do you think the effects of an energy drink with a moderate caffeine content on cognitive performance are positive or negative?	Positive	19% (39)	10% (7)	17% (3)	34% (22)	12% (6)	**0.008**
	Negative	43% (87)	55% (39)[c]	33% (6)	33% (21)[a,d]	44% (22)[c]	
	Not sure	38% (77)	35% (25)	50% (10)	33% (21)	44% (22)	

Energy drinks were classified as "moderate" when they contained 80 mg of caffeine per 250 mL serving, reflecting traditional energy drinks (such as Red Bull and Monster) versus energy drinks classified as 'high" when they contained ~150-300 mg of caffeine per 250 mL serving (such as Bullet and Celsius). Kruskal-Wallis Tests indicate significant differences between groups with P≤0.05 as significant; pairwise comparisons are indicated between columns using [a,b,c,d] in which "a" matches "no energy drink", and "b" matches "moderate caffeine energy drink", c matches "both moderate and high caffeine energy drink" that will be abbreviated below as COM, from combination, followed by d "high caffeine energy drink". Individual Dunn's pairwise comparisons per question with P≤0.05:
Q1: NO vs. MOD: P=0.024, MOD vs. HIGH: P=0.011, MOD vs. COM: P=0.03;
Q2: MOD vs. HIGH: P=0.031, MOD vs. COM: P=0.012, NO vs. HIGH: P=0.006, NO vs. COM: P<0.001;
Q3: NO vs. HIGH: P<0.001, NO vs. COM: P<0.001, MOD vs. HI: P=0.002, MOD vs. COM: P<0.001;
Q4: NO vs. HIGH: P=0.007, NO vs. COM: P<0.001;
Q5: NO vs. COM: P<0.001, HIGH vs. COM: P=0.027;
Q6: NO vs. COM: P<0.001, HIGH vs. COM: P=0.028.

The other UL suggests limiting caffeine intake ≤2.5 mg/kg/day [28], which provides a little more flexibility with the consumption of caffeine rich food sources during the day, if body weight is considered. Based on the average body weight of girls in the U.S. (42-56 kg), using the CDC weight-for-age table for girls between 12-18 years [29], the average UL for caffeine consumption could range from 105-140 mg/day. This means that basically all female student athletes that reported consuming energy drinks with a high caffeine content (i.e. all types exceeding 80 mg of caffeine per serving, which means most likely a caffeine content ranging from 150-300 mg), or those consuming multiple energy drinks a day, are likely to exceed the UL of 2.5 mg/kg/day.

Caffeine is known to have positive effects on sports performance [30], and there is a clear link between the use of energy drinks and practicing sports in adolescents.[9] Caffeine can be ergogenic in various sports modalities and intensities, with effect sizes ranging from very small to moderate effects.[30] The effectiveness of caffeine has been shown for low doses (1-3 mg per kg of body weight), as well for moderate doses (3-6 mg per kg of body weight).[2] Higher doses do not provide additional ergogenic effects, but rather exacerbate the negative side effects of caffeine [31], such as increased heart rate and blood pressure [32], anxiety and insomnia.[33] At the same time, the actual impact of caffeine in children and adolescents is understudied. Therefore, it is unclear if a lower caffeine dose fitting within the UL for youth athletes may have the desired ergogenic effect.[34] In the meantime, from a practical perspective, we suggest that when the total daily caffeine intake for young athletes stays within 2.5 mg/kg, caffeine can safely be used as a potential ergogenic aid regardless of beverage type.
It has been difficult for the non-scientific community, including the media, politicians, and the general public, to take a well-informed stand toward the consumption of energy drinks by adolescents. Maybe as a result of this, the current available positions on caffeine use in children tend to be conservative suggesting complete removal of energy drinks from the diet [11,27,35–37], while moderate caffeine consumption has been deemed safe for children.[27,28] Considering that caffeine is part of the regular diet of many adolescents, we feel that the suggestion to remove caffeine completely from the diet, as has been suggested earlier [38], may be unnecessary, as well as not practical. At the same time, this age group is highly susceptible to advertising campaigns [8], and industry marketing has been targeting specific drinks at men and women, for example, supporting a lean body composition.[39] This study shows that a substantial number of young female athletes are attracted to energy drinks with a very high caffeine content, even though manufacturers advise against their use below the age of 18. Therefore, schools offering sport programming focusing on young (female) athletes should include discussion about the consumption of energy drinks as part of their athletic performance and healthy lifestyle education. Earlier research showed that strict advising to not use energy drinks was not associated with lower student self-reported energy drink consumption.[40] It is important to consider that those reporting the use of energy drink with a high caffeine content, as described in this study, seem to be more positive about the potential (dis)advantages, as reported in Table 3, of energy drinks similar to earlier reporting.[17] This suggests that schools should carefully foster discussion about the use of energy drinks which includes common reasons for use, such as taste, improving exercise performance, impact on study performance, and use at parties [19], while allowing students to make their own decisions about a healthy lifestyle.

In general, we feel that the investigation of energy drink behavior exclusively in an all-girl population provides valuable insights into the preferences and consumption patterns of young female athletes from an urban area in the Northeastern U.S. At the same time, a limitation is the relatively small sample size, collected in an urban area, which may limit generalization to more rural areas.[19] No clear insights could be provided about the reasons for energy drink use in these populations, and no data were collected providing further insight in the actual side effects that athletes experienced (e.g., responses to caffeine ingestion, including insomnia, and emotion, such as mood fluctuations). The study did not assess actual caffeine intake, and therefore the discussion is limited to estimated total caffeine consumption coming from energy drinks. Finally, despite seeking professional and athlete feedback, no formal validation of the questionnaire was performed to reduce potential measurement error or to increase reliability.[23,24]

Conclusions

Two thirds of female high school athletes reported the use of energy drinks during the last 12 months, of which roughly half reported them at least once a week. The use of energy drinks with a high caffeine content (i.e. 150-300 mg per 250 mL) is widespread, with more than half of the high school athletes within this sample reporting their use potentially leading to a caffeine intake exceeding the UL. Finally, users of energy drinks with a high caffeine content are more positive about the potential advantages and negative side effects than non-users.

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