

Relationship Between Energy Drink Consumption and Nutrition Knowledge in Student-Athletes

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ABSTRACT

Objective: To identify the relationships between energy drink consumption, nutrition knowledge, and socio-demographic characteristics in a convenience sample of student-athletes.

Design: Cross-sectional.

Setting: Online survey.

Participants: A total of 194 student-athletes (112 female and 82 male).

Main Outcome Measures: Socio-demographic characteristics, knowledge of human nutrition, energy drink consumption habits.

Analysis: Chi-square tests of independence, independent *t* tests, and hierarchical regression analyses were applied.

Results: Most student-athletes in the sample (85.5%) did not consume energy drinks, but those who did tended to be male ($P = .004$), had lower overall knowledge of nutrition ($P = .02$), and had a lower grade point average ($P < .001$) than did nonusers. Also, energy drink consumption was associated with the overall nutrition knowledge score when adjusted for socio-demographic characteristics, with nonusers having greater nutrition knowledge ($P = .007$) than users.

Conclusions and Implications: Student-athletes tend to refrain from energy drink use but those who use it have a tendency to have lower nutrition knowledge than do nonusers. Therefore, nutrition education targeted toward student-athletes should encompass the consumption of energy drinks because limited evidence shows the benefits of collegiate athletes consuming energy drinks.

Key Words: nutritional supplements, energy drink consumption, nutrition knowledge, student-athletes, sports, college students (*J Nutr Educ Behav.* 2017;49:19-26.)

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INTRODUCTION

Gaining a competitive advantage in sports goes beyond traditional training measures such as working harder in the weight room and on the practice field compared with competitors. There is also a need to consider athletes' dietary behaviors, because optimal nutrition

may enhance athletic performance. In general, nutrient requirements can be achieved through a healthy diet with no need for nutritional supplements or ergogenic aids.¹ However, studies exploring athletes' diet quality showed that their diets tend to be inadequate in nutrients (especially vitamins E and D, folate, pantothenic acid, calcium,

magnesium, potassium, total fat, dietary fiber, and phosphorus) and low in fruits, vegetables, and dairy products.²⁻⁴ Moreover, studies found that ergogenic aids such as energy drinks are popular among student-athletes.⁵

Energy drinks are often a combination of caffeine (main active ingredient), taurine, guarana, glucuronolactone, B vitamins, and ginseng.^{6,7} Regulation of these highly caffeinated beverages has been challenging.⁸ Energy drinks contain 72–300 mg caffeine/8-oz serving compared with 65–125 mg caffeine/8-oz serving of percolated coffee.^{7,9} Consuming 150–200 mg/kg caffeine can lead to fatal caffeine overdose as a result of ventricular tachycardia.¹⁰ Although the consumption of excess caffeine can be life-threatening, energy drink manufacturers tend to target young males, claiming that their product increases energy and alertness and improves athletic performance.^{8,9} Emond et al¹¹ suggested that adolescents are exposed to

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these claims by advertisements that are run on television channels popular within their age group. This is concerning because frequent energy drink consumption has been correlated with higher intake of sugar-sweetened beverages, which contributes to undesired weight gain and obesity.¹²⁻¹⁴

It has been suggested that collegiate student-athletes consume these beverages to improve athletic performance.¹⁵ However, there is conflicting evidence regarding whether performance actually improves as a result of consuming energy drinks.^{6,16-22} Performance improvements may result from the content of caffeine and/or carbohydrates in the energy drinks, and questions exist regarding whether energy drinks are the proper mode of delivery for high doses of caffeine required to stimulate neuromuscular performance.^{20,23} Regardless, studies showed that athletes have low overall nutrition knowledge, especially concerning the relationship between diet and diseases.^{4,24} Evidence from the literature also showed that nutrition knowledge is related to dietary intake in the general population.^{4,25} Studies looking at this relationship within athletes found that fruit and vegetable consumption seemed to be weakly predicted by athletes' nutrition knowledge, but no study was found exploring the relationship between nutrition knowledge and the consumption of energy drinks.⁴ Therefore, there is a need to better understand whether nutrition knowledge is related to energy drink consumption in athletes, because consumption of these drinks has increased in the young adult population (aged 18–25 years), especially among males.^{8,26}

This study aimed to identify the relationships among general nutrition knowledge, energy drink consumption, and socio-demographic characteristics in a convenience sample of American student-athletes who compete at the National Collegiate Athletic Association (NCAA) Division III level. The NCAA consists of 3 separate levels, I, II, and III, in which differences exist both athletically and academically. Performance expectations are greater for NCAA I student-athletes because athletic programs have higher budgets and athletic scholarships are available to student-athletes, whereas NCAA III athletic

program budgets are lower and athletic scholarships are not available to student-athletes.²⁷ Overall, Division III athletes tend to play for the enjoyment of the sport.²⁸ Academically, Umbach et al²⁹ reported that students at Division III institutions undergo a greater degree of academic challenge and have more interaction with faculty than do students at Division I institutions. Furthermore, they reported that students at Division III institutions engage more in active and collaborative learning activities than do their peers at Division I institutions. Robst and Keil³⁰ found that student-athletes competing at NCAA III schools have higher grade point averages (GPAs), enroll in classes of greater difficulty, and have higher graduation rates than do non-student-athletes at the same institutions.

Based on that, the current researchers formulated 2 hypotheses. The first hypothesis was that NCAA Division III student-athletes who did not consume energy drinks would have higher knowledge of nutrition than would student-athletes who consumed energy drinks and competed within the same athletic division. The second hypothesis was that NCAA Division III student-athletes who did not consume energy drinks would have a higher GPA and would more likely be female compared with student-athletes who consumed energy drinks and competed within the same division.

METHODS

Survey Design and Participants

The University of Minnesota Institutional Review Board determined that this investigation was exempt from review under federal guidelines. This cross-sectional study was administered online to undergraduate student-athletes. The student-athletes competed within the Upper Midwest Athletic Conference, a member of the NCAA, at the Division III level. The survey was available to these athletes from November 10 to December 21, 2014. Nine colleges and universities competed within the conference, 5 of which voluntarily participated in this study. For athletes to be eligible for this study, they had to have been undergraduate student-athletes from 1

of the 5 participating universities and at least age 18 years.

Procedure

Athletic directors from the participating universities directly e-mailed the survey link and informational letter to their student-athletes. Student-athletes received 2 separate e-mails. First, they received an introductory e-mail that explained the investigation and a link to the online survey. Fourteen days after they received the introductory e-mail, student-athletes received a follow-up e-mail that reiterated the introductory e-mail and the link to the survey was again provided to them. In total, 984 eligible student-athletes were invited to take part in this study. A cookie was placed on their computer to prevent respondents from taking the survey more than once. No incentives were provided.

Survey Design

The survey was administered using the online tool, Qualtrics (Qualtrics Labs, Provo, UT, 2014). All participants completed the online survey consisting of questions regarding gender, age, college cumulative GPA, nutrition courses taken during high school and college, student-athlete status, sport(s) in which they currently participated, the General Nutrition Knowledge Questionnaire for adults (GNKQ), and consumption of energy drinks. The GNKQ is a valid and reliable scale that has been deemed useful for assessing the relationship between knowledge and dietary behavior.³¹ The GNKQ was designed by Parmenter and Wardle³¹ for the UK adult population and consists of 4 sections: dietary recommendations, sources of foods/nutrients, choosing everyday foods, and diet-disease relationships. Some wording changes were performed on the original GNKQ to adapt it for the American adult population; these changes did not affect the validity of the questionnaire (Cronbach $\alpha = .74$ for the overall score). This instrument was used in other published investigations that assessed nutritional knowledge of student-athletes.^{32,33} The researchers obtained permission to use this instrument. The research team designed energy drink questions to be answered only

by participants who identified themselves as energy drink consumers (see [Supplementary Material](#)).

Statistical Analysis

Analyses were performed using IBM SPSS Statistics (version 22, IBM Corp, Armonk, NY, 2013) using only completed surveys. Descriptive analyses were performed to characterize the sample size, including information about gender, age, sports, energy drink consumption, nutrition-related training, and overall GPA. Descriptive analyses were also performed to characterize energy drink users. Chi-square test of independence was applied to assess the association between socio-demographic characteristics and the consumption of energy drinks. The normality of sample sizes was visually checked by plotting histograms and a P-plot and by looking at the distribution of the variables, such as measures of central tendency, variability, and shape. Independent *t* tests assessed relationships among nutrition knowledge scores, socio-demographic characteristics, and energy drink consumption.

To estimate whether nutrition knowledge scores were related to the number of energy drinks consumed per week, correlations (*r*) between the nutrition knowledge score of each section and the number of drinks consumed were calculated. Hierarchical regression analysis was performed to examine the relationship between energy drink consumption and nutrition knowledge score at each section, controlling for socio-demographic characteristics. Residuals were examined for all outcomes and approximated normal distribution in most cases. The presence of outliers was checked, but because the results were not sensitive to its inclusion or exclusion, the full sample was used. $P \leq .05$ was considered to be statistically significant.

RESULTS

Socio-demographic Characteristics

Initially, 208 individuals opened the survey and identified themselves as being aged ≥ 18 years; however, 14 stated that they were not currently a student-athlete and were excluded

from the current study. Therefore, the final sample was 194 student-athletes.

Most participants were aged 18–21 years (91.8%) and did not consume energy drinks (85.5%). The results of chi-square test of independence showed that student-athletes who reported consuming energy drinks were more frequently male (about 68%) and had a lower GPA (about 61%). However, no differences between user and nonusers were found for age, type of sport in which they participated, and completion of nutrition courses in high school or college ([Table 1](#)).

As reported in [Table 2](#), participants scored 58.4% on the GNKQ on average. The section about dietary recommendations had the highest scores (64.5%) and the section about diet and disease had the lowest scores (47%). There were no significant differences in age, GPA, or nutrition training regarding nutrition knowledge in this student-athlete population. No gender differences were observed for most sections of the GNKQ apart from the area of

choosing everyday foods, in which males scored 0.57 (95% confidence interval [CI], 0.93–0.21; $P = .002$) higher than females, representing a medium-sized effect ($d = 0.47$).

Energy Drink Users

The majority of energy drink users consumed Monster (61%) and/or Red Bull (57%). They identified that they consumed energy drinks because they enjoyed the taste (54%) or that energy drinks enhanced their focus (50%) ([Figure](#)). The majority consumed < 1 drink/wk (54%) or 1–2 drinks/wk (29%). Generally, the majority of users (64%) felt that they benefited from consuming energy drinks. Reported benefits included increased alertness (79%), increased productivity (75%), and better focus (67%). Only 12.5% of energy drink users reported that they felt that their athletic performance improved by consuming these beverages.

The majority of energy drink users (57%) reported that they did not

Table 1. Socio-Demographic Characteristics of the Total Sample and Socio-Demographic Differences Between Energy Drink Users and Nonusers

	Total, % (n) (n = 194)	Users, % (n) (n = 28)	Nonusers, % (n) (n = 166)	χ^2 of Independence
Gender				
Female	57.7 (112)	32.1 (9)	62.0 (103)	8.78*
Male	42.3 (82)	67.9 (19)	38.0 (63)	
Age, y				
18–19	49.0 (95)	42.9 (12)	50.0 (83)	1.69
20–21	42.8 (83)	42.9 (12)	42.8 (71)	
≥ 22	8.2 (16)	14.3 (4)	7.2 (12)	
Athlete of individual sports ^a				
Yes	47.4 (92)	39.3 (11)	48.8 (81)	0.86
No	52.6 (102)	60.7 (17)	51.2 (85)	
Athlete of group sports ^b				
Yes	64.9 (126)	71.4 (20)	63.9 (106)	0.60
No	35.1 (68)	28.6 (8)	36.1 (60)	
Nutrition class ^c				
Yes	52.1 (101)	42.9 (12)	53.6 (89)	1.11
No	47.9 (93)	57.1 (16)	46.4 (77)	
College grade point average				
≤ 3.2	31.4 (61)	60.7 (17)	26.5 (44)	16.03**
3.21–3.8	40.7 (79)	35.7 (10)	41.6 (69)	
3.81–4.00	27.8 (54)	3.6 (1)	31.9 (53)	

^aAn athlete of cross-country, swimming and diving, golf, tennis, or track and field; ^bAn athlete of baseball, basketball, football, soccer, softball, or volleyball; ^cHave taken nutrition class in high school or in college; * $P < .01$; ** $P < .001$. Note: Users consume energy drinks; nonusers do not consume energy drinks.

Table 2. Nutrition Knowledge, Socio-Demographic Characteristics, and Consumption of Energy Drinks

Variable	n	Overall ^b (Mean [SD])	Knowledge Section								
			Statistic	1 ^c (Mean [SD])	Statistic	2 ^d (Mean [SD])	Statistic	3 ^e (Mean [SD])	Statistic	4 ^f (Mean [SD])	Statistic
All participants Scores	194	58.4 (8.5)		7.1 (1.5)		39.1 (6.1)		4.1 (1.3)		8 (2.9)	
Gender											
Male	82	58.9 (1.0)	$t = -0.56$	7.1 (0.17)	$t = -0.48$	39.4 (0.73)	$t = -0.66$	4.51 (0.13)	$t = -3.1^{**}$	7.73 (0.34)	$t = 1.3$
Female	112	58.2 (0.76)		7.0 (0.14)		38.8 (0.54)		3.93 (0.12)		8.31 (0.26)	
Age, y											
18–19	95	58.1 (0.86)	$t = -0.50$	6.9 (0.15)	$t = -1.3$	39.0 (0.6)	$t = -0.11$	4.0 (0.13)	$t = -1.3$	8.0 (0.28)	$t = 0.03$
≥ 20	99	58.7 (0.88)		7.2 (0.15)		39.1 (0.64)		4.3 (0.12)		8.0 (0.32)	
Nutrition class ^a											
Yes	101	58.9 (0.78)	$t = 0.72$	7.0 (0.15)	$t = -0.43$	39.6 (0.57)	$t = 1.3$	4.1 (0.13)	$t = -0.46$	8.0 (0.27)	$t = -0.27$
No	93	58.0 (0.95)		7.1 (0.15)		38.4 (0.68)		4.2 (0.13)		8.1 (0.33)	
College grade point average											
≤ 3.2	61	56.8 (1.1)	$F = 2.4$	7.0 (0.19)	$F = 1.9$	37.9 (0.80)	$F = 1.8$	4.21 (0.15)	$F = 0.02$	7.68 (0.40)	$F = 1.4$
3.21–3.8	79	58.3 (0.98)		7.0 (0.16)		39.2 (0.71)		4.16 (0.16)		7.97 (0.33)	
3.81–4.0	54	60.4 (1.0)		7.4 (0.20)		40.1 (0.77)		4.16 (0.15)		8.6 (0.37)	
Energy drinks											
User	28	53.6 (2.2)	$t = -2.4^*$	6.8 (0.30)	$t = -1.1$	36.1 (1.5)	$t = -2.0^*$	4.21 (1.19)	$t = -0.63$	6.5 (0.7)	$t = -2.3^*$
Nonusers	166	59.2 (0.59)		7.1 (0.11)		39.5 (0.43)		4.2 (0.10)		8.3 (0.21)	

F indicates F test; t , t test.

^aNutrition class at school or college; ^bAll items, maximum score = 100; ^cDietary Recommendations, maximum score = 11; ^dSources of food/nutrients, maximum score = 65; ^eHealthy food choices, maximum score = 7; ^fDiet and disease, maximum score = 17; * $P < .05$; ** $P < .01$.

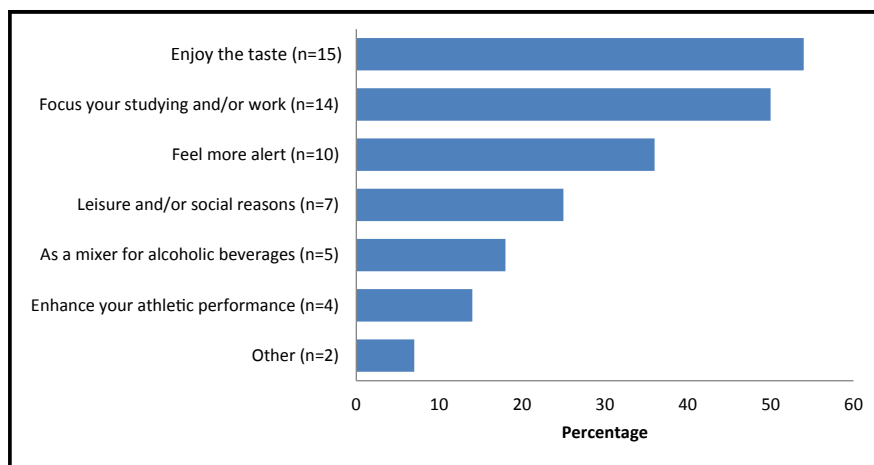


Figure. Participants' main reasons for consuming energy drinks.

ders (33%), or had trouble sleeping at night (25%). Overall, the majority (57%) of energy drink consumers indicated that the positive effects outweighed the negative effects of consuming energy drinks.

Comparison of GNKQ Between Energy Drink Consumers and Non-consumers

Based on the independent *t* test results, student-athletes who reported consuming energy drinks had an overall knowledge score of 5.6 (95% CI, 10.46-0.91; *P* = .02) points lower than nonusers, which represented a medium-sized effect (*d* = 0.7). Also, energy drink users' nutrition knowledge scores were on average 3.4 (95% CI, 6.74-0.07; *P* = .05) points and 1.74 (95% CI, 3.2-0.24; *P* = .02) points lower than nonusers'

experience side effects from consuming these beverages. Those who had side effects reported that they experienced shaking and/or tremors (35%), experienced stomach-aches and/or gastrointestinal disor-

Table 3. Multiple Regression Predicting Nutrition Knowledge Scores From Gender, Age, College Grade Point Average (GPA), Nutrition Class, and Energy Drink Consumption

	Knowledge Section														
	Overall ^c			1 ^d			2 ^e			3 ^f			4 ^g		
	B	β	Model Sum	B	β	Model Sum	B	β	Model Sum	B	β	Model Sum	B	β	Model Sum
Model 1															
Gender ^a	1.3	.08		.21	.07		.94	.07		.62	.24**		-.41	-.06	
Age, y	.49	.08		.10	.09		.33	.07		-.007	-.008		.06	.03	
GPA	.61	.17*		.09	.14		.36	.14		.03	.05		.13	.10	
Nutrition class ^b	-.50	-.02		.16	.05		-.93	-.07		.13	.05		.14	.02	
R ²			.03			.027			.03			.054			.02
R ² Adj			.014			.007			.01			.034			.001
F			1.6			1.31			1.5			2.70*			.96
Model 2															
Gender ^a	1.9	.11		.25	.08		1.3	.10		.66	.25**		-.24	-.04	
Age, y	.53	.08		.10	.09		.35	.08		-.004	-.005		.07	.03	
GPA	.42	.11		.08	.12		.24	.09		.02	.03		.07	.06	
Nutrition class ^b	-.18	-.01		.18	.06		-.75	-.06		.15	.06		.22	.03	
Energy drinks ^b	5.5	.22**		.33	.07		3.3	.19*		.34	.09		1.5	.18*	
R ²			.08			.03			.06			.06			.05
R ² Adj			.05			.007			.04			.04			.02
F			3.3**			1.2			2.5*			2.48*			2.0
ΔR ²			.04			.005			.03			.008			.03
ΔF			9.5**			1.04			6.4**			1.58			6.07**

B indicates the unstandardized coefficient; β, the standardized coefficient; R², the multivariate coefficient, the overall fit of the model; R² Adj, R² adjusted; F, the F test; ΔR², changes in R²; ΔF, the F statistic for R² change.

^aFemale = 0, male = 1; ^bNutrition class at school or college where yes = 0 and no = 1; ^cAll items, maximum score = 100;

^dDietary Recommendations, maximum score = 11; ^eSources of food/nutrients, maximum score = 65; ^fHealthy food choices, maximum score = 7; ^gDiet and disease, maximum score = 17; **P* < .05; ***P* < .01.

scores in the areas of sources of foods/nutrients and diet and disease relationship, respectively. However, no differences in energy drink consumption were observed in the areas of dietary recommendations and choosing everyday foods.

The number of energy drinks consumed per week was positively and significantly correlated to the nutrition knowledge score in the area of dietary recommendations ($r = .48$; $P < .001$). However, it was also negatively and not significantly correlated to the nutrition knowledge score in the areas of healthy food choices ($r = -.18$; $P = .35$) and diet and disease ($r = -.23$; $P = .23$). No correlation was found between energy drinks consumed per week and nutrition knowledge score in sources of food/nutrients ($r = .09$) and overall score ($r = .04$).

To determine whether the energy drinks were independently associated with nutrition knowledge, the researchers performed multiple regression analysis. The results in Table 3 show that energy drink consumption was independently associated with overall GNKQ scores and the scores for sources of foods/nutrients and diet-disease relationships, and that nonusers had greater nutrition knowledge. The addition of the energy drink consumption variable to the models accounting for gender, age, GPA, and nutrition class (model 2) led to a statistically significant increase in the multivariate coefficient (R^2) of 0.047 ($F_{1,188} = 9.575$; $P = .002$) in predicting the overall score and an increase in the R^2 of 0.032 ($F_{1,188} = 6.47$; $P = .12$) in predicting sources of foods/nutrients' scores. No significant increase in R^2 was observed in the area of diet-disease relationships ($F_{1,188} = 6.075$; $P = .15$). Most socio-demographic characteristics did not significantly predict nutrition knowledge, with the exception of gender, which was independently associated with the area of choosing everyday foods ($P = .001$).

DISCUSSION

The purpose of this study was to identify relationships among general nutrition knowledge, energy drink consumption, and socio-demographic characteristics in a convenience sample of collegiate student-athletes. The results showed

that most students-athletes did not consume energy drinks, but those who did tended to be male, had lesser overall knowledge of nutrition—especially in the areas of sources of food/nutrients and the diet and disease relationship—and had a lower GPA than did those who did not use energy drinks.

The results of this study showed that most student-athletes scored lower in the diet-disease relationship knowledge section, which is in accordance with results from other studies conducted with athlete samples.^{4,24} The study also showed that most student-athletes did not consume energy drinks, and those who did were mainly motivated to do so because they enjoyed the taste. Curiosity about energy drink taste was a factor associated with why college students decided to try energy drinks in the first place.³⁴ Just a few students-athletes mentioned consuming energy drinks to enhance their performance. This contrasts with results from previous investigations using NCAA I or elite student-athlete samples, which showed that most student-athletes in this program tended to consume energy drinks to improve their athletic performance.^{5,26,35-37} However, this research focused on NCAA III student-athletes, a level that did not get much attention within the literature. Differences exist between NCAA III and NCAA I athletic programs in terms of performance expectations, which may explain the differences in motivation and actual consumption of energy drinks. The NCAA I student-athletes had greater performance expectations because these programs have higher budgets and athletic scholarships are available to student-athletes whereas NCAA III athletic program budgets are lower and athletic scholarships are not available to student-athletes.²⁷

This study also found that the consumption of energy drinks was greater among male student-athletes and student-athletes with lower GPAs. This is in accordance with results from other studies; for example, Pettit and DeBarr³⁸ found that males were more likely than females to consume energy drinks when the researcher explored relationships regarding perceived stress, energy drink consumption, and academic performance among college students. Furthermore, Champlin et al³⁹ reported that greater energy drink con-

sumption was associated with lower GPAs among college students in general. Bulut et al⁴⁰ reported that students who studied during nighttime hours were 1.6 times more likely to consume energy drinks because of students' desire to remain awake or seek improvements in mental performance. Results from the current investigation also showed that most participants tended to use energy drinks because they liked the taste and these drinks helped them focus on their studies or work.

The results of this study also showed that users of energy drinks scored significantly lower on both the section about sources of food/nutrients and that of diet and disease knowledge than did nonusers. Because health risks are involved with consuming energy drinks in large quantities as a result of their elevated caffeine content, there is a need to educate student-athletes better about nutrition and energy drink consumption. Weeden et al⁴¹ suggested that student-athletes complete a nutrition course in college to improve their nutrition knowledge. However, with regard to the sample in the current investigation, completion of a nutrition class had no effect on nutritional knowledge. Karpinski⁴² suggested that a nutrition course designed specifically for the personal and unique needs of student-athletes may be more effective for implementing behavioral changes. Without this type of course, it is important to examine where the student-athletes received their nutritional knowledge. Further studies should explore better ways to promote nutrition knowledge within this population and how to incorporate a section on energy drink consumption, because the consumption of these drinks has little impact on performance and can be harmful to health when consumed in large quantities.^{6,16,17,43}

IMPLICATIONS FOR RESEARCH AND PRACTICE

There are some limitations that may affect the generalizability of these results. This convenience sampling study had a cross-sectional design, which cannot indicate causality. Participants of this study were student-athletes participating in an athletic conference in the Midwestern US. Therefore, this

sample may not reflect the opinions of other populations of student-athletes who participate in different athletic conferences across the US. Furthermore, only student-athletes who competed at the NCAA III level were surveyed. It would be interesting to compare the results of the survey among NCAA III, NCAA II, and NCAA I schools or to compare the results with those of student-athletes who compete within a National Association of Intercollegiate Athletics–sponsored conference. A further limitation of this study is that student-athletes self-reported energy drink consumption habits, which may have led to underreporting.

This investigation suggested that student-athletes competing at the NCAA III level tend to refrain from energy drink use. However, student-athletes who consume them tended to be male and to have a lower GPA. Furthermore, student-athletes who used energy drinks had a tendency to have lower overall knowledge of nutrition and lower knowledge in areas of the sources of food/nutrients and the diet–disease relationship than did nonusers. Therefore, there is a need for nutrition education targeted to this population, because optimal nutrition has an important role in athletes' performance and health. Nutrition education for student-athletes should also encompass the consumption of energy drinks, because it has little impact on performance and can lead to health risks when consumed in large quantities.

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SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.jneb.2016.08.008>.

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Thank you to Board of Editor Members as they complete their terms for JNEB

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CONFLICT OF INTEREST

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