A Survey of Energy Drink Consumption Patterns Among College Students at a Mostly Hispanic University

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Background: The purpose of this study was to determine energy drink (ED) consumption patterns among Hispanic college students. We measured the prevalence and frequency of ED consumption according to gender, degree programs, and specific university-related and social situations. In addition, we assessed the frequency of consumption of EDs mixed with alcoholic beverages.

Methods: A total of 508 college students from the University of Puerto Rico, the largest Hispanic institution of higher education statewide, completed an online questionnaire.

Results: Twenty-one percent of participants reported consuming EDs with the majority consuming EDs either occasionally (every 2–3 months) or at least once or twice a month. Men were found to be more likely to consume EDs than women. Undergraduate students were found less likely to consume EDs than graduate students. Most students consumed EDs while studying and during social activities. More than one-third of participants that consume EDs admitted mixing them with an alcoholic beverage. Graduate students were found to consume EDs mixed with alcohol more often.

Conclusions: The majority of students consumed EDs occasionally and while studying. Most side effects reported after consuming EDs were similar to previous findings. The higher consumption of EDs and of EDs mixed with alcohol by students in graduate programs could be explained by a higher and more complex study load requiring longer periods of wakefulness and concentration. Future studies looking at the consumption patterns of EDs in more competitive graduate programs such as medical and/or dentistry school should be considered.

Keywords: energy drinks, caffeine, Hispanic, college, students

Introduction

CAFFEINE is a methylxanthine drug, which is consumed more than any other psychostimulant worldwide.^{1–8} In addition, it is also the most common stimulant in the so-called “energy drinks” (EDs), which have been recently used at an alarming frequency by individuals looking to extend “peak” activity during working hours or even by athletes seeking a “boost” in performance at endurance events.^{9–11} Since the introduction of “Red Bull” to the US market in 1997, the consumption of EDs has risen dramatically, translating into a 50% growth in sales by 2005. Red Bull was followed by the release of more than 500 new

brands of EDs worldwide in 2006¹² representing the fastest growing product within the beverage industry.¹³

The consumption of EDs among adolescents and young adults is especially troubling since this activity has been linked to high risk behaviors such as smoking, drinking, illicit drug use, unsafe sexual practices, and fighting.^{14–16} In addition, recent studies have linked the consumption of EDs to poor dietary habits, as well as unhealthy behaviors such as video gaming, use of unhealthy weight control programs, and substance abuse.^{17,18} In addition, the combination of EDs and alcoholic beverages^{15,19,20} has led to increased alcohol intake and, consequently, alcohol-related adverse events.^{21–24}

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Recent studies have demonstrated ED use, alone or in combination with alcohol, to be common in university student populations. A survey study carried out with college students attending a public university in the Central Atlantic region of the United States revealed that 51% percent of those students had consumed more than one ED each month. The majority of users consumed EDs for insufficient sleep (67%), to increase energy (65%), and to drink with alcohol while partying (54%).²⁵ Another survey with college students in New York revealed that the frequency of ED consumption was positively associated with marijuana use, sexual risk taking, fighting, seat belt omission, and taking risks on a dare for the sample as a whole, and associated with smoking, drinking, alcohol problems, and illicit prescription drug use for white students, but not for black students.^{26,27}

A web-based survey conducted with college students from 10 universities in North Carolina revealed that 24% of the students had consumed alcohol mixed with EDs (AmEDs) within the last 30 days. Students who reported consuming AmEDs had significantly higher prevalence of alcohol-related negative consequences, including being taken advantage of sexually, taking advantage of others sexually, riding with an intoxicated driver, being physically hurt or injured, and requiring medical treatment.¹⁵

In addition, studies have shown that the consumption of EDs is high among college athletes. A recent study, which surveyed college athletes, revealed that 85.9% responded that within the last year, they used EDs, dietary supplements, or prescription medications to enhance athletic performance.²⁸ Taken together, the use of EDs alone and combined with alcohol among the youth is a major issue that needs further investigation.

Energy-drink consumption has been significantly associated with gender, meaning that men reported a higher consumption of EDs than women did even within educational institutions where the student body is mostly comprised by women.^{26,27,29,30} A study performed with 136 US undergraduates pursuing health-related degrees also found men reporting higher consumption of EDs than women.²⁹ Furthermore, a study in 496 US college students²⁵ and another study conducted with a stratified random sample of 4271 college students from 10 universities in North Carolina both found that the majority of ED consumers were men.¹⁵ These findings suggest that gender difference as related to the use of EDs is an important factor and its potential relationship to social conventions and determinants should be explored.

Although several studies have looked at ED consumption among college students in the United States, including those with a significant amount of Hispanic students, very few studies have addressed consumption patterns among principally Hispanic universities. In 2010, a graduate student from the University of Puerto Rico died of heart failure. Forensic evidence pointed that the consumption of EDs could have aggravated a previously undetected

cardiac condition of the student.³⁰ This unfortunate incidence detonated a national debate regarding the actual physiological effects that acute and chronic ED consumption could have on the student population.

A recent study focused on a sample of 275 graduate students at the University of Puerto Rico-Medical Sciences Campus studying caffeinated-beverage consumption and its potential association with sociodemographic characteristics and self-perceived academic stress.³¹ Although it was confirmed that consuming caffeinated beverages is a popular practice among participants in this sample and students admitted consuming them mainly to stay awake during studying, no associations were found between the consumption of caffeinated beverages and academic stress or load prompting further studies on a wider and more diverse student sample population. In addition, the study did not assess the side effects reported by the participants after consuming EDs, the possible link of using EDs during social activities, and potential gender differences among ED users.

Apart from this recent study, regarding the use of EDs among Hispanic students, few studies have targeted this population at the college (undergraduate/graduate) level.³¹ Thus, the purpose of the current study was to determine the patterns, prevalence, and frequency of ED consumption among college students from different undergraduate and graduate degree programs at a mostly Hispanic university. Furthermore, we assessed the patterns, prevalence, and frequency of consumption of EDs mixed with alcoholic beverages.

Methods

This survey study was authorized by the Institutional Review Board of the University of Puerto Rico at Río Piedras (protocol 1213-095) and complied with ethical standards for the protection of human participants in research. Data were collected with the participants' informed consent and under strict confidentiality. Participation in the survey was completely voluntary and there was no incentive for being a participant in the study (e.g., college credits/monetary).

Participants

In this study, students were randomly surveyed based on availability. A total of 508 students participated in the study, of which 315 (62.01%) were women and 193 (37.99%) were men. Regarding the age groups of the study participants, a total of 343 (67.52%) students were between the ages of 18 and 21, 132 (24.22%) students were between the ages of 22 and 25, 21 (4.04%) students were between the ages of 26 and 29, and 21 (4.04%) students were 30 years or older at the time of the study. The mean age of the study participants was 20.4 ± 1.9 years. No previous questions regarding nationality, beverage preferences, and/or participation on academic

or social activities were asked prior to them answering the survey. All students had to be enrolled in the University of Puerto Rico-Río Piedras campus (UPR-RP; San Juan metropolitan area), which was confirmed through student identification. This campus, which is the largest of 11 campuses that comprise the UPR system, has a student population of nearly 16,217 students (79.3% undergraduate students and 20.7% graduate students) and about 1420 faculty members as documented in the university website: www.uprrp.edu/?p=4914 and in the following university-related website www.universia.pr/universidades/universidad-puerto-rico-recinto-rio-piedras/in/11542. The UPR-RP has consistently granted the largest number of doctorate degrees to Hispanics in the United States and it is the first and only public university in Puerto Rico.

Focus group

To initially develop the questionnaire of this survey, we explored general aspects of ED consumption among college students using the focus group technique. A total of 24 students from the College of Social Sciences, UPR-RP, participated in three focus group sessions (8 students per session) that were moderated by a clinical psychologist. Social Sciences is one of the largest and more diverse colleges within the UPR-RP with regards to total students and academic programs so the findings gathered are generalizable to the university population as a whole.

The focus groups included open-ended questions, which were formulated based on a comprehensive literature search of recently published work (cited throughout this work) regarding different situations in which students consume EDs, the most common EDs consumed by college students, frequency of consumption, side effects, and consumption mixed with alcoholic beverages. We also asked about the side effects participants reported after consuming EDs with alcoholic beverages.

The focus groups were highly helpful by providing us with information regarding the different types of EDs being consumed by students, usual places where students purchase EDs, how frequently do they consume EDs, and during which types of social activities did they consume them, among others. The answers provided by the focus group participants, together with our own literature search, were instrumental in the development of the final questionnaire.

Questionnaire

We developed a 24-item questionnaire (in Spanish) for this study, which was based on the most relevant and frequent suggestions acquired from the previously conducted focus group discussions. The first part of the instrument was designed to assess demographics (e.g., age, gender, and place of birth), current educational status (e.g., degree program, year, and major), and participation in an official university athletic team. Question 8 was a screening yes-or-no question, in which participants needed to answer

whether or not they consume EDs. Participants who answered “no” to this question were asked to respond why they had not tried EDs before. At this point, the survey ended automatically.

Participants who answered “yes” in Question 8 were instructed to continue with the survey, which assessed the age at which they started consuming EDs, who (friend/family) or what (media/news) motivated them to begin consuming EDs, the type of ED usually consumed, during which activities they usually consumed them, how often and where they usually consume them, and which side effects were associated with ED consumption. They were then asked if “they had consumed EDs mixed with alcoholic beverages?” If a participant indicated “no,” then the questionnaire will end at this time. Participants who indicated “yes” to this question were instructed to continue the survey, which then assessed what was the main reason they decided to consume EDs mixed with an alcoholic beverage, the type of ED and alcoholic beverage they prefer when consuming this mixture, and which effects were associated with the consumption of this mixture.

Data collection

The questionnaire was made available for completion using the online program for survey and questionnaire administration called “Survey Monkey.” We posted flyers around the UPR-RP with information about the study and the web link to access the survey. In addition, we scheduled classroom visits and provided information directly to the students. To ensure the diversity of the sample, research assistants performed recruitment at different times of the day and on different days of the week in an unbiased manner (no specific gender or nationality was targeted). Upon access to the online questionnaire, participants were first asked to agree with an electronic consent form before participating.

The average time to complete the questionnaire was about 5 minutes. Data collection lasted about 1 year (2013–2014) and was acquired based on research assistant availability thus being an opportunistic recruitment approach and not based on priori power calculations. This survey was conducted about 3 years after the reported death of the public health graduate student at the UPR-Medical Sciences Campus (2010);³⁰ thus, the data reported in this study were not confounded by the media coverage of that event.

Data analysis

The statistical analysis used was Pearson’s Chi-square (χ^2) test, which allowed us in this work to measure the relationship between two categorical variables comparing the frequencies observed in each of the categories assessed against the frequencies expected by chance. These analyses were performed using the Statistical Package for the Social Sciences, 23 version (SPSS 23). An alpha level of 0.05 ($p < 0.05$) was used for all statistical tests.

TABLE 1. DEMOGRAPHICS OF THE PARTICIPANTS

<i>Variables</i>	<i>f (%)</i>
Gender	
Men	37.99
Women	62.01
Age (years)	
<18	0.59
18–25	94.30
>25	5.11
Birthplace	
Puerto Rico	94.06
Other	5.94
Academic program	
Undergraduate	91.90
Graduate	8.10
College/School	
Natural Sciences	27.50
Social Sciences	21.70
Business Administration	12.90
Humanities	10.20
Architecture	8.23
Education	8.03
Communication	6.8
Law	3.41
General Studies	1.20

Results

Demographics of the study sample are summarized in Table 1. A total of 508 students, most of them undergraduates identified as Puerto Rican natives, completed the online survey. Almost half of the sample was composed of students from the colleges of Natural and Social Sciences and the other half were students from the various colleges and schools (0.3% of study participants did not respond to this question). We found that the distribution of ED consumption was mostly consistent among colleges/schools (all were between 19% and 24%) with the exception of law school where 47.1% of participants admitted consuming EDs. Because of the small sample of law students surveyed, this result was not statistically significant (Pearson's χ^2 test).

Regarding the history of ED consumption, 21.5% of participants ($n=107$) reported drinking EDs more than once. More than 46% of participants confirmed that they had never consumed an ED ($n=231$) and 32% admitted having consumed an ED only once ($n=159$). When comparing men and women, 27.13% of men admitted consuming EDs more than once, while this number was less in women (17.9%). More than 94% of participants admitted consuming EDs before the age of 21 with the majority admitting starting to consume EDs between the ages of 16 and 18 (58.3%), at the age of 16 (10.8%), and after the age of 21 (6.8%). When we asked who or what motivated them to begin consuming EDs, a considerable amount of participants admitted that it was a friend who motivated them to consume EDs (42.2%), followed by a place of business who sold

TABLE 2. FREQUENCY OF ENERGY DRINK CONSUMPTION

<i>ED consumption</i>	<i>f (%)</i>	
	<i>M</i>	<i>W</i>
Every 2–3 months	39.2	56.6
1–2 times/month	27.5	16.9
3–4 times/month	9.8	7.5
1–2 times/week	15.7	9.43
3–4 times/week	2.0	5.6
1–2 times/day	5.9	3.8
3–4 times/day	0	0

EDs, energy drinks; M, men; W, women.

them such as a vending machine, pharmacy, or gas station (22.6%), a media outlet such as a promotional TV commercial, kiosk, or banner (11.8%), and through printed legal advertisements (7.8%).

When assessing the frequency of ED consumption (Table 2), nearly half of the participants (48.1%) reported drinking one ED every 2–3 months, which was considered to be “occasionally,” followed by the participants that admitted consuming 1 or 2 EDs per month (22.1%), 1 or 2 EDs per week (12.5%), 3–4 EDs per month (8.7%), 1 or 2 EDs per day (4.8%), and 3 or 4 EDs per week (3.9%). Regarding the frequency of ED consumption between men and women (Table 2), we found that men consumed EDs occasionally at a lower frequency (39.2%) compared to women (56.6%). In addition, the percentage of men that admitted consuming 1 or 2 EDs per month (27.5%) was higher than the percentage of women consuming the same amount of EDs per month (17%).

We then proceeded to assess specific instances and places where participants normally consume EDs. Participants were allowed to choose more than one answer in these questions. When we asked “during which specific activities you usually consume EDs”?, the majority of the participants admitted consuming EDs while studying (72.1%), during social activities (e.g., parties) (32.7%), while playing sports (18.3%), during sexual activities (9.6%), and with meals (2.9%). When comparing between the genders (Table 3), the percentage of women admitting consuming EDs while studying (84.9%) was significantly higher than men (58.8%; $\chi^2=7.029$, $p=0.008$). In addition, the

TABLE 3. OCCASIONS IN WHICH PARTICIPANTS TYPICALLY CONSUME ENERGY DRINKS

<i>Occasions to consume EDs</i>	<i>f (%)</i>	
	<i>M</i>	<i>W</i>
Studying	58.8	84.9 ^a
Social activities	39.2 ^a	26.4
Sport activities	29.4 ^a	7.6
Sexual activities	13.7 ^a	5.7
With meals	5.8	0

^aSignificantly different ($p<0.05$).

amount of men admitting consuming EDs during social activities (39.2%) was significantly higher than women (26.4%; $\chi^2=5.746$, $p=0.017$). Moreover, the percentages of men admitting consuming EDs while playing sports (29.4%) and during sexual intercourse (13.7%) were significantly higher than those of women (7.6%; $\chi^2=8.816$, $p=0.003$ and 5.7%; $\chi^2=14.054$, $p<0.001$, respectively).

Of those study participants who admitted consuming EDs while playing sports, we found that students who were athletes (played in official university teams) consumed significantly more EDs while playing sports than nonathlete ED drinkers ($\chi^2=9.320$, $p=0.002$). When we asked about places where they usually consume EDs, they reported that they mostly consume EDs while at home (47.1%) or at the university (46.2%) followed by while driving (35%), at social gatherings (parties; 25%), and at work (16.4%). Interestingly, athletes were also found to consume EDs less frequently while at home compared to nonathletes ($\chi^2=4.750$, $p=0.037$), suggesting a relationship between sports and the use of EDs among athletes.

We also assessed the subjective effects that participants report when consuming EDs. The majority reported feeling “energized” after consuming EDs (71.4%) followed by more awake (56.2%), more able to concentrate (focused; 38.1%), having an accelerated pulse (36.2%), stronger heart palpitations (31.4%), loss of appetite (15.2%), and no effects (9.5%). We found that women had a higher frequency of subjective effects overall compared to men (Table 4). Women consistently reported having significantly increased wakefulness (66.8% versus 45.1% in men; $\chi^2=4.443$, $p=0.035$).

The last part of the questionnaire assessed the incidence at which college students at the UPR-RP consumed EDs mixed with alcoholic beverages and the side effects after consuming these mixed beverages. Participants were allowed to select more than one answer. More than 38% of participants (38.2%; $n=39$) admitted mixing EDs with some type of alcoholic beverage. Of those students, 34.8% were undergraduates and 65.2% were graduate students. We asked to the participants “With which type of alcoholic beverage you prefer mixing EDs with?” and the most popular alco-

TABLE 4. COMMON SUBJECTIVE EFFECTS OF ENERGY DRINK CONSUMPTION

Effects of EDs	f (%)	
	M	W
More energy	64.7	77.8
Wakefulness	45.1	66.8 ^a
Increased concentration	35.3	40.7
Accelerated pulse	29.4	42.6
Palpitations	27.5	35.2
Loss of appetite	13.7	16.7
None	15.7	3.7

^aSignificantly different ($p<0.05$).

TABLE 5. COMMON SUBJECTIVE EFFECTS OF ALCOHOL MIXED WITH ENERGY DRINKS

Effects of AmEDs	f (%)	
	M	W
Euphoria	66.7	42.9
More energy	50.0	57.1
Palpitations	11.1	23.8
Loss of alcohol's effect	16.7	23.8
Sleep problems	22.2	14.3
Dizziness	5.6	0
None	0	23.8 ^a

^aSignificantly different ($p<0.05$).

AmEDs, alcohol mixed with energy drinks.

holic beverage was Jägermeister (53.9%) followed by vodka (41%), rum (28.2%), whisky (20.5%), tequila (10.3%), and beer (10.3%). It was found that study participants who mixed EDs with any of these alcoholic beverages consumed significantly more EDs than those who consumed EDs alone ($\chi^2=6.643$, $p=0.010$).

In addition, study participants that mixed EDs with alcohol consumed significantly more EDs during social activities compared to students that only consumed EDs without alcohol ($\chi^2=7.415$, $p=0.006$). We then asked “what or how do you feel after consuming EDs mixed with an alcoholic beverage”? The majority of participants reported feeling “energized” (53.9%) and “euphoric” (53.9%) after consuming EDs with alcohol followed by “not feeling the effects of alcohol” (“not drunk”; 20.5%), “more awake” (18%), having “stronger heart palpitations” (18%), and having “no effects” (12.9%).

When comparing men versus women (Table 5), only the percentage frequency of women admitting feeling “no effects” (23.8%) after consuming EDs mixed with an alcoholic beverage was higher compared to men, but this result was marginally significant (0%; $\chi^2=7.641$, $p=0.06$). Of all schools surveyed, the highest percentage of students admitting having consumed EDs with alcohol were from the school of business administration (66.7%). This was followed by school of humanities (40%), natural sciences (38.7%), social sciences (28.6%), education (14.3%), and architecture (12.5%). Although 75% of law students reported having mixed EDs with an alcoholic beverage, the small sample of students surveyed makes this result not significant, but worth exploring in future research initiatives.

Discussion

This study assessed for the first time the consumption patterns of EDs within an institution of higher learning composed principally of Hispanic undergraduate students (more than 95%) with the exception of a study among graduate students at the University of Puerto Rico-Medical Sciences campus.³¹ Ríos *et al.* interestingly reported that around 29% of students questioned (275 total students)

consumed EDs, a very similar figure to our study results (21.5%). Their study also assessed the consumption of other caffeinated beverages such as soft drinks (87%), coffee (83%), and tea (40%) with students admitting consuming them mainly to stay awake during studying.³¹

Our web-based survey on ED consumption completed by study participants revealed other interesting, and sometimes worrying, correlations between gender and social activities with the consumption of EDs or AmEDs. Although a high number of college students admitted consuming EDs at least once, mostly as undergraduates, less than 25% of them actually consumed these beverages with some type of frequency with most consuming them occasionally (defined for this study as two to three times per month). Among adolescents and young adults, recent studies have shown that about 30%–50% consume EDs.³² In comparison, 40%–60% of college students report using EDs as confirmed by recent studies.^{33,34}

As mentioned above, our study revealed that less than 25% of college students consumed EDs frequently, which is lower than the national average among mainland US colleges. We confirmed through our study that these lower patterns of consumption were not due to less access to EDs since student participants and recruiting volunteers reported ED availability in vending machines, fast food restaurants, supermarkets, and pharmacies within the immediate premises of the university. Also, more than 94.2% of participants admitted consuming EDs before the age of 21 with the majority (58.3%) admitting starting between the ages of 16 and 18. These numbers are comparable to recent studies conducted in the mainland United States where college students admitted consuming EDs for the first time between the ages of 16 and 20 years.^{34,35} In addition, the reported early age of consumption of EDs is validated by a recent study conducted in public schools around Canada, which showed that nearly two-thirds of high school students reported consuming EDs at least once in the previous year, with about 20% reporting use once or more per month.³⁶

Gender differences and the patterns of ED consumption

With regard to the frequency of ED consumption and gender differences, we found that when comparing lower frequencies of ED consumption, our results contrasted with studies that have linked higher consumption of EDs among college men. Men were found to consume more EDs than women when assessing higher frequency patterns of consumption, which is in accordance to recent findings in the mainland United States.^{34,37,38} These findings suggest that more women than men in our sample consumed EDs occasionally because men who consumed EDs were more likely to consume more EDs at higher frequencies of use (i.e., women were more likely to be infrequent consumers, whereas men were more likely to be frequent consumers).

An additional important aspect that could shed light on our current results was the finding that the majority of par-

ticipants admitted that it was a friend who motivated them to consume EDs. The low number of frequent ED consumers within those students surveyed combined with the fact that most of the students are using EDs only occasionally and being introduced to them by peers, let us to believe that most college students within the University of Puerto Rico are using EDs as a “means to an end” beverage and not part of their everyday diet/lifestyle. This theory is supported by the finding that a considerable number of women and men use EDs while studying with women reporting using more EDs than men.

As shown in the results (Table 3), there was a significant difference between genders with regards to during which specific activities do college students consume EDs. Men consumed EDs more often during social activities compared to women. These results have been found in other studies, which have linked the use of ED with specific aspects of masculinity (defined as a set of attributes, behaviors, and roles generally associated with boys and men).^{26,27} One study assessing ED consumption on male college students suggests strong correlations between hegemonic masculinity and social norms such as risk taking, violence, and dominance with high consumption of EDs.^{26,27} They conclude that young men college students associate the power and sense of being a man with the use of ED. This study also indicates that men tend to use AmED on social aspects to demonstrate the element associated to being a man with regards to risk taking (see below).

Other studies have validated this correlation between this masculinity ideology and the expectations of gender with high consumption of EDs.³⁹ This cultural and social aspect of masculinity could explain why there are a higher number of men engaging in high frequency drinking. For future investigations, it should be important to study the etiology of this phenomenon on college students to understand other possible explanations and predictors of ED use and consumption.

Similarly, there was a significant difference between genders in terms of uses of EDs for sports-related activities. As shown in our results (Table 3), men reported higher consumption of EDs while playing sports versus women. Although the link between hegemonic masculinity and ED consumption could partially account for this phenomenon, there is recent evidence that supports ergogenic effects of ED consumption on athletes.⁴⁰ This previous finding is supported by our current data, which show that athletes consume more EDs while playing sports and less EDs at home compared to non-athletes. When relating ED consumption and potential enhancement in physical performance, recent data show higher ED consumption in male compared to women athletes.²⁸ Taken together, our results show that male athletes consume EDs with higher frequency than women and this could be explained by an increased urge among male athletes to improve their overall image and physical performance.

Consumption of EDs and alcoholic beverages

EDs have become popular mixers for alcohol, in part, because drinkers experience a different subjective response to the alcohol when drinking it as opposed to a beverage that is not mixed with caffeine and other stimulant ingredients.^{19,24,41} Laboratory investigations have demonstrated that AmED beverages increase subjective ratings of stimulation following drinking, reduce the feeling of fatigue, or reduce perceived intoxication compared to the same dose of alcohol administered alone,^{42–44} coinciding with social drinkers' perceptions of the effects of these beverages. Incidences of drinking to intoxication, intention to drive while impaired, riding with an intoxicated driver, being physically hurt or injured, requiring medical treatment, and risk for alcohol dependence have all been found to be increased with AmED consumption, even after adjusting for the amount of alcohol consumed.^{20,33,45}

Our study showed that more than 38% of the study participants that admitted drinking EDs have also mixed them with alcoholic beverages with higher percentages among graduate students. These results are comparable to recent studies, which have shown that 25 to 40% of college students have reported using AmEDs during mostly social (off campus) activities.^{46,47} The higher frequency of usage of EDs among graduate students could be explained by the fact that this group has been more exposed to the possibility of consuming EDs during the completion of their undergraduate degrees.

Recent data indicate that the use of AmED is also very popular among medical students,^{19,48–51} including Hispanics.³¹ This behavior can be dangerous since the use of AmEDs can reduce the adverse symptoms of alcohol intoxication, including the depressant effects. As a consequence, users of AmEDs might not feel the signs of alcohol intoxication, thus increasing the probability of accidents and/or favoring the possibility of development of alcohol dependence.³³

It is important to mention that the subjective effects of EDs and AmEDs reported did not take into consideration inclusion or exclusion criteria for the participants such as prior consumption of caffeine, tobacco, other alcoholic beverages, over the counter and prescribed medications, and preexisting mental illnesses, among others. Thus the report of subjective effects after consumption of EDs and of AmEDs might be affected by these confounding factors. In addition, due to the cross-sectional nature of the study, causation cannot be inferred (i.e., the variables may be related, but from the methodology used it is not possible to tell whether one causes the other) only suggested, although the data can be used to pursue better informed future studies.

Future studies through focus groups could further explore the possible use of EDs in combination with alcohol and other drugs, including caffeine-containing beverages such as coffee and with drugs such as caffeine pills,

tobacco, or prescribed (or over the counter) medications. In addition, the consumption patterns of EDs in more competitive graduate programs such as law, architecture, medical, and/or dentistry school should be considered.

Conclusions

This study confirms that Hispanic college students were found to consume EDs mostly to counteract insufficient sleep, have more energy, drink with alcohol while partying, and principally during studying. In addition, the results of this study can help public health officials to identify college students who need encouragement to reduce ED intake and increase healthier beverage consumption. Further studies aimed at raising awareness among university students of the ingredients and potential health hazards of ED consumption, including mixing them with alcoholic beverages, are extremely necessary. Finally, studies looking to aid students in recognizing the amounts of caffeine that are present in the wide variety of caffeine-containing products they consume, the amounts of caffeine that are actually consumed in various social and academic situations, and the side effects associated with their consumption should also be encouraged.

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References

1. Ferré S. An update on the mechanisms of the psychostimulant effects of caffeine. *J Neurochem*. 2008;105:1067–1079.
2. Frary CD, Johnson RK, Wang MQ. Food sources and intakes of caffeine in the diets of persons in the United States. *J Am Diet Assoc*. 2005;105:110–113. Erratum in: *J Am Diet Assoc*. 2008;108:727.
3. Nehlig A, Daval JL, Debry G. Caffeine and the central nervous system: Mechanisms of action, biochemical, metabolic and psychostimulant effects. *Brain Res Rev*. 1992;17:139–170.
4. Nehlig A. Are we dependent upon coffee and caffeine? A review on human and animal data. *Neurosci Biobehav Rev*. 1999;23:563–576.
5. Fredholm BB, Battig K, Holmen J, Nehlig A, Zvartau EE. Actions of caffeine in the brain with special reference to factors that contribute to its widespread use. *Pharmacol Rev*. 1999;51:83–133.
6. Fredholm BB, Svenningsson P. Adenosine-dopamine interactions: Development of a concept and some comments on therapeutic possibilities. *Neurology*. 2003;61:S5–S9.
7. Higgins JP, Tuttle TD, Higgins CL. Energy beverages: Content and safety. *Mayo Clin Proc*. 2010;85:1033–1041.

8. Griffiths RR, Juliano LM, Chausmer A. Caffeine: Pharmacology and clinical effects. In: *Principles of Addiction Medicine*, Third Edition. Graham AW, Schultz TK, Mayo-Smith MF, Ries RK, and Wilford BB (Eds). Chevy Chase, MD: American Society of Addiction Medicine; 2003: pp. 193–224.
9. Cauli O, Morelli M. Caffeine and the dopaminergic system. *Behav Pharmacol*. 2005;16:63–77.
10. Temple JL. Caffeine use in children: What we know, what we have left to learn, and why we should worry. *Neurosci Biobehav Rev*. 2009;33:793–806.
11. Rath M. Energy drinks: What is all the hype? The dangers of energy drink consumption. *J Am Acad Nurse Pract*. 2012;24:70–76.
12. Reissig CJ, Strain EC, Griffiths RR. Caffeinated energy drinks—a growing problem. *Drug Alcohol Depend*. 2009;99:1–10.
13. Zucconi S, Volpato C, Adinolfi F, Gandini E, Gentile E, Loi A, Fioriti L. Gathering consumption data on specific consumer groups of energy drinks, Supporting Publications EN-394, 2013, p. 190. Available at www.efsa.europa.eu/publications (accessed July 21, 2016).
14. Walsh M, Marquardt K, Albertson T. Adverse effects from ingestion of Redline energy drinks. *Clin Toxicol*. 2006;44:642.
15. O'Brien MC, McCoy TP, Rhodes SD, *et al*. Caffeinated cocktails: Energy drink consumption, highrisk drinking, and alcohol-related consequences among college students. *Acad Emerg Med*. 2008;15:453–460.
16. Cobb CO, Nasim A, Jentink K, Blank MD. Subst Abus. The role of caffeine in the alcohol consumption behaviors of college students. *Subst Abus*. 2015;36:90–98.
17. Larson N, Laska MN, Story M, Neumark-Sztainer D. Sports and energy drink consumption are linked to health-risk behaviours among young adults. *Public Health Nutr*. 2015;18:2794–2803.
18. Poulos NS, Pasch KE. Energy drink consumption is associated with unhealthy dietary behaviours among college youth. *Perspect Public Health*. 2015;135:316–321.
19. Oteri A, Salvo F, Caputi AP, Calapai G. Intake of energy drinks in association with alcoholic beverages in a cohort of students of the School of Medicine of the University of Messina. *Alcohol Clin Exp Res*. 2007;31:1677–1680.
20. Curry K., Stasio M. J. The effects of energy drinks alone and with alcohol on neuropsychological functioning. *Hum Psychopharmacol*. 2009;24:473–481.
21. Cotter BV, Jackson DA, Merchant RC, Babu KM, Baird JR, Nirenberg T, Linakis JG. Energy drink and other substance use among adolescent and young adult emergency department patients. *Pediatr Emerg Care*. 2013;29:1091–1097.
22. Jackson DA, Cotter BV, Merchant RC, Babu KM, Baird JR, Nirenberg T, Linakis JG. Behavioral and physiologic adverse effects in adolescent and young adult emergency department patients reporting use of energy drinks and caffeine. *Clin Toxicol (Phila)*. 2013;51:557–565.
23. Peacock A, Bruno R, Martin FH, Carr A. The impact of alcohol and energy drink consumption on intoxication and risk-taking behavior. *Alcohol Clin Exp Res*. 2013;37:1234–1242.
24. Marczynski CA, Fillmore MT, Bardgett ME, Howard MA. Effects of energy drinks mixed with alcohol on behavioral control: Risks for college students consuming trendy cocktails. *Alcohol Clin Exp Res*. 2011;35:1282–1292.
25. Malinauskas BM, Aeby VG, Overton RF, Carpenter-Aeby T, Barber-Heidal K. A survey of energy drink consumption patterns among college students. *Nutr J*. 2007;31:6:35.
26. Miller KE. Energy drinks, race, and problem behaviors among college students. *J Adolesc Health*. 2008;43:490–497.
27. Miller KE. Wired: Energy drinks, jock identity, masculine norms, and risk taking. *J Am Coll Health*. 2008;56:481–489.
28. Hoyte C, Albert D, Heard K. The use of energy drinks, dietary supplements, and prescription medications by United States college students to enhance athletic performance. *J Community Health*. 2013;38:575–580.
29. Pettit ML, DeBarr KA. Perceived stress, energy drink consumption, and academic performance among college students. *J Am Coll Health*. 2011;59:335–341.
30. Rivera-Vázquez A. 2010. Available at http://www.wapa.tv/noticias/salud/relacionan-bebidas-energizantes-y-muerte_20110409101313.html (accessed August 1, 2016).
31. Ríos JL, Betancourt J, Pagán I, Fabián C, Cruz SY, González AM, González MJ, Rivera-Soto WT, Palacios C. Caffeinated-beverage consumption and its association with socio-demographic characteristics and self-perceived academic stress in first and second year students at the University of Puerto Rico Medical Sciences Campus (UPR-MSC). *P R Health Sci J*. 2013;32:95–100.
32. Seifert SM, Schaechter JL, Hershorin ER, Lipshultz SE. Health effects of energy drinks on children, adolescents, and young adults. *Pediatrics*. 2011;127:511–528.
33. Arria AM, Caldeira KM, Kasperski SJ, *et al*. Energy drink consumption and increased risk for alcohol dependence. *Alcohol Clin Exp Res*. 2011;35:365–375.
34. Deliens T, Clarys P, De Bourdeaudhuij I, Deforche B. Correlates of university students' soft and energy drink consumption according to gender and residency. *Nutrients*. 2015;7:6550–6566.
35. Reid SD, Ramsarran J, Brathwaite R, Lyman S, Baker A, Cornish DC, Ganga S, Mohammed Z, Sookdeo AT, Thapelo CK. Energy drink usage among university students in a Caribbean country: Patterns of use and adverse effects. *J Epidemiol Global Health*. 2014;5:103–116.
36. Azagba S, Langille D, Asbridge M. An emerging adolescent health risk: Caffeinated energy drink consumption patterns among high school students. *Prev Med*. 2014;62:54–59.
37. West DS, Bursac Z, Quimby D, Prewitt TE, Spatz T, Nash C, Mays G, Eddings K. Self-reported sugar-sweetened beverage intake among college students. *Obesity*. 2006;14:1825–1831.
38. Levant R, Parent M, Mccurdy E, Bradstreet T. Moderated mediation of the relationships between masculinity ideology, outcome expectations, and energy drink use. *J Health Psychol*. 2015;34:1100–1106.
39. Salinero J, Lara B, Abian-Vicen J, Gonzalez-Millán C, Areces F, Gallo-Salazar C, Coso, J. The use of energy drinks in sport: Perceived ergogenicity and side effects in male and female athletes. *Br J Nutr*. 2014;112:1494–1502.

40. Pai KM, Kamath A, Goel V. Effect of Red Bull energy drink on muscle performance: An electromyographic overview. *J Sports Med Phys Fitness*. 2015;55:1459–1465.
41. Marczinski CA, Fillmore MT. Clubgoers and their trendy cocktails: Implications of mixing caffeine into alcohol on information processing and subjective reports of intoxication. *Exp Clin Psychopharmacol*. 2006;14:450–458.
42. Ferreira SE, de Mello MT, Pompeia S, de Souza-Formigoni ML. Effects of energy drink ingestion on alcohol intoxication. *Alcohol Clin Exp Res*. 2006;30:598–605.
43. Miyake ER, Marmortein NR. Energy drink consumption and later alcohol use among early adolescents. *Addict Behav*. 2015;43:60–65.
44. Marczinski CA, Fillmore MT, Henges AL, Ramsey MA, Young CR. Effects of energy drinks mixed with alcohol on information processing, motor coordination and subjective reports of intoxication. *Exp Clin Psychopharmacol*. 2012;20:129–138.
45. Arria AM, Caldeira KM, Kasperski SJ, O'Grady KE, Vincent KB, Griffiths RR, Wish ED. Increased alcohol consumption, nonmedical prescription drug use, and illicit drug use are associated with energy drink consumption among college students. *J Addict Med*. 2010;4:74–80.
46. Patrick ME, Maggs JL. Energy drinks and alcohol: Links to alcohol behaviors and consequences across 56 days. *J Adolesc Health*. 2014;54:454–459.
47. Mallett KA, Scaglione N, Reavy R, Turrissi R. Longitudinal patterns of alcohol mixed with energy drink use among college students and their associations with risky drinking and problems. *J Stud Alcohol Drugs*. 2015;76:389–396.
48. Likus W, Milka D, Bajor G, Jachacz-Łopata M, Dorzak B. Dietary habits and physical activity in students from the Medical University of Silesia in Poland. *Rocz Panstw Zakl Hig*. 2013;64:317–324.
49. Hidiroglu S, Tanriover O, Unaldi S, Sulun S, Karavus M. A survey of energy-drink consumption among medical students. *J Pak Med Assoc*. 2013;63:842–845.
50. Aslam HM, Mughal A, Edhi MM, Saleem S, Rao MH, Aftab A, Hanif M, Ahmed A, Khan AM. Assessment of pattern for consumption and awareness regarding energy drinks among medical students. *Arch Public Health*. 2013;71:31.
51. Casuccio A, Bonanno V, Catalano R, Cracchiolo M, Giugno S, Sciuto V, Immordino P. Knowledge, attitudes, and practices on energy drink consumption and side effects in a cohort of medical students. *J Addict Dis*. 2015;34:274–283.

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