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Sleepy Teens and Energy Drink Use: Results from an Ethnically Diverse Sample of Youth

Wendy M. Troxel, PhD¹, Joan S. Tucker, PhD, Brett Ewing, MS, Jeremy N.V. Miles, Ph.D., and Elizabeth J. D'Amico, PhD

¹RAND Corporation; 1776 Main St, Santa Monica, CA 90407, USA

Abstract

This study examines the association between use of energy drinks/products (EP), EP expectancies, and the association between EP use and sleep in a racially/ethnically diverse sample (N=2,485) of adolescents. Prevalence of EP use was approximately 18%, with no statistically significant racial/ethnic differences in prevalence. There were significant racial/ethnic differences in EP expectancies; Hispanic and Multiracial/Other groups endorsed less positive expectancies than Whites and Asians. EP use was significantly associated with later weekend bedtimes, shorter weekend total sleep time (TST), a smaller weekend/weekday difference in TST, and more trouble sleeping, even after adjusting for covariates. There were no significant race/ethnicity interactions between EP use and sleep. EP use is an independent correlate of sleep problems in adolescents across racial/ethnic groups.

Keywords

Sleep; Energy Drinks; Energy Products; Adolescents; Caffeine

Introduction

Sleep problems are highly prevalent among adolescents, and have increased among U.S. youth over the past two decades (Keyes, Maslowsky, Hamilton, & Schulenberg, 2015). Sleep problems in adolescence are associated with a host of negative consequences including poor academic functioning, increased risk of depression and anxiety, substance use disorders, and cardiometabolic problems (Curcio, Ferrara, & De Gennaro, 2006; Ivanenko, Crabtree, & Gozal, 2005; Javaheri, Storfer-Isser, Rosen, & Redline, 2011; Wong, Robertson, & Dyson, 2015). Given the crucial role of sleep in contributing to healthy development and functioning across the lifespan, and that adolescence is a period of intense neurobiological, psychosocial, and physical development (Carskadon, Acebo, & Jenni, 2004), it is critical to identify factors that may contribute to the rising rates of sleep disturbance in this vulnerable group.

Address correspondence to: Wendy M. Troxel, PhD, RAND Corporation, 1776 Main St., Santa Monica, CA 90407, Tel: 412.683.2300 x4427, Fax: 412.683.2800, wtroxel@rand.org.

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Adolescence represents a vulnerable period for insufficient sleep and other sleep problems due to the interface between the circadian tendency towards phase delay that occurs in adolescence, in conjunction with social pressures to stay up late and early school start times (Carskadon et al., 2004; Carskadon, Wolfson, Acebo, Tzischinsky, & Seifer, 1998). In addition, several behavioral factors have been identified that may increase the prevalence of sleep problems among adolescents, including the widespread use of caffeinated products, such as soda, energy drinks and related products (e.g., “shots”; (Grandner et al., 2014; Miller, 2008b; Packaged Facts, 2013; Terry-McElrath, O'Malley, & Johnston, 2014)).

There are well-documented effects of caffeine on sleep, which are purported to be mediated by antagonism of the adenosine A1 receptor (Roehrs & Roth, 2008; Temple, 2009). In fact, the most commonly reported side effects associated with caffeine are insomnia, nervousness, headache, and tachycardia. For instance, in a comprehensive review of the literature on the effects of caffeine on sleep and daytime functioning, Roehrs and Roth (2008) concluded that regular dietary caffeine intake is associated with measurable increases in sleep disturbances and daytime sleepiness and that “[T]he risks to sleep and alertness of regular caffeine use are greatly underestimated by both the general population and physicians.” (p.153). However, the vast majority of research on the epidemiology, pharmacology, or associated consequences of caffeine use has been in adults, with relatively less attention paid to use of caffeine among children and adolescents. The available evidence shows that as with adults, adolescents who regularly consume caffeinated products show signs of caffeine dependence (Bernstein, Carroll, Thuras, Cosgrove, & Roth, 2002; Oberstar, Bernstein, & Thuras, 2002), and that caffeine consumption among adolescents is associated with sleep disturbances, feelings of jitteriness and nervousness, loss of appetite and somatic symptoms (Aepli, Kurth, Tesler, Jenni, & Huber, 2015; Frary, Johnson, & Wang, 2005).

Although caffeinated sodas remain the primary dietary source of caffeine among younger age groups (Temple, 2009), concerns have been raised by policymakers and researchers about the use of energy products (EP) specifically, given the particularly high concentration of caffeine contained in these products and that EP use is often associated with other high-risk behaviors such as heavy alcohol use, drug use and risky sexual behaviors (Arria et al., 2010; Miller, 2008a; SAMHSA, 2013). Furthermore, these products are often marketed specifically towards youth as a means of reducing tiredness, boosting energy, and/ increasing mental alertness (Bramstedt, 2007). Moreover, specifically with regard to the potential effects of EP on adolescents' sleep, these products not only contain 70–80mg of caffeine per 8 fl oz (237ml) serving, or approximately three times the concentration found in cola drinks, but little is known about the potential interactions between caffeine and other common ingredients (e.g. taurine, guarana) contained within these products (Seifert, Schaechter, Hershorin, & Lipshultz, 2011). Guarana, for instance, is the plant with the highest caffeine content (Woods, 2012), thereby providing another source of caffeine within energy drinks. Thus, the combination of high doses of caffeine along with other alertness-promoting substances may contribute to sleep disturbance (Branum, Rossen, & Schoendorf, 2014; Roehrs & Roth, 2008), which in turn could lead to further use of EP to increase daytime alertness and compensate for sleep loss (Grandner et al., 2014). Furthermore, because sleepiness is a known side effect of caffeine withdrawal even after periods of abstinence as brief as several hours (Juliano & Griffiths, 2004), use of EP may initiate a vicious cycle of

caffeine withdrawal, leading to daytime sleepiness, leading to greater consumption of EP, and further sleep disturbance. Thus, EP use could contribute to insufficient sleep and sleep problems with potential bidirectional influences and downstream consequences for adolescent health and functioning.

Although EP have been available in the U.S. market since 1997, the research on the epidemiology of EP use and associated consequences is still in its infancy. However, the existing data show that teens and emerging adults ages 18 to 34 are the most frequent consumers of these products, with surveys showing that 31–54% of this age group reporting that they regularly consume EP, and with consistently higher rates for males than females (Arria et al., 2011; Heckman, Sherry, & de Mejia, 2010; Miller, 2008a). (Given that reducing sleepiness and/or increasing alertness is a primary reason why people consume EP (Ishak, Ugochukwu, Bagot, Khalili, & Zaky, 2012) and that teens are a high-risk group for sleep loss and sleep disruption (Keyes et al., 2015), it is not surprising that both teens and young adults are motivated to use these products to manage daytime sleepiness (Calamaro, Mason, & Ratcliffe, 2009).)

To date, there have been few studies on the association between EP use specifically (as opposed to caffeine use more generally) and sleep, and the existing work has primarily focused on college student or young adult samples, with limited racial/ ethnic or socioeconomic diversity, and limited characterization of sleep (e.g., typically focused on sleep duration only) (Larson, Laska, Story, & Neumark-Sztainer, 2015). In a study of U.S. service members age 18 to 24 years, those who consumed EP regularly were significantly more likely to report insufficient sleep (sleeping less than 5 hours per night) than those who did not regularly consume EP (Toblin, Clarke-Walper, Kok, Sipos, & Thomas, 2012). However, sleep quality has multiple components, and it is important to consider the association between EP use and sleep duration, as well as timing, quality, and variability of sleep, as each of these dimensions are critically important for adolescent health and functioning, and may be affected by EP use. For instance, given the known consequences of caffeine on sleep architecture, including the percentage of time spent in slow-wave or “deep” sleep, it is plausible that EP use affects not only the quantity of sleep, but also the quality of sleep. For example, Larson and colleagues (Larson et al., 2015) found that in young adults (ages 20–34), 18.8% reported using energy drinks at least once a week, and energy drink consumption was associated with increased risk of trouble sleeping as well as insufficient duration of sleep. To our knowledge, no prior study has examined the association between EP use and multiple domains of sleep that are particularly relevant to adolescents’ functioning (Carskadon et al., 1998), including sleep quality, duration, timing, and the weekend-weekday variability in sleep timing.

There are also racial/ethnic disparities in sleep. For example, African Americans typically report higher rates of poor sleep quality and insufficient sleep duration as compared to whites (as reviewed in Grandner et al., 2014). Thus, it is important to understand how EP use and its association with sleep may differ across racial/ethnic groups as such investigation may identify key targets for intervention among vulnerable groups. The few epidemiologic studies examining racial/ethnic differences in EP use have generally focused on young adults or college student samples and resulted in mixed findings. For instance, whereas one study

found higher EP use among non-Hispanic whites than Hispanic and black students (Miller, 2008a) more recent studies have shown that Hispanics are more likely to consume EP than other racial/ethnic groups. Researchers have suggested that such changing demographic trends with regard to EP use may reflect changing trends in EP marketing strategies, which are increasingly targeted towards minority youth (Miller, 2008b; Packaged Facts, 2013). Thus, examining whether racial/ethnic differences in EP use and its correlates are evident in younger adolescents will fill an important gap in the literature. Findings from this work can help inform policy efforts aimed at regulating such marketing strategies for this population.

As part of this examination of the overall prevalence of EP use and racial/ethnic differences in EP use, it is also important to focus on EP use expectancies given their central importance to conceptual models of substance use (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Witkiewitz & Marlatt, 2004). Simply stated, how individuals evaluate their experiences and their expectations regarding potential outcomes are critical components of how they develop attitudes and make decisions about behavior (Ludden & Wolfson, 2010). To date, only a handful of studies have investigated EP use expectancies, most studies have focused on college student samples, and to our knowledge no prior study has examined racial/ ethnic differences in EP use expectancies. In general, primary reasons for use include energy/ performance enhancement or to decrease sleepiness/increase alertness (Attila & Cakir, 2011; Ludden & Wolfson, 2010). Even if racial/ethnic groups do not differ in their EP use during adolescence, disparities in positive outcome expectancies for EP use may indicate a heightened vulnerability of certain groups to initiate EP use in the future. Thus, it is important to assess racial/ ethnic disparities in these associations as it can affect how providers and clinicians address this problem with youth.

The current study extends the small, extant literature on EP use and sleep in two important respects. First, this study is the first to examine the prevalence of EP use specifically (rather than caffeine use more generally) and EP expectancies in a racially/ethnically diverse sample of adolescents, whereas the majority of the existing literature has focused on college student or young adult samples. Second, this study examines the associations between EP use and several key sleep outcomes that have been identified as particularly important for adolescent health and functioning (National Sleep Foundation, 2000): self-reported sleep timing (bedtimes and wake-up times), sleep duration and variability in sleep duration (weekdays vs. weekends), and sleep quality. We expected that EP users would report later bedtimes, shorter sleep duration, poorer sleep quality, and would exhibit greater difference in weekend versus weekday sleep duration, as this difference score may be an indicator of “weekend oversleep” for sleep-deprived teens, and is associated with other high-risk behaviors, including substance use (Hasler & Clark, 2013). Finally, we examined racial/ ethnic differences in EP use, EP expectancies, and the associations of EP and the sleep outcomes. Given the small literature and mixed findings on racial/ethnic differences in EP use among college students, we did not have specific hypotheses regarding racial/ethnic differences. All analyses adjusted for sociodemographic (e.g., family structure, parent education (Troxel, Lee, Hall, & Matthews, 2014) and psychosocial risk factors (e.g., mental health symptoms (Swendsen & Merikangas, 2000) that may explain associations of EP use with sleep quality and patterns.

Methods

Adolescents from this study originated from 16 middle schools across three school districts in southern California that were part of a large, ongoing longitudinal study with a school-based intervention that occurred in 2008 (D'Amico et al., 2012). As previously reported (D'Amico et al., 2012), 92% of parents returned a consent form at the baseline; 71% gave permission for their child to participate in the original study. Of consented students, 94% completed the baseline survey, which is higher or comparable to other school-based survey completion rates with this population (Johnston, O'Malley, & Bachman, 1998). We continued to follow two cohorts of youth (the original 6th grade cohort, and the original 7th grade cohort) as they transitioned into high school. Questionnaires for the current study were administered from May 2014 to May 2015 via a web survey when the sleep and EP measures were added to the survey and youth were on average 17.3 years old ($n=2,493$). Eight youth had missing data for the EP use questions; thus the analytic sample comprised 2,485 youth. Missingness was less than 0.5% for all variables except mother's education (mother's education missingness was 7.4%).

Race/ethnicity and covariates

Participants self-reported their race/ethnicity and based on the distribution of the racial/ethnic categories, the following four categories were used in the current analyses: non-Hispanic white (20.2%), Hispanic (46.0%), Asian (20.5%), and "Multiracial/Other" (13.3%; which included African American 2.3%, American Indian 0.6%, Native Hawaiian 0.7%, Multiracial 9.8%). In addition to examining racial/ethnic differences in observed associations, we included covariates known to be associated with sleep and EP use including age, gender, educational attainment of mother (high school diploma/GED or less versus any post-high school education), family structure (i.e., two-parent household versus single-parent household), and an indicator for whether the student had attended one of the original intervention schools. We also included a summary mental health score using five items (focused on past month anxiety and depression symptoms) from the Mental Health Inventory, MHI-5 (Berwick et al., 1991). Scores on the MHI-5 were scaled such that they ranged from 0 to 100, with higher scores indicating better mental health ($\alpha=0.78$).

EP use

Past month use was assessed with the item: "During the past month, how many days did you consume an energy drink?" ("0 days" to "20–30 days"). Overall, 82.09% reported "zero" days of use; 8.37 % reported 1 day; 4.51% reported 2 days; 2.94% reported 3–5 days; 1.01% reported 6–9 days; .56 reported 10–19 days; and .52% reported 20–30 days. Based on the distribution and consistent with prior reports of energy drink use in adolescents which suggests a low proportion of high frequency users (e.g., Monitoring the Future (Terry-McElrath et al., 2014), we analyzed this variable in two ways: 1) as a binary variable indicating "any EP use" in the past month versus none; and 2) as a continuous variable indicating frequency of days used in the past month. Results were consistent with both approaches. We therefore present analyses with the binary variable given the highly skewed distribution of the variable.

EP expectancies

Five items queried perceived positive effects of EP use, which were derived from the Caffeine Expectancy Questionnaire (Huntley & Juliano, 2012) and modified to refer specifically to beliefs about energy products. The expectancies (i.e., helps you stay awake, makes you more alert/energetic, improves athletic performance, helps you concentrate/focus, helps you maintain/reduce weight) were rated on a scale from 1 “strongly disagree” to 4 “strongly agree.” Each item was examined separately in the analyses.

Sleep measures

Participants were asked when they “usually go to bed” and “wake up” separately for weekdays and weekend days. Similar measures have been used in several prior studies with adolescents (Larson et al., 2015; Pasch, Laska, Lytle, & Moe, 2010), and have been shown to significantly correlate with diary and actigraphy assessments (Wolfson et al., 2003). The primary outcomes for the current study were self-reported bedtimes and wake times (weekdays and weekends), total sleep time (TST; derived from reported bedtimes and wake times (weekdays and weekends), the difference between weekend and weekday sleep (i.e., weekend TST-weekday TST), and a single item assessing “trouble sleeping” taken from the Patient Health Questionnaire (PHQ) Somatic Symptom Severity Scale measure (Kroenke, Spitzer, & Williams, 2002); “During the past 4 weeks, how much have you been bothered by any of the following problems?”: not bothered, bothered a little, bothered a lot. Given the considerable variability in adolescent sleep patterns during the school week and on the weekends, we analyzed weekday and weekend bedtimes and TST separately.

Analytic Strategy

Descriptive statistics (mean/SD or percentage) are presented for sociodemographic characteristics, sleep, and EP expectancies for the total sample and split by EP user status (i.e., user/non-user). Additionally, we describe racial/ethnic differences in EP expectancies using analysis of variance (ANOVA) and post-hoc tests to examine pairwise comparisons among the four racial/ethnic groups. Due to the large number of post-hoc tests, we used the Benjamini and Hochberg method to adjust p-values (Benjamini & Hochberg, 1995). For the primary analyses, we conducted a series of models which regressed individual sleep outcomes on EP use, controlling for sociodemographics, an intervention school indicator (0/1), and mental health symptoms. Continuous sleep outcomes (bedtimes, wake times, TST, and weekend-weekday TST difference) were modeled with general linear models. Given that the trouble sleeping item was a three-level categorical variable, this outcome was modeled with a multinomial logistic regression where the reference outcome category was “not at all bothered” by trouble sleeping. Finally, we added interaction terms for race/ethnicity and the binary EP use variable to each model to test whether associations of EP with sleep behaviors differed according to racial/ethnic category.

Results

We report descriptive statistics for the total sample and for EP users/non-users in Table 1 along with p-values comparing the users and non-users. Rates of past month EP use (17.9% overall) did not significantly differ by the different racial/ethnic categories ($p=0.33$). Males

were more likely than females to use EP (24% versus 13%; $p<0.001$). On average, adolescents' self-reported bedtime was 11:15 p.m. during the week, with EP users staying up 15 minutes later than non-EP users during the week. On the weekends, the average bedtime was 12:30 a.m., again with EP users reporting later weekend bedtimes (by 30 minutes) than non-users. The majority of respondents reported "not being bothered" by trouble sleeping (53.2%); however, EP users were more likely to report being bothered by trouble sleeping "a little" or "a lot" as compared to non-users ($p=0.013$). EP users had higher positive expectancies regarding EP use for each of the 5 expectancy items.

As shown in Table 2, there were statistically significant racial/ethnic differences in EP expectancies. Post-hoc comparisons indicated that Asian adolescents reported significantly stronger EP expectancies than Hispanic and multiracial/other adolescents on all items except for beliefs about EP use to "help you concentrate/focus". Non-Hispanic white adolescents reported significantly stronger expectancies about EP use than Hispanic adolescents on all but two items ("improves athletic performance" and "helps you concentrate/focus"). Additionally, non-Hispanic white adolescents reported significantly strong EP expectancies than multiracial/other adolescents for the belief about EP use to help maintain/reduce weight.

Any EP use and sleep problems

Table 3 presents regression models evaluating the main effect of "any" EP use on sleep patterns and trouble sleeping. EP use was associated with later weekend bedtimes, shorter weekend TST, and a smaller difference in TST between weekdays and weekends (i.e., less weekend "oversleep"). EP use was also associated with a greater likelihood of being bothered by trouble sleeping. However, EP use was not significantly associated with weekday bedtimes or weekday TST. Additionally, to evaluate whether there were racial/ethnic differences in associations between EP use and sleep behaviors, we conducted secondary analyses that added the race/ethnicity*EP use interaction terms to the models shown in Table 3. There were no statistically significant race/ethnicity* EP use interactions for any sleep outcomes.

Discussion

Since their introduction to the U.S. market in 1997, there has been increasing concern among clinicians, researchers, and policymakers about the use of energy products (EP) among youth given the particularly high concentration of caffeine contained in these products, and that EP use is often associated with other high-risk behaviors such as heavy alcohol use, drug use and risky sexual behaviors (Arria et al., 2010; Miller, 2008a; SAMHSA, 2013). However, there are several critical gaps in the literature concerning the prevalence, correlates, and consequences of EP use in adolescent samples, as most of the research to date has focused on college student samples, with limited racial/ethnic diversity. Moreover, despite the well-documented effects of caffeine use more generally on sleep, this is the first study to examine the effects of EP use, specifically, on several dimensions of sleep (duration, quality, and bedtimes) among a large sample of adolescents and assess racial/ethnic differences in observed associations.

In this large and racially/ethnically diverse sample of adolescents, we found that approximately 18% reported any EP use in the past month, with most reporting 1 drink/shot per month. By comparison, in the Monitoring the Future Study (Terry-McElrath et al., 2014), which includes a comparable age range of adolescents, 30% of adolescents in 10th grade reported using any EP per day on average. However, average frequency of use was less than 1 drink per day. Thus, although our data suggest a lower prevalence of any EP use in the past month as compared to the average daily use assessment in MTF, the frequency of EP use was similar. Of note, EP use in our sample was consistently related to sleep outcomes, whether we used a binary or continuous measure, suggesting that even at low reported frequencies of use, adolescents who consume any EP may be at-risk for sleep disturbances. Findings further indicated that youth who reported more positive EP expectancies were more likely to use EP. This fits with the substance use literature, whereby positive expectancies are strongly associated with drinking and other drug use behavior (Baker et al., 2004). We did not find racial/ethnic differences in EP use; however, there were group differences in EP expectancies, an area that has not been examined previously in this population. Specifically, Asian and non-Hispanic white youth reported the highest positive expectancies compared to Hispanic and Multiethnic/Other youth. It may therefore be important to target these positive expectancies in prevention efforts, as has been done in the substance use field (D'Amico et al., 2012). Future studies should also consider the effects of adolescents' sleep expectancies in relation to EP use and EP expectancies.

Regarding associations between EP use and sleep disturbances, consistent with our hypotheses, we found that EP use was associated with multiple indices of sleep disturbance, including later weekend bedtimes, shorter weekend sleep duration, and more trouble sleeping. Contrary to expectations, however, we found that EP use was significantly associated with *lesser* variability in weekend versus weekday sleep duration. This runs counter to the argument that adolescents may primarily use EP to stay awake for school and that EP use may contribute to erratic sleep patterns, characterized by weekend over-sleep to compensate for sleep debt that has accumulated during the week. Rather, these findings suggest that adolescents may use EP on the weekends as a means to stay up later to engage in social activities, and perhaps such use may serve as a segue to other high-risk behaviors, including heavy drinking and drug use (Miller, 2008a), as well as further contributing to cumulative sleep deprivation.

Finally, given known racial/ethnic differences in adolescent sleep and the equivocal evidence concerning racial/ethnic differences in EP use, we examined whether the association between EP use and sleep outcomes differed across racial/ethnic groups. We did not find evidence for moderation by race/ethnicity for any of the sleep outcomes. However, given our findings of significant racial/ethnic differences in EP expectancies, and given that EP marketing strategies have recently begun to aggressively target minority youth (Packaged Facts, 2013), it will be important to monitor these trends in EP expectancies, use, and associated consequences over time. Such findings have important implications for identifying at-risk groups and for policy efforts focused on adolescents.

There are several limitations which must be taken into consideration when interpreting findings from this study. First, the data are cross-sectional and thus temporality or causal

relationships cannot be inferred. In fact, it is plausible that dynamic and bidirectional associations exist between EP use and sleep behaviors, such that EP use leads to sleep disturbance, which further perpetuates EP use to compensate for daytime sleepiness. Consistent with this notion, prior research has shown that adolescents who reported daytime sleepiness were 76% more likely to consume caffeinated products (including energy drinks) as compared to adolescents who did not report daytime sleepiness (Calamaro et al., 2009). To disentangle cause from effect and to evaluate the degree to which EP use and sleep problems dynamically interact over time, prospective studies are needed which track nightly sleep patterns and daily EP consumption, using sleep diaries and/ or actigraphy. In fact, it is highly plausible that a vicious cycle may exist, such that EP use leads to increased sleep disturbance, which in turn, leads to further EP use, and so on. A second limitation is the use of self-reported measures of EP use and sleep patterns, which may have introduced bias or common method variance. A strength of our study is the broader assessment of sleep patterns using assessments that have been validated in prior work with adolescents (Wolfson et al., 2003), particularly given that prior work has primarily on sleep duration only. However, research that includes objective measures of sleep patterns via wrist actigraphy or polysomnography would reduce recall or other biases inherent to self-report and provide a more comprehensive assessment of sleep patterns and variability. Furthermore, use of validated assessments of sleep quality, such as the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) are preferred over single-item assessments; however, we note that single-item measures of trouble sleeping have been used in numerous epidemiologic studies, and have been associated with diverse indicators of adolescent health and functioning (Roane & Taylor, 2008; Wong, Brower, Fitzgerald, & Zucker, 2004). Finally, although this study was unique in contributing to the limited existing literature on racial/ethnic differences in EP use and the association with sleep, the “Multiracial/Other” group was quite heterogeneous in that it combined the relatively small subgroups of African Americans, American Indians, Native Hawaiians, and Multi-ethnic respondents.

In sum, the current study makes an important contribution to the literature on EP use and sleep behaviors among adolescents by examining associations with multiple dimensions of sleep patterns and quality, including duration and timing on weekends and weekdays, testing whether these associations differ across four racially/ethnically distinct groups, and controlling for a host of risk factors that are known to covary with race/ethnicity, sleep and EP use. The robust nature of the results suggests that EP use is an independent correlate of sleep problems among adolescents, even after controlling for known risk factors for sleep disturbances, including sociodemographic characteristics and mental health symptoms. Understanding racial/ethnic differences in EP use and expectancies, as well as the associations between EP use and sleep behaviors, is critical to inform prevention efforts by helping parents, schools, communities and providers know how, when, and with whom to intervene. Although the current study did not find racial/ethnic differences in the association between EP use and sleep, the racial/ethnic differences in EP expectancies highlights the need for continued research in this area to address potential differences and emerging disparities. Finally, this research has important policy implications, particularly given the aggressive EP marketing strategies that target youth (Packaged Facts, 2013), as well as the burgeoning research demonstrating that EP use with or without alcohol is associated with a

host of risky behaviors in adolescents and young adults (Arria et al., 2010; Miller, 2008a; SAMHSA, 2013). Furthermore, as a society, it is imperative that we consider the consequences of living in an increasingly 24/7 world, particularly for our nation's youth, where it is becoming increasingly commonplace to sacrifice sleep for other demands or simply by choice, and to compensate for insufficient sleep by increased consumption of highly caffeinated energy products. Given the profound consequences of insufficient sleep and poor sleep quality for adolescents' physical, socio-emotional, and cognitive development, assessing sleep health and providing education about healthy sleep hygiene, including the effects of caffeine on sleep, should be a routine part of adolescent healthcare.

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Table 1

Descriptive Statistics for Total Sample and According to EP User Status

	Total Sample (N = 2,485 ^a)		Non-User (n = 2,040)		User (n = 445)		P-Value ^b
	Mean/%	SD	Mean/%	SD	Mean/%	SD	
Gender							
Female	54.25		57.45		39.55		<.0001
Male	45.75		42.55		60.45		
Race/Ethnicity							0.3278
Asian	20.48		20.25		21.57		
Hispanic	46.04		46.81		42.47		
Multiracial/Other	13.32		12.89		15.28		
White	20.16		20.05		20.67		
Age	17.31	0.67	17.31	0.67	17.33	0.70	0.6535
Mother's Education							0.9979
<High School	14.64		14.65		14.59		
High School	17.55		17.57		17.46		
>High School	67.81		67.78		67.94		
Living Situation							0.295
<2 Parent Household	35.01		34.55		37.16		
2 Parent Household	64.99		65.45		62.84		
MHL-5	65.84	20.32	65.87	20.45	65.86	19.59	1.00
Intervention							0.4296
No CHOICE	49.32		48.95		51.02		
CHOICE	50.68		51.05		48.98		
Sleep Variables							
Weekday Bedtime ^c	11:15 p.m.	1.3 hours	11:15 p.m.	1.3 hours	11:30 p.m.	1.4 hours	0.0139
Weekend Bedtime ^c	12:30 a.m.	1.5 hours	12:30 a.m.	1.5 hours	1:00 a.m.	1.7 hours	<.0001
Total Sleep Time, Weekend	9.09	1.63	9.15	1.60	8.83	1.78	0.0006
Total Sleep Time, Weekday	7.40	1.41	7.40	1.41	7.38	1.38	0.8347

	Total Sample (N = 2,485 ^a)		Non-User (n = 2,040)		User (n = 445)		P-Value ^b
	Mean/%	SD	Mean/%	SD	Mean/%	SD	
Total Sleep Time, Difference	1.69	1.92	1.75	1.92	1.45	1.90	0.0029
Bothered by Trouble Sleeping							0.0126
Bothered a Little	31.00		30.68		32.42		
Bothered A Lot	15.84		14.97		19.82		
Not Bothered	53.16		54.34		47.75		
Expectancies							
Helps you stay awake	2.94	1.03	2.88	1.05	3.21	0.87	<.0001
Makes you more alert/energetic	2.89	1.01	2.84	1.03	3.14	0.87	<.0001
Improves athletic performance	2.18	0.97	2.11	0.97	2.49	0.91	<.0001
Helps you concentrate/focus	1.79	0.87	1.74	0.86	1.99	0.92	<.0001
Helps you maintain/reduce weight	2.24	0.97	2.15	0.96	2.65	0.92	<.0001

Notes:

^aEight youth missing the EP use question were not included in the analyses.

^bP-values reported from Chi-square tests for categorical variables and t-tests for continuous variables.

^cEstimated average bedtimes are reported; analyses conducted with the bedtime variables use minutes from midnight, scaled to every 10 minutes.

Table 2

Energy Product Expectancies According to Racial/Ethnic Group

	Total Sample (N=2,485)		Asian (n=512)		Hispanic (n=1,146)		Multiracial/ Other (n=333)		White (n=502)		P-value ^b
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Helps you stay awake	2.94	1.03	3.14 ^{h,m}	0.87	2.78 ^{a,w}	1.08	2.91 ^a	1.07	3.11 ^h	0.94	<.0001
Makes you more alert/energetic	2.89	1.01	3.10 ^{h,m}	0.84	2.74 ^{a,w}	1.07	2.87 ^a	1.05	3.05 ^h	0.94	<.0001
Improves athletic performance	2.18	0.97	2.34 ^{h,m}	0.92	2.12 ^a	1.00	2.11 ^a	0.95	2.19	0.93	<.0001
Helps you concentrate/focus	1.79	0.87	1.87	0.86	1.73	0.88	1.74	0.87	1.85	0.88	0.0072
Helps you maintain/reduce weight	2.24	0.91	2.40 ^{h,m}	0.90	2.15 ^{a,w}	1.00	2.12 ^{a,w}	0.95	2.34 ^{h,m}	0.96	<.0001

Note:

^bp-value reported from ANOVA. Post-hoc tests were conducted to test for differences between the racial/ethnic categories. The Benjamini and Hochberg (1995) false discovery rate (FDR) correction was used to adjust p-values given the multiple testing. Superscripts indicate significance at $p < .05$: ^asignificantly different than Asian, ^hsignificantly different than Hispanic, ^msignificantly different than multiracial/other, ^wsignificantly different than white.

Table 3

Results of Multivariate Regression Models of EP Use and Adolescent Sleep Problems

	Weekday Bedtime (10 Mins)	Weekend Bedtime (10 Mins)	Weekend TST (Hours)	Weekday TST (Hours)	TST Difference (Hours)	Trouble Sleeping	
						Bothered a Little	Bothered A Lot
	Beta (95% CI)	Beta (95% CI)	Beta (95% CI)	Beta (95% CI)	Beta (95% CI)	OR (95% CI)	OR (95% CI)
Past Month Energy Drink Use	0.52 (−0.28, 1.32)	2.59 (1.62, 3.55) ***	−0.3 (−0.48, −0.13) **	0.03 (−0.11, 0.18)	−0.33 (−0.54, −0.13) **	1.30 (1.01, 1.66) *	1.67 (1.22, 2.30) **
Age	0.62 (0.17, 1.08) **	0.7 (0.15, 1.25) *	−0.03 (−0.13, 0.07)	0.04 (−0.04, 0.13)	−0.07 (−0.19, 0.05)	0.93 (0.81, 1.07)	0.92 (0.76, 1.11)
Female	−0.99 (−1.61, −0.36) **	−1.21 (−1.97, −0.46) **	0.11 (−0.02, 0.25)	0.03 (−0.08, 0.15)	0.08 (−0.08, 0.24)	1.54 (1.27, 1.88) ***	1.45 (1.12, 1.89) **
Race							
Multiracial/Other	0.28 (−0.79, 1.34)	−0.11 (−1.39, 1.18)	0.06 (−0.18, 0.29)	−0.12 (−0.32, 0.07)	0.19 (−0.09, 0.46)	1.07 (0.77, 1.49)	1.24 (0.80, 1.92)
Hispanic	−0.58 (−1.45, 0.29)	−0.18 (−1.23, 0.87)	−0.04 (−0.23, 0.15)	0.04 (−0.12, 0.2)	−0.07 (−0.3, 0.15)	1.19 (0.9, 1.56)	1.28 (0.89, 1.85)
Asian	3.38 (2.44, 4.32) ***	0.48 (−0.66, 1.61)	−0.02 (−0.23, 0.18)	−0.51 (−0.68, −0.33) ***	0.49 (0.25, 0.73) ***	1.24 (0.93, 1.66)	0.95 (0.63, 1.43)
White (ref)							
Mother's Education							
< High School	−0.55 (−1.52, 0.42)	−1.52 (−2.69, −0.36) *	0.32 (0.11, 0.53) **	0.02 (−0.15, 0.2)	0.29 (0.04, 0.54) *	0.98 (0.72, 1.33)	1.24 (0.84, 1.81)
High School	−0.95 (−1.8, −0.11) *	−0.24 (−1.26, 0.78)	−0.03 (−0.21, 0.16)	0.1 (−0.05, 0.26)	−0.13 (−0.35, 0.08)	1.00 (0.77, 1.31)	1.11 (0.78, 1.56)
> High School							
Two Parent Household	−0.83 (−1.47, −0.18) *	−1 (−1.78, −0.22) *	0.07 (−0.07, 0.21)	0.12 (0, 0.23)	−0.05 (−0.22, 0.11)	0.94 (0.77, 1.15)	0.84 (0.65, 1.10)
MHI-5	−0.08 (−0.09, −0.06) ***	−0.07 (−0.09, −0.05) ***	0.01 (0, 0.01) ***	0.01 (0.01, 0.01) ***	−0.01 (−0.01, 0) **	0.98 (0.97, 0.98) ***	0.95 (0.95, 0.96) ***
Intervention	0.02 (−0.59, 0.63)	−0.58 (−1.32, 0.16)	0.05 (−0.08, 0.19)	0.01 (−0.1, 0.12)	0.04 (−0.12, 0.2)	0.99 (0.82, 1.20)	0.77 (0.60, 0.99) *

Note:

*
p < .05;**
p < .01;***
p < .001