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A Comparison of Sociodemographic Correlates of Cigarette, Alcohol, and Energy Drink Consumption among High School Students in the United States, 2010-2015

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INTRODUCTION

Socioeconomic differentials in risk-endangering behaviors among adolescents are likely an important step on the pathway to social disparities in health that emerge in later life, as many of these behaviors track into adulthood. Adolescence is a period universally marked by sharp increases in autonomy and willingness to experiment; thus, systematic group divergences in behaviors and lifestyle practices that occur at this time in life point to the importance of societal influences on uptake of such behaviors. Much of the literature on socioeconomic and demographic differentials in adolescent behaviors has focused on substance use and abuse, particularly the use of cigarettes and alcohol.^{1,2} Socioeconomic disadvantage is consistently associated with smoking prevalence among adolescents, while associations with alcohol use are reversed. Higher parental income and white race are both associated with higher levels of alcohol use and binge drinking.^{3,4} The reasons for these differences are not well understood,⁵ but differences in social factors, such as family and peer influence, perceived and actual availability of these substances, and perceptions of risk associated with such behaviors are all thought to play important roles.

One category of substance use that has received little attention from a social disparities lens is the use of energy drinks. Energy drinks emerged in the market in the 1990s and quickly became popular among both young adults and adolescents.⁶ Containing high amounts of stimulants like caffeine and taurine, as well as taste-enhancing sugar or other sweeteners, energy drinks were claimed by marketers to increase energy, improve athletic performance, and enhance critical thinking.^{6,7} The amount of caffeine in energy drinks is unregulated and can range from 50 to 500 mg per can. It was only in the late 1990s and early 2000s that public health practitioners raised the alarm on a dangerous, sometimes fatal, practice of mixing alcohol with energy drinks that seemed to be emerging among adolescents and young adults.^{8,9} Even without alcohol, high doses of caffeine produce known negative physiological effects, such as lack of sleep, jitteriness, upset stomach, inattention, and anxiety.¹⁰⁻¹³ Despite the public health messaging surrounding the use of energy drinks and its labeling as a risky behavior, however, the prevalence of consumption has continued its increase in the past 15 years, likely reflecting the lack of regulation governing its use.

Identifying socioeconomic and demographic characteristics of energy drink use among adolescents may give us clues to its persistence in this population. Moreover, it is important to juxtapose this examination with an examination of the correlates of other substance use in this population whose availability is more restricted. We hypothesize that the

lack of regulations governing the sale of energy drinks to adolescents should alter the sociodemographic distribution of its use relative to regulated substances such as cigarettes and alcohol. Specifically, we hypothesize a narrowing or disappearance of sociodemographic differentials and a general elevation in use across all sociodemographic categories, relative to either cigarette or alcohol consumption.

The analyses described in this paper were accordingly developed to answer 2 related research questions. First, among adolescents in the United States, does the strength and patterning of association of various sociodemographic correlates vary with the type of substance consumed: energy drinks, cigarettes, and alcohol? Second, do the sociodemographic covariates of energy drink consumption in this population vary by whether or not these youth are regular users of cigarettes or alcohol? Examining these associations is important to further our understanding of sociodemographic disparities in risky behaviors in an adolescent population. Moreover, the evidence from this study will provide a direction and strategy to develop interventions and policies to decrease energy drink consumption in adolescent population.

METHODS

Monitoring the Future (MTF) is a population-based survey of health risk behaviors of adolescents in the United States. Funded by the National Institute on Drug Abuse and conducted by the University of Michigan Survey Research Center staff, the MTF survey has regularly obtained data from 12th grade students since its inception in 1975; 8th and 10th graders were added in 1991. Currently, about 50,000 students in approximately 420 public and private secondary schools participate in each of the annual cross-sectional surveys. The MTF uses multistage random sampling conducted at 3 levels (geographic areas as primary sampling units [PSUs], one or more schools in each area, and classes within each school). For each school, up to 350 students are recruited to complete a self-administered questionnaire related to the use of illicit as well as licit substances. Sampling weights for students, calculated to account for sampling strategy, variations in selection probabilities of PSUs, and for different sample sizes of each school, yield a nationally representative sample of adolescents. Beginning in 2010, a measure for daily energy drinks consumption was added to the MTF survey. Because the MTF uses multiple forms to reduce respondent burden, the question on energy drinks is only administered to a subset of participants. This study makes use of pooled cross-sectional data obtained from the 6 years from 2010 through 2015, limited to 10th and 12th grade students who were administered the

questions relating to energy drinks use. All data collected as part of the MTF survey are freely available to researchers. For this study, MTF datasets were downloaded from National Addiction and HIV Data Archive Program (<http://www.icpsr.umich.edu/icpsrweb/NAHDAP/>).

Measures

The daily average frequency and amount of energy drink consumption was assessed with 2 survey questions: 1) “Energy drinks are non-alcoholic beverages that usually contain high amounts of caffeine, including such drinks as Red Bull, Full Throttle, Monster, and Rockstar. They are usually sold in 8- or 16-ounce cans or bottles. About how many (if any) energy drinks do you drink PER DAY, on average?” 2) “Energy drinks are also sold as small ‘shots’ that usually contain just 2 or 3 ounces. How many (if any) energy drink shots do you drink PER DAY, on average?” Responses to both questions ranged from 0 to 7 or more per day (*None, Less than one per day, One, Two, Three, Four, Five or six, and Seven or more*). For the purposes of these analyses, a dichotomous variable was constructed indicating any use versus non-use of energy drinks and energy drink shots. The constructed measure is assumed to assess customary use of energy drinks, given the wording of the survey questions. Dichotomous variables indicating customary use of cigarettes and use of alcohol were constructed from student self-report of any smoking or drinking in the past 30 days. The use of cigarettes or alcohol in the past 30 days will be referred to as current use of cigarettes or alcohol in this study.

Sociodemographic variables used in these analyses included sex, grade, race-ethnicity, maternal education, and paternal education. Self-reported race/ethnicity was categorized into black, white (Caucasian), Hispanic (Mexican or Cuban or Puerto Rican or Other Hispanic), and a fourth, residual category “Other/unknown race,” which included multiple race and missing race. Maternal and paternal education were each recoded into 3 categories: less than high school, high school, at least some college; this is comparable to previous studies.^{14,15} Other covariates controlled for in analyses included region (Northeast, North Central, South, West), metropolitan status (Standard Metropolitan Statistical Area [SMSA] vs. non-SMSA), and year of survey data collection (2010 through 2015).

Statistical Analysis

Distributions of sociodemographic characteristics were obtained via weighted tabulations in order to provide descriptive data on the study

sample. The prevalence of energy drink consumption was examined, both for the entire study sample as well as by sample strata, defined by cigarette use and by alcohol use. To address the first research question, the sociodemographic patterning of use of energy drinks, cigarettes and alcohol were obtained via 3 logistic regression analyses that included the following variables as covariates: race/ethnicity, sex, grade, region, paternal and maternal education, metropolitan status, and year of data. These models yielded adjusted odds ratios of consumption of energy drink consumption, cigarette use, and alcohol respectively, across categories of the sociodemographic measures. The second research question was addressed by examining covariate-adjusted probability of energy drink consumption across strata of cigarette use and across strata of alcohol use. Logistic regression models were used to obtain the adjusted probability of energy drink consumption at each level of sociodemographic variables, within the strata of interest. All analyses included weights to adjust for differential probability of selection and were run using the *svy* suite of commands included in Stata v14.2 for analysis of complex survey data.

RESULTS

Descriptive sample statistics of the analytic sample are provided in Table 1. The MTF survey has only a limited number of variables that can be considered sociodemographic descriptors. Of 43,823 survey respondents, a large majority (68%) were 10th grade students. About two-thirds of the sample was White, with the remainder distributed primarily among Hispanics (17.5%), and blacks (13%). Only a small portion (3.4%) of the sample did not fall into any of these three racial/ethnic categories. Over a third of the sample (34.5%) was from the South, and about 19% of the sample was from the Northeast region. A majority of students (62.4%) were sampled from schools that were not in a large metropolitan area and had a father (56.5%) or a mother (65.5%) who had some college education. Paternal education of less than high school was reported by 16.2% of the sample, and maternal education of less than high school was reported by 12.5% of the population. The sample was about equally distributed across the 6 years of data included (2010-2015).

Table 1. Sociodemographic Characteristics of Sample, Monitoring the Future (2010-2015), 10th and 12th Grade

	N	Weighted Percent % (CI)
Total	43,823	100.0
Grade		
10	29,774	67.9 (67.4 – 68.4)
12	14,049	32.1 (31.6 – 32.6)
Use of energy drinks		
None	30,249	73.0 (72.5 – 73.5)
Any	10,831	27.0 (26.5 – 27.5)
Among cigarette users	4,721	52.3 (50.7 – 53.9)
Among non-cigarette users	35,847	23.5 (23.0 – 24.0)
Among alcohol users	12,232	38.4 (37.4 – 39.4)
Among non-alcohol users	27,347	21.6 (21.0 – 22.1)
Use of cigarettes		
No	37,768	87.6 (87.2 – 88.0)
Yes	5,181	12.4 (12.0 – 12.8)
Use of alcohol		
No	28,685	69.1 (68.6 – 69.6)
Yes	13,162	30.9 (30.4 – 31.4)
Sex		
Male	21,005	49.4 (48.8 – 49.9)
Female	21,277	50.6 (50.1 – 51.2)
Race/ethnicity		
Black	4,717	13.0 (12.6 – 13.4)
White	24,619	66.0 (65.5 – 66.6)
Hispanic	6,500	17.5 (17.1 – 18.0)
Other	1,233	3.4 (3.2 – 3.6)
Region		
Northeast	8,900	18.7 (18.3 – 19.1)
North Central	10,414	23.9 (23.4 – 24.3)
South	14,336	34.5 (34.0 – 35.0)
West	10,173	22.9 (22.5 – 23.4)
School is in a large Metropolitan Statistical Area (MSA)		
No	27,343	62.4 (61.5 – 63.2)
Yes	16,480	37.6 (37.0 – 38.2)
Paternal Education		
Less than high school	5,900	16.2 (15.9 – 17.0)
High school	10,060	27.3 (26.8 – 27.9)

Some college	22,293	56.5 (55.7 – 56.9)
Maternal Education		
Less than high school	4,793	12.5 (11.5 – 13.0)
High school	8,591	22.1 (21.0 – 23.1)
Some college	26,832	65.5 (65.0 – 66.4)
Year		
2010	7,741	17.7 (17.3 – 18.1)
2011	7,638	17.4 (17.0 – 17.8)
2012	7,559	17.3 (16.9 – 17.7)
2013	6,610	15.1 (14.7 – 15.5)
2014	6,601	15.0 (14.6 – 15.4)
2015	7,674	17.5 (17.1 – 17.9)

Prevalence of energy drink use was substantial (Table 1). Across the sample, 27% of adolescents reported using energy drinks on a regular basis, substantially higher than the 12.4% of adolescents who reported current use of cigarettes and comparable to the 30.9% of students who reported current use of alcohol. As other studies have shown, use of energy drinks was strongly associated with other risky behaviors, particularly with the use of cigarettes. Consumption of energy drinks was twice as high among adolescents who reported use of cigarettes, compared to those who did not (52% vs. 24%). Similarly, close to 40% of participants who reported use of alcohol also reported use of energy drinks, compared to 22% of students who did not use alcohol.

Sociodemographic patterning of energy drink use was evident in this population. Table 2 presents sociodemographic correlates of energy drink use, cigarette use, and alcohol use among adolescents side by side to allow comparison of sociodemographic patterning across these 3 behavior categories (statistical comparisons are not possible as these estimates were derived from 3 separate models). Differences in racial/ethnic patterning of substance use were striking. In the case of current use of cigarettes and alcohol, white students had substantially higher odds of consumption than black students, at 3.2 and 2.0 relative to blacks, but in the case of energy drink use, the odds were just 1.4 times higher among whites. Likewise, Hispanics had over 1.6 times higher odds of cigarette and alcohol consumption compared to blacks, but with energy drink consumption, their odds of consumption were comparable to those of blacks. It is very clear that racial and ethnic differences exist in substance use but disappears in the case of energy drink use. Age differences (grade as a proxy) are noteworthy as well. While both cigarette smoking and alcohol use increased substantially from 10th to 12th grade (odds of 1.62

and 1.68 in 12th grade relative to 10th grade), there is little difference in the prevalence of energy drink consumption across these grades. On the other hand, gender differences were slightly wider for energy drinks so that the odds were 43% lower among females than males compared to the case of cigarette and alcohol use (30% and 15% lower odds for females, respectively). The effects of parental education were interesting. Overall, parental education showed the strongest association with cigarette smoking, followed by use of energy drinks and alcohol. In particular, adolescents with a college-educated father were 51% less likely to smoke cigarettes and 37% less likely to use energy drinks. Surprisingly, paternal and maternal education were poor predictors of alcohol use.

In a final set of analyses, we examined whether the sociodemographic gradient for energy drink use differs by strata of cigarette use and alcohol use. Table 3 presents the probability of energy drink use across categories of smoking and alcohol use. Two findings were readily evident. First, use of energy drinks was substantially higher among current users of cigarettes or alcohol than non-smokers or non-alcohol users. Second, sociodemographic gradients were similar across smokers and non-smokers and users and non-users of alcohol. Thus, regardless of smoking or alcohol use status, the odds of energy drink consumption for whites was consistently greater than that of blacks and Hispanics; similarly, a gender group difference of about 10 percentage points in probability of energy drink consumption existed across users and non-users of alcohol or cigarettes. Between 10th and 12th grade students, probability of energy drink consumption was evenly distributed across all strata of cigarette and alcohol use. Paternal education was the only sociodemographic variable in these analyses that showed differential associations across strata of substance use, with a strong gradient evident in all groups except for adolescent smokers, where energy drink consumption was about 50%, regardless of paternal education level.

Table 2. Association of Sociodemographic Characteristics with Use of Energy drinks, Cigarettes, and Alcohol*, Monitoring the Future (2010-2015), 10th and 12th Grade

	Use of Energy Drinks		Use of Cigarettes		Use of Alcohol	
	<i>Odds Ratio (CI)</i>	<i>p-value</i>	<i>Odds Ratio (CI)</i>	<i>p-value</i>	<i>Odds Ratio (CI)</i>	<i>p-value</i>
Race						
Black						
White	1.39 (1.25, 1.55)	0.000	3.22 (2.66, 3.90)	0.000	1.99 (1.79, 2.22)	0.000
Hispanic	1.05 (0.92, 1.20)	0.465	1.56 (1.25, 1.96)	0.000	1.70 (1.49, 1.94)	0.000
Sex						
Male						
Female	0.57 (0.53, 0.60)	0.000	0.70 (0.65, 0.76)	0.000	0.85 (0.81, 0.90)	0.000
Grade						
10th grade						
12th grade	1.15 (1.08, 1.23)	0.000	1.62 (1.49, 1.77)	0.000	1.78 (1.68, 1.89)	0.000
Maternal Education						
Less than high school						
High school	0.91 (0.80, 1.02)	0.100	0.81 (0.70, 0.95)	0.010	0.97 (0.86, 1.09)	0.630
Some college	0.73 (0.65, 0.82)	0.000	0.67 (0.58, 0.78)	0.000	1.00 (0.89, 1.11)	0.945
Paternal Education						
Less than high school						
High school	0.85 (0.77, 0.94)	0.000	0.75 (0.66, 0.86)	0.000	0.94 (0.85, 1.04)	0.197
Some college	0.63 (0.57, 0.70)	0.000	0.49 (0.42, 0.56)	0.000	0.79 (0.71, 0.87)	0.000

*Analyses were also adjusted for metropolitan status, region of the country, and year of data collection as possible confounders.

Table 3. Association of Sociodemographic Characteristics with Use of Energy Drinks, Stratified by Smoking and Alcohol-Use Status*, Monitoring the Future (2010-2015), 10th and 12th Grade

	Among Smokers		Among Non-Smokers		Among Alcohol Users		Among Non-Alcohol Users	
	<i>Probability (CI)</i>	<i>p-value</i>	<i>Probability (CI)</i>	<i>p-value</i>	<i>Probability (CI)</i>	<i>p-value</i>	<i>Probability (CI)</i>	<i>p-value</i>
Race								
Black	0.46 (0.37, 0.56)		0.23 (0.22, 0.25)		0.38 (0.33, 0.42)		0.22 (0.20, 0.24)	
White	0.54 (0.52, 0.56)	0.143	0.27 (0.26, 0.28)	0.001	0.42 (0.41, 0.44)	0.084	0.26 (0.25, 0.27)	0.000
Hispanic	0.47 (0.41, 0.53)	0.932	0.24 (0.22, 0.25)	0.857	0.34 (0.31, 0.37)	0.202	0.22 (0.20, 0.24)	0.668
Sex								
Male	0.57 (0.54, 0.60)		0.31 (0.30, 0.32)		0.46 (0.45, 0.48)		0.29 (0.28, 0.31)	
Female	0.47 (0.44, 0.50)	0.000	0.20 (0.20, 0.21)	0.000	0.34 (0.32, 0.35)	0.000	0.19 (0.18, 0.20)	0.000
Grade								
10th grade	0.53 (0.50, 0.55)		0.26 (0.25, 0.26)		0.41 (0.40, 0.43)		0.24 (0.23, 0.25)	
12th grade	0.52 (0.49, 0.55)	0.966	0.27 (0.26, 0.29)	0.017	0.40 (0.38, 0.42)	0.407	0.26 (0.25, 0.28)	0.014
Maternal Education								
Less than high school	0.55 (0.50, 0.61)		0.30 (0.28, 0.32)		0.45 (0.41, 0.49)		0.29 (0.27, 0.32)	
High school	0.54 (0.51, 0.58)	0.813	0.28 (0.27, 0.30)	0.214	0.43 (0.40, 0.45)	0.305	0.27 (0.26, 0.29)	0.225
Some college	0.51 (0.48, 0.53)	0.165	0.24 (0.24, 0.25)	0.000	0.39 (0.37, 0.40)	0.003	0.23 (0.22, 0.24)	0.000
Paternal Education								
Less than high school	0.54 (0.50, 0.59)		0.31 (0.29, 0.33)		0.47 (0.44, 0.50)		0.29 (0.27, 0.32)	
High school	0.54 (0.50, 0.57)	0.816	0.28 (0.27, 0.29)	0.015	0.41 (0.39, 0.43)	0.004	0.27 (0.26, 0.29)	0.136
Some college	0.51 (0.48, 0.54)	0.216	0.23 (0.22, 0.24)	0.000	0.37 (0.36, 0.39)	0.000	0.21 (0.20, 0.22)	0.000

*Analyses were also adjusted for metropolitan status, region of the country, and year of data collection as possible confounders.

DISCUSSION

Sociodemographic differences in health-damaging behaviors are an important mechanism of social disparities in health outcomes.¹⁶⁻¹⁸ Commonly implicated reasons for adolescents' initiation into and persistence of health-endangering behaviors include both intrapersonal factors, such as a generalized impulsivity or sensation-seeking trait, low emotional intelligence, and greater physiological arousal in response to rewards,¹⁹⁻²² as well as intrapersonal factors, such as peer and familial influences that arise through both observation and persuasion, and intrapersonal stress.²³⁻²⁵ Environmental factors, such as targeted marketing, likely also plays a role in adolescent uptake of risky behaviors.²⁶ Therefore, increased understanding of the reasons for sociodemographic patterning of risky behaviors in adolescence is a worthy goal.

In the analyses described in this paper, we examined sociodemographic patterning of energy drink consumption among adolescents in the US population. Although there is a substantial literature on the sociodemographic correlates of cigarette use and alcohol use in this population, there is a surprising dearth of research on the socioeconomic patterning of energy drink use. This paper is, to our knowledge, the first to examine such patterning and to provide depth to this examination by comparing this patterning to sociodemographic correlates of other substance use, especially in the US representative adolescent population.

This approach provided us several insights into the sociodemographic and possible behavioral determinants of energy drink use. First, our results made it evident that prevalence of energy drink consumption was higher than current cigarette use and approximate to current alcohol use, suggesting easy access to and popularity of this substance. Moreover, higher odds of energy drink consumption were observed in whites, males, 12th-grade students, and those with less than high-school-educated mother or father. These results were in consonance with a study conducted in Canada except that there was no significant difference between males and females and the consumption of energy drinks was also associated with sensation-seeking behaviors, depression, and substance use in adolescents.¹⁴ Similar results were reported in adult populations as well such that whites were more likely to consume energy drink mixed with alcohol compared to other race/ethnic groups.¹⁵

Second, we noted, as others have,²⁹ that energy drink use prevalence was strongly correlated with the use of cigarettes in particular. The use of alcohol also raised the probability of energy drink use but less so than cigarette use. Furthermore, we noted that the probability of energy drink use increases with cigarette or alcohol use in the overall population,

as well as in every sociodemographic category we examined, including each racial/ethnic group, gender, grade, and levels of paternal and maternal education. Previous studies had looked at the association between energy drink consumption and risky behaviors like use of alcohol, tobacco, and marijuana, mainly focusing on college students.³⁰⁻³⁸ Mixing alcoholic beverages with energy drinks has become very popular among college students in an attempt to avoid inebriation.³⁷ Furthermore, energy drink users were more likely to be involved in risky sexual behaviors and driving under the influence.³² Therefore, it is crucial to prevent adolescents from engaging in risky behaviors in the foreseeable future.

Third, in stratified analyses, we noted that sociodemographic patterning in energy drink use was largely similar across cigarette and alcohol use categories, suggesting that the effects of other substance use are independent of sociodemographic effects on use. Regardless of smoking or alcohol use status, whites and males were more likely to consume energy drinks. However, in contrast to the pattern of cigarette³⁹ and alcohol use⁴⁰ in adolescents where an increasing prevalence from younger age (lower grade) to older age (higher grade) group was observed, the energy drink consumption was evenly distributed between 10th- and 12th-grade students. This provides evidence that energy drinks are not only easily accessible but also widely accepted at a younger age group, possibly acting as a gateway to other riskier behaviors.

This study is subject to a few limitations. First, the survey was collected using cross-sectional design. We evaluated the data from 2010 to 2015, but the study samples were randomly selected each year. A longitudinal study would have provided more accurate results on the pattern of energy drink use. Second, the amount of energy drink consumption (i.e., 8- or 16-ounce cans) could not be distinguished as the original survey question was worded in that format. Third, the questions on energy drinks and energy drink shots were combined to estimate the overall energy drink consumption due to the low prevalence of energy drink shot use (7.9%, CI 7.6–8.2), although both energy drinks and energy drink shots included similar ingredients except for higher caffeine concentration in energy drink shots.⁴¹

In spite of these limitations, this study provided an important aspect of energy drink use in adolescent population and sociodemographic characteristics. The large sample size made the findings exceptionally robust, and multistage sampling design enabled the results to be generalizable to the adolescent population in the US. Hence, the results from this study can provide reliable evidence on developing interventions and policy regulations on energy drinks. In terms of policy, our findings

suggest that some form of regulation combined with strong public health messaging may reduce the overall prevalence of energy drink use. In particular, adding more barriers to access to energy drinks (i.e., limiting by age) would decrease the younger age initiation of energy drink use. An important implication for public health practice is that adolescents who practice one risky health behavior are at higher risk of practicing other risky behaviors; therefore, these adolescents need to be targeted early for intervention.

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