



Published in final edited form as:

Drug Alcohol Depend. 2016 October 1; 167: 36–41. doi:10.1016/j.drugalcdep.2016.07.016.

Alcohol Mixed With Energy Drinks: Associations with Risky Drinking and Functioning in High School

Joan S. Tucker^a, Wendy M. Troxel^b, Brett A. Ewing^a, and Elizabeth J. D’Amico^a

^aRAND Corporation, 1776 Main Street, Santa Monica, CA 90407-2138 USA

^bRAND Corporation, 4570 Fifth Avenue, Suite 600, Pittsburgh, PA 15213-2665 USA

Abstract

Background—Mixing alcohol with energy drinks is associated with heavier drinking and related problems among college students. However, little is known about how high school drinkers who mix alcohol with energy drinks (AmED) compare to those who do not (AwoED). This study compares high school AmED and AwoED users on their alcohol use during middle and high school, as well as key domains of functioning in high school.

Methods—Two surveys were conducted three years apart in adolescents initially recruited from 16 middle schools in Southern California. The analytic sample consists of 696 past month drinkers. Multivariable models compared AmED and AwoED users on alcohol use, mental health, social functioning, academic orientation, delinquency and other substance use at age 17, and on their alcohol use and related cognitions at age 14.

Results—AmED was reported by 13% of past month drinkers. AmED and AwoED users did not differ on alcohol use or cognitions in middle school, but AmED users drank more often, more heavily, and reported more negative consequences in high school. AmED users were also more likely to report poor grades, delinquent behavior, substance use-related unsafe driving, public intoxication, and drug use than AwoED users in high school. Group differences were not found on mental health, social functioning, or academic aspirations.

Conclusions—AmED use is common among high school drinkers. The higher risk behavioral profile of these young AmED users, which includes drug use and substance use-related unsafe driving, is a significant cause for concern and warrants further attention.

Keywords

Adolescents; Alcohol; Energy Drinks; High School

1. Introduction

Both alcohol use and energy drink consumption are widespread among high school students. According to national data, 37% of 12th graders report drinking alcohol in the past 30 days (Miech et al., 2015), and 30% report consuming energy drinks or shots (Terry-McElrath et

al., 2014). Energy drink consumption poses its own health risks for young people (Arria et al., 2011; Seifert et al., 2011), but using it as a mixer for alcoholic beverages (e.g., Red Bull with vodka) has been identified as a particularly high-risk drinking behavior (Marczinski and Fillmore, 2014; McKetin et al., 2015). Despite a ban on the marketing and distribution of prepackaged caffeinated alcoholic drinks by the U.S. Food and Drug Administration (FDA), adolescents' consumption of alcohol mixed with energy drinks (AmED) is likely to be a continuing public health concern for the foreseeable future.

Although there has been little research on AmED use among adolescents, studies of college students provide valuable insights into the reasons why young people engage in AmED use and the behavioral correlates of this drinking behavior (Striley and Khan, 2014). Various motivations and expectancies for using AmEDs have been reported by college students (Droste et al., 2014). Some of these are neutral with regard to alcohol use, such as liking the taste of AmEDs, using it to celebrate a special occasion, and wanting to drink something different (Verster et al., 2014). However, other expectations are more negative in terms of their expected effects on alcohol consumption, such as AmED use hastening the onset of intoxication (Marczinski et al., 2011), reducing the sedative effects of drunkenness (Marczinski et al., 2011), and being able to sober up more quickly (Woolsey et al., 2010). Expectations that some of the potential deterrents to alcohol use are ameliorated by mixing it with energy drinks may lead some young people to engage in riskier drinking when mixing alcohol with energy drinks. This is consistent with results from studies of college students which have consistently shown that AmED users engage in heavier drinking, experience more frequent drunkenness, and have more negative alcohol-related outcomes compared to those who consume alcohol without energy drinks (AwoED) (e.g., Brache and Stockwell, 2011; Mallett et al., 2015; Patrick and Maggs, 2014; Woolsey et al., 2010; Woolsey et al., 2015).

In addition to its association with heavier drinking and alcohol-related negative outcomes, college students who engage in AmED use are more likely to report engagement in other problem behaviors such as illicit drug use (Brache and Stockwell, 2011; Snipes and Benotsch, 2013) and high-risk sexual behavior (Snipes and Benotsch, 2013). There is also some limited evidence for impairment in social functioning, as AmED users have a higher likelihood of being involved in verbal altercations with others (Brache and Stockwell, 2011). For at least some of these problem behaviors, the association appears to be due to a higher general risk taking tendency among AmED users (Brache and Stockwell, 2011).

Despite approximately 25% of high school seniors in the U.S. reporting AmED use in the past year (Martz et al., 2015), few studies have focused on AmED use or its correlates in this younger age group. National data comparing 12th graders who had engaged in past year AmED use to those who had not found that AmED users were more likely to be male and non-Hispanic white, have academic problems (poor grades, cutting class), and engage in heavy drinking and drug use (Martz et al., 2015). Two additional studies focused specifically on lifetime alcohol users, comparing those who had ever engaged in AmED use and those who had not. One of these studies involved a U.S. national sample of 15–23 year olds, finding that AmED users were more likely to engage in hazardous alcohol use, with no evidence that this differed by age (Emond et al., 2014). The other study involved a survey of

15–19 year olds in the South of Italy (Flotta et al., 2014), finding that AmED users were more likely to be male, and to have a greater number of sex partners, ever used marijuana, and ridden with a driver who had been drinking alcohol. Another study of past month alcohol users between ages of 13–18 found that AmED use was associated with tobacco and marijuana use and nonmedical use of prescription stimulants (Khan et al., 2016). Finally, a study of 16–17 year olds in Iceland found a strong association between lifetime frequency of AmED use and lifetime frequency of drunkenness (Kristjansson et al., 2015). Together, this small literature suggests that the higher risk profile of AmED users is not limited to college students, but is found among adolescent AmED users as well in the areas of alcohol and illicit drug use, academic disengagement, and social activities.

The present study significantly extends these few cross-sectional studies on AmED use among high school students in several respects. Focusing on current (past month) alcohol users, we first compare those who mix alcohol with energy drinks (AmEDs) and those who do not (AwoEDs) on demographic characteristics (race/ethnicity, gender, maternal education, and household composition). The racial/ethnic comparison is particularly important given that previous studies, both of adolescents and college students, have tended to use predominantly non-Hispanic White samples. Using longitudinal data, we then compared these two groups on their alcohol behaviors and cognitions three years earlier to examine whether AmED users would already be showing a higher risk profile in middle school. Finally, we compared AmED and AwoED users on their current alcohol use, as well as a range of other indicators of functioning that included mental health, social functioning, academic orientation, delinquency, and other substance use. We hypothesized that AmED users would report heavier drinking, more negative alcohol-related consequences, and poorer functioning in high school compared to AwoED users.

2. Methods

2.1. Participants and Procedures

Participants originated from 16 middle schools across three school districts in southern California that were part of a large, ongoing longitudinal study with a voluntary after-school substance use prevention intervention that occurred in 2008 (D'Amico et al., 2012). As previously reported, 92% of parents returned a consent form at the baseline, 71% of parents gave permission for their child to participate in the original study, and 94% of consented students completed the baseline survey (D'Amico et al., 2012). We continued to follow two cohorts of youth (the original 6th grade cohort, and the original 7th grade cohort) throughout middle school (Waves 2–5) and into late adolescence (Waves 6–7). The survey for the current study was administered online between May 2014 and May 2015 (Wave 7) when the energy drink measures were added to the survey and youth were on average 17.3 years old ($n=2,493$). The analytic sample for the cross-sectional late adolescence analyses was restricted to $n=696$ youth who reported having at least one drink of alcohol in the past 30 days on the Wave 7 survey. The analytic sample for the longitudinal analyses, which was further restricted to those with middle school data (Wave 5), was $n=537$ with a mean age of 14.3 years old. Missingness was less than 0.5% for all variables except mother's education (which was 4.5%).

2.2. Measures

Covariates—These included race/ethnicity, age, gender, mother’s education, family structure, and an indicator for whether the student had attended one of the original intervention schools. Based on the distributions for race/ethnicity, participants were classified as non-Hispanic white, Hispanic, Asian, and Multiracial/Other (African American, American Indian, Native Hawaiian, or Multiracial).

Alcohol use—Past month drinking was assessed with separate items asking how many days they consumed: (a) at least one drink of alcohol; and (b) at least one energy drink mixed with alcohol (0=0 days to 6=20–30 days) (Ellickson et al., 2003; WestEd, 2008). Participants were included in the analyses if they reported any past month alcohol use. They were then classified in terms of whether they mixed alcohol with energy drinks in the past month based on the latter item. Quantity of use was assessed by asking how many drinks they have on the days they drink alcohol. We also examined two indicators of potential higher-risk drinking: whether they ever drank alcohol while alone (Tucker et al., 2006; Tucker et al., 2014) and age of alcohol use initiation.

Alcohol cognitions—Positive expectancies about alcohol (e.g. “alcohol relaxes you”), negative expectancies about alcohol (e.g. “alcohol makes you do things you might regret”), and resistance self-efficacy (RSE) for alcohol use were measured with scales developed in Project ALERT (Ellickson et al., 2003). Items were rated on a scale from 1=*strongly disagree* to 4=*strongly agree* (Orlando et al., 2005), with average higher scores indicating stronger agreement with the expectancies (positive $\alpha=0.79$; negative $\alpha=0.77$). RSE consisted of three items assessing the respondent’s ability to refuse alcohol if offered in different social situations (1=*I would definitely use* to 4=*I would definitely not use*), with average higher scores indicating higher RSE ($\alpha=0.95$). Perceived peer prevalence of alcohol use was assessed by asking how many of their peers out of 100 they thought had consumed at least one drink in the past month (WestEd, 2008). Finally, respondents rated how often they experienced each of six negative consequences from alcohol use (e.g. doing something they regretted) in the past year (WestEd, 2008). These items were dichotomized (0=*never* vs. 1=*at least once*) and summed to create a total consequence score ($\alpha=0.75$).

High school functioning—*Mental health* was assessed with the five-item Mental Health Inventory (MHI-5) (Ware and Sherbourne, 1992), which rates symptom frequency in the past 30 days (1=*none of the time* to 6=*all of the time*; $\alpha =.78$). Summed ratings are transformed to a possible range of 0 to 100, with higher scores indicating better mental health. *Social functioning* was assessed with seven items from the PROMIS Peer Relationships Short Form item bank (0=*never* to 4=*always*; $\alpha=.93$) (DeWalt et al., 2013). Summed ratings are transformed to a t-score, with higher scores indicating better social functioning. *Academic orientation* was assessed in terms of academic performance (received grades of mostly C or worse in the past year; yes/no) and academic aspirations (highest level of school they plan to finish: 1=*I may not finish high school* to 6=*I plan to go to graduate school or professional school*) (D’Amico et al., 2008). Items from Project ALERT (Tucker et al., 2006) were used to assess frequency of past year school problems (4 items), stealing, fighting, property damage (2 items), selling marijuana, and being drunk or high in a public

place (0=*never* to 5=*20 or more times*). Responses to the first nine items were averaged to create a measure of delinquency ($\alpha=0.83$). The last item on public intoxication was examined separately given its particular relevance to alcohol use. On the same scale, participants rated how often in the past year they had driven after drinking or using drugs, or been a passenger in a car with a driver who had been drinking or using drugs; these two items were combined into a dichotomous indicator of ever driving under the influence (DUI) or riding with a driver under the influence (RWDUI) (Ewing et al., 2015). Finally, four items assessed use of other substances in the past 30 days (0=*0 days* to 6=*20–30 days*): marijuana (Ellickson et al., 2003), inhalants and over-the-counter medicines to get high (WestEd, 2008), and prescription medicines to get high (Tucker et al., 2015). Given the distributions of these variables, each was dichotomized (0=*no*, 1=*yes*) prior to analysis.

2.3. Statistical Analyses

Descriptive statistics are presented for sociodemographic characteristics for the total sample and separately by alcohol mixing status (i.e., AwoEDs and AmEDs). We compared these two groups using chi-square and t-tests (Table 1). We also conducted two sets of logistic regression models. The first set regressed each measure of alcohol behavior and cognition in middle school on high school alcohol mixing status (Table 2). The second set regressed each measure of alcohol behavior, consequences, and functioning in high school on high school alcohol mixing status (Table 3). Analyses controlled for sociodemographic characteristics and an intervention school indicator (0/1).

3. Results

3.1. Comparison of AwoED and AmED Users on Demographic Characteristics

As shown in Table 1, the sample was 41.95% male and 41.38% Hispanic (White=29.02%, Asian=15.52%, Multiracial/Other=14.08%). Mean age was 14.29 (SD=0.89) at the middle school assessment and 17.44 (SD=0.62) at the high school assessment. Most students reported that their mother had more than a high school education (72.07%) and that they lived in a two-parent household (63.82%). Thirteen percent of students reported past month AmED use. AmED users and AwoED users did not significantly differ on these demographic characteristics, although there was a trend towards AmED users being older ($p=.056$).

3.2. Comparison of AwoED and AmED Users on Middle School Alcohol Characteristics

As noted above, the sample only included past month alcohol users. During middle school, these respondents reported on average drinking less than 1 day per month and consuming approximately 3 drinks on the days which they drank. Less than 10% of the current past-month drinkers reported solitary drinking. Respondents tended to report higher negative alcohol expectancies than positive alcohol expectancies and estimated that approximately a third of their peers were drinking alcohol. Table 2 shows results from logistic regression models that predicted high school alcohol mixing status (AmED=1, AwoED=0) from alcohol behaviors and cognitions three years earlier in middle school. AmED and AwoED users did not significantly differ on their frequency or quantity of alcohol use, whether they

ever drank while alone, positive and negative expectancies about alcohol use, perceived prevalence of peer drinking, or perceived ability to resist drinking in social situations.

3.3. Comparison of AwoED and AmED Users on High School Alcohol Characteristics

The top of Table 3 shows results from logistic regression models that predicted high school alcohol mixing status (AmED=1, AwoED=0) from age of alcohol use initiation and alcohol behaviors in high school. AmED and AwoED users did not significantly differ on their age of alcohol use initiation, with both groups initiating at age 15 on average. However, compared to AwoED users, those who engaged in AmED use reported a significantly higher number of drinking days in the past month and typical number of drinks consumed on drinking days, as well as more negative drinking consequences in the past year (0.56 vs. 1.56 consequences, respectively).

3.4. Comparison of AwoED and AmED Users on High School Functioning

The bottom of Table 3 shows results from logistic regression models that examine the association between indicators of high school functioning and alcohol mixing status (AmED=1, AwoED=0). AmED and AwoED users did not significantly differ on mental health, social functioning, or academic aspirations. However, AmED users were more likely to earn poor grades (14% vs. 9%), were involved in more frequent delinquent behavior in the past year (1.53 vs. 1.35), were more likely to have been drunk or high in a public place in the past year (67% vs. 43%), and were more likely to have driven under the influence or ridden with a driver under the influence in the past year (62% vs. 39%). In terms of other substance use in the past 30 days, AmED users were more likely to report marijuana use (68% vs. 43%, respectively), inhalant use (4% vs. 1%), and over-the-counter medication misuse (6% vs. 1%). The two groups did not differ in terms of their prescription medication misuse.

4. Discussion

Studies of AmED use have largely focused on college campuses, where AmED use is common (Brache and Stockwell, 2011; Marcziński et al., 2011), finding that young adults who consume alcohol mixed with energy drinks are more likely to engage in heavier drinking and experience related problems compared to those that consume alcohol alone (Marcziński and Fillmore, 2014). Much less is known about adolescent AmED users, despite national data indicating that one in four high school seniors have engaged in AmED use in the past year (Martz et al., 2015). This longitudinal study is the first to compare high school drinkers who report mixing and not mixing their alcoholic beverages with energy drinks to better understand the ways in which these groups might differ on key demographic characteristics, alcohol-related behaviors and cognitions during middle school, and different aspects of high school functioning.

Recent data from a U.S. national sample of 12th grade students suggest that AmED use is more likely among males and non-Hispanic Whites (Martz et al., 2015). However, in the present study we did not find that AmED users significantly differed from AwoED users on gender or race/ethnicity. Further, these two groups were similar on several other demographic characteristics that we examined – namely, age, parental education, and

household structure. This discrepancy across studies may be due to the fact that we restricted our sample to past month alcohol users. Alcohol use during high school has been found to vary by demographic characteristics such as gender and race/ethnicity (Kann et al., 2014). When focusing exclusively on high school drinkers, however, our results suggest that these and other demographic characteristics do not differentiate which youth will mix their alcohol with energy drinks and which youth will not. Of course, it may be the case that other aspects of AmED use differ for certain groups; for example, although female drinkers may not differ from their male peers in their propensity to engage in AmED use, they may be more affected by AmED use due to physiological differences in alcohol metabolism (Baraona et al., 2001). Continuing to examine demographic differences in AmED use and related behaviors is an important direction for future research.

In addition to comparing the demographic profiles of AmED and AwoED users, this study is the first to use longitudinal data to address the important question of whether certain middle school characteristics may be useful in the early identification of youth at risk of engaging in AmED use. For example, characteristics such as early initiation of drinking (Heron et al., 2012) and overestimation of peer alcohol use (Juvonen et al., 2007) are established risk factors for subsequent drinking behavior. Our results indicated that both AmED and AwoED users exhibited early warning signs of their future alcohol use in high school. For example, both AmED and AwoED users, when they were in middle school, reported that over one-third of the students in their grade drank alcohol at least once a month. However, there were no significant differences between high school AmED and AwoED users on their earlier normative beliefs or any of the other alcohol-related behaviors and cognitions that we examined in middle school. Combined with the lack of sociodemographic group differences just described, our results suggest that early detection of high school drinkers at risk for AmED use may be challenging. However, there may be other relevant factors that we did not consider in this study, such as early initiation of energy drink use or having favorable attitudes toward energy drinks in middle school. Further, impulsivity or sensation seeking may serve as early risk factors and common pathways to AmED use and other high-risk behaviors. Given that this is the first study to examine middle school risk factors for future AmED use, there is a clear need for additional longitudinal research in this area.

Despite the lack of early differences in alcohol-related behaviors and cognitions, the AmED and AwoED users clearly diverged in their behavior by high school. The AmED users were drinking on more days per month, consuming more drinks per day, and experiencing more alcohol-related consequences compared to AwoED users. For example, AmED users reported drinking 1–2 times per week, on average, compared to about 2 days per month for AwoED users. Further, striking differences were found on other risk behaviors such as being drunk or high in a public place, substance use-related unsafe driving, and marijuana use. About two-thirds of AmED users report engaging in these behaviors, a rate that was about 50% higher than among AwoED users. Finally, AmED users were more likely to have poor grades and to be involved in delinquent behaviors such as school behavioral problems, stealing, fighting, and property damage. In some respects, our results are similar to the previous studies comparing AmED and AwoED users in samples that included high school-aged youth, which found more hazardous drinking, substance use-related unsafe driving, and other substance use among AmED users (Emond et al., 2014; Flotta et al., 2014; Khan et al.,

2016; Martz et al., 2015). However, this is the only study comparing current AmED and AwoED users in an exclusively high school sample, examining a wide range of outcomes that include other forms of substance use, mental health, social functioning, academic performance, academic aspirations, delinquency, and DUI/RWDUI. Thus, the present study paints a much more detailed picture of how current AmED and AwoED users compare in terms of their functioning in high school across a variety of domains. Results suggest that even among high school drinkers, those who mix alcohol with energy drinks have a significantly higher-risk profile.

This higher risk profile of AmED users is often interpreted as being due to the stimulant effects of caffeine, one of the main ingredients in energy drinks, counteracting the depressant effects of alcohol (Verster et al., 2012). This counteracting effect may serve to impair the drinker's awareness of their alcohol intoxication and increase total alcohol consumption. However, two recent meta-analyses have called this interpretation into question, based on within-subject analyses of AmED users that compared drinking occasions in which they mixed alcohol with energy drinks and drinking occasions in which they did not (Benson et al., 2014; Verster et al., 2016). An alternative explanation for the associations of AmED use with heavier alcohol use and risk behaviors is that there are phenotypical differences between AmED and AwoED users, such as personality traits or propensity for risk-taking, that manifest in group differences across a range of behaviors such as heavier drinking, other forms of substance use, poor grades, delinquency and so forth. While more research is needed to fully understand these associations, our results suggest that, at a minimum, AmED use is an important marker for high school drinkers who are at especially high risk for heavier drinking, drug use, and other risk behaviors.

Several study limitations should be noted. First, results are based on a sample from southern California and thus may not generalize to adolescents in other geographic areas. Second, our measure of AmED frequency was highly skewed in this younger sample, necessitating the use of a dichotomous measure of any vs. no use. As the cohort gets older, and AmED use increases, we will be able to use a more fine-grained measure in subsequent analyses. Third, although this is the first study of adolescent AmED use to include a longitudinal component, the examination of domains of functioning as they related to AmED use was cross-sectional. Thus, we cannot draw conclusions about how AmED use may be related to delinquency, drug use, or other problematic behaviors that we examined over time. Fourth, more frequent assessments could be useful in understanding when and how AmED and AwoED users diverge in their alcohol use and functioning.

5. Conclusions

Among high school drinkers, those who mix alcohol with energy drinks are at especially high risk for heavier drinking and related negative consequences, poor grades, and involvement in a range of other risk behaviors. These behaviors may not only pose an immediate threat to the health and well-being of these adolescents, but may present challenges as these youth attempt to navigate the transition into young adulthood. While continued efforts are needed to address the problem of underage drinking in general, our results suggest that AmED users may need additional assistance given their higher risk

profile. Towards this end, it may be useful for future research to focus on identifying early risk factors for adolescent AmED use, understanding the reasons why adolescents engage in AmED use, and establishing the mechanisms through which AmED use is associated with other problematic behaviors during high school.

Acknowledgments

This work was funded by a grants from the National Institute on Alcohol Abuse and Alcoholism (R01AA016577: “Brief Voluntary Alcohol and Drug Intervention for Middle School Youth” & R01AA020883: “Adolescent AOD Use Trajectories: The Role of Race and Ethnicity”) to Elizabeth J. D’Amico. The authors wish to thank the districts and schools who participated in and supported this project. We would also like to thank Kirsten Becker and Megan Zander-Cotugno for overseeing survey administrations.

References

- Arria AM, Caldeira KM, Kasperski SJ, Vincent KB, Griffiths RR, O’Grady KE. Energy drink consumption and increased risk for alcohol dependence. *Alcohol Clin Exp Res.* 2011; 35:365–375. [PubMed: 21073486]
- Baraona E, Abittan CS, Dohmen K, Moretti M, Pozzato G, Chayes ZW, Schaefer C, Lieber CS. Gender differences in pharmacokinetics of alcohol. *Alcohol Clin Exp Res.* 2001; 25:502–507. [PubMed: 11329488]
- Benson S, Verster JC, Alford C, Scholey A. Effects of mixing alcohol with caffeinated beverages on subjective intoxication: a systematic review and meta-analysis. *Neurosci Biobehav R.* 2014; 47:16–21.
- Brache K, Stockwell T. Drinking patterns and risk behaviors associated with combined alcohol and energy drink consumption in college drinkers. *Addict Behav.* 2011; 36:1133–1140. [PubMed: 21840130]
- D’Amico E, Miles JNV, Stern SA, Meredith LS. Brief motivational interviewing for teens at risk of substance use consequences: a randomized pilot study in a primary care clinic. *J Subst Abuse Treat.* 2008; 35:53–61. [PubMed: 18037603]
- D’Amico EJ, Tucker JS, Miles JNV, Zhou AJ, Shih RA, Green HD. Preventing alcohol use with a voluntary after-school program for middle school students: results from a cluster randomized controlled trial of CHOICE. *Prev Sci.* 2012; 13:415–425. [PubMed: 22311178]
- DeWalt DA, Thissen D, Stucky BD, Langer MM, DeWitt EM, Irwin DE, Lai JS, Yeatts KB, Gross HE, Taylor O, Varni JW. PROMIS Pediatric Peer Relationships Scale: development of a peer relationships item bank as part of social health measurement. *Health Psychol.* 2013; 32:1093–1103. [PubMed: 23772887]
- Droste N, Tonner L, Zinkiewicz L, Pennay A, Lubman DI, Miller P. Combined alcohol and energy drink use: motivations as predictors of consumption patterns, risk of alcohol dependence, and experience of injury and aggression. *Alcohol Clin Exp Res.* 2014; 38:2087–2095. [PubMed: 24846819]
- Ellickson PL, McCaffrey DF, Ghosh-Dastidar B, Longshore DL. New inroads in preventing adolescent drug use: Results from a large-scale trial of project ALERT in middle schools. *Am J Public Health.* 2003; 93:1830–1836. [PubMed: 14600049]
- Emond JA, Gilbert-Diamond D, Tanski SE, Sargent JD. Energy drink consumption and the risk of alcohol use disorder among a national sample of adolescents and young adults. *J Pediatr.* 2014; 165:1194–1200. [PubMed: 25294603]
- Ewing BA, Tucker JS, Miles JNV, Shih RA, Kulesza M, Pedersen ER, D’Amico EJ. Early substance use and subsequent DUI in adolescents. *Pediatrics.* 2015; 136:868–875. [PubMed: 26438702]
- Flotta D, Mico R, Nobile CGA, Pileggi C, Bianco A, Pavia M. Consumption of energy drinks, alcohol, and alcohol-mixed energy drinks among Italian adolescents. *Alcohol Clin Exp Res.* 2014; 38:1654–1661. [PubMed: 24717140]

- Heron J, Macleod J, Munafo MR, Melotti R, Lewis G, Tilling K, Hickman M. Patterns of alcohol use in early adolescence predict problem use at age 16. *Alcohol Alcoholism*. 2012; 47:169–177. [PubMed: 22215001]
- Juvonen J, Martino SC, Ellickson PL, Longshore D. “But others do it”! Do misperceptions of schoolmate alcohol and marijuana use predict subsequent drug use among young adolescents? *J Appl Soc Psychol*. 2007; 37:740–758.
- Kann L, Kinchen S, Shanklin SL, Flint KH, Hawkins J, Harris WA, Lowry R, Olsen EO, McManus T, Chyen D, Whittle L, Taylor E, Demissie Z, Brener N, Thornton J, Moore J, Zaza S. Youth Risk Behavior Surveillance - United States, 2013. *MMWR Surveill Summ*. 2014; 63:1–168.
- Khan SR, Cottler LB, Striley CW. Correlates of use of alcohol mixed with energy drinks among youth across 10 US metropolitan areas. *Drug Alcohol Depen*. 2016; 163:236–241.
- Kristjansson AL, Mann MJ, Sigfusdottir ID, James JE. Mode of daily caffeine consumption among adolescents and the practice of mixing alcohol with energy drinks: relationships to drunkenness. *J Stud Alcohol Drugs*. 2015; 76:397–405. [PubMed: 25978825]
- Mallett KA, Scaglione N, Reavy R, Turrisi 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. [PubMed: 25978824]
- Marczinski CA, Fillmore MT. Energy drinks mixed with alcohol: what are the risks? *Nutr Rev*. 2014; 72:98–107. [PubMed: 25293549]
- Marczinski 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. [PubMed: 21676002]
- Martz ME, Patrick ME, Schulenberg JE. Alcohol mixed with energy drink use among us 12th-grade students: prevalence, correlates, and associations with unsafe driving. *J Adolesc Health*. 2015; 56:557–563. [PubMed: 25907654]
- McKetin R, Coen A, Kaye S. A comprehensive review of the effects of mixing caffeinated energy drinks with alcohol. *Drug Alcohol Depen*. 2015; 151:15–30.
- Miech, R.; Johnston, L.; O’Malley, P.; Bachman, J.; Schulenberg, J. Monitoring the Future national survey results on drug use, 1975–2014: Volume I, Secondary school students. Institute for Social Research, The University of Michigan; Ann Arbor: 2015.
- Orlando M, Ellickson PL, McCaffrey DF, Longshore DL. Mediation analysis of a school-based drug prevention program: effects of project ALERT. *Prev Sci*. 2005; 6:35–46. [PubMed: 15766004]
- Patrick ME, Maggs JL. Energy drinks and alcohol: links to alcohol behaviors and consequences across 56 days. *J Adolesc Health*. 2014; 54:454–459. [PubMed: 24309196]
- Seifert SM, Schaechter JL, Hershorer ER, Lipshultz SE. Health effects of energy drinks on children, adolescents, and young adults. *Pediatrics*. 2011; 127:511–528. [PubMed: 21321035]
- Snipes DJ, Benotsch EG. High-risk cocktails and high-risk sex: examining the relation between alcohol mixed with energy drink consumption, sexual behavior, and drug use in college students. *Addict Behav*. 2013; 38:1418–1423. [PubMed: 23006245]
- Striley CW, Khan SR. Review of the energy drink literature from 2013: findings continue to support most risk from mixing with alcohol. *Curr Opin Psychiatr*. 2014; 27:263–268.
- Terry-McElrath YM, O’Malley PM, Johnston LD. Energy drinks, soft drinks, and substance use among United States secondary school students. *J Addict Med*. 2014; 8:6–13. [PubMed: 24481080]
- Tucker JS, Ellickson PL, Collins RL, Klein DJ. Does solitary substance use increase adolescents’ risk for poor psychosocial and behavioral outcomes? a 9-year longitudinal study comparing solitary and social users. *Psychol Addict Behav*. 2006; 20:363–372. [PubMed: 17176171]
- Tucker JS, Ellickson PL, Collins RL, Klein DJ. Are drug experimenters better adjusted than abstainers and users? : A longitudinal study of adolescent marijuana use. *J Adolesc Health*. 2006; 39:488–494. [PubMed: 16982382]
- Tucker JS, Ewing BA, Miles JNV, Shih RA, Pedersen ER, D’Amico EJ. Predictors and consequences of prescription drug misuse during middle school. *Drug Alcohol Depend*. 2015; 156:254–260. [PubMed: 26455553]

- Tucker JS, Pedersen ER, Miles JNV, Ewing BA, Shih RA, D'Amico EJ. Alcohol and marijuana use in middle school: comparing solitary and social-only users. *J Adolesc Health*. 2014; 55:744–749. [PubMed: 25223477]
- Verster JC, Aufricht C, Alford C. Energy drinks mixed with alcohol: misconceptions, myths, and facts. *Int J Gen Med*. 2012; 5:187–198. [PubMed: 22399863]
- Verster JC, Benson S, Scholey A. Motives for mixing alcohol with energy drinks and other nonalcoholic beverages, and consequences for overall alcohol consumption. *Int J Gen Med*. 2014; 7:285–293. [PubMed: 24971033]
- Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I Conceptual framework and item selection. *Med Care*. 1992; 30:473–483. [PubMed: 1593914]
- WestEd, California Department of Education. California Healthy Kids Survey. 2008. Available at <http://chks.wested.org/>
- Woolsey C, Waigandt A, Beck NC. Athletes and energy drinks: reported risk-taking and consequences from the combined use of alcohol and energy drinks. *J Appl Sport Psychol*. 2010; 22:65–71.
- Woolsey CL, Williams RD, Housman JM, Barry AE, Jacobson BH, Evans MW. Combined use of alcohol and energy drinks increases participation in high-risk drinking and driving behaviors among college students. *J Stud Alcohol Drugs*. 2015; 76:615–619. [PubMed: 26098038]

Table 1

Associations of Demographic Characteristics with High School Past Month Alcohol Mixing Status

Demographics	Alcohol Mixing Status			<i>p</i> =
	Total analytic sample (<i>N</i> = 696)	AwoED users (<i>n</i> = 603)	AmED users (<i>n</i> = 93)	
	<i>M</i> (<i>SD</i>) / (%)	<i>M</i> (<i>SD</i>) / (%)	<i>M</i> (<i>SD</i>) / (%)	
Age	17.44 (0.62)	17.43 (0.62)	17.56 (0.60)	.056
Race/ethnicity				.148
Asian	15.52	15.92	12.90	
Hispanic	41.38	42.62	33.33	
Multiracial/Other	14.08	13.27	19.35	
White	29.02	28.19	34.41	
Gender				.818
Female	58.05	57.88	59.14	
Male	41.95	42.12	40.86	
Maternal education				.630
< high school	13.67	13.57	14.29	
High school	14.26	14.78	10.99	
> high school	72.07	71.65	74.73	
Household structure				.272
Two parent	63.82	64.61	58.70	
Single parent	36.18	35.39	41.30	

Note. AwoED = Alcohol without energy drink; AmED = Alcohol mixed with energy drink.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 2

Longitudinal Associations of Middle School Alcohol Characteristics with High School Past Month Alcohol Mixing Status

Middle school alcohol characteristics	Alcohol Mixing Status		OR (95% CI)
	AwoED users (n=470)	AmED users (n=67)	
	M (SD)	M (SD)	
Number of days used, past month	0.44 (1.16)	0.46 (1.25)	1.20 (0.84, 1.73)
Number of drinks on drinking days	3.29 (1.39)	3.00 (1.55)	0.77 (0.48, 1.23)
Any solitary use	5.76%	7.46%	1.28 (0.30, 5.43)
Positive alcohol expectancies	2.17 (0.98)	2.04 (0.89)	0.61 (0.27, 1.40)
Negative alcohol expectancies	3.28 (0.88)	3.10 (1.01)	0.97 (0.44, 2.10)
Alcohol normative beliefs	33.74 (27.22)	37.42 (29.11)	1.00 (0.98, 1.03)
Alcohol resistance self-efficacy	3.06 (0.99)	3.01 (0.98)	0.67 (0.31, 1.44)

Note. Analyses control for age, race/ethnicity, gender, maternal education, household structure, and intervention status. Alcohol mixing status is coded as AmED=1, AwoED=0.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 3

Cross-sectional Associations of High School Alcohol Characteristics and Functioning with High School Past Month Mixing Status

High school variables	Alcohol Mixing Status		OR (95% CI)
	AwoED users (n=603)	AmED users (n=93)	
	M (SD) / %	M (SD) / %	
Alcohol use and consequences			
Age of alcohol use initiation	15.06 (2.25)	15.00 (2.23)	0.94 (0.78,1.13)
# drinking days, past month ^a	2.25 (1.29)	3.46 (1.30)	2.75 (2.08, 3.63) ***
# drinks on drinking days ^b	3.85 (1.26)	4.49 (0.89)	2.33 (1.60, 3.40) ***
# negative consequences, past year	0.56 (1.04)	1.56 (1.60)	1.80 (1.52, 2.15) ***
Functioning			
Mental health	65.97 (20.12)	63.31 (22.31)	0.87 (0.70,1.10)
Social functioning	44.23 (6.70)	44.62 (6.02)	1.03 (0.79,1.35)
Grades of C or worse	9.14	13.98	2.03 (1.00,4.09) *
Academic aspirations	5.27 (0.81)	5.28 (0.85)	0.93 (0.72,1.20)
Delinquency	1.35 (0.44)	1.53 (0.52)	1.41 (1.19,1.67) ***
Drunk/high in public place	43.02	67.39	2.98 (1.83,4.84) ***
DUI/RWDUI	38.97	61.96	2.53 (1.58,4.05) ***
Marijuana use	43.45	67.74	2.90 (1.78,4.73) ***
Inhalant use	1.00	4.30	4.68 (1.25,17.49) *
Prescription medicine misuse	3.32	6.45	2.01 (0.76,5.33)
Over-the-counter medicine misuse	1.00	6.45	7.56 (2.23,25.65) **

Note. Models control for age, race/ethnicity, gender, maternal education, household structure, and intervention status. AwoED=Alcohol without energy drink; AmED=Alcohol mixed with energy drink. DUI/RWDUI= driving under the influence or riding with driver under the influence.

^a2=2 days, 3=3–5 days, 4=6–9 days.

^b3=1 drink, 4=2 drinks, 5=3+ drinks.

* p<.05,

** p<.01,

*** p<.001.

All scales were standardized to allow for comparison of the magnitude of the odds ratios.