Original Investigation

Extreme Binge Drinking Among 12th-Grade Students in the United States
Prevalence and Predictors

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IMPORTANCE The prevalence of underage alcohol use has been studied extensively, but binge drinking among youth in the United States is not yet well understood. In particular, adolescents may drink much larger amounts than the threshold (5 drinks) often used in definitions of binge drinking. Delineating various levels of binge drinking, including extreme levels, and understanding predictors of such extreme binge drinking among youth will benefit public health efforts.

OBJECTIVE To examine the prevalence and predictors of 5+ (≥5 drinks) binge drinking and of 10+ (≥10 drinks) and 15+ (≥15 drinks) extreme binge drinking among 12th graders in the United States.

DESIGN, SETTING, AND PARTICIPANTS A nonclinical nationally representative sample of high school seniors in the annual Monitoring the Future study between 2005 and 2011. The sample included 16 332 high school seniors (modal age, 18 years) in the United States. Response rates were 79.1% to 84.7%.

MAIN OUTCOMES AND MEASURES Prevalence of consuming 5 or more, 10 or more, and 15 or more drinks in a row in the last 2 weeks.

RESULTS Between 2005 and 2011, a total of 20.2% of high school seniors reported 5+ binge drinking, 10.5% reported 10+ extreme binge drinking, and 5.6% reported 15+ extreme binge drinking in the last 2 weeks. Rates of 5+ binge drinking and 10+ extreme binge drinking have declined since 2005, but rates of 15+ extreme binge drinking have not significantly declined. Students with college-educated parents were more likely to consume 5 or more drinks but were less likely to consume 15 or more drinks than students whose parents were not college educated. Students from more rural areas were more likely than students from large metropolitan areas to consume 15 or more drinks. Substance-related attitudes, socializing with substance-using peers, the number of evenings out with friends, and other substance use (cigarettes and marijuana) predicted all 3 levels of binge and extreme binge drinking.

CONCLUSIONS AND RELEVANCE Binge drinking at the traditionally defined 5+ drinking level was common among high school seniors representative of all 12th graders in the contiguous United States. A significant segment of students also reported extreme binge drinking at levels 2 and 3 times higher. These data suggest the importance of assessing multiple levels of binge drinking behavior and their predictors among youth to target effective screening and intervention efforts.

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Adolescent alcohol consumption is a major public health problem in the United States and a high priority for organizations, such as the Office of the Surgeon General,[1] Centers for Disease Control and Prevention,[2] World Health Organization,[3] American Academy of Pediatrics,[4] and National Institute on Alcohol Abuse and Alcoholism.[5] Approximately 5000 persons younger than 21 years die each year from alcohol-related fatalities,[6] while problems linked to underage drinking were estimated in 2001 to cost about $62 billion.[7] Underage drinking is also a predictor of alcohol problems and early mortality in adulthood.[8-11]

Consuming a large amount of alcohol in a single sitting (binge or heavy-episodic drinking) confers acute risks (eg, injury, impaired driving, and alcohol poisoning) and long-term risks (eg, liver damage, alcohol dependence, and alterations to the developing brain).[2,12-15] In alcohol studies, binge drinking is commonly defined as 5 or more drinks[16] (or ≥4 for women and ≥5 for men[16,17]) based on the approximation that consuming 5 drinks in a 2-hour period would lead to a blood alcohol concentration of up to 80 mg/dL (0.08%) for the typical adult.[17] The 5+ measure has been a valuable tool for research predicting consequences of alcohol use.[16,18-20] However, sole reliance on a 5+ binge drinking threshold obscures meaningful variance in the quantity of alcohol consumed per occasion. Serious acute consequences of alcohol use are considerably more likely at very high levels of alcohol use.[21,22] Despite the known risks, the extent of alcohol use among youth at the high end of binge drinking remains unclear.

Recent studies using multiple cutoffs for binge drinking have found variable consequences (eg, high risk for injuries at ≥5 drinks for women and ≥8 drinks for men[23]) and have shown that considerable numbers of persons engage in high levels of binge drinking (eg, in a sample aged 19-30 years, 14.7% reported ≥10 and 5.6% reported ≥15 drinks in a row in the last 2 weeks[24]). Significant sex differences at various levels of binge drinking in a sample of first-term college freshmen were found (33.7% of women vs 40.6% of men at ≥4 drinks for women and ≥5 drinks for men, 8.2% vs 19.9% at ≥8 drinks for women and ≥10 drinks for men, and 1.8% vs 7.6% at ≥12 drinks for women and ≥15 drinks for men[25]). Increasingly, studies document risky single-occasion drinking (≥10 drinks for women and ≥11 drinks for men)[26] and event-specific drinking with particularly high levels of alcohol use[27] (eg, drinking during spring break,[28-32] in 21st-birthday celebrations,[33-37] at sporting events,[38,39] and for local and national holidays[19,40]). Thus far, a large proportion of the research on binge drinking[16,25,41-44] and the few studies[20,25] on more extreme binge drinking focus on college students, often from single universities.

To date, research has not examined extreme binge drinking or the prevalence of consuming dangerously high levels of alcohol in one sitting specifically among youth. Despite declines in overall alcohol use among teens in the last decade and a half, alcohol exposure remains high. In 2011, a total of 70% of US 12th graders reported using alcohol in their lifetime, 51% reported ever being drunk, and 22% reported binge drinking (≥5 drinks in a row) in the last 2 weeks.[45] Rates are generally similar or higher in other Western countries.[46,47]

Drawing on theoretical perspectives and comprehensive reviews,[48-52] as well as empirical literature cited below, this study examines common US sociodemographic predictors and high school risk and protective factors associated with binge drinking and extreme binge drinking. To identify the youth at highest risk, the study compares empirically supported risk factors for consuming at least 5, 10, and 15 drinks in a row. For traditionally defined binge drinking (≥5 drinks), demographic findings have shown that male sex, white race/ethnicity, and higher parental education or socioeconomic status are consistent predictors of greater alcohol use among adolescents.[45,49,53-55] Binge drinking also differs in relation to geographic region and urbanicity: The Midwest and Northeast have the highest rates of 5+ binge drinking,[45] and rural high school students have higher rates of alcohol abuse, particularly for boys.[56] Students who are more religious exhibit lower levels of binge drinking than their peers.[57-59] Risk and protective factors within the school and peer context,[49,60-62] including lower mean grades, plans to attend college, and higher frequency of skipping school, also predict greater adolescent alcohol use. During high school, students who believe that their friends get drunk are more likely to drink themselves.[63-65] Additional risk factors include a lower level of disapproval and a lower perceived risk of binge drinking.[45,62,66] The use of other substances, including cigarettes and marijuana, is consistently correlated with heavier drinking.[50,62]

Methods

Study Design

The study was approved by a University of Michigan institutional review board. To our knowledge, this is the first national study to date to examine extreme binge drinking among youth. It uses data from the annual Monitoring the Future study[45] to examine the prevalence and predictors of 5+ (≥5 drinks) binge drinking and of 10+ (≥10 drinks) and 15+ (≥15 drinks) extreme binge drinking among nationally representative samples of American high school seniors between 2005 and 2011. Annually since 1975, the Monitoring the Future study has used questionnaires administered in classrooms to survey nationally representative samples of about 16 000 American high school seniors (modal age, 18 years) each year.[67] Measures assessing 5+ binge drinking have been included since the inception of the study and are consistent with other investigations[16]; measures of extreme binge drinking were added in 2005.

The analyses used cohorts of 12th graders from the high school classes of 2005 to 2011 who answered questions regarding 5+ binge drinking and 10+ and 15+ extreme binge drinking. Measures of 10+ and 15+ extreme binge drinking were included on 1 of 6 questionnaire forms. Multiple questionnaire forms were used to decrease respondent burden and were randomly assigned within classrooms to individuals. Analyses accounted for the complex multistage sample design, and the data were weighted to adjust for differential selection probabilities. Response rates for surveys from 2005 to 2011 were 79.1% to 84.7%, with almost all nonresponse because of absenteeism. The weighted sample (n = 16 332) is 52.3% female and 64.5% white, 11.0% black, 13.1% Hispanic, and 11.5% of other race/ethnicity.

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Measures

Binge Drinking and Extreme Binge Drinking

The question "During the last 2 weeks, how many times (if any) have you had 5 or more drinks in a row?" assessed 5+ binge drinking. The same stem question assessed 10+ extreme binge drinking (≥10+) and 15+ extreme binge drinking (≥15+) in the last 2 weeks. Response options were none, once, twice, 3 to 5 times, 6 to 9 times, and 10 or more times. For these analyses, responses were dichotomized as none (0) or any (1). A drink was defined for respondents as any of the following: "a 12-ounce can (or bottle) of beer; a 4-ounce glass of wine; a 12-ounce bottle (or can) of wine cooler; or a mixed drink, shot glass of liquor, or the equivalent."

Demographics

Cohort year was a continuous variable for the years 2005 to 2011. Sex was coded as male (1) or female (0). Race/ethnicity was dummy coded as white (reference group), black, Hispanic, or other. Parental college education served as a proxy for socioeconomic status, with the maximum maternal or paternal education coded as some college or more (1) or no college education (0). Geographic region was defined as the region in which the respondent's school was located and included the South (reference group), Northeast, Midwest, and West. Population density referred to the area surrounding the respondent's school, classified based on US Census Bureau categories as large metropolitan statistical area (MSA) (such as urban areas) (reference group), other MSA (such as suburbs), or non-MSA (such as rural areas). Religiosity was based on the self-reported importance of religion and was coded from not important (1) to very important (4).

High School Risk and Protective Factors

For educational success and plans, grades in high school were coded from D or lower (1) to A (9). College plans were coded as planning to graduate from a 4-year college or more (1) and planning on less than a 4-year college education (0). The number of days students reported cutting school (ie, missing without an excuse) in the last 4 weeks was coded from none (1) to 11 or more (7). For social life and substance-related attitudes, evenings out without parents in a typical week were coded from less than 1 evening (1) to 6 or 7 evenings (6). Students' beliefs about how many of their friends get drunk at least once a week were coded as none (1) to all (5). Alcohol attitudes were measured by disapproval of binge drinking (ie, ≥5 drinks) on the weekend, scored as do not disapprove (1) to strongly disapprove (3), and by perceived risk of binge drinking on the weekend, scored as no risk (1) to great risk (4). Finally, other substance use predictors were cigarette use in the last 30 days, scored from none (1) to 2 or more packs per day (7), and marijuana use in the last 30 days, scored from none (1) to 40 or more times (7).

Results

The prevalence rates of 5+ binge drinking, 10+ extreme binge drinking , and 15+ extreme binge drinking in the full sample and by sex, race/ethnicity, parental education, geographic region, and population density are given in **Table 1**. Among 12th graders, 20.2% reported consuming 5 or more alcoholic drinks, 10.5% reported consuming 10 or more drinks, and 5.6% reported consuming 15 or more drinks in a row at least once in the last 2 weeks. The table summarizes the considerable variation in these rates as a function of the sociodemographic characteristics. Cohort year was negatively correlated with 5+ binge drinking and 10+ extreme binge drinking but not with 15+ extreme binge drinking. χ^2 Tests revealed significant differences ($P < .001$) by sex, race/ethnicity, parental education, and population density, with one exception: 5+ binge drinking rates did not vary by population density. Pairwise comparisons are given in the table. Below, we consider in more detail sociodemographic differences in a multivariate context with the other covariates. We also examined interactions of all predictors by cohort year; only 1 of 60 reached the $P < .05$ statistical significance level. This indicates that the associations between predictors and outcomes have remained stable over time.

Table 2 gives estimates of the partial predictive power of the demographic and high school risk factors for binge drinking and extreme binge drinking based on multivariate logistic regression models. Dummy variables were included for all predictors with missing data, with means also assigned for continuous predictors. Students with missing data on sex were more likely to binge drink at all levels. Students with missing data on high school grades were less likely to engage in 5+ binge drinking. Those with missing data on college plans were more likely to engage in 5+ binge drinking. Students with missing data on days cutting school were more likely to report 15+ binge drinking. Students with missing data on disapproval of binge drinking were more likely to engage in all levels of binge drinking. Those with missing data on perceived risk of binge drinking were less likely to report 5+ binge drinking. Students with missing data on cigarette or marijuana use had greater odds of 15+ binge drinking. There were no significant differences between students having missing data compared with students having valid data for religiosity, race/ethnicity, and parental education, as well as for friends getting drunk and evenings out with friends.

Young men were more likely than young women to engage in all levels of binge drinking. Differences by race/ethnicity indicated that white students were more likely to engage in all levels of binge drinking than black students and were more likely to report 5+ binge drinking and 10+ extreme binge drinking than students of most other races/ethnicities. White students and Hispanic students did not differ. The association between parental education and binge drinking differed across the thresholds of binge drinking. Compared with students whose parents were not college educated, students whose parents were college educated had greater odds of engaging in 5+ binge drinking and lower odds of engaging in 15+ extreme binge drinking, with no difference in 10+ extreme binge drinking rates. There were few differences by geographic region or population density, although students in the Northeast and West were less likely to engage in 15+ extreme binge drinking than students in the South. Compared with students in large MSA areas, students in non-MSA (ie, more rural) areas had greater odds of engaging in 15+ extreme binge drinking. High school grades and college plans did not pre-

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Table 1. Binge Drinking and Extreme Binge Drinking Prevalence by Demographic Subgroups[a]

Variable	%		
	5+ Binge Drinking	Extreme Binge Drinking	
		10+	15+
Total (n = 16 332)	20.2	10.5	5.6
Cohort year			
2005 (n = 2438)	22.0	10.5	5.5
2006 (n = 2330)	22.0	12.6	7.0
2007 (n = 2374)	20.5	10.8	5.2
2008 (n = 2288)	19.2	10.1	5.2
2009 (n = 2249)	20.7	10.4	5.8
2010 (n = 2356)	18.5	9.6	6.0
2011 (n = 2297)	18.1	9.6	4.4
Sex			
Female (n = 7963)	15.0[b]	5.3[b]	2.3[b]
Male (n = 7266)	24.7[c]	15.1[c]	8.3[c]
Race/ethnicity			
White (n = 9656)	23.8[b]	12.5[b]	6.3[b]
Black (n = 1740)	7.6[c]	3.2[c]	1.8[c]
Hispanic (n = 2112)	15.9[d]	7.7[d]	4.6[d]
Other (n = 1794)	14.5[e]	7.0[e]	4.4[e]
Parental education			
No college education (n = 4076)	18.1[b]	10.1[b]	6.0[b]
Some college or more (n = 10 724)	20.3[c]	9.9[c]	4.8[c]
Geographic region			
South (n = 5879)	18.4[b]	10.3[b]	5.9[b,c]
Northeast (n = 3040)	24.2[c]	11.9[b,c]	5.2[b]
Midwest (n = 3891)	22.7[c]	12.8[c]	7.3[c]
West (n = 3522)	16.9[b]	7.3[d]	3.5[d]
Population density			
Large MSA (n = 4900)	20.4[b]	10.1[b]	4.9[b]
Other MSA (n = 7875)	19.8[b]	9.9[b]	5.2[b]
Non-MSA (n = 3556)	20.7[b]	12.5[c]	7.4[c]

Abbreviation: MSA, metropolitan statistical area.

[a] Measures assessed consumption of at least 5, 10, and 15 drinks in a row in the last 2 weeks. There were missing data on sex (n = 1030), race/ethnicity (n = 1031), and parental education (n = 1532); those with missing data on these variables tended to report higher rates of binge drinking. Correlation coefficients between cohort year and each of the binge drinking behaviors are $r = 0.03$ ($P < .001$) for 5+ binge drinking, $r = 0.02$ ($P < .01$) for 10+ extreme binge drinking, and $r = 0.01$ ($P < .07$) for 15+ binge drinking. χ^2 Tests for difference in proportions across each of the 3 thresholds of binge drinking by sex, race/ethnicity, parental education, and population density were all significant at $P < .001$, with one exception: there were no significant differences based on population density for 5+ binge drinking. Pairwise comparisons are shown by superscript values, where different superscript values indicate significant differences at $P < .05$.

dict binge drinking at any threshold in multivariate analyses. For all binge levels, greater odds of binge drinking were predicted by cutting school for more days, perceiving that more friends get drunk, and spending more evenings out with friends. Disapproving of binge drinking and perceiving greater risk of 5+ binge drinking predicted lower odds in all cases. Finally, last-month cigarette and marijuana users were more likely to report binge drinking at all levels.

While most predictors were in the same direction and of similar magnitude across the 3 thresholds of binge drinking, a notable exception was parental education: Students with more educated parents had higher odds of 5+ binge drinking but lower odds of 15+ extreme binge drinking. In addition, students of "other" races/ethnicities were less likely than white students to engage in 5+ binge drinking and 10+ extreme binge drinking, although there was no difference for 15+ extreme binge drinking. There were few regional differences in predictors of binge drinking, although students in the Northeast and West were less likely than students in the South to engage in 15+ extreme binge drinking. Despite these few and important exceptions, most risk factors had consistent patterns of association with the 3 thresholds of binge drinking and extreme binge drinking.

Discussion

Our objectives were to quantify and draw attention to the prevalence of extreme binge drinking rates among the nation's high school seniors and to examine predictors of these behaviors. We estimate that more than 1 in 10 high school seniors had 10 or more drinks in a row and more than 1 in 20 had 15 or more drinks in a row at least once in the last 2 weeks. Within a 2-week period, among high school seniors who report consuming 5 or more drinks in a row, more than half report consuming 10 or more drinks in a row, and among those who report consuming 10 or more drinks in a row, more than half report consuming 15 or more drinks in a row. In addition, some subgroups (eg, young men, students from more rural areas, and individuals of white race/ethnicity) show particu-

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Table 2. Multivariate Logistic Regressions Predicting Binge Drinking and Extreme Binge Drinking Among US 12th-Grade Students[a]

Variable	Odds Ratio (95% CI)		
	5+ Binge Drinking	Extreme Binge Drinking	
		10+	15+
Demographic Subgroups			
Cohort year	0.99 (0.96-1.02)	1.01 (0.97-1.05)	1.01 (0.97-1.06)
Male sex[b]	1.45 (1.28-1.64)[c]	2.74 (2.32-3.24)[c]	3.20 (2.61-3.94)[c]
Race/ethnicity[d]			
Black	0.38 (0.27-0.51)[c]	0.31 (0.21-0.46)[c]	0.38 (0.22-0.66)[c]
Hispanic	0.86 (0.72-1.04)	0.88 (0.68-1.14)	1.18 (0.85-1.65)
Other	0.65 (0.54-0.79)[c]	0.69 (0.53-0.90)[e]	1.04 (0.75-1.42)
Geographic region[f]			
Northeast	1.14 (0.94-1.40)	0.99 (0.79-1.23)	0.72 (0.56-0.94)[g]
Midwest	1.05 (0.89-1.23)	1.05 (0.86-1.30)	1.07 (0.84-1.38)
West	1.06 (0.87-1.30)	0.81 (0.59-1.12)	0.67 (0.47-0.96)[g]
Population density[h]			
Other MSA	0.94 (0.80-1.09)	0.98 (0.81-1.19)	1.12 (0.90-1.40)
Non-MSA	0.93 (0.77-1.11)	1.20 (0.95-1.51)	1.51 (1.15-1.99)[e]
Parental education some college or more[i]	1.22 (1.07-1.40)[g]	0.98 (0.82-1.17)	0.79 (0.64-0.99)[g]
Religiosity	0.94 (0.88-1.00)	1.00 (0.93-1.09)	0.93 (0.84-1.03)
High School Risk and Protective Predictors			
Educational success and plans			
High school grades	1.01 (0.98-1.04)	1.01 (0.97-1.05)	1.02 (0.96-1.08)
College plans[j]	0.97 (0.81-1.15)	0.84 (0.69-1.04)	0.84 (0.66-1.08)
Days cut school	1.09 (1.05-1.14)[c]	1.07 (1.02-1.12)[e]	1.11 (1.05-1.17)[c]
Social life and substance-related attitudes			
Evenings out with friends	1.23 (1.18-1.29)[c]	1.17 (1.11-1.25)[c]	1.16 (1.07-1.25)[c]
Friends get drunk	1.72 (1.64-1.81)[c]	1.83 (1.70-1.96)[c]	1.83 (1.67-1.99)[c]
Disapprove of binge drinking	0.49 (0.45-0.53)[c]	0.50 (0.44-0.57)[c]	0.49 (0.41-0.59)[c]
Perceived risk of binge drinking	0.70 (0.67-0.74)[c]	0.68 (0.64-0.73)[c]	0.72 (0.65-0.78)[c]
Other substance use			
Cigarettes	1.38 (1.31-1.46)[c]	1.32 (1.23-1.41)[c]	1.35 (1.26-1.45)[c]
Marijuana	1.23 (1.18-1.27)[c]	1.20 (1.16-1.24)[c]	1.17 (1.12-1.23)[c]

Abbreviation: MSA, metropolitan statistical area.

[a] Unweighted n = 16 330 (weighted n = 16 332). Dummy variables were included for missing data on sex and race/ethnicity. All high school predictors were controlled for but are not included in the table.

[b] Reference category is female.

[c] $P < .001$.

[d] Reference category is white.

[e] $P < .01$.

[f] Reference category is South.

[g] $P < .05$.

[h] Reference category is large MSA.

[i] Reference category is no college education.

[j] Reference category is planning to get less education than a 4-year college degree.

larly high rates of extreme binge drinking. Such high levels of alcohol intake clearly put youth at risk for injuries and fatalities from alcohol-related suicide, drowning, homicide, alcohol poisoning, and motor vehicle crashes.[6]

Although 5+ binge drinking specifically and the frequency of drinking generally have decreased among adolescents since record high levels in the late 1970s and early 1980s and have continued since 2005 to decrease further,[45] the period since 2005 has not shown such declines for 15+ extreme binge drinking. This suggests that extreme binge drinking behavior may be less affected by changing norms and is more entrenched in specific adolescent subcultures,[68] as has been argued for the college level.[69]

Many of the sociodemographic and risk factors predictive of 5+ binge drinking were similarly predictive of 10+ and 15+ extreme binge drinking. In particular, young men engaged in more binge drinking at all levels than young women, and youth of white race/ethnicity engaged in more binge drinking at all levels than those of black, Hispanic, or other races/ethnicities, similar to findings for lower-level drinking in prior empirical studies.[45,70,71] Related behaviors and attitudes about drinking predicted binge drinking at all levels. The fact that the same risk factors predicted 5+ binge drinking and 10+ and 15+ extreme binge drinking suggests that additional, more prognostic predictors for the different thresholds of binge drinking are needed.

We found some predictors that varied in magnitude depending on the threshold of binge drinking. In particular, higher parental education was a risk factor for 5+ binge drinking but was a protective factor against 15+ extreme binge drinking. This finding adds nuance to reports that youth of higher socioeconomic status are at greater risk for binge drinking,[45,53-55,72] suggesting that their risk is for the lower threshold of binge drinking; at the same time, youth of lower socioeconomic status and those from more rural areas may be at higher risk for very extreme binge drinking and concomitant consequences.

Clearly, a combination of classic binge drinking measures and assessments of extreme binge drinking is warranted to refine our understanding of such high levels of alcohol use among youth. Differentiating between levels of binge drinking, in

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terms of behavioral predictors and resulting consequences, may help determine specific risks and contribute to more effective screening and tailored intervention methods. The results of this study help reconcile what seemed like conflicting findings, namely, that reported levels of 5+ binge drinking were declining in recent years among adolescents[45] at the same time that medical emergencies involving alcohol use by teens were rising.[73]

Important strengths of the study include the nationally representative data, with the ability to examine demographic and regional differences across multiple recent years. The study has several limitations. First, high school dropouts were not included in the sampling frame. Because 5+ binge drinking tends to be higher among those who have early school difficulties,[60] our prevalence estimates may be conservative compared with a full population of 18-year-olds. Second, the same measures of binge drinking were used for male and female youth, although sex differences in average size and metabolism of alcohol mean that the same number of drinks is likely riskier for young women than for young men. Third, the available data were based on self-report of youth consumption of 5, 10, or 15 or more drinks in a row, although an exact definition was not given. It also may be difficult for respondents to remember the number of drinks consumed at these high levels. Of course, this limitation comes with the benefits of large national samples. Future research should document the contexts of drinking and the duration of the drinking occasion and consequences experienced. Additional work is needed to assess extreme binge drinking in other populations, including youths 19 years or older, and may consider a broader range of family, school, and community risk factors, as well as genetic and mental health indicators to describe more clearly the cause of the different levels of binge drinking. The documented rates of extreme binge drinking, and the fact that they have not changed across recent historical time, support the need for additional research to develop effective prevention and intervention strategies to reduce high-risk alcohol behaviors of youth.

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