Frequent Binge Drinking Among US Adolescents, 1991 to 2015

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abstract

BACKGROUND AND OBJECTIVES: Scientific understanding of the forces involved in the decades-long decline of adolescent alcohol use in the United States is limited. This study examines specific changes in US adolescent frequent binge drinking (FBD) by age (variation due to maturation), period (variation across time that does not covary across age), and cohort (variation common to adolescents born around the same time).

METHODS: We analyzed nationally representative, multicohort data from 8th, 10th, and 12th grade students sampled between 1991 and 2015 from Monitoring the Future (n = 1 065 022) to estimate age, period, and cohort effects on adolescents' FBD (defined as ≥2 occasions of ≥5 drinks in a row during the past 2 weeks). Age-Period-Cohort analyses were stratified by sex, race/ethnicity, and socioeconomic status (SES). Trends in the associations between demographics and FBD across historical time were examined.

RESULTS: Decreases in FBD during adolescence were attributable to period and cohort effects independent of age variations. Birth cohorts between 1985 and 1990 showed the greatest decline in FBD. The Age-Period-Cohort results were consistent across sex, race/ethnicity, and SES, with the exception of slower declines seen among African American adolescents compared with white adolescents since 2007. We also found convergence in FBD by sex and divergence by SES.

CONCLUSIONS: Recent declines in adolescent FBD have been driven by period and cohort effects. Attention is warranted for the slower declines in FBD seen among African American adolescents since 2007, a narrowing difference by sex, and a growing gap by SES.

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WHAT'S KNOWN ON THIS SUBJECT: Alcohol use in adolescence is related to various adverse consequences. Adolescent alcohol use has declined since the 1990s in the United States, although no systematic analysis of age, period, and cohort effects on frequent binge drinking has previously been conducted.

WHAT THIS STUDY ADDS: Age, period, and cohort effects have driven decreases in adolescent frequent binge drinking. Similar patterns were observed across demographics, but African American adolescents have experienced slower declines since 2007. Sex convergence and socioeconomic status divergence were found across historical time.

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Greater alcohol use during adolescence is associated with increased likelihood of adverse correlates, including lower academic achievement,[1] risky sexual behaviors,[2,3] psychiatric problems,[4,5] and development of alcohol use disorder.[6–8] Efforts have been made to reduce adolescent alcohol involvement,[9] and overall declines have been observed in the United States since the 1990s.[10] However, our understanding of the forces that may drive the historical change in adolescent drinking is limited. Existing literature on trends in alcohol use among adolescents has focused on binge drinking, defined as ≥5 drinks in a row.[11,12] The number of days involved in binge drinking tends to increase by age during adolescence.[13] Such patterns of frequent binge drinking (FBD) deserve our attention because the number of heavy drinking days is related to injury and other health consequences.[14–17]

Trends over time in alcohol use are sometimes examined in terms of age, period, and cohort effects. Age effects refer to variation over time that is attributable to maturation, with older adolescents, for instance, more likely to engage in heavy drinking than younger adolescents.[10,18] Independent of those age patterns, period effects refer to increases and decreases in the population mean level of drinking that are common across all adolescents and that may be attributable to policy or other social change that is ubiquitous in effect. Cohort effects, then, refer to variation over time that is common to groups of adolescents born around the same time and coming of age together through historical time. Among adults, both cohort and period effects describe long-term patterns of alcohol consumption[19–21]; for example, binge drinking is less prevalent for those born in the 1980s[22] (cohort effect), and alcohol consumption among those of legal drinking age is influenced by changes in alcohol policy[23] (period effect). However, little attention has been paid specifically to trends in adolescent drinking despite their importance as predictors of the risk of alcohol abuse and dependence in adulthood.[6–8,24]

By using Age-Period-Cohort (APC) analysis, the current study examined age, period, and cohort effects on changes in adolescent drinking trends, with a particular focus on FBD, defined as ≥2 occasions of ≥5 drinks in a row in the past 2 weeks.[25] Consuming ≥5 drinks is typically referred to as binge drinking or heavy episodic drinking; trends in frequent consumption (averaging once per week) of ≥5 drinks has not been thoroughly explored to date. Due to potential variation in alcohol use across demographic subgroups,[11,26,27] separate analyses were conducted by sex, race/ethnicity, and socioeconomic status (SES). Specific research questions included: (1) What are the age, period, and cohort effects on FBD trends among US adolescents? (2) Are there differences in the age, period, and cohort effects across demographic subgroups? and (3) How do associations between demographic subgroups and FBD change over historical time?

METHODS

Sample

Monitoring the Future has conducted nationally representative cross-sectional surveys of 8th-, 10th-, and 12th-grade students annually since 1991, with ~45 000 adolescents included per year.[10] Approximately 420 public and private schools are sampled each year in a multistage, random sampling design with replacement, with a maximum of 350 students from each school; schools typically participate for 2 years. Student response rates on self-administered questionnaires range from 79% to 91%. Almost all nonresponse is due to absenteeism; ~1% of students refuse to participate. A detailed description of design and procedures is provided elsewhere.[10]

The current study includes all adolescents who provided valid responses for alcohol-use items from 1991 through 2015 (92.3% of the total sample). Due to low numbers of cases, adolescents <13 years and >19 years of age were excluded (1.8%), as were those who did not provide their age (2.0%). The final analytic sample included 1 065 022 adolescents (379 992 in 8th grade, 360 961 in 10th grade, and 324 069 in 12th grade).

Measures

Alcohol Use

Our primary analysis examined past 2-week binge drinking (ie, ≥5 drinks in a row). The survey queried, "Think back over the last 2 weeks. How many times have you had ≥5 drinks in a row? (A 'drink' is a bottle of beer, a glass of wine, a wine cooler, a shot glass of liquor, or a mixed drink)." FBD was defined as ≥2 occasions of binge drinking in the past 2 weeks (1 = Yes, 0 = No). Sensitivity analyses were conducted to test the usefulness of our definition of FBD; we varied the definition of FBD as (1) ≥1 occasions, and (2) ≥6 occasions in the past 2 weeks. Furthermore, supplemental analyses were conducted to examine changes in occasional/heavy drinking (1 = drinking in the past 30 days and up to 1 occasion of binge drinking in the past 2 weeks; 0 = no drinking in the past 30 days). A survey question "On how many occasions have you had alcoholic beverages to drink during the last 30 days?" was used in combination with the binge drinking question.

Demographics

APC models were stratified by several demographic covariates. Race

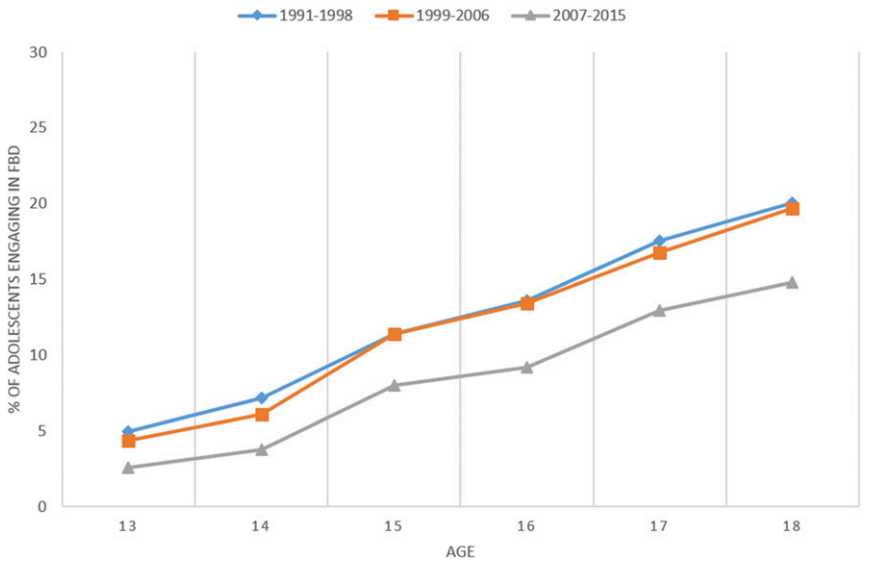

FIGURE 1
Percentage of adolescents engaging in FBD by age and historical period.

and ethnicity were self-reported by respondents who were allowed to select multiple categories. We categorized respondents into: white, African American, Hispanic, and other race/ethnicity. Those who reported >1 category were included in the other race/ethnicity category. SES was operationalized as parental education based on the highest level achieved by either parent: some college or more compared with high school or less. Analyses were also stratified by respondent self-identified sex (boy or girl).

Statistical Analysis

APC models were estimated by using the Clayton and Schiffler approach.[28,29] This approach iteratively estimates models incorporating age, period, and cohort effects; the best-fitting model is selected based on model fit statistics (by using likelihood-based deviance along with degrees of freedom). The approach is iterative because the simultaneous linear effects of age, period, and cohort cannot be directly estimated (due to a linear dependence across the 3 variables). The Clayton and Schiffler approach first includes a linear effect of age and then the sum of period and cohort effects (ie, drift), which only identifies the extent to which trends over time increase or decrease. Period and cohort effects are then estimated as nonlinear deviations around the total linear change. We chose the year 1986 as the reference birth cohort because it was in the midpoint of the cohort distributions, and we chose 2007 as the reference period because it was a changing point in the overall rate of alcohol use. The APC modeling was conducted by using "*apc.fit*" in the "*Epi*" package in the R software (www.r-project.org/).

In addition to estimating APC models, we examined the association between demographics and FBD in 3 historical time periods (1991 to 1998, 1999 to 2006, and 2007 to 2015) using logistic regression models stratified by the time periods.

RESULTS

Figure 1 shows the percent of adolescents engaging in FBD by age and 3 different period categories: 1991 to 1998, 1999 to 2006, and 2007 to 2015. FBD increased by age during adolescence in all time periods. The patterns were similar between 1991 to 1998 and 1999 to 2006 but decreases were observed from 2007 to 2015 for all age groups. However, Fig 1 does not provide an assessment of potential cohort effects and how cohort effects may be distinct from the overall secular trends captured in period effects.

APC Analyses of FBD

The inclusion of age, period, and cohort effects produced the best model fit for trends over time in FBD (n = 116 129) versus other drinking (any drinkers and nondrinkers, n = 948 893) (Supplemental Table 2). FBD increased with age (age effects in Fig 2); <5% of adolescents aged 13 to 14 years reported FBD, whereas ~20% of adolescents 18 years of age did. Regarding period effects (Fig 2), FBD has declined since 1990; the risk of adolescent FBD in 2015 was ~0.9 times the risk during the reference period, 2007. Birth cohorts born around 1990 (ie, 8th graders in 2003 to 2004, 10th graders in 2005 to 2006, and 12th graders in 2007 to 2008) had a lower risk of FBD compared with those born in the earlier and later cohorts (cohort effects in Fig 2), independent of age-related trends and the overall decrease in risk across the period.

APC Analyses by Demographics

APC analyses for FBD by sex indicate that the best-fitting models include age, period, and cohort effects separately for both boys and girls (Fig 3, Supplemental Table 2). APC results were consistent across race/ethnicity, with an exception of nonsignificant age, period, and cohorteffects for Hispanic adolescents (Fig 4, Supplemental Table 3). Similarly, APC analyses were generalizable across SES (Fig 5, Supplemental Table 4).

Demographic Moderators of Alcohol Use Across Time

We divided the data into 3 time periods to estimate trends in the association of demographics

with FBD (Table 1). Tests of interaction with time periods indicated substantial variation in FBD by sex. Girls were less likely than boys to report FBD, but the effects were weakened (odds ratio [OR] from 0.58 in 1991 to 1998 to 0.71 in 2007 to 2015), showing a converging trend by sex ($P < .0001$ for interactions). Although no significant variations were found by race/ethnicity across time periods, African American students were less likely than white students to report FBD where the effects were weakened (OR from 0.42 in 1991 to 1998 and 1999 to 2006 to 0.53 in 2007 to 2015), suggesting a convergence ($P < .0001$ for interactions between the 1999–2006 and 2007–2015 cohorts, and the 1991–1998 and 2007–2015 cohorts). Higher SES adolescents were less likely to report FBD compared with those from lower SES, and the effects were strengthened (OR from 0.83 in 1991 to 1998 to 0.79 in 2007 to 2015), suggesting a growing difference ($P < .0001$ for the comparison between the 1991–1998 and 2007–2015 cohorts).

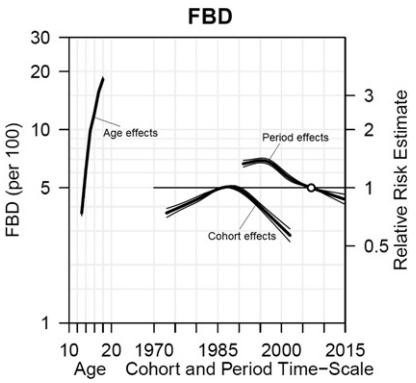

FIGURE 2
Age, period, and cohort effects on the probability of adolescents reporting FBD from 1991 to 2015 (N = 1 065 022). The cohort and period time scale contains relative risk estimates for the effect of cohort (left line) and period (right line). Thin lines indicate 95% confidence intervals. The cohort estimates are compared with a referent cohort, 1986; thus, the lines can be interpreted as the average proportion of US students' FBD, regardless of time period, compared with the average proportion in 1986. The period estimates are compared with a referent period of 2007, and thus the lines can be interpreted as the average proportion of US students' FBD in that year, regardless of cohort, compared with the average proportion in 2007.

Sensitivity Analysis

To examine the robustness of our results, we repeated the analyses with 2 alternative cut points, 1 with a lower level of frequency (≥1 or more binges in the last 2 weeks), and 1 with a higher level of frequency (≥6 binges in the last 2 weeks). Both of these cut points produced consistent APC results (Supplemental Fig 6, Supplemental Table 5). A converging gap by sex and growing disparity by SES in recent cohorts (2007 to 2015) were also found (Supplemental Table 6).

Supplemental Analysis

APC supplemental analyses on occasional/heavy drinking (ie, any drinking in the past 30 days and up to 1 occasion of binge drinking in the past 2 weeks, n = 238 202) compared with no drinking (n = 710 691) revealed that the best-fitting model included age, period and cohort effects (Supplemental Table 7). As illustrated in Supplemental Fig 7, occasional/heavy drinking increased with age, and those born around 1990 had the highest decline of occasional/heavy drinking versus no drinking compared with those in the preceding and subsequent birth cohorts. Positive period effects have been observed since 2007; the decline in occasional/heavy drinking has been slower after 2007. Girls were more likely than boys to engage in occasional/heavy drinking, whereas higher SES adolescents were less likely to be involved in occasional/heavy drinking (Supplemental Table 8). In general, adolescent occasional/heavy drinking patterns were similar to FBD, with the exception of the slower declines in occasional/heavy drinking after 2007 and the greater probability of girls than boys being involved in occasional/heavy drinking.

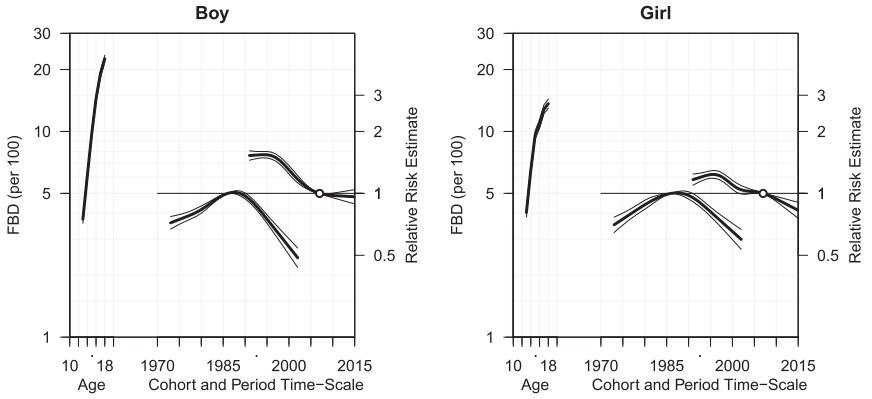

FIGURE 3
Age, period, and cohort effects on the probability of adolescents reporting FBD from 1991 to 2015, by sex.

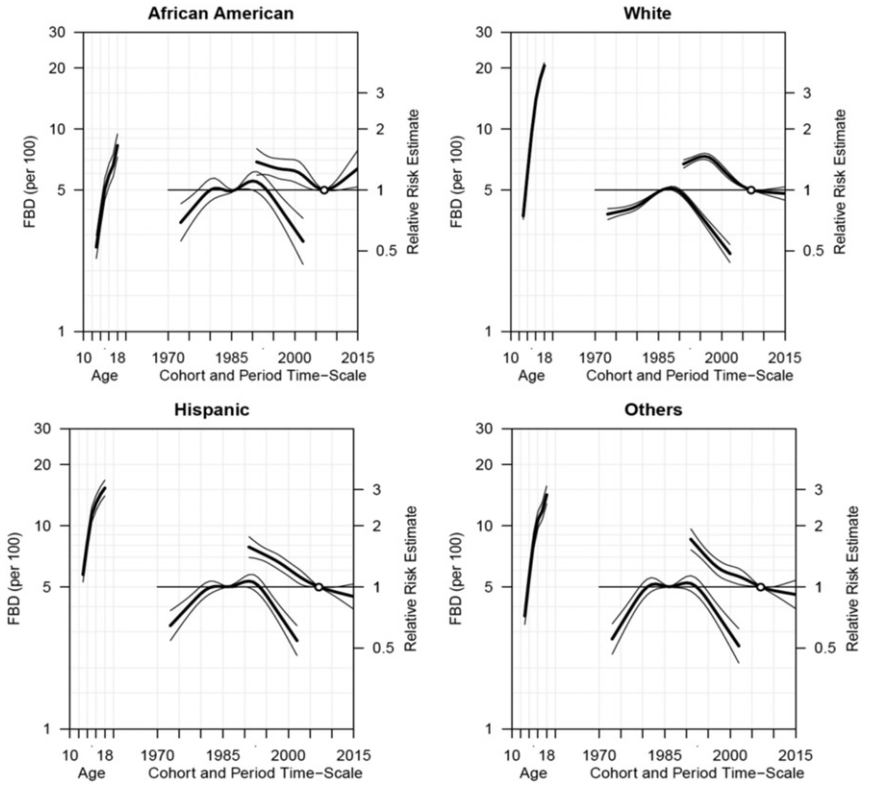

FIGURE 4
Age, period, and cohort effects on the probability of adolescents reporting FBD from 1991 to 2015, by race/ethnicity.

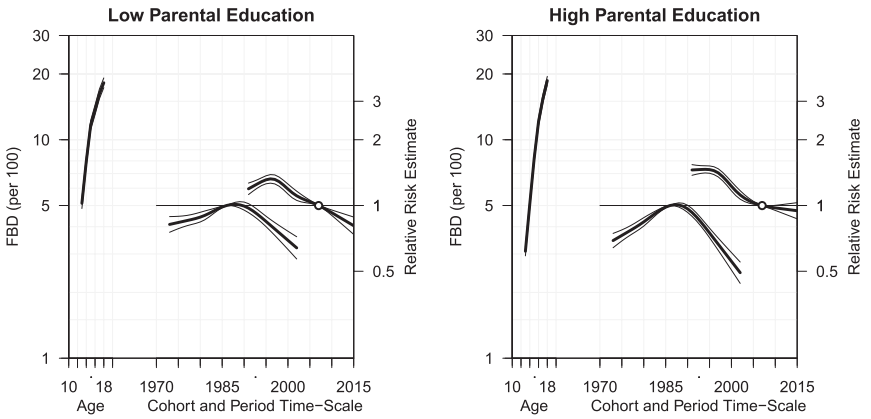

FIGURE 5
Age, period, and cohort effects on the probability of adolescents reporting FBD from 1991 to 2015, by SES.

DISCUSSION

Using nationally representative multicohort data from a large sample of adolescents, the current study systematically examines age, period, and cohort effects on FBD in the United States. First, we found that FBD decreased in recent years among all ages during adolescence, which is consistent with previous research on declines in adolescent alcohol use.[10] The trends were best described by effects attributable to period and cohort in addition to age-related variation. In other words, decreases in adolescent FBD across the past 25 years were driven by factors influencing all age groups simultaneously as well as influences on particular birth cohorts. Since 1991, the risk of FBD has decreased among adolescents independently of age and birth cohorts. Furthermore, those born around 1990 had the highest decline of FBD compared with those in the preceding and subsequent cohorts of adolescents.

TABLE 1 ORs for Association Between Demographic Variables and Probability of FBD, by Time Periods

	1991–1998 n = 363 178	1999–2006 n = 339 799	2007–2015 n = 362 045	Interactions		
				1991–1998 vs 1999–2006	1999–2006 vs 2007–15	1991–1998 vs 2007–2015
Sex						
Boy	1	1	1			
Girl	0.58 (0.57–0.60)	0.65 (0.64–0.67)	0.71 (0.70–0.73)	***	***	***
Race						
White	1	1	1			
African American	0.42 (0.40–0.44)	0.42 (0.40–0.44)	0.53 (0.51–0.56)	N/S	***	***
Hispanic	1.00 (0.97–1.04)	0.97 (0.93–1.00)	0.96 (0.93–1.00)	N/S	N/S	N/S
Other	0.75 (0.72–0.77)	0.75 (0.72–0.78)	0.78 (0.75–0.81)	N/S	N/S	N/S
Parent education						
High school or less	1	1	1			
College or more	0.83 (0.82–0.85)	0.81 (0.79–0.83)	0.79 (0.77–0.81)	N/S	N/S	***
Age, y						
13–14	1	1	1			
14–15	1.40 (1.33–1.47)	1.35 (1.28–1.43)	1.44 (1.33–1.55)	N/S	N/S	N/S
15–16	2.41 (2.30–2.53)	2.84 (2.69–2.99)	3.29 (3.07–3.52)	***	***	***
16–17	2.82 (2.69–2.95)	3.28 (3.12–3.45)	3.74 (3.50–4.00)	**	**	***
17–18	4.08 (3.90–4.27)	4.49 (4.26–4.72)	5.64 (5.28–6.02)	***	***	***
18–19	4.59 (4.39–4.81)	5.18 (4.92–5.44)	6.40 (6.00–6.83)	***	***	***

95% confidence intervals are in parentheses. N/S, not significant.
** $P < .01$.
*** $P < .001$.

Factors underlying these effects may include increased public efforts to reduce the risk of underage drinking in the United States[9,30] (eg, National Institute on Alcohol Abuse and Alcoholism Intervention Guide for Practitioners, 2015[31]), and increased levels of disapproval of heavy alcohol use among recent cohorts of adolescents.[10] Furthermore, online social networking[32] may affect drinking patterns among recent cohort adolescents because most young people report drinking for social motives.[33] As some research has suggested,[11] however, declines in alcohol use may also be attributable to an increase in preference for other drugs (eg, nonmedical use of prescription medication), although more rigorous investigation is necessary to understand the mechanisms.

Overall, APC results were consistent across diverse demographic groups with a few notable differences. Boys and higher SES adolescents experienced rapid increases in FBD by age compared with girls and lower SES adolescents, respectively. African American adolescents showed the lowest rates of FBD among all racial groups across all ages, consistent with previous research on their delayed onset and lower prevalence of heavy drinking.[34,35] Furthermore, although period effects have led to decreases for all racial groups, the decline in FBD among African American adolescents has been slower than among white adolescents since 2007. The recent declines in FBD among adolescents suggest that the economic recession in the late 2000s, when a population-level increase in the prevalence of FBD was observed in the United States,[36] may have had less of an effect on the drinking patterns of adolescents. This finding is consistent with previous research showing a weak association between state-level economy and any alcohol use among adolescents.[37] The slower decrease among African American adolescents, however, may indicate variations in that link.

Regarding the trends in the association between demographics and drinking over historical time, the analyses revealed substantial convergence in FBD by sex in more recent time periods. The convergence resulted from greater declines in boys' FBD than in girls' FBD among recent cohorts of adolescents, as shown in the cohort effects from APC analyses. In fact, this finding is consistent with growing evidence of a convergence in the sex gap for alcohol initiation and progression to alcohol problems both in the United States and elsewhere.[10,38–41] Furthermore, trends in other risk behaviors are increasing faster among adolescent girls in the United States than among boys, including preference for risky activities.[42] Changes in sex roles[43] and a shift in the targeting of alcohol marketing to young female consumers[44] may have contributed to this narrowing sex gap. Although the causes are speculative, we provide evidence of greater declines in FBD among boys than girls born in recent cohorts.

The analyses also found growing discrepancy by SES in FBD among adolescents in the United States. That is, higher SES adolescents were less likely than those from a lower SES to engage in FBD, and the strength of the association is growing in more recent time periods. These findings

are in contrast to some previous research on the positive association between binge drinking and SES.[45] The FBD group in the current study includes those who engage in binge drinking ≥2 times in the past 2 weeks, whereas previous research referred to any binge episode.[46,47] Other research[48] has found mixed results by grade in the association between SES and drinking, in which the prevalence of binge drinking is higher for 8th and 10th graders from lower SES despite the opposite association for 12th graders. A study of high-intensity drinking of ≥15 drinks in a row found a higher incidence among lower SES 12th graders.[49] Our findings add evidence that lower SES students may be at greater risk of problematic drinking.[49] More detailed research is needed to understand the SES effect and risky drinking among adolescents.

Regarding race and ethnicity, we found a convergence between African American and white adolescents, especially in recent years, despite the fact that African American adolescents typically show unique drinking patterns (eg, delayed onset of heavy drinking[34,35]). This finding may again point to the slower declines in heavy drinking among African American adolescents, although future research is needed to understand the changing mechanisms of this convergence.

Despite the declines in FBD, supplemental analyses reveal that the decrease in occasional/heavy drinking among adolescents has been slower in recent years, regardless of their age and birth cohorts. The occasional/heavy drinking group is, however, substantially heterogeneous, including those who have had only 1 drink in the last 30 days and those who have engaged in binge drinking once in the last 2 weeks. Additional research is warranted for those who drink to a lesser degree.

The current study has several limitations. First, alcohol use may vary within categories of use (eg, beverage types[21,33,48]). Second, the Monitoring the Future data do not include those who drop out of secondary schools; however, this concern is somewhat alleviated because dropout rates have been declining in the United States.[50] Third, APC models do not explicate the mechanisms underlying APC effects.

CONCLUSIONS

Declines in FBD among adolescents are attributable to age, period, and cohort effects, with variations by demographics. These declines likely reflect successful intervention attempts to reduce alcohol use among adolescents. However, practitioners should take note that these effects have not been equal across demographic groups, particularly with regard to slower declines among African American adolescents (compared with white adolescents). Screening for alcohol use and FBD in particular remains important. The narrowing difference by sex but the growing gap by SES also deserve close attention by researchers and practitioners.

ABBREVIATIONS

APC: age-period-cohort
FBD: frequent binge drinking
OR: odds ratio
SES: socioeconomic status

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