ORIGINAL ARTICLE

# Birth Cohort Effects on Adolescent Alcohol Use

## *The Influence of Social Norms From 1976 to 2007*

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**Context:** The substantial changes in adolescent alcohol use prevalence over time suggest that population-level environmental factors are important determinants of use, yet the potential influence of such environmental factors is inadequately understood.

**Objective:** To investigate whether adolescents in birth cohorts and/or time periods characterized by restrictive social norms toward alcohol were at decreased risk for alcohol use and binge drinking, controlling for individual attitudes (disapproval) toward use.

**Design, Setting, and Participants:** In 32 annual national surveys of US high school students, a total of 967 562 students contributed outcome data from 1976 through 2007.

**Main Outcome Measures:** Frequency of past-year alcohol use and any instance of binge drinking (≥5 drinks) in the past 2 weeks, analyzed using multilevel models clustering individuals within periods and birth cohorts. Period- and cohort-specific social norm scores (indicating the proportion disapproving of weekend binge drinking) were modeled as predictors, controlling for individual attitudes and demographic characteristics.

**Results:** Individuals who matured in birth cohorts with more restrictive social norms were less likely to use alcohol compared with individuals who matured in cohorts with more permissive norms; each 5% increase in the cohort-specific disapproval was associated with a 12% decrease in the odds of past-year alcohol use (odds ratio = 0.88; 99% CI, 0.87-0.89). The effects of cohort-specific disapproval were notably stronger among white adolescents than nonwhite adolescents.

**Conclusions:** This study documents the importance of considering time-varying population-level risk factors in the study of adolescent alcohol use and indicates that, even after an individual's personal attitudes are accounted for, risk is shaped by cohort effects whereby the norms within the cohort contribute to the risk of adolescent alcohol use.

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Adolescent use of alcohol remains a substantial public health problem,[1] and early onset of alcohol use is associated with a range of adverse health and developmental outcomes in adolescence and adulthood.[2-6] Public health research aiming to delay the uptake of alcohol has traditionally focused on identification of risk factors at the individual and immediate social contextual levels[7-9]; however, evidence that risk factors on multiple levels of organization[10-12] as well as adolescent health and development generally[13-15] are important causes of substance use is accumulating. This has stimulated innovative epidemiologic research focusing on characteristics of geographically defined locations, eg, alcohol availability,[16-18] price,[19] laws,[20,21] media exposure,[22] and socioeconomic indicators.[23-29] The substantial fluctuation in alcohol use over time,[30] however, suggests that characteristics of time periods or particular birth cohorts may also be important causes of adolescent alcohol use. Such characteristics have received little systematic investigation. One central characteristic that changes across time[31] is alcohol-related social norms.

Social norms have long been an important component of adolescent alcohol and drug use etiology and prevention.[32-34] Theoretical decision-making models posit that decisions to engage in a behavior are based on 2 main predictors: attitudes about the behavior and perceived social norms regarding the behavior.[32,33] The individual's attitude regarding the behavior may be in part based on the social norm, but whereas the attitude is an individual-level concept, the social norm is often con-

ceptualized as a group-level phenomenon. Social norms regarding alcohol use are generally operationalized in terms of individual-level adolescent perceptions of the social norms and attitudes of those around them,[35-38] eg, how strongly others disapprove of a certain behavior. While these measures are predictive of alcohol use, individual perceptions may not be accurate and group-level norms are conceptually distinct from individual-level norms, exerting influence independent of individual perceptions of norms. Evidence since the 1980s and 1990s indicates that, descriptively, trends in attitudes such as perceived risk and disapproval are associated with change over time in the prevalence of marijuana use and other forms of drug use,[1,39,40] suggesting that time trends in broader population-level social norms may be important determinants of substance use. While data from the Monitoring the Future (MTF) study have shown evidence of cohort effects in perceived risk and disapproval,[40] to date there has not been an effort to separate cohort-specific norms from period-specific norms and to quantify their relative effects on alcohol use.

Further, norms may differ across age, period, and birth cohort. Period-specific norms reflect the general norm among all individuals living in a certain time, regardless of age. Cohort-specific norms reflect the particular norms of individuals born in the same generational group.[41] For example, historical evidence indicates that adolescents and young adults in the late 1960s and early 1970s had permissive attitudes toward substance use compared with older adults in the same period and with individuals of the same age in later periods.[42,43] The relative impact of period-specific vs cohort-specific social norms on trends in alcohol use over time has never been tested, leaving important theoretical and applied gaps in the literature. There is substantial evidence, however, to posit that individuals may be affected to a greater degree by the social norms within their birth cohort than by period-specific social norms. The shaping of norms within a population is an ongoing process that may involve laws, media, and attitude changes in the broader cultural landscape.[41,44] Alcohol policies and laws focusing on certain age groups (eg, changes in the legal drinking age) could potentially give rise to cohort-specific norms affecting alcohol use that would produce cohort effects. If these attitudes vary by birth cohort, then social norm–mediated cohort effects in alcohol consumption may follow.

While previous studies have documented strong cohort effects on alcohol consumption and binge-drinking patterns in the United States,[45] methodological difficulties and limited availability of multicohort data have hampered systematic investigation of factors mediating potential age, period, and cohort effects in substance use. However, recent methodological advances have shown promising resolutions to methodological issues,[46-48] and national surveillance research on adolescence now encompasses enough years to provide sufficient variation across time.[1]

This study is designed to address whether the quantity and frequency of alcohol use can be predicted by period- and cohort-specific social norms. We use data from the MTF study, a substantial resource providing data on alcohol use patterns among more than 1 million adolescents surveyed from 1976 to 2007. Unlike many age-period-cohort analyses that focus only on describing how patterns of alcohol use vary across age, period, and cohort, we test a hypothesis regarding a potential mediator—changing social norms—that would result in birth cohort effects. Using multilevel modeling, we directly test whether variation in social norms at the cohort level predicts cohort-specific drinking patterns independent of age and period effects. Further, we examine whether sociodemographic characteristics modify the effect of social norms.

## METHODS

### STUDY AND COLLECTION OF DATA

The MTF study[1] conducts an annual cross-sectional survey of high school students in approximately 130 US public and private high schools. High schools are selected under a multistage random sampling design with replacement. Schools are invited to participate for 2 years. Schools that decline participation are replaced with schools that are similar in geographic location, size, and urbanicity. Between 95% and 99% of all selection sample units obtain 1 or more participating schools for all study years. Starting in 1975, approximately 15 000 students in 12th grade were surveyed annually during spring. Student response rates ranged from 77% (in 1976) to 91% (in 1996, 2001, and 2006). Almost all nonresponse is due to absenteeism; fewer than 1% of students refuse to participate.

In 1991, 8th and 10th graders were added, with approximately 17 000 students in 8th grade (in about 150 schools) and 15 000 students in 10th grade (in about 125 schools) sampled annually. Self-administered questionnaires were given to students, typically in classroom settings with a teacher present. Teachers were instructed to avoid close proximity to the students during administration to ensure students could respond confidentially. The study was approved by the institutional review board of the University of Michigan.

### ASSESSMENT OF AGE, PERIOD, AND BIRTH COHORT

A total of 3 ages (ages 17-19 years) were available from 1976 to 1990, and 7 ages (ages 13-19 years) were available from 1991 to 2006. Within each grade, 95% of students fell into 3 birth years. Birth cohorts ranged from 1958 to 1994. Of a total possible sample of 1 103 481 students, age and alcohol information was available for 1 032 052 respondents (94% of the sample).

### MEASURES

#### Outcomes

We examined 2 outcomes, one characterizing drinking patterns via the frequency of alcohol use and the other characterizing potentially problematic drinking by the quantity of alcohol use. To measure alcohol frequency, respondents were asked the number of occasions they consumed alcohol in the past 12 months. Alcohol use was measured as a 7-level ordinal variable: 0 occasions, 1 or 2 occasions, 3 to 5 occasions, 6 to 9 occasions, 10 to 19 occasions, 20 to 39 occasions, and 40 or more occasions. To measure alcohol quantity, particularly heavy use, respondents were asked the number of occasions they consumed 5 or more drinks consecutively (binge drinking) in the past 2 weeks (dichotomized as any vs none).

### Individual-Level Attitudes Toward Acceptability of Using Alcohol

A subset of the total MTF sample was randomized to questionnaires containing an item capturing attitudes toward binge drinking with multiple response options. Respondents were asked the following: "Individuals differ in whether or not they disapprove of people doing certain things. Do you disapprove of people (who are 18 or older) . . . having 5 or more drinks once or twice each weekend?" We evaluated 3 response options: don't disapprove, disapprove, and strongly disapprove. Attitude measures in the MTF sample relate strongly to use.[18,48,49]

### Sociodemographic Characteristics

Previously identified demographic risk factors for alcohol use at the individual level were also included in regression models.[1,49-52] These included sex, age, race/ethnicity, highest level of respondent-identified parental education, average grades in school (A's, B's, or below B's), and whether the father lived at home. Race was categorized as white vs nonwhite.

### Other Individual-Level Covariates

We included several other variables characterizing the alcohol environment of the adolescent, including how easy it would be for the adolescent to obtain alcohol (probably impossible, very difficult, fairly difficult, fairly easy, very easy) and how many of their friends get drunk at least once a week (none, a few, some, most, all). Finally, we captured polysubstance use and the specificity of the alcohol norm effect by controlling for any past-year marijuana use by each respondent.

### Cohort- and Period-Level Social Norms

At the population level, an aggregate measure of the adolescents' attitude toward weekend binge drinking was created to characterize the social norm associated with periods (year) and birth cohorts. For simplicity, the measure was dichotomized (strongly disapprove or disapprove vs don't disapprove). We then estimated the proportion of students who disapproved of binge drinking in each period (ie, year of measurement) (12th graders provided data from 1976-1991, and 8th and 10th graders were added thereafter). This variable represented the period-specific social norm. For grade 12, these percentages ranged from a low of 55.1% in 1979 to a high of 84.2% in 1992. Next, we estimated the percentage of students who disapproved of alcohol use in each birth cohort. This variable represented the cohort-specific social norm averaged across periods. For grade 12, these percentages ranged from a low of 54.3% for the 1962 birth cohort to a high of 88.9% for the 1994 birth cohort. All period- and cohort-specific social norm proportions are shown in **Figure 1**.

## STATISTICAL ANALYSIS

### Split-Sample Design

A split-sample design was used to mitigate same-source bias in estimating the effect of period- and cohort-specific norms. Same-source bias can arise in multilevel studies when the data on group-level variables are derived from the aggregation of individual-level data.[11]

As per standard procedures,[53] the adolescent social norm was based on a percentage of the total sample, who were then excluded from the models estimating the parameters. We used 6% of the sample for estimating the social norm, which yielded 64 490 adolescents, leaving 967 562 adolescents to be used in the outcome estimation. In eTable 1 (http://www.archgenpsychiatry.com), we show the distribution of all study covariates in the 2 samples; on no level of the covariates did the samples differ by more than 1%. Further, sensitivity analyses demonstrated that larger subsamples would not result in meaningful changes in the distribution of any study covariates (eTable 1). This subsample was ascertained using PROC SURVEYSELECT in SAS statistical software version 9.2 (SAS Institute, Inc).

### Sample Weighting and Treatment of Missing Data

Sample weights were included to adjust for the minor differences in probability of selection across groups. Clustering by school and primary sampling unit introduces nonindependence to this sample, but variables that would allow for adjustment for clustering across time were not available. To account for clustering, we set our $\alpha$ level for type I error to .01. All analyses were completed using SAS statistical software version 9.2 and MPLUS statistical software version 6.12.[54] The MPLUS program uses full-information maximum-likelihood estimation methods so that observations with data available on a particular covariate contribute to the estimation of that covariate. Variables in the core questionnaire were asked of all students, with missing data due to respondent nonresponse (race had the highest proportion of missing data, at 15.3%). Questions on adolescent attitudes, ease of obtaining alcohol, and peer group alcohol use were obtained by design only on certain forms and thus answered by a random subsample of participants. Depending on grade and survey year, variables in the noncore forms were randomized to 2 to 4 questionnaires among 4 to 6 potential forms; thus, missing information on these variables is substantial (30%-50% depending on grade and year) but random, and the sample sizes remained large for robust statistical estimation.

### Analytic Strategy

Our principal analytic approach was to use multilevel models that included the period and cohort disapproval variable as the indicator of the group-level social norm. In these models, individuals were clustered by period and birth cohort. Two group-level disapproval variables were simultaneously considered: one representing the disapproval for each birth cohort and the other representing the disapproval for each period. First, we analyzed cohort- and period-specific social norms as a continuous variable and transformed estimates to indicate the change in odds based on a 5–percentage point change in disapproval. Preliminary analyses suggested that population-level disapproval had a linear relation with log odds of alcohol use and binge drinking. Second, we used categorical variables for each 5–percentage point increase in population-level disapproval to detect any non–log-linear effects. We first estimated models adjusted for age at the individual level only and then included individual-level sociodemographic, alcohol environment, and polysubstance use covariates.

### Multiple-Group Analysis

Finally, we estimated whether the structure of the multilevel model differed by sociodemographic characteristics. For this, we used multiple-group analysis, which tests for invariance of the functional form of the model across groups. We calculated a coefficient for the difference between groups by using a 2-level mixture model with the KNOWNCLASS option of MPLUS version 6.12 mixture models.[55] We also assessed the strength of the difference in odds ratios (ORs) by demographic character-

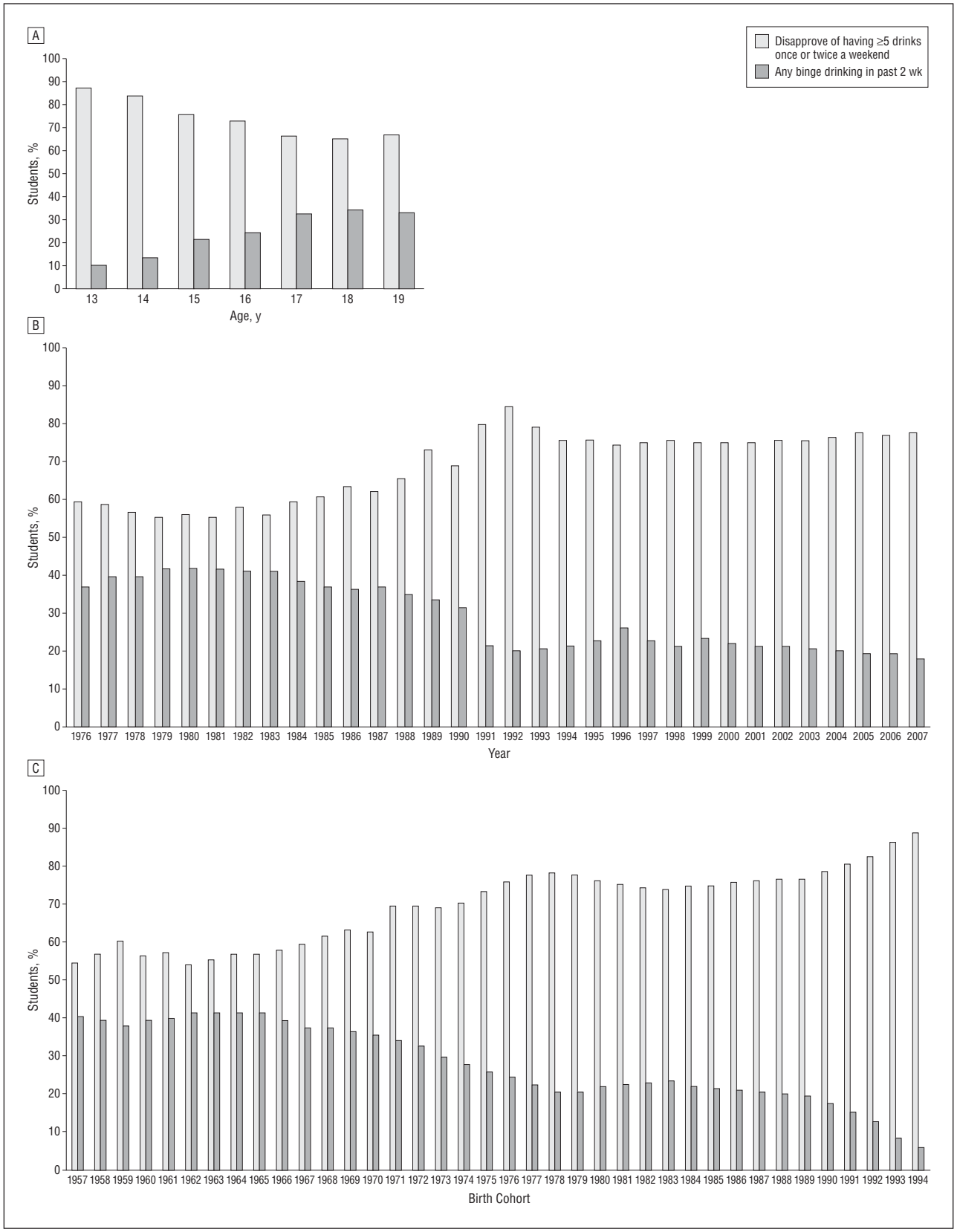


**Figure 1.** Age (A), period (B), and cohort (C) associations with percentage of students who reported binge drinking in the past 2 weeks and percentage of high school students in the United States disapproving or strongly disapproving of consuming 5 or more drinks on weekends among 967 562 students from 1976 to 2007.

istics; given the large sample size of the MTF study, only changes greater than 10% were considered meaningful.[56] We tested for invariance for female vs male respondents, white vs nonwhite respondents, and parental education.

**Table. Effect of Population-Level Disapproval on Frequency of Alcohol Consumption in the Past Year and Any Binge Drinking in the Past 2 Weeks Among 967 562 High School Students in the United States From 1976 to 2007[a]**

| Outcome | Model 1[b] | Model 2[b] | Model 3[c] |
|---|---|---|---|
| Frequency of alcohol consumption in past y | | | |
| Period-specific disapproval | | | |
| OR (99% CI) | 0.71 (0.70-0.72) | | 0.97 (0.93-1.02) |
| *P* value | <.01 | | .54 |
| Cohort-specific disapproval | | | |
| OR (99% CI) | | 0.75 (0.72-0.78) | 0.76 (0.73-0.80) |
| *P* value | | <.01 | <.001 |
| Log likelihood | −1 794 972.499 | −1 796 988.765 | −830 897.653 |
| $R^2$, within | 0.150 | 0.125 | 0.215 |
| *P* value | <.01 | <.01 | <.001 |
| $R^2$, between | 0.861 | 0.834 | 0.786 |
| *P* value | <.01 | <.01 | <.001 |
| Any binge drinking in past 2 wk | | | |
| Period-specific disapproval | | | |
| OR (99% CI) | 0.88 (0.86-0.90) | | 1.08 (0.94-1.20) |
| *P* value | <.01 | | .12 |
| Cohort-specific disapproval | | | |
| OR (99% CI) | | 0.86 (0.85-0.87) | 0.88 (0.80-0.94) |
| *P* value | | <.01 | <.001 |
| Log likelihood | −476 995.29 | −477 022.99 | −76 736.21 |
| $R^2$, within | 0.049 | 0.043 | 0.412 |
| *P* value | <.01 | <.01 | <.001 |
| $R^2$, between | 0.898 | 0.887 | 0.788 |
| *P* value | <.01 | <.01 | <.001 |

Abbreviation: OR, odds ratio.

[a] Alcohol use is measured as a 7-level ordinal variable: 0 occasions, 1 or 2 occasions, 3 to 5 occasions, 6 to 9 occasions, 10 to 19 occasions, 20 to 39 occasions, and 40 or more occasions. Models are estimated in random-effects models with period-specific and cohort-specific disapproval as random effects and age as an individual-level effect.

[b] Controlled for individual-level age.

[c] Controlled for year- and cohort-specific disapproval, individual-level age, individual-level disapproval, perceived availability of alcohol, proportion of friends who get drunk, sex, race, highest level of parental education, average school grades (A's, B's, or below B's), and whether the father lives in the home.

## RESULTS

### ALCOHOL USE BY AGE, PERIOD, AND COHORT

The percentage of students reporting a past 2-week episode of binge drinking and the percentage reporting that they disapprove of weekend binge drinking by age, period, and cohort are shown in Figure 1. By age, the prevalence of binge drinking increases and disapproval decreases until approximately age 17 years, after which both measures remain stable. By period, binge drinking was highest (41.8%) and disapproval was lowest (55.1%) in 1979 (corresponding to the peak in US per capita consumption[45]); in contrast, binge drinking was lowest in 2007 (18.0%) but disapproval was highest (84.2%) in 1992. By cohort, binge drinking was highest (41.6%) and disapproval was lowest (54.3%) for the cohort born in 1962.

### MULTILEVEL MODEL

First, we evaluated the effect of cohort- and period-specific disapproval on alcohol use occasions when disapproval was defined as a continuous predictor (**Table**). For period, each 5–percentage point increase in period-specific disapproval (eg, comparing a year in which 55% of adolescents disapproved of alcohol with a year in which 60% of adolescents disapproved of alcohol, regardless of age) was associated with a 0.71-fold decrease in alcohol-using occasions in a model adjusted only for age (OR=0.71; 99% CI, 0.70-0.72; $P<.001$). For birth cohort, each 5–percentage point increase in cohort-specific disapproval (eg, comparing a birth cohort in which 55% of adolescents disapproved of alcohol with a birth cohort in which 60% of adolescents disapproved of alcohol, regardless of age) was associated with a 0.75-fold decrease in alcohol-using occasions in a model adjusted only for age (OR=0.75; 99% CI, 0.72-0.78; $P<.001$). In a regression model simultaneously controlling for period- and cohort-specific disapproval as well as individual-level disapproval and demographic characteristics, cohort-specific disapproval remained significantly associated with the number of alcohol-using occasions (OR=0.76; 99% CI, 0.73-0.80), whereas period-specific disapproval was not significant. Findings regarding binge drinking are also reported in the Table, with similar conclusions compared with frequency of drinking occasions. Specifically, in fully controlled models, cohort-level disapproval remained a strong negative predictor of binge drinking (OR=0.88; 99% CI, 0.80-0.94), whereas period-specific disapproval did not.

We conducted two sensitivity analyses of these results. We replicated our analytic strategy using grade cohorts rather than age cohorts (ie, an individual in the 8th grade in 1991 was calculated as being in the same grade cohort as an adolescent in the 10th grade in 1993 and the 12th grade in 1995, regardless of age). The results

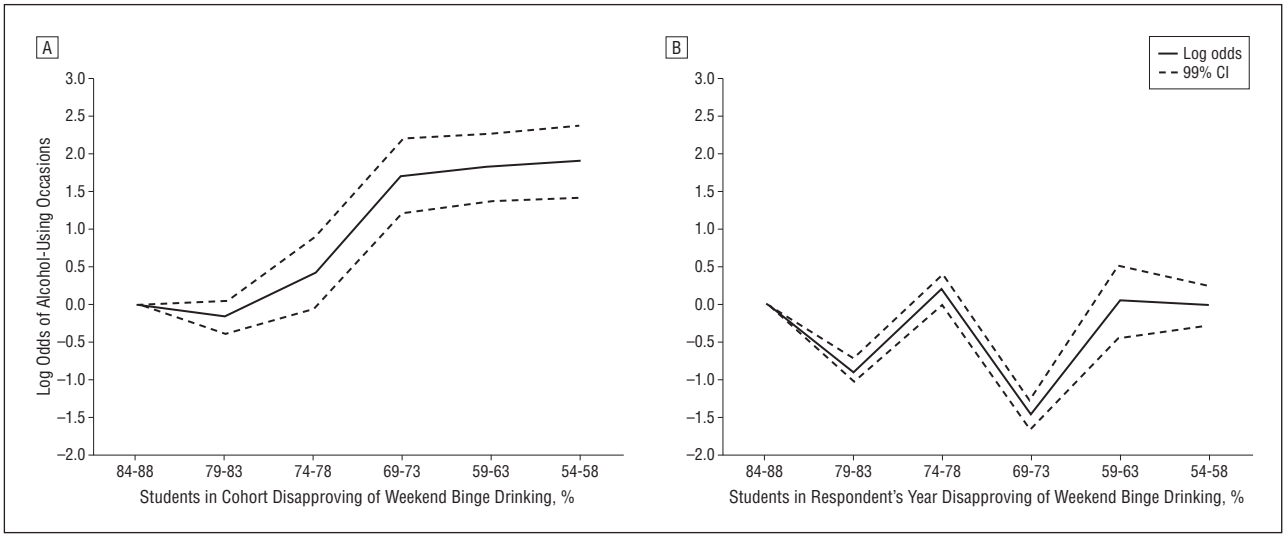


**Figure 2.** Summary log odds for the effect of cohort-specific (A) and period-specific (B) disapproval on frequency of alcohol consumption in the past year among 967 562 high school students in the United States from 1976 to 2007. Log odds are from multilevel polytomous regression with a cumulative logit link function; models controlled for year- and cohort-specific disapproval, individual-level age, individual-level disapproval, perceived availability of alcohol, proportion of friends who get drunk, sex, race, highest level of parental education, average school grades (A's, B's, or below B's), and whether the father lives in the home. Alcohol use is measured as a 7-level ordinal variable: 0 occasions, 1 or 2 occasions, 3 to 5 occasions, 6 to 9 occasions, 10 to 19 occasions, 20 to 39 occasions, and 40 or more occasions. There were no cohorts or periods with disapproval of 64% to 68%.

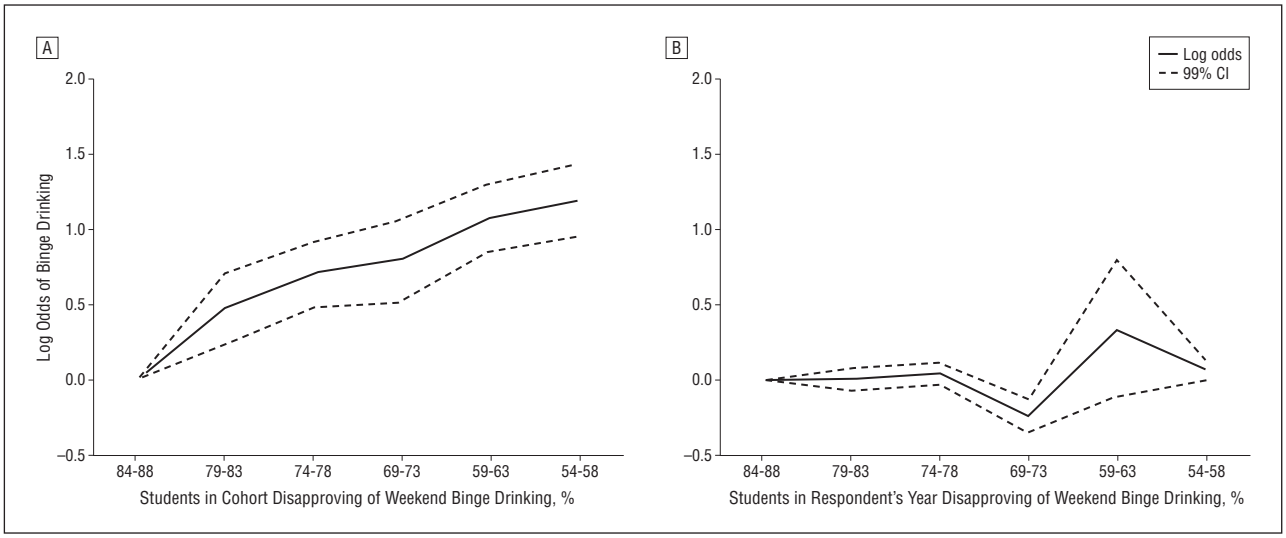


**Figure 3.** Log odds for the effect of cohort-specific (A) and period-specific (B) disapproval on binge drinking in the past 2 weeks among 967 562 high school students in the United States from 1976 to 2007. Log odds are from multilevel logistic regression; models controlled for year- and cohort-specific disapproval, individual-level age, individual-level disapproval, perceived availability of alcohol, proportion of friends who get drunk, sex, race, highest level of parental education, average school grades (A's, B's, or below B's), and whether the father lives in the home. There were no cohorts or periods with disapproval of 64% to 68%.

were unchanged, eg, greater grade cohort–specific disapproval was associated with lower frequency of alcohol use (OR=0.86; 99% CI, 0.85-0.88). Additionally, to establish the temporal sequence between social norms predicting alcohol use in these data, we created a 1-year cohort and 1-year lags between alcohol use and the social norm of the birth cohort. Thus, an individual's frequency of alcohol use and odds of binge drinking are predicted by the social norm of the $n-1$ period and $m-1$ birth cohort, respectively. Results were unchanged. Cohort-specific social norms remain significantly predictive of alcohol use frequency (OR=0.87; 99% CI, 0.83-0.92) and binge drinking (OR=0.86; 99% CI, 0.79-0.93).

Second, we evaluated the effect of cohort- and period-specific disapproval on alcohol use occasions when disapproval was defined as a categorical predictor. Results are shown in **Figure 2** for frequency of drinking occasions in the past year and in **Figure 3** for binge drinking. For period, no consistent or theorized pattern emerges for the relation between period-specific disapproval and alcohol use or binge drinking in controlled regression. For cohort, a stepwise increase in the odds of alcohol use occurs as the birth cohort–specific disapproval decreases, until a threshold effect of approximately 59% to 63% of the birth cohort disapproving is reached. Odds of binge drinking monotonically increase as disapproval decreases.

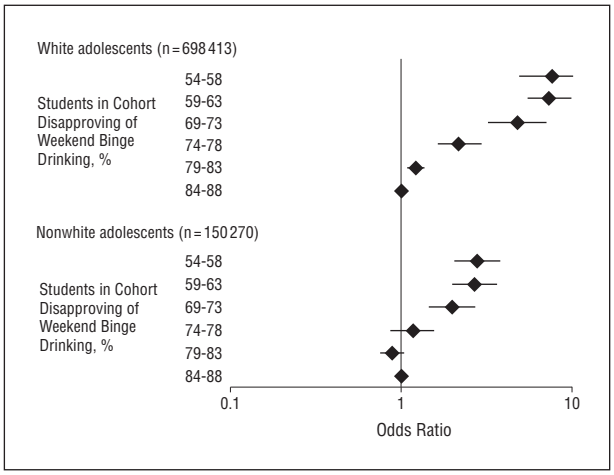


**Figure 4.** Association between cohort-specific disapproval of frequent binge drinking and frequency of alcohol use in the past year among 698 413 white adolescents and 150 270 nonwhite adolescents in the United States from 1976 to 2007. Error bars indicate 99% CIs. There were no cohorts with disapproval of 64% to 68%.

### MULTIPLE-GROUP ANALYSIS

Finally, we conducted multiple-group analyses to determine whether the structure of the model differed by sex, race, and highest level of parental education. All multiple-group analyses were statistically significant ($P < .01$). We then examined the ORs for the association between cohort-specific disapproval and alcohol use within demographic subgroups. The OR for men vs women differed by 6%, and the ORs comparing parental educational levels differed by less than 5%; this suggests little evidence of an appreciable difference. The ORs for nonwhite respondents compared with white respondents, however, differed by 18%. Given the magnitude of this difference, ORs for the effect of cohort-specific disapproval on alcohol use subset by race are shown in **Figure 4**. Further, the distribution of all study covariates by race is shown in eTable 2. The effect of disapproval on use was stronger among white adolescents, especially those living in birth cohorts where 63% of adolescents or fewer disapproved of frequent binge drinking (Figure 4). Among white adolescents, the odds of alcohol consumption occasions decreased by approximately 25% for each 5–percentage point increase in disapproval (OR = 0.75; 99% CI, 0.65-0.84). Among nonwhite adolescents, the odds of alcohol consumption occasions decreased by approximately 14% for each 5–percentage point increase in disapproval (OR = 0.86; 95% CI, 0.84-0.91).

## COMMENT

This study resulted in two main findings. First, we document that members of birth cohorts with more restrictive social norms regarding alcohol use have fewer alcohol-using occasions and lower odds of binge drinking, controlling for individual-level attitudes toward alcohol, alcohol availability, peer group use, and demographic characteristics; this cohort effect was stronger than the period effect. Second, we document significant variation in cohort-specific disapproval effects across race, ie, the effect of population-level disapproval on alcohol use is stronger among white adolescents than nonwhite adolescents. Overall, the findings document the importance of considering time-varying population-level risk factors in the study of adolescent alcohol use and indicate that even after accounting for an individual's personal attitudes, risk is shaped by cohort effects whereby the norms within the cohort contribute to the risk of adolescent alcohol use.

This work suggests that the broader social context in which youths are embedded determines, in part, the risk for problematic alcohol use during adolescence. These results not only underscore the importance of social context and social norms as potential determinants of alcohol use in adolescence but also illustrate that variation in the social context at the population level is a potential determinant of the population's alcohol use. Sociological and historical public health scholarship on the use of alcohol and other substances has extensively documented the ways in which public perception could shape the use of alcohol and other substances[42,57] both directly and indirectly through policies and laws. For example, historical evidence indicates that the rise of the temperance movement–motivated reductions increased social sanctions on alcohol use and that laws to restrict the production and sale of alcohol in the United States were enacted when per capita consumption was already decreasing.[57,58] These results provide empirical support for the hypothesis that these norms shape the alcohol-using experience of cohorts as they progress through the life course. In future studies, we will examine more specific hypotheses about the role of policies such as the change in legal drinking age as mediators of the relation between norms and alcohol use.[59,60]

A critical finding in this study was that cohort effects rather than period effects predict alcohol use and binge drinking. This suggests that population-level factors (eg, policies, laws, norms) affect individuals in specific age groups at a given point in time, influencing the trajectory of alcohol use across their life course.[59,60] We identified similar findings for marijuana use,[48] suggesting that the experience of cohorts across time provides greater understanding of substance use than the experience of populations across time alone.

We note, however, that while we are interested in the hypothesis that social norms shape the patterning of alcohol use, the patterning of alcohol use may also shape the social norms in the community. However, the temporal relation of norms to use is supported by our sensitivity analyses indicating that time-lagged social norms predict future alcohol use and binge drinking. By documenting that cohort-specific social norms are associated with alcohol use, future research can progress to test more specific hypotheses about the magnitude of the relation from norms to use and, conversely, from use to norms as well as about cohort-specific mechanisms of change. The strength of our approach compared with other age-period-cohort approaches is that by testing a specific mechanism for how cohort effects arise (rather than simply the observation of a cohort effect with no mechanism tested), we can proceed to test additional and alternative possible mechanisms such as the specific role of policies and laws.

While cohort-specific social norms may reduce drinking in part by affecting attitudes toward alcohol use, these results indicate that there is a direct effect of cohort-specific social norms independent of the influence of norms on attitudes. Pathways through which social norms affect alcohol use that are unmediated by their effect on personal attitudes have been theorized as contagion models.[61-64] However, individuals self-select into peer groups in ways that may be related to substance use, suggesting a more complicated etiologic pathway. Alternatively to contagion models, there is evidence that socially normative cues affect behavior without direct perception from individuals.[65] Further development of contagion models through complex systems and generative models[66-68] that allow nonindependent outcomes may be helpful as a future research area. We additionally note that these results do not negate the importance of individual-level disapproval for predicting alcohol use. In fact, the model-predicted change in the odds of binge drinking comparing an adolescent who personally disapproves of weekend binge drinking with one who does not is more than 40%; to achieve the same reduction in odds of binge drinking from a change in cohort-specific social norms, there would need to be at least a 17% increase in the proportion of disapproving adolescents. Given that the cohort-specific proportions ranged by almost 30 percentage points, a 17% change across time is reasonable. Thus, personal attitudes toward drinking remain an important determinant of individual risk, but these results suggest that population-level norms may have a substantial effect above and beyond the impact of those personal attitudes.

We also document that the effects of cohort-specific social norms on alcohol use vary according to sociodemographic characteristics, most notably that the effect of disapproval on alcohol use is stronger for white adolescents than for nonwhite adolescents. Our results on racial/ethnic differences in individual covariates are consistent with other studies documenting that, overall, black adolescents report higher disapproval of alcohol use and consume less alcohol compared with white adolescents.[1,69-73] Thus, the effects of disapproval may be less salient for black adolescents than white adolescents owing to the overall higher mean disapproval and overall lower mean use.[72]

Importantly, this study represents a potential model for future investigations of age-period-cohort effects. Rather than engaging in analyses that partition variance into components of age, period, and cohort, the study directly tests specific hypotheses about a mechanism that may give rise to such effects over time. Investigations aimed at teasing apart mechanisms through which age, period, and cohort effects arise are increasing in the literature[74,75] and represent an informative process to advance the literature on time trends.

While this work analyzed historical trends in social norms and alcohol use, these findings have clinical implications as well as population-level implications for intervention and prevention strategies. Clinician assumptions that patients acquire all their attitudes about drinking from a society with uniform, consistent norms may lead to overlooking external sources of variability in patients' attitudes toward and willingness to change. Taking such variability into account may help clinicians address readiness to change in a more informed and effective manner. At a population level, our results suggest that tracked social norms regarding alcohol use can serve as useful warning signs for pending increases in alcohol use and binge drinking in adolescence and thereafter, allowing for critical public health efforts and for resource allocation to clinicians for intervention and treatment. Adolescence is a critical age in which to intervene regarding alcohol use; given the evidence that early alcohol use portends health consequences later in life,[2-6] developing programs to identify populations in need of resources can reduce the population burden of alcohol-associated illness.

Limitations of the study are noted. From 1976 to 1990, only 12th-grade respondents were surveyed (ages ranging from 17-19 years). Thus, limited age and cohort variation during this period reduces the ability to separate period effects from cohort effects. Several sensitivity analyses were conducted to assess the impact of differential age availabilities across years. First, we stratified each multilevel regression by age to examine evidence for variation in the magnitude of the effects across age and found little evidence for systematic variation in the relation between disapproval and use by age. Second, we stratified each multilevel regression by year of observation, with 1 stratum indicating observation from 1976 through 1990 when only 12th-grade respondents were included and 1 stratum indicating observation from 1991 forward when 8th-, 10th-, and 12th-grade respondents were included. The direction and magnitude of the effect estimates were similar in these subsets, indicating little evidence for bias. Finally, because MTF is a school-based survey, high school dropouts are not included in any survey estimates. The conclusions from this study can be generalized only to high school–attending students, who represent the majority of adolescents in the United States.

These limitations are best viewed within the context of the considerable strengths of this study. By using large national samples of multicohort data with a consistent sampling frame and measurement, we were able to robustly document norm-specific cohort effects as well as to consider within-cohort variation according to sociodemographic characteristics. We suggest that our results can aid in theory and methodological advancement regarding the epidemiology and etiology of substance use. In the analyses, by extending multilevel models to consider age-period-cohort effects, we were able to get beyond previous limitations associated with age-period-cohort analyses.

This research adds to the accumulating body of evidence suggesting that social norms, conceptualized at multiple levels, are important determinants of adolescent alcohol use.[44,64,76,77] We document specificity in the effect of social norms defined across time, with the disapproval within an individual's birth cohort as a salient risk factor for alcohol use. Future studies incorporating a wide range of group-level norms, patterns of use, and individual-level attitudes would be helpful to extend the current research and determine the specific attitudes and behaviors that shape patterns of alcohol and cigarette use at the individual level. As theory continues to develop regarding the complex processes through which social

norms across time impact individual behavior, strong hypothesis testing regarding these mechanisms will continue to advance the research agenda focusing on the prevention of adolescent substance use.

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