The State Sets the Rate: The Relationship Among State-Specific College Binge Drinking, State Binge Drinking Rates, and Selected State Alcohol Control Policies

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Alcohol is a significant contributor to morbidity and mortality in the United States[1] and worldwide.[2] Excessive consumption of alcohol is associated with adverse health and social consequences for both individuals and communities and accounts for approximately 75 000 deaths and $184 billion in overall economic costs in the United States annually.[3–9] Binge drinking is a risky pattern of alcohol use that is generally defined as the consumption of 5 or more drinks in a row on a single occasion,[10] although some researchers use a standard of 4 or more drinks for women.[11–13] Binge drinking often results in acute impairment and is associated with a variety of problems including motor vehicle crashes, other unintentional injuries, assaults, domestic violence, rape, unintended pregnancy, vandalism, alcohol poisoning, and alcohol dependence.[3–6,14–18] The reduction of binge drinking among adults is a leading health goal in *Healthy People 2010*.[19]

Among adults, binge drinking rates vary considerably by state,[15] as do alcohol control policies.[20] Several studies have shown that state-specific laws and policies are important predictors of alcohol consumption and alcohol-related problems among adults and underage youth.[21–23] However, few studies of binge drinking by college students have examined drinking patterns in the state where the college is located as well as alcohol control policies in the state. Rather, most research on college drinking has focused on personal characteristics of students, such as their attitudes, expectations, and beliefs about drinking.[24] One reason for the lack of attention to contextual influences on college drinking patterns is that most studies of college drinking are conducted on single campuses. This design limitation restricts the ability of researchers to study the effects of alcohol control policies, because all students on any

Objectives. We assessed the relationship between college binge drinking, binge drinking in the general population, and selected alcohol control policies.

Methods. We analyzed binge drinking rates from 2 national surveys, the Harvard School of Public Health College Alcohol Study and the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System. Binge drinking data were linked to a summary measure of 7 salient alcohol control policies and a rating of resources devoted to law enforcement.

Results. State-level college and adult binge drinking rates were strongly correlated (Pearson correlation coefficient = 0.43; *P* < .01). Attending college in states with the lowest binge drinking rates (adjusted odds ratio [OR] = 0.63; 95% confidence interval [CI] = 0.41, 0.97) and presence of more stringent alcohol control policies (adjusted OR = 0.57; 95% CI = 0.33, 0.97) were independent predictors of student binge drinking, after adjusting for state law enforcement and individual-, college-, and state-level covariates.

Conclusions. State of residence is a predictor of binge drinking by college students. State-level alcohol control policies may help reduce binge drinking among college students and in the general population. (*Am J Public Health.* 2005;95: 441–446. doi: 10.2105/AJPH.2004.043810)

single campus are subject to an identical policy environment.[24,25]

The purpose of this study, then, was to determine the extent to which college binge drinking rates were related to binge drinking rates among the general population and to state alcohol control policies.

METHODS

Sample

The data for the present analyses were drawn from the Harvard School of Public Health College Alcohol Study (CAS) survey and the Centers for Disease Control and Prevention's (CDC) Behavioral Risk Factor Surveillance System (BRFSS). For each of the 2 surveys, data from the years 1999 and 2001 were combined to achieve a sufficient sample size for analysis within each state.

The CAS is a mail survey of randomly selected students at 120 accredited 4-year colleges and universities in 40 states in the United States. CAS participant schools were

not sampled to be representative of colleges by state. Instead, schools were selected to be nationally representative of all college students, and participant schools represent a cross-section of colleges that is similar in characteristics to the national distribution of all US colleges.[17,18] For the present analysis, we excluded 1 school located in the District of Columbia because comparable data were not available from the BRFSS for adults.

The CAS survey includes detailed questions on students' drinking behavior and problems, use of other substances, and other health behaviors (e.g., unsafe sex, physical activity). The survey also collects information on the students and their residential settings. The survey responses were anonymous and confidential, and on this basis, the study was given exempt review status by the Harvard School of Public Health's human subjects committee.

In the present study, CAS data were weighted by using a direct standardization procedure based on respondents' sex, age,

and race/ethnicity to reflect the true underlying distribution of a college's demographics. Details of the survey questionnaire, methodology, sample composition, and data weighting and rate standardization are described elsewhere.[16,17] Overall response rates for the CAS were 59% in 1999 and 52% in 2001. No significant differences were observed in the binge drinking rates between the survey years for the CAS (46.3% in 1999 and 45.4% in 2001; odds ratio [OR]=0.98; 95% confidence interval [CI]=0.96, 1.01).

The BRFSS is a series of state-based, cross-sectional telephone surveys of noninstitutionalized US adults aged 18 years or older. The survey is conducted by state health departments and coordinated by the CDC.[26,27] The BRFSS collects data about health behaviors and health-related conditions. The survey uses a multistage cluster design based on random-digit dialing to select a representative sample of respondents. A detailed description of survey methods is available elsewhere.[28,29] Because the BRFSS excludes people living in institutional settings, college students living in dormitories are undersampled. Subjects with missing data for alcohol consumption were excluded from the present analysis. Data were weighted according to the age, gender, and racial/ethnic distributions in each state. The BRFSS response rate was 55% in 1999 and 51% in 2001.

Measures

Binge drinking estimates from the CAS and the BRFSS. The CAS definition of binge drinking is the consumption of 5 or more drinks in a row for men, and 4 or more drinks in a row for women, at least once in the past 2 weeks. The CAS determines binge drinking status on the basis of student responses to 4 questions: (1) gender, (2) recency of last drink, (3) frequency of drinking 5 or more drinks during the past 2 weeks (for men), and (4) frequency of drinking 4 or more drinks during the past 2 weeks (for women).[12,13,30]

The BRFSS definition of binge drinking is the consumption by a man or woman of 5 or more drinks on at least 1 occasion in the previous 30 days. Binge drinking is assessed among respondents who reported having at least 1 drink in the past 30 days by asking: "Considering all types of alcoholic beverages,

how many times during the past 30 days did you have 5 or more drinks on an occasion?"

State-level binge drinking rates for each survey were calculated as the percentage of all respondents classified as binge drinkers on the basis of self-report. To conduct multivariate analyses examining the relationship between state- and college-level binge drinking among individual college students, we created an aggregate variable that classified college students in the CAS into 1 of 4 categories by quartile according to the prevalence of binge drinking in the state where their college was located.

Measurement of CAS covariates. To examine whether state binge drinking rates were predictive of binge drinking among college students, we controlled for a number of variables that are known risk factors for college binge drinking. High-school binge drinking (yes/no) was defined as usually having had 5 or more drinks for men, or 4 or more drinks for women, when drinking during high school. Other covariates included whether the respondent was of legal drinking age (yes/no), gender, year in school, race/ethnicity, and state where the student attended high school relative to the state where they were attending college (same state/different state). Social covariates included 2 measures of parental behavior regarding alcohol use (parental alcohol consumption, parental disapproval of alcohol consumption in high school) and 2 measures of perceived peer group influences (whether 70% or more of their friends binge drank, and whether 30% or fewer of their friends binge drank). We also examined participation in athletics (yes/no)[31] and membership in a Greek organization (yes/no).[32] Finally, we examined college characteristics known to be associated with student binge drinking, including setting (commuter or noncommuter), geographic location (Northeast, North Central, South, or West), setting (rural/small town or urban/suburban), college type (public or private), and a rating of admissions competitiveness.[33] Survey year and school response rate were included as controls in all analyses.

State-level alcohol control policies. We also linked state and local alcohol control laws and policies pertaining to promotion and sales of high volumes of alcohol to CAS data. We gathered information on state alcohol laws and policies from a report by the University

of Minnesota Alcohol Epidemiology Program,[34] a precursor to the current Alcohol Policy Information System available through the National Institute on Alcohol Abuse and Alcoholism.[35] We collected information on local laws and polices by contacting the local city hall clerk and included this information in the analysis in those localities where local laws were more stringent than and superceded state laws. The individual laws that were specifically examined included keg registration, "illegal per se" laws that make it unlawful to drive with a blood alcohol concentration of 0.08% or greater, and restrictions on happy hours, open containers, beer sold in pitchers, and billboards and other advertising. For the purposes of our analysis, states were then split into 2 categories: (1) those with 4 or more alcohol control laws and (2) those with fewer than 4 laws.[22]

We assessed the intensity of law enforcement activity around state alcohol control policies with a rating prepared by Mothers Against Drunk Driving (MADD).[20] MADD, a national advocacy group dedicated to reducing drunk driving, assigned letter grades for each state on a scale of A to F to reflect state investment in resources (e.g., equipment, personnel) for enforcement of alcohol control policies. We transformed these grades into a 4-level categorical variable (A, A-, B+; B, B-, C+; C, C-, D+; D, D-, F) for the analyses.

Statistical Analysis

Pearson correlation coefficients (r) between the 2 surveys were estimated for binge drinking rates by state. State rates were estimated from the BRFSS data for 2 groups: (1) adults of all ages and (2) respondents aged 18 to 24 years who were not students.

Logistic regression models were constructed to examine the influence of state-level binge drinking rates among adults on individual college students attending college in the same state. We conducted analyses using the generalized estimating equation approach[36,37] in a marginal logistic regression model setting[38] to provide robust standard errors of state- and college-level rates of binge drinking.

Student responses with missing data were excluded from the analysis, with the exception of those responses missing observations on the location where they attended high school. In

general, data on variables of interest for this analysis were missing in less than 1% of the cases for each variable. However, data on the state of high school attendance were missing for approximately 10% of respondents, so these data were included as a separate indicator in the modeling (i.e., same state [referent], different state [yes/no], missing data [yes/no]).

Using the first set of models, we examined the univariate relationship between individual binge drinking and policy environment to determine the best specification of the variables of interest. We then fitted models that controlled for known correlates of college binge drinking. In subsequent models, we added the state binge drinking rate from the BRFSS, and finally we added state alcohol policy data, including ratings of law enforcement activities. Model fit was assessed with the likelihood ratio test.[39] Analyses were conducted using SAS version 8.3 (SAS Institute Inc, Cary, NC) on the Unix platform.

RESULTS

The total unweighted sample size for the CAS for 1999 and 2001 combined was 22 453. State-specific college binge drinking rates were available for 40 states. The sample sizes in these states ranged from 71 (Idaho) to 1999 (California) respondents. The sample size for the 1999 and 2001 BRFSS surveys combined was 352 266. Among these were 31 042 young adults aged 18 to 24 years, of whom 7007 reported being a college student.

The CAS binge drinking rate for college students was 46.5% (SD=13.5; range= 0.3%–80.1%; n=40 states), the BRFSS rate among all adults was 14.8% (SD=3.8; range=7.3%–26.3%; N=50 states), and the BRFSS rate among 18- to 24-year-old nonstudents was 31.0% (SD=7.6; range= 15.1%–49.2%; n=50 states).

Correlation Between State and College Binge Drinking

We found significant correlations between the rates of binge drinking among college students from the CAS and the rates among adults of all ages in the same state from the BRFSS ($r=0.43$; $P<.01$; n=40) (Figure 1). There was also a strong correlation between binge drinking rates among college students from the CAS and rates among nonstudents aged 18 to 24 in the same state from the BRFSS ($r=0.45$; $P<.01$; n=40). Removing individual states that appeared to be outliers

from the analyses did not substantially alter the observed relationship.

State Binge Drinking Rate and College Student Binge Drinking

We explored whether state binge drinking rates and/or state alcohol control measures were independent predictors of binge drinking among college students. In univariate analysis we found significant associations between an individual's binge drinking status and the binge drinking rate among adults in the same state. This finding was consistent with those from the correlation analysis. We also found a significant association between college students' binge drinking status and whether they lived in a state with a comprehensive set of alcohol control policies, as well as the level of resources devoted to the enforcement of these policies as reported by MADD (Table 1).

The rate of binge drinking among college students was 36.1% in the 10 states with the lowest quartile of adult binge drinking and 52.7% in the 10 states with the highest quartile of adult binge drinking (adjusted OR= 0.63; 95% CI=0.41, 0.97). The binge drinking rate among college students was 33.1% in the 8 states with 4 or more laws that restrict promotion and sales of high volumes of alcohol, and 48.3% in those with fewer than 4 such laws (adjusted OR=0.57; 95% CI= 0.33, 0.97).

After controlling for known correlates of binge drinking, we still found that state adult binge drinking rates and state alcohol control policies were both independent predictors of binge drinking among college students in the same states (Table 1). Specifically, students whose college was located in states with a comprehensive set of state or community alcohol control policies had a lower odds of binge drinking. Although state law enforcement ratings were statistically significant when examined in univariate analysis, they were not associated with college student binge drinking when included with individual- and college-level covariates, or when included in the same model with the alcohol control policies.

We conducted a sensitivity analysis to examine whether these findings were driven by a single state. Removing all the individuals who resided in states that appeared to be
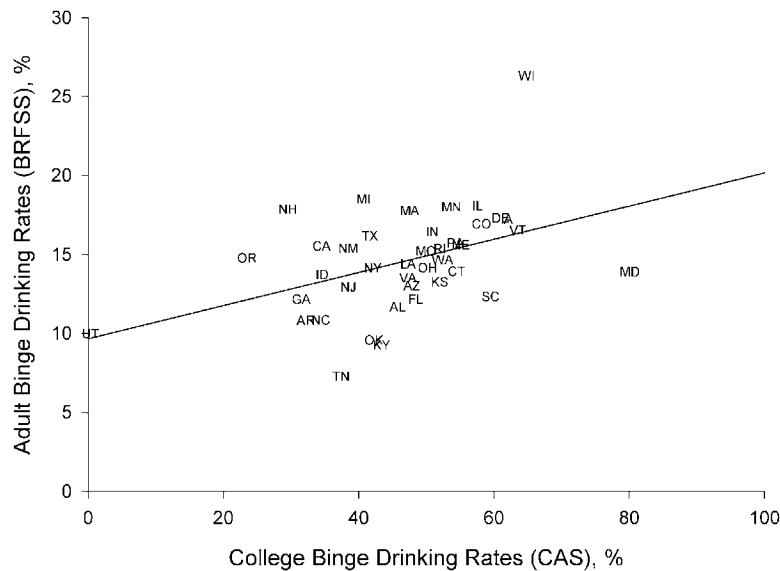

FIGURE 1—Correlation between binge drinking rates among college students and adults in the general population, by state ($r = 0.43$; n = 40 states).

TABLE 1—Relationship Between Binge Drinking by College Students and State Rates of Binge Drinking by Adults, State Alcohol-Control Policies, and Rated State Resources for Alcohol Control Enforcement

	% Binge Drinking	Model 1 Univariate OR (95% CI)	Model 2 AOR[a] (95% CI)	Model 3 AOR[a] (95% CI)	Model 4 AOR[a] (95% CI)	Model 5 AOR[a] (95% CI)	Model 6 AOR[a] (95% CI)
State binge drinking rate (rate; no. states, sample size)							
Lowest quartile (<12.7; 10; 3497)	36.1	0.65 (0.43, 0.98)	0.57 (0.37, 0.89)	. . .	. . .	0.61 (0.40, 0.95)	0.63 (0.41, 0.97)
2nd quartile (12.7–14.5; 10; 4564)	47.6	0.91 (0.63, 1.30)	1.05 (0.81, 1.36)	. . .	. . .	1.09 (0.84, 1.43)	1.15 (0.87, 1.53)
3rd quartile (14.5–16.5; 10; 7386)	44.4	0.74 (0.55, 1.00)	0.87 (0.69, 1.10)	. . .	. . .	0.89 (0.71, 1.12)	0.88 (0.70, 1.10)
Highest quartile (>16.5; 10; 5449)	52.7	1.00	1.00	. . .	. . .	1.00	1.00
State-level alcohol control policies[b] (no. states; sample size)							
4 or more alcohol control laws (7; 3369)	33.1	0.53 (0.37, 0.78)	. . .	0.68 (0.49, 0.96)	. . .	0.73 (0.54, 0.99)	0.57 (0.33, 0.97)
Less than 4 alcohol control laws (33; 17 527)	48.3	1.00	. . .	1.00	. . .	1.00	1.00
State law enforcement rating[c] (no. states; sample size)							
Grade A, A–, B+ (3; 2282)	34.2	0.55 (0.34, 0.87)	. . .	. . .	1.10 (0.71, 1.70)	. . .	1.69 (0.91, 3.12)
Grade B, B–, C+ (17; 7510)	44.7	0.93 (0.60, 1.45)	. . .	. . .	1.22 (0.90, 1.67)	. . .	1.10 (0.80, 1.51)
Grade C, C–, D+ (15; 9135)	49.4	0.92 (0.62, 1.38)	. . .	. . .	1.16 (0.85, 1.57)	. . .	1.12 (0.79, 1.58)
Grade D, D–, F (4; 1798)	45.7	1.00	. . .	. . .	1.00	. . .	1.00
–2 log likelihood			–11 393.6408	–11 432.2414	–11 445.2975	–11 386.1860	–11 375.9657

Note. OR = odds ratio; CI = confidence interval; AOR = adjusted odds ratio. A baseline model including response rate only had a –2 log likelihood of –14 181.8891. A baseline adjusted model[a] had a –2 log likelihood of –11 447.6085. Sample comprised 40 states and 20 896 respondents.
[a]Adjusted for gender, legal drinking age, race/ethnicity, year in college, binge drinking in high school, high school location, parents' alcohol use, parents attitudes about alcohol use, friends' binge drinking, membership in Greek organization, participation in athletics, college location and setting, commuter status, public versus private status, admissions competitiveness, survey year, and college survey response rate.
[b]University of Minnesota Alcohol Epidemiology Program[34] and Harvard School of Public Health College Alcohol Study (see Methods section for a description of state-level alcohol control policies).
[c]Mothers Against Drunk Driving.[20]

outliers by state did not substantially alter the observed relationships.

DISCUSSION

We found that state-specific binge drinking rates from the CAS for college students correlated strongly with state-specific binge drinking rates from the BRFSS, for the entire adult population as well as for 18- to 24-year-old nonstudents. Furthermore, in a multivariate analysis, we found that the binge drinking rate in the general population was an independent predictor of binge drinking among students who attended college in the same state. This relationship persisted after we adjusted for known risk factors for college binge drinking.

The presence of stronger state alcohol control policies in 8 states was protective against binge drinking among college students. This finding is consistent with previous studies that found a more comprehensive set of policies at the state level to be associated with less drinking[22] and driving after drinking.[23] However, even after we adjusted for alcohol control policies and ratings of law enforcement, the binge drinking rate in the state where a student's college was located was still a significant predictor of college binge drinking.

It is not surprising that college binge drinking is related to adult binge drinking and to alcohol control policies in the state in which the college is located. First, there is a growing body of scientific evidence demonstrating that the larger policy environment is an important determinant of drinking behaviors and alcohol-related problems for both college students and the general population.[40] For example, studies have found low-priced alcohol and a high density of alcohol outlets are associated with higher rates of both college and adult binge drinking.[41–45] Other studies have found that implementation of comprehensive drinking-and-driving countermeasures are inversely related to drinking after driving in both the general population[21] and among college students.[23,42]

Second, there are obvious theoretical reasons why college binge drinking rates would be related to adult rates and to the larger policy environment. Most alcohol purchase and consumption among college students occurs off-campus[46] and so would be affected by state laws and policies concerning the sale and consumption of alcohol. Furthermore, alcohol use among high-school students and underaged youth is strongly associated with the policy environment and the other social, cultural, and legal factors to which they are

exposed.[47,48] In turn, high-school binge drinking is an important predictor of college binge drinking.[49]

This study had several limitations. The CAS is a mail-in survey that focuses exclusively on college students, whereas the BRFSS is a telephone survey that includes all adults aged 18 or older and excludes those living in institutional settings (e.g., college students living in dormitories). However, any differences in binge drinking prevalence based on survey mode and sample population would tend to lessen the positive correlation that we noted between BRFSS and CAS binge drinking rates. The CAS and the BRFSS also did not use identical measures to assess binge drinking, differing in both the number of drinks for females (4 in the CAS and 5 in the BRFSS) and in the time period assessed (2 weeks for the CAS and 30 days for the BRFSS). However, these measurement differences would tend to bias the results toward a null (i.e., unassociated) relationship.

Surveys may underestimate alcohol consumption through a combination of survey noncoverage and respondent underreporting. Mailed questionnaires and telephone surveys are subject to self-report and nonresponse bias. However, survey methods to study alcohol consumption are widely used and are generally considered to be valid for examining substance use when the responses provided are perceived to be confidential.[50–52] It is not possible to eliminate nonresponse bias, but we employed weighting procedures to minimize its impact.[16,17]

The comparison of state-specific rates of binge drinking among college students with state-specific rates among adults and young adults is an ecologic analysis; the correlation between these 2 rates could therefore be due to other factors. Furthermore, it is possible that the relationship between state binge drinking rates as a predictor of binge drinking among college students was influenced by other factors that were not assessed in this study.

Because the larger environment is known to be such an important predictor of college binge drinking, we recommend the adoption of effective population-based and clinical interventions to prevent binge drinking. Strategies that have proven to be effective include increasing state and local alcohol taxes, en-

forcing minimum legal drinking age laws, limiting liquor outlet density, mandating keg registration, and implementing server training programs aimed at reducing sales to already-intoxicated individuals.[5,40–42,53–61] In addition, the US Preventive Services Task Force recommends screening and brief counseling for excessive drinking among adults; brief physician advice has been shown to reduce the number of binge drinking episodes by more than 40%.[62] Finally, recent evidence demonstrates that alcohol marketing reaches audiences that are disproportionately underaged, and the Federal Trade Commission has recommended restricting alcohol advertising in settings where more than 25% of the audience is below the legal drinking age.[63,64] This combination of environmental and clinical interventions is likely to have the greatest impact on preventing binge drinking and its many consequences, not only among college students but among the general public as well.[65] ∎

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Contributors

T. F. Nelson led the writing and completed the analyses. T.S. Naimi assisted with the writing and analyses. R. D. Brewer and H. Wechsler helped originate the study and supervised its implementation. All of the authors contributed to the conceptualization and design of the study, interpreted findings, and edited drafts.

Human Participant Protection

No protocol approval was required for this study.

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