

Alcohol Environments and Disparities in Exposure Associated With Adolescent Drinking in California

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Despite federal, state, and local interventions, underage drinking continues to be a serious problem. A national survey found that 17.6% of adolescents drank alcohol in the past 30 days, 11.1% were binge drinkers, and 2.7% were heavy drinkers.¹ Health and social problems associated with youths' drinking include motor vehicle crashes,^{2,3} violence,⁴ risky sexual behaviors,^{5,6} assault and rapes,⁷ and brain impairment.^{8–11} Adolescent alcohol use has substantial societal costs.¹² Drinking at an early age also increases the risk of addiction and other alcohol-related problems in adulthood.^{13–15} In 2007, the surgeon general responded to this problem in the *Call to Action to Prevent and Reduce Underage Drinking*, which emphasized environmental contributions to the problem.¹⁶

Underage drinkers obtain their alcoholic beverages from a variety of sources, including parents' stocks, friends, parties, and commercial outlets.¹⁷ In 1 study, buyers who looked underage were able to purchase alcohol with high success rates from both on-site (for consumption on the premises, such as bars and restaurants) and off-site (for consumption elsewhere, such as liquor stores) establishments.^{18,19} Sales to minors have been found to be significantly associated with the percentage of Hispanic residents in a neighborhood and with population density.²⁰

As long as adolescents can obtain alcohol from commercial sources, neighborhood outlets are likely to play a role in underage drinking. Rhee et al. argued that environment plays an essential role in drinking initiation and that genetics are important in developing alcohol dependence.²¹ Perceived alcohol availability was significantly associated with higher levels of alcohol consumption among young men²² and with drinking in public locations for adolescent girls.²³ Density of outlets for alcohol in cities was associated with youths' drinking and driving and with riding in a car driven by a person under the influence of alcohol.²⁴

Differences in alcohol environments may exacerbate health disparities across sociodemographic groups. LaVeist and Wallace found

Objectives. We investigated sociodemographic disparities in alcohol environments and their relationship with adolescent drinking.

Methods. We geocoded and mapped alcohol license data with ArcMap to construct circular buffers centered at 14595 households with children that participated in the California Health Interview Survey. We calculated commercial sources of alcohol in each buffer. Multivariate logistic regression differentiated the effects of alcohol sales on adolescents' drinking from their individual, family, and neighborhood characteristics.

Results. Alcohol availability, measured by mean and median number of licenses, was significantly higher around residences of minority and lower-income families. Binge drinking and driving after drinking among adolescents aged 12 to 17 years were significantly associated with the presence of alcohol retailers within 0.5 miles of home. Simulation of changes in the alcohol environment showed that if alcohol sales were reduced from the mean number of alcohol outlets around the lowest-income quartile of households to that of the highest quartile, prevalence of binge drinking would fall from 6.4% to 5.6% and driving after drinking from 7.9% to 5.9%.

Conclusions. Alcohol outlets are concentrated in disadvantaged neighborhoods and can contribute to adolescent drinking. To reduce underage drinking, environmental interventions need to curb opportunities for youth to obtain alcohol from commercial sources by tightening licensure, enforcing minimum-age drinking laws, or other measures. (*Am J Public Health*. 2009;99:264–270. doi: 10.2105/AJPH.2007.122077)

that in Baltimore, MD, predominantly Black and low-income census tracts have more liquor stores per capita than do tracts of other race and income groups.²⁵ Gorman and Speer found retail liquor outlets abundantly located in poor and minority neighborhoods in a city in New Jersey.²⁶ Only 1 national study has been published, and it reported higher densities of liquor stores in zip codes with higher percentages of Blacks and lower-income non-Whites.²⁷ That study covered all urban areas in the United States, but the urban zip codes had a mean land area of 40.1 square miles and a mean population of 21 920 persons,²⁷ arguably too large to represent neighborhoods. Even census tracts may be too large and too dissimilar to capture neighborhood effects: in Los Angeles County they can range from 0.04 square miles to 322 square miles.

The objectives of this study were (1) to describe the quantity and geographic pattern of alcohol retailers in small areas around individual homes and (2) to examine relationships between alcohol environments and

adolescent drinking. We analyzed data from the entire state of California to investigate the effects of spatial accessibility on alcohol sales to adolescents.

METHODS

Data

Data on alcohol outlets came from the California Department of Alcoholic Beverage Control database and included addresses and license types of all alcohol retailers in the state.²⁸ We classified alcohol outlets by license type: off-site or on-site. In 2003, California had 30 650 active on-site licenses and 21 836 active off-site licenses.²⁸

Participant data were obtained from the California Health Interview Survey, a computer-assisted telephone interview with a 2-stage, geographically stratified, random-digit-dialing design that attempts to interview 1 adult and 1 adolescent per household and to get information on 1 child in households with

children. The survey is representative of the state's noninstitutionalized population living in households. Details are available elsewhere.²⁹

The California Health Interview Survey 2003 included survey data for 42 044 adults, 4010 adolescents, and 8526 children, who were linked by family identifiers. We excluded 3679 households in rural areas because their environments were not comparable. For our analysis of alcohol environments, we focused on 14 595 households with children younger than 18 years (not all households with children participated in the child and adolescent surveys). For our analysis of adolescent drinking, we used data on 3660 adolescents aged 12 to 17 years. We used a subsample of 687 adolescents aged 16 to 17 years who had ever had a few sips of alcoholic drinks for our analysis of adolescent driving after drinking.

Measures of Alcohol Environments

We defined alcohol environments by distance from homes. We used ArcMap version 9.1 (ESRI, Redlands, CA) to draw circles with radii of 0.1 miles, 0.5 miles, 1.0 mile, and 2.0 miles centered at respondents' residences. We first looked at immediate distances with 0.1-mile-radius circles and at circular bands between 0.1-mile and 0.5-mile radii. We considered that outlets in these areas might be the most problematic because of their proximity to adolescents' residences. A distance of 0.5 miles is approximately a 10-minute walk³⁰ and thus within the reach of adolescents. Outlets beyond easy walking distance were examined in circular bands between 0.5- and 1.0-mile radii and between 1.0- and 2.0-mile radii (all 4 constructed buffers were mutually exclusive). We mapped the business locations in the Department of Alcoholic Beverage Control database to the buffers around each household and calculated the number of alcohol retailers within each buffer.

Previous research focused on density measures, such as the number of establishments per city, per resident, or per roadway mile.^{27,31–33} We used the raw count in each buffer rather than outlet-density measures in a predefined geographic area (such as census tracts) because individuals may live close to alcohol outlets in what is defined as a low-density area if that area includes large sections that are lightly populated, such as deserts or mountains. Similarly, in

densely populated urban areas, population measures may yield low densities of alcohol outlets per resident even when most households are within walking distance of these outlets.

Statistical Analyses

We compared the mean and median number of alcohol outlets (for all licenses and for on-site and off-site establishments separately) across racial/ethnic groups (non-Hispanic White, non-Hispanic Black, Hispanic, Asian/Pacific Islander, and other) and income groups (incomes quartiles derived from self-reported total household annual income before tax). We then stratified by both race/ethnicity and income. We also performed a zero-inflated Poisson regression with number of outlets as the dependent variable and race/ethnicity and income as the key explanatory variables, controlling for population density in the census tracts. We estimated this model separately for each definition of the dependent variable (all licenses, on-site, and off-site) within each buffer. The data included all households with children younger than 18 years.

We analyzed 3 dichotomous dependent variables for adolescent drinking with logistic regression: at least 1 alcoholic drink in the past 30 days, at least 1 heavy drinking episode (5 drinks in a row, also referred to as binge drinking) in the past 30 days, and ever driving after drinking. The primary explanatory variables were the number of alcohol outlets within the 0.5-mile radii, 0.5- to 1.0-mile bands, and 1.0- to 2.0-mile bands. For each dependent variable, we estimated 2 models that differed in the key explanatory variables. For the first model, total number of licenses was the key explanatory variable. For the second model, off-site and on-site establishments were the key explanatory variables. We used the latter model to determine what type of outlets had predictive power for adolescent drinking, because the underlying processes in illegally obtaining alcoholic beverages may differ.

Additional explanatory variables included in all models were adolescents' characteristics (gender, age, race, paid employment in the past 12 months, current smoking, and marijuana use in the past 30 days), family characteristics (household income and parents' marital status), parents' drinking behavior (self-reporting by parent or guardian of any heavy drinking

episode, defined as 5 drinks in a row in the past 30 days, and excess drinking, defined as consuming more than 60 drinks per month), and neighborhood sociodemographic characteristics (census tract total population, tract median household income, and percentage of Whites and Blacks in the population, according to data extracted from the 2000 US Census).

In all regression models we used robust standard errors to account for clustering data caused by the survey's multistage sample design. First, the state was divided into 44 geographic sampling strata, including 41 single-county strata and 3 multicounty strata comprising the 17 remaining counties in California. Second, within each geographic stratum, residential telephone numbers were selected through random-digit-dialed sampling. The regression was also weighted to control for differential sampling rates within geographic stratum and racial/ethnic groups.

To improve the interpretation of logistic regression coefficients, we changed levels of alcohol availability in adolescents' neighborhoods and predicted the resulting prevalence of adolescent drinking in the estimated model. We changed only the key explanatory variable, retaining all other variables. This provided the adjusted difference in the prevalence of a drinking measure between 2 levels of alcohol availability, that is, it accounted for all individual, family, and neighborhood sociodemographic characteristics in the model except the alcohol environments. For the differences in alcohol environments, we compared the average number of outlets around Asian/Pacific Islander and White households and around low- and high-income households.

RESULTS

Disparities in Alcohol Environments

Table 1 provides descriptive statistics of the sample, divided into 4 quartiles of gross annual household income: less than \$24 000, \$24 000 to \$49 000, \$50 000 to \$90 000, and more than \$90 000. Fewer than 11% of non-Hispanic Whites belonged to the bottom income quartile, compared with 32.0% of non-Hispanic Blacks, 50.4% of Hispanics, 20.8% of Asian/Pacific Islanders, and 32.9% of other groups. By contrast, 36.0% of non-Hispanic

TABLE 1—Descriptive Statistics of Sample Population: California, 2003

	Percentage of Total Sample	Mean % (SD)
Adults		
Non-Hispanic Whites	47.6	
Lowest income quartile		10.8 (0.31)
Second income quartile		22.5 (0.42)
Third income quartile		30.7 (0.46)
Highest income quartile		36.0 (0.48)
Non-Hispanic Blacks	7.1	
Lowest income quartile		32.0 (0.47)
Second income quartile		27.7 (0.45)
Third income quartile		25.2 (0.43)
Highest income quartile		15.1 (0.36)
Hispanics	30.1	
Lowest income quartile		50.4 (0.50)
Second income quartile		33.0 (0.47)
Third income quartile		11.9 (0.32)
Highest income quartile		04.7 (0.21)
Asian/Pacific Islanders	11.4	
Lowest income quartile		20.8 (0.41)
Second income quartile		25.0 (0.43)
Third income quartile		25.1 (0.43)
Highest income quartile		29.1 (0.45)
Other racial/ethnic groups	3.8	
Lowest income quartile		32.9 (0.47)
Second quartile		31.6 (0.47)
Third quartile		22.4 (0.42)
Highest income quartile		13.2 (0.34)
Adolescents (n = 3660)		
Ever had alcoholic drinks		35.1 (0.48)
At least 1 drink in past 30 d		15.0 (0.36)
Any binge drinking in past 30 d		05.6 (0.23)
Ever driven after drinking ^a		06.0 (0.24)
Current smoker		05.0 (0.22)
Used marijuana in past 30 d ^b		05.0 (0.22)
Girl		48.9 (0.50)
Age, y		14.36 ^c (1.67)
Paid employment in past 12 mo		40.5 (0.49)
Parents married or living with a partner		82.2 (0.38)
Parent's excess drinking		02.1 (0.13)
Parent's binge drinking in past mo		13.1 (0.34)

Note. All statistics were weighted. Adults included in the sample were only from households with children younger than 18 years (N = 14 595). Race/ethnicity was that of the adult interviewed. Lowest income quartile was \$24 000 or less; second quartile was \$24 000 to \$49 000; third quartile was \$50 000 to \$90 000; and the highest quartile was more than \$90 000.

^aAmong respondents 16 years or older who ever had more than a few sips of alcoholic drinks.

^bAmong respondents with parent or guardian's permission to be asked questions about illicit drug use (98.7%).

^cMean age.

Whites, 15.1% of non-Hispanic Blacks, 4.7% of Hispanic, 29.1% of Asian/Pacific Islanders, and 13.2% of other groups were in the top income quartile.

Average age in the adolescent sample was 14.3 years, reflecting the period of drinking initiation. However, the survey did not ask for age at first alcoholic drink. Approximately 35%

of adolescent respondents reported ever having more than just a few sips of alcoholic drinks. Fifteen percent reported having at least 1 drink, and 5.6% reported at least 1 heavy drinking episode in the past 30 days. Five percent reported they were current smokers (i.e., had had ≥ 1 cigarette per day in the past 30 days), and 5.0% reported marijuana use in the past 30 days. Of those aged 16 or 17 years who ever consumed alcohol, 6.0% reported ever driving after drinking.

Table 2 shows the mean number of alcohol outlets within different buffers, stratified by income and race/ethnicity. Compared with non-Hispanic Whites, people of other groups were surrounded by more alcohol outlets, regardless of the size of the buffers. For instance, within 0.1 mile, we found an average 0.21 outlets around residences of Whites; Blacks had 0.24, Hispanics 0.39, and Asian/Pacific Islanders 0.33 ($P < .001$). Participants who were in lower-income quartiles were surrounded by more alcohol outlets. We found this geographic pattern even within each racial/ethnic group. We observed the same distribution pattern across income groups within each racial/ethnic group. Our results were consistent in the sensitivity analyses: comparison of the median number of outlets, separation of off-site from on-site outlets, and zero-inflated Poisson regression model with income and race/ethnicity as key predictors of alcohol outlets.

Alcohol Sales and Adolescent Drinking

The results from 6 logistic regression models (3 dependent variables \times 2 model specifications) are reported in Table 3. In model 1, the total number of alcohol outlets within 0.5 miles from homes was significantly associated with adolescent binge drinking ($P < .001$) and driving after drinking ($P < .001$), after taking into account adolescents' individual and family characteristics, parent or guardian's drinking behavior, and neighborhood sociodemographic characteristics. Alcohol outlets located farther away than 0.5 miles of homes appeared to have no relationship with any measure of adolescent drinking.

For model 2 we separated off-site and on-site establishments. Both types of outlet, when located within 0.5 miles of residences, were independently and significantly associated with binge drinking, and the magnitude of their effects was approximately the same. On-site retailers

TABLE 2—Mean Number of All Alcohol Outlets Around Residences, by Race/Ethnicity and Income: California, 2003

	0.1-Mile Radii, Mean	0.1- to 0.5-Mile Bands, Mean ^a	0.5- to 1.0-Mile Bands, Mean ^b	1.0- to 2.0-Mile Bands, Mean ^c
All income groups				
All racial/ethnic groups	0.30	6.97	19.20	61.55
Non-Hispanic Whites (Ref)	0.21	5.27	15.23	49.78
Non-Hispanic Blacks	0.24**	6.22**	17.50**	63.63**
Hispanics	0.39**	8.10**	21.79**	68.38**
Asian/Pacific Islanders	0.33**	9.18**	24.04**	74.53**
Other racial/ethnic groups	0.36**	6.22**	19.15***	62.44***
All racial/ethnic groups				
Lowest income quartile (Ref)	0.44	9.09	23.70	74.55
Second income quartile	0.34**	7.03**	19.37**	59.81**
Third income quartile	0.20**	5.66**	16.16**	52.52**
Highest income quartile	0.16**	5.21**	15.67**	54.54**
Non-Hispanic Whites				
Lowest income quartile (Ref)	0.29	6.24	16.87	49.66
Second income quartile	0.28	5.78*	15.34	48.09
Third income quartile	0.15**	4.67**	14.14***	45.47
Highest income quartile	0.18***	5.19***	15.60	44.54*
Non-Hispanic Blacks				
Lowest income quartile (Ref)	0.30	8.41	21.46	78.42
Second income quartile	0.24*	5.43**	16.84	60.48*
Third income quartile	0.24*	5.46**	16.17*	57.63***
Highest income quartile	0.10***	4.29**	12.58***	48.16**
Hispanics				
Lowest income quartile (Ref)	0.47	9.38	24.72	76.79
Second income quartile	0.35**	7.28**	19.88**	62.48**
Third income quartile	0.23**	6.00**	16.93**	54.90**
Highest income quartile	0.15**	5.43**	16.00**	53.93**
Asian/Pacific Islanders				
Lowest income quartile (Ref)	0.53	12.02	29.54	96.67
Second income quartile	0.49	11.01*	29.83	78.97***
Third income quartile	0.21***	9.01***	22.10***	70.54**
Highest income quartile	0.14**	5.72**	16.80**	58.31**
Other racial/ethnic groups				
Lowest income quartile (Ref)	0.44	8.83	21.20	68.27
Second income quartile	0.34	5.24***	19.69	65.23
Third income quartile	0.45	5.80***	18.44	62.48
Highest income quartile	0.06***	2.79**	13.98***	41.21*

Note. Sample included 14 595 households with children aged 0 to 17 years. Lowest income quartile was \$24 000 or less; second quartile was \$24 000 to \$49 000; third quartile was \$50 000 to \$90 000; and the highest quartile was more than \$90 000.
^aArea between the 0.1-mile radius and the 0.5-mile radius.
^bArea between the 0.5-mile radius and the 1.0-mile radius.
^cArea between the 1.0-mile radius and the 2.0-mile radius.
 P*<.05; *P*<.01; ****P*<.001.

located within 0.5 miles were significantly associated with driving after drinking.

With a binge drinking rate of 5.6% among adolescents, an odds ratio of 1.03 (all licensed

outlets, 0.5-mile radii, 5 drinks in past 30 days) corresponds to an increase of 0.1 percentage point for a single additional alcohol outlet within 0.5 miles. The difference in the mean

number of all alcohol outlets located within the 0.5-mile radii between the bottom and top income quartile was approximately 4 (Table 2).

We used model 1 to simulate changes in the prevalence of adolescent drinking if changes were made in the alcohol environment within the 0.5-mile radii. If everyone lived in neighborhoods that had the number of alcohol outlets found in the neighborhoods of typical Asian/Pacific Islander households, the prevalence of adolescent binge drinking and driving after drinking would be 6.4% and 7.9%, respectively (Table 4). If the average number of outlets in the neighborhoods of White households were the same for all households with adolescents, the corresponding statistics would drop to 5.6% and 6.0%, respectively. Table 4 also shows the simulation results of changing alcohol environments by income quartiles and the groups exposed most and least to alcohol sales.

Age, current smoking, and marijuana use were positively and significantly associated with adolescent drinking. Adolescent girls were least likely to binge drink. Asian/Pacific Islander and Black adolescents were least likely to drink at all. Family income did not predict the first 2 measures of drinking but was significantly associated with driving after drinking. Parents' marital status and drinking behavior did not predict youths' drinking except that living with married parents was a protective factor against having at least 1 drink. Hispanic adolescents were much more likely to drive after drinking even after accounting for other factors than were other adolescents. Percentage of Blacks in neighborhoods was significantly associated with youths' driving after drinking.

DISCUSSION

We found that alcohol outlets within walking distance from homes were associated with 2 adverse alcohol behaviors among adolescents: increased binge drinking and driving after drinking. The potential effects of differences in alcohol environments could be substantial. Our estimated model indicated that changing the number of outlets within 0.5 miles from 9.5 (the environment of Asian/Pacific Islander adolescents) to 5.5 (the environment of White adolescents) for all adolescents would reduce binge drinking from 6.4% to 5.6% and driving after drinking from 7.9% to 6.0%.

TABLE 3—Effects of Alcohol Outlets on Adolescent Drinking: California, 2003

Explanatory Variable	1 Drink in Past 30 Days, ^a OR (95% CI)	5 Drinks in Past 30 Days, ^a OR (95% CI)	Ever Driven after Drinking, ^b OR (95% CI)
Model 1			
All licensed outlets, 0.5-mile radii	1.01 (0.90, 1.03)	1.03** (1.01, 1.05)	1.11** (1.05, 1.17)
All licensed outlets, 0.5- to 1.0-mile bands	0.99 (0.98, 1.01)	0.98 (0.97, 1.01)	0.96 (0.90, 1.01)
All licensed outlets, 1.0- to 2.0-mile bands	1.00 (1.00, 1.00)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)
Model 2			
Off-site outlets			
0.5-mile radii	1.00 (0.94, 1.07)	1.03* (1.01, 1.07)	1.06 (0.87, 1.30)
0.5- to 1.0-mile bands	0.98 (0.94, 1.02)	0.99 (0.97, 1.01)	0.90 (0.75, 1.07)
1.0- to 2.0-mile bands	1.00 (0.98, 1.01)	1.00 (0.98, 1.01)	1.05 (0.99, 1.12)
On-site outlets			
0.5-mile radii	1.01 (0.99, 1.03)	1.03* (1.01, 1.07)	1.14** (1.05, 1.23)
0.5- to 1.0-mile bands	1.00 (0.98, 1.02)	0.99 (0.97, 1.01)	0.99 (0.88, 1.11)
1.0- to 2.0-mile bands	1.00 (1.00, 1.01)	1.00 (1.00, 1.03)	0.97 (0.93, 1.01)
Girl	0.95 (0.73, 1.25)	0.65* (0.42, 1.00)	0.57 (0.23, 1.44)
Age, y	1.60** (1.46, 1.76)	1.79** (1.58, 2.03)	2.05 (0.77, 5.48)
Race/ethnicity			
Non-Hispanic Whites (Ref)	1.00	1.00	1.00
Hispanics	1.15 (0.78, 1.67)	1.17 (0.57, 2.39)	4.31*** (1.44, 12.93)
Asian/Pacific Islanders	0.56* (0.31, 1.01)	0.59 (0.24, 1.40)	1.05 (0.08, 13.91)
Non-Hispanic Blacks	0.42* (0.19, 0.90)	0.56 (0.14, 2.20)	1.21 (0.16, 9.16)
Other	0.82 (0.41, 1.63)	1.07 (0.34, 3.34)	2.07 (0.36, 11.97)
Paid employment in past 12 mo	1.14 (0.85, 1.52)	1.18 (0.74, 1.87)	1.00 (0.38, 2.66)
Current smoker	2.63** (1.48, 4.68)	4.30** (2.15, 8.60)	7.93** (2.93, 21.45)
Marijuana use in past 30 d	15.66** (9.03, 27.15)	17.91*8 (9.59, 33.44)	5.42** (2.44, 12.04)
Income quartile			
Lowest income quartile (Ref)	1.00	1.00	1.00
Second income quartile	1.39 (0.91, 2.13)	0.86 (0.44, 1.68)	6.89*** (1.71, 27.75)
Third income quartile	1.17 (0.72, 1.90)	0.78 (0.38, 1.60)	4.69* (1.19, 18.55)
Highest income quartile	1.46 (0.85, 2.48)	1.17 (0.56, 2.43)	11.20*** (2.12, 59.16)
Parents married or living with a partner	0.59*** (0.42, 0.85)	0.65 (0.36, 1.16)	0.47 (0.17, 1.32)
Parent's excess drinking	0.28 (0.08, 1.00)	0.14 (0.01, 1.38)	0.30 (0.11, 2.22)
Parent's binge drinking	1.51 (0.98, 2.33)	1.64 (0.92, 2.91)	1.55 (0.65, 3.69)
Census tract population	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)
Tract median household income	0.94 (0.62, 1.43)	1.02 (0.50, 2.08)	0.83 (0.23, 2.99)
Tract White population, %	0.61 (0.28, 1.29)	0.99 (0.25, 3.96)	3.32 (0.46, 24.12)
Tract Black population, %	0.42 (0.07, 2.35)	0.98 (0.04, 23.29)	9.09* (2.46, 34.23)

Note. OR=odds ratio; CI=confidence interval. All statistics were weighted. Lowest income quartile was \$24 000 or less; second quartile was \$24 000 to \$49 000; third quartile was \$50 000 to \$90 000; and the highest quartile was more than \$90 000. Model 1 included the same other explanatory variables as model 2, but these estimates were not reported because of space limitations. Specifications for models 1 and 2 and definitions of the included variables are explained in the "Statistical Analysis Section."

^aAmong adolescents aged 12 to 17 years (n=3660).

^bAmong adolescents aged 16 to 17 years (n=687).

*P<.05; **P<.01; ***P<.001.

On-site and off-site alcohol outlets contributed to adolescent binge drinking with the same magnitude of effects. For driving after drinking, the effect of on-site establishments was larger and statistically significant. However, each of the point estimates for on-site and

off-site outlets was contained in the confidence interval of the other, indicating that there were no major differences between them. Another study showed that the likelihood that on-site establishments sold alcohol to underage youths was not much lower than that for off-site

establishments.¹⁹ We therefore concluded that any alcohol outlets within a half mile of residences had an effect and that we did not have the statistical precision to distinguish between the effects of on-site and off-site outlets on driving after drinking.

TABLE 4—Simulated Prevalence of Adolescent Drinking by Alcohol Availability

Mean No. of Alcohol Outlets Within 0.5 Mile of Residences ^a	Binge Drinking, %	Ever Driven After Drinking, %
Asian/Pacific Islander level (mean = 9.51)	6.4	7.9
Non-Hispanic White level (mean = 5.48)	5.6	6.0
Lowest income level (mean = 9.53)	6.4	7.9
Highest income level (mean = 5.37)	5.6	5.9
Asian/Pacific Islander lowest income level (mean = 12.55)	6.7	9.8
Non-Hispanic White highest income level (mean = 5.37)	5.6	5.9

Note. Regression model 1, with total number of alcohol outlets as key explanatory variables, was used. All statistics were weighted.

^aIn the simulation, only alcohol outlets in the 0.5-mile radii changed. Alcohol environments in the outer bands were kept constant.

Our findings also confirm sociodemographic disparities in alcohol environments.^{25–27} Alcohol availability, measured by mean and median number of licenses, was significantly higher around residences of minority and lower-income families. Some of the descriptive associations are attributable to the tendency of minority and lower-income people to live in more-densely populated areas. But even after control for population density in the census tracts, race and income of individual respondents remained highly significant predictors of number of outlets around their homes. Zoning is likely to play an important role not captured by density measures, and more desirable (and expensive) residences are usually at a distance from high-traffic commercial areas. Interestingly, however, the demographic effect was not limited to residential neighborhoods: around secondary schools nationwide, the percentage of minority students, especially Asian American students, positively predicted the number of liquor stores within 400 meters (0.25 miles) of their schools.³⁴

From an ecological standpoint, higher levels of alcohol outlets and advertising within minority and poorer communities stand in stark contrast to lower rates of alcohol use among minorities. Among non-Hispanic White adults, 65.3% report currently drinking, compared with 46.6% of Blacks and 51.2% of Hispanics.³⁵ Among young people aged 12 to 20 years, prevalence of drinking in the past 30 days was 34.3% among non-Hispanic Whites, 20.2% among non-Hispanic Blacks, and 26.6% among Hispanics.³⁶ Culture seems to be an important factor in suppressing drinking prevalence among minorities, even with their higher exposure to alcohol sales. Nevertheless, the geographic

mismatch between supply and demand may cause minority and low-income residents to suffer disproportionately from some alcohol-related problems not from their own consumption but from that of others. Living near alcohol outlets may expose them to risks such as violent crimes,^{33,37} motor vehicle crashes³¹ and assaults,³⁸ and misdemeanor and felony drunken driving.^{39,40}

We found no association between family income and any drinking or binge drinking, but higher-income youths were more likely to drive after drinking, probably because of greater access to motor vehicles. Given the significant findings of binge drinking and driving after drinking, the lack of association between proximity of outlets and at least 1 drink in the past 30 days was surprising. One possible explanation is that the source of alcohol for this level of consumption is parents' stock or what is served at the dinner table. Binge drinking, which often takes place at parties or in a group of friends, requires larger quantities of alcohol. Youths who binge drink are also more likely to engage in other problem behaviors, including illegal alcohol purchases. Hispanic youths were more likely to drive after drinking, a finding that is supported by national statistics⁴¹ and a study that showed a positive relationship between alcohol sales to minors and percentage of Hispanic residents.²⁰

Limitations

Our study had important limitations. Observational studies of neighborhood effects are subject to a self-selection bias. Drinkers with certain unobserved or unobservable characteristics can choose to live near alcohol outlets (and outlets may open in areas of higher

demand), thus making the presence of outlets appear to have a greater effect. Controlling for parents' drinking behavior and focusing on adolescents, who have little or no influence over where they live, should ameliorate such possible biases at least partially.

In a sensitivity analysis, we computed alcohol outlet statistics for the sample of households without children and found that the average number of alcohol outlets was higher for all sociodemographic groups, suggesting that households with children sort themselves into neighborhoods with less alcohol availability. Many other factors might explain the association between sociodemographics and outlet density, varying from zoning regulations to economic factors that affect location decisionmaking by the alcohol retail industry, but they would not affect the association between youths' drinking and alcohol outlets that we observed. Our sample was not large enough to detect interactions between sociodemographic groups and alcohol sales, especially because factors associated with adolescent drinking tend to offset one another. For example, higher-income families are more likely to have children who drive, and thus these youths are more likely to be engaged in driving after drinking, even though they are the least exposed to alcohol sales.

Conclusions

Many long-term health behaviors are shaped during adolescence. Problems that require treatment often do not manifest themselves until much later in life, so primary prevention is crucial for young people. The highest prevalence of alcohol dependence in the United States is among young adults aged 18 to 29 years⁴²; typically they began drinking during their early adolescent years.⁴³

Our results suggest that living close to alcohol outlets is a risk factor for youths. In California, retail licenses are not typically approved within 100 feet of a residence or within 600 feet of schools, public playgrounds, and nonprofit youth facilities, but proximity by itself is not sufficient to deny a license.²⁸ Our findings suggest that the proximity rule needs to be tightened and more stringently enforced and that environmental interventions are needed to curtail young people's access to commercial sources of alcohol, through tightening licensure or enforcing minimum-age drinking laws. ■

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This article was accepted May 1, 2008.

Contributors

K.D. Truong originated the study, conducted the analysis, and wrote the article. R. Sturm advised on the analysis, contributed to the writing and interpretation of the data, and supervised the research process.

Acknowledgments

This research was funded by the Robert Wood Johnson Foundation's Substance Abuse Policy Research Program (grant 63262) and the National Institute on Alcohol Abuse and Alcoholism (grant AA017265). Funding for data access was provided by the National Institute of Environmental Health Sciences (grant P50ES012383).

Human Participant Protection

No protocol approval was required for this study because it relied on secondary, nonidentifiable aggregate data

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