ARTICLE

Effects of Alcohol Advertising Exposure on Drinking Among Youth

Leslie B. Snyder, PhD; Frances Fleming Milici, PhD; Michael Slater, PhD; Helen Sun, MA; Yuliya Strizhakova, PhD

Objective: To test whether alcohol advertising expenditures and the degree of exposure to alcohol advertisements affect alcohol consumption by youth.

Design: Longitudinal panel using telephone surveys.

Setting: Households in 24 US media markets, April 1999 to February 2001.

Participants: Individuals aged 15 to 26 years were randomly sampled within households and households within media markets. Markets were systematically selected from the top 75 media markets, representing 79% of the US population. The baseline refusal rate was 24%. Sample sizes per wave were 1872, 1173, 787, and 588. Data on alcohol advertising expenditures on television, radio, billboards, and newspapers were collected.

Main Exposures: Market alcohol advertising expenditures per capita and self-reported alcohol advertising exposure in the prior month.

Main Outcome Measure: Self-reported number of alcoholic drinks consumed in the prior month.

Results: Youth who saw more alcohol advertisements on average drank more (each additional advertisement seen increased the number of drinks consumed by 1% [event rate ratio, 1.01; 95% confidence interval, 1.01-1.02]). Youth in markets with greater alcohol advertising expenditures drank more (each additional dollar spent per capita raised the number of drinks consumed by 3% [event rate ratio,1.03; 95% confidence interval, 1.01-1.05]). Examining only youth younger than the legal drinking age of 21 years, alcohol advertisement exposure and expenditures still related to drinking. Youth in markets with more alcohol advertisements showed increases in drinking levels into their late 20s, but drinking plateaued in the early 20s for youth in markets with fewer advertisements. Control variables included age, gender, ethnicity, high school or college enrollment, and alcohol sales.

Conclusion: Alcohol advertising contributes to increased drinking among youth.

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Author Affiliations:
Department of Communications Sciences (Drs Snyder and Milici and Mss Sun and Strizhakova) and Center for Health Communication and Marketing (Dr Snyder), University of Connecticut, Storrs; and Department of Journalism and Technical Communication, Colorado State University, Ft Collins (Dr Slater). Dr Slater is currently at the School of Communication, Ohio State University, Columbus. Dr Strizhakova is currently at the Department of Communication and Journalism, Suffolk University, Boston, Mass.

THE CAUSES OF ALCOHOL USE among youth, including older children, adolescents, and young adults, are a major public health concern. Drinking among youth can result in a panoply of negative consequences, including poor grades, risky sex, alcohol addiction, and car crashes.[1-4] Drinkers younger than 21 years, who consume approximately 20% of all alcoholic drinks,[5] imbibe more heavily than adults per drinking episode[6] and are involved in twice as many fatal car crashes while drinking.[7] The problem is getting worse, with youth initiating drinking at an earlier age on average than they did in the past.[8]

There is much public policy debate about whether alcohol advertising is partially responsible for youth consumption levels. The alcohol industry is not subject to federal restrictions on their advertising practices but has voluntary advertising codes created by the major alcohol trade groups. Even when the alcohol industry adheres to a code requiring that at least 70% of the audience (50% before fall 2003) for print, radio, and television advertisements consist of adults of legal drinking age, many youth are exposed to alcohol advertisements.[9,10] There are often greater concentrations of alcohol advertisements in media aimed at youth than at adults.[10-13] However, studies of advertising content and youth exposure rates have not assessed the impact of advertising on youth. In 1997, the US Congress asked the National Institutes of Health for more scientific evidence on the relationship between advertising and alcohol use among those younger than the legal drinking age.[14]

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The most important question regarding alcohol advertising effects is whether the association between alcohol advertising and use is causal.[14] Cross-sectional sur-

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veys have found small, statistically significant, positive correlations (mean $r=0.19$) between self-reported alcohol advertising and youth drinking,[15-19] but they cannot establish causality.[20] Cumulative exposure to alcohol advertising and some effective advertising campaigns may change the way youth think about alcoholic beverages[21-27] and may increase drinking. Recently, exposure to some forms of alcohol advertising has been linked to drinking onset.[28] On the other hand, drinkers like alcohol advertisements more than nondrinkers like the advertisements,[24,26] have greater brain responses to alcohol advertisements,[29] and may remember them better.[25,30] An association between advertising exposure and drinking may therefore be due in part to drinkers reporting greater exposure than nondrinkers. It is also possible that advertisements induce drinkers to drink more. Another approach to research on alcohol advertising has shown that bans lead to a reduction in aggregate alcohol consumption,[31,32] but it is unknown how bans would affect youth.

We examined a national cohort of youth longitudinally to assess the effects of alcohol advertising on drinking amounts over time. The first hypothesis was that youth who reported greater exposure to alcohol advertising would have increased alcohol use over time. The second hypothesis concerned the effect of living in an environment with comparatively greater or fewer alcohol advertisements. By examining market-level measures of advertising expenditures per capita, we avoid the potential self-reporting bias among drinkers. We predicted that greater alcohol advertising expenditures per capita are correlated with greater youth drinking.

METHODS

A random sample of youth aged 15 to 26 years from 24 US Nielsen media markets were interviewed 4 times during 21 months. Interviews were conducted in April through July 1999, December through January 2000, May through June 2000, and December through January 2001, using computer-aided telephone interviewing.

SAMPLING

Twenty-four media markets were sampled to enable comparisons of advertising incidence across markets. Industry data on advertising were available for the 75 largest Nielsen media markets[33] in the United States, representing the 79% of the US population that lives in markets with populations of more than 957 000. To select markets, we conducted a cluster analysis in each of 6 US census geographic regions based on population size; population ethnic and religious composition; average income; annual state consumption of beer, wine, and liquor; state laws prohibiting sales of beer and liquor for off-premise consumption from restaurants, bars, grocery stores, gas stations, or drugstores; and percentage of households with cable television.[33-35] Markets were sampled from the identified clusters so that each geographic region in the sample was proportional to the number of top 75 markets within the region. Priority was given to markets with industry data on radio and billboard advertising, but otherwise selection was random. The selected 24 markets in the aggregate were not statistically different from the markets not selected on any of the measured criteria.

Households within markets were systematically sampled from a list of randomly selected households with telephones in the selected markets.[36] The list was purchased from Genesys Sampling Systems.[37] Within a household, the youth with the most recent birthday was selected. The mean ± SD response rate across markets at baseline was 27% ± 12%, and the refusal rate was 24% ± 7%, with many households of unknown eligibility not reached after 20 callbacks.[38] The sample sizes per wave were 1872, 1173, 787, and 588. The mobility of the 18- to 26-year-old segment of the population contributed greatly to sample attrition. Only 19% of the attrition at the second interview was due to a refusal to participate, compared with 68% due to disconnected numbers or respondent no longer in residence. Compared with youth who remained in the sample, youth who dropped out by the fourth interview were slightly older (20.2 vs 19.7 years), less likely to have been in high school (27.6% vs 42.3%), less likely to have been living at home (58.8% vs 70.7%), and drank more alcohol as of baseline (23.6 drinks per month vs14.9 drinks per month). Having greater attrition among drinkers is similar to other longitudinal youth alcohol use studies.[39] To minimize the effects of sampling and attrition, participants contributed as much data as was collected for them in the analysis (no cases were dropped), and the variables related to attrition were controlled statistically in the analyses.

The data were weighted at baseline by age, gender, and market to reflect the US population aged 15 to 26 years in the top 75 media markets. Weighting to a known population distribution adjusts for sampling fluctuations, nonresponse, and noncoverage.[36] The weighted data produced similar coefficients to the unweighted analyses.

The study received approval from the University of Connecticut institutional review board. Study participants and the parents of study participants younger than 18 years gave their oral consent before the baseline interview.

OUTCOME MEASURE

Respondents were asked 3 questions about alcohol use: "On how many days did you drink any alcoholic beverage in the past 4 weeks" (frequency), "When you drank alcohol, how many drinks, glasses, bottles, or cans did you have per day, on average" (average quantity), and "What is the maximum number of alcoholic drinks, glasses, bottles, or cans you had on one occasion" (maximum quantity). Alcohol use was computed by multiplying drinking frequency by the mean of the average and maximum quantity of drinking. For example, if a respondent reported drinking 5 times in the past month, having 2 drinks on average, and a maximum quantity on one occasion of 4, we multiplied 5 by $(2+4)/2$ for a final score of 15. Thus, the measure estimated the number of alcoholic drinks consumed in the past month.

ADVERTISING MEASURES

Advertising exposure was measured using 2 questions that assessed self-reported beer or liquor and premixed drink (eg, Smirnoff Ice) advertising exposure in the past month on each of 4 media (television, radio, magazines, and billboards) for a total of 8 items. The 8 items were summed to make an index. The question format was, "How many times in the past 4 weeks have you seen (media) ads for (beer/liquor or premixed drinks)?" To standardize across response formats on different surveys, "none" was coded as 0, "a few" and responses of 1 to 3 were coded as 2, "some" and responses of 4 to 6 were coded as 5, and "many" and responses of 7 or greater were coded as 10. (Ten was the modal response for the continuous response format for answers of 7 or greater.)

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MARKET ALCOHOL ADVERTISING EXPENDITURES PER CAPITA

Industry data on the amount spent on alcohol advertisements (in thousands) on television, radio, newspaper, and outdoors (mostly billboards) in each market in 1999 and 2000 were purchased from TNS Media Intelligence (formerly, Competitive Media Reporting).[40] The figure was divided by the market adult population size[33] to create an expenditures-per-capita index.

OTHER MEASURES

Data collection took place for several months for each wave. Time of the interview per individual and per wave was measured as the number of months past the start of the study (April 1999) that the interview took place. Thus, for someone interviewed in December 1999, the time was 8 months.

ALCOHOL SALES PER CAPITA

The total number of beer, wine, and liquor cases (in hundreds) sold per 1000 adults in each state in 2000 was purchased from an industry source.[41] It is important to control for total alcohol consumption levels because markets with greater sales may attract more alcohol advertising from brands competing to sell in markets with more heavy drinkers. In addition, adults who consume more on average may have an influence on youth drinking through tolerant attitudes and modeling. It is estimated that four fifths of all alcoholic beverages are consumed by adults.[5]

DEMOGRAPHICS

Age was an individual's age in years beyond 15 years measured at baseline. Other demographic variables included the dummy variables of female, gender, current school status (in high school, in college, or not in school), and ethnicity (African American, Hispanic, or neither).

STATISTICAL ANALYSIS

We used multilevel modeling to handle the complex sample and repeated-measures design.[42] There were 3 levels of analysis: (1) 4418 observations, accounting for the repeated measures within individuals, (2) 1858 individuals, and (3) 24 markets. The software used was HLM 6.01.[43] Because the outcome variable was count data (number of drinks) with many zeros (nondrinkers), we conducted nonlinear analysis using a Poisson sampling model with a log-link function.[42,44-46] The weights were applied at level 2. Analysis of the unconditional model showed that the largest share of the variance in alcohol use was within individuals (81%), reinforcing the importance of examining alcohol use within individuals.

We modeled growth in drinking over time by including month of interview in the model at level 1.[47] Since youth often increase their drinking as they age, we allowed growth to vary by age by including an interaction term between time and age.

The model examined the impact on alcohol use of alcohol advertising at the 3 levels: differences within individuals over time in advertising exposure, differences between individuals in advertising exposure, and market-level advertising expenditures. Alcohol advertising exposure at level 1 was centered on the individual's mean alcohol advertising exposure across all observations. Centering around an individual's mean is recommended when the aggregate of the level 1 predictors has a separate and distinct relationship with the outcome variable compared with variations within an individual.[42,45,47] The individual's mean advertising exposure was added as an independent variable at level 2, and market-level advertising expenditures were added at level 3. We added an interaction term between time and age and market advertising expenditures to test for differential growth in drinking over time by differences in market advertising expenditures and as youth age.

The model controlled for several potential confounders, including gender, age, ethnicity, and school status, all of which are known to vary with alcohol use.[48] Since school status could vary over time, 2 dummy variables for school status (high school, college, and no school) were entered at level 1. Another potential confounder, alcohol sales per capita, was entered at level 3. Alcohol sales, market advertising expenditures, time, and age were centered around the grand mean to aid in interpretation of the coefficients. Centering is particularly useful when dealing with interaction terms.[49] Error terms were included for all variables at level 3. Among the level 1 variables, the intercept and time were allowed to randomly vary. (If more than 2 factors were treated as randomly varying, the model would not converge.) The model tested was as follows:

$$\eta = \gamma_{000} + \gamma_{001}\,(\text{Alcohol Sales per Capita}) + \gamma_{002}\,(\text{Market Advertising Expenditures per Capita}) + \gamma_{010}\,(\text{Female}) + \gamma_{020}\,(\text{Age}) + \gamma_{030}\,(\text{Black}) + \gamma_{040}\,(\text{Hispanic}) + \gamma_{050}\,(\text{Mean Advertising Exposure}) + \gamma_{100}\,(\text{Time}) + \gamma_{110}\,(\text{Time}\cdot\text{Age}) + \gamma_{101}\,(\text{Time}\cdot\text{Age}\cdot\text{Market Advertising Expenditures per Capita}) + \gamma_{200}\,(\text{Advertising Exposure, Within Individual}) + \gamma_{300}\,(\text{High School}) + \gamma_{400}\,(\text{College}) + r_0 + r_1\,(\text{Time}) + u_{00} + u_{01}\,(\text{Female}) + u_{02}\,(\text{Age}) + u_{03}\,(\text{Black}) + u_{04}\,(\text{Hispanic}) + u_{05}\,(\text{Mean Advertising Exposure}) + u_{10}\,(\text{Time}) + u_{11}\,(\text{Time}\cdot\text{Age}) + u_{20}\,(\text{Advertising Exposure, Within Individual}) + u_{30}\,(\text{High School}) + u_{40}\,(\text{College}) + e$$

where η is the log-link function for drinking, γ is the estimated coefficient, e is the level 1 (observation) random effect, r is the level 2 (individual) random effect, and u is the level 3 (market-level) random effect.

The analysis was repeated for the subset of the sample younger than 21 years because of the importance of underage drinking. The sample sizes were 2286 at level 1, 1094 at level 2, and 24 at level 3. The intercept was the only random factor among the level 1 variables. The results show the unit-specific models and the event rate ratios. The event rate ratio, which for a Poisson model is the exponential of a coefficient, can be interpreted as the percentage change in the dependent variable associated with an increase of 1 unit in the independent variable, holding other factors constant.[42]

RESULTS

Sixty-one percent of the sample had at least 1 drink in the past month at baseline (**Table 1**). Drinkers consumed 38.5 total drinks on average in the past month at baseline (95% confidence interval [CI], 34.3-42.7), imbibing an average of 4.5 drinks per episode (95% CI, 4.3-4.8). Drinkers younger than 21 years had 29 drinks on average at baseline, with 4.5 drinks on average each drinking session (95% CI, 4.1-4.8). The market alcohol advertising spending ranged from $78 000 (Tulsa, Okla) to $88 750 000 (Los Angeles, Calif) during 1999 and 2000, with a mean of $14 800 000 worth of alcohol advertising (95% CI, $13 800 000-$15 800 000). Per capita spending ranged from $0.20 to $17.3, averaging $6.8 (95% CI, 6.6-7.0). Individuals reported seeing an average of 22.7 alcohol advertisements per month at baseline.

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Table 1. Demographics, Alcohol Advertisement Exposure, and Market Alcohol Advertisement Expenditures by Mean Alcohol Use and Changes in Alcohol Use Over Time

Characteristic	% of Sample	Mean Baseline Alcohol Use in Prior Month (95% CI)	Mean Change in Alcohol Use From Baseline to Time 4 (95% CI)
Total	100.0	23.4 (20.7 to 26.1)	2.4 (–1.6 to 6.4)
Drinkers (any drink in past month baseline)	60.8	38.5 (34.3 to 42.7)	1.2 (–6.3 to 8.7)
Drinkers younger than 21 y	49.3*	29.0 (23.9 to 34.0)	17.5 (6.1 to –28.8)
Gender			
Male	51.2	36.7 (37.8 to 41.5)	1.9 (–5.8 to 9.7)
Female	48.8	9.8 (8.0 to 11.6)	2.7 (0.5 to 5.1)
Race/ethnicity			
Hispanic	8.2	24.2 (21.3 to 27.1)	–.2 (–6.9 to .5)
Black	11.4	25.6 (22.6 to 28.6)	2.6 (–0.9 to 6.1)
White	69.9	17.9 (13.4 to 22.4)	3.1 (–2.1 to 8.2)
Education, baseline			
In high school	28.0	6.5 (4.3 to 8.8)	6.7 (3.6 to 9.9)
In college	31.0	27.6 (22.6 to 32.5)	13.6 (3.0 to 24.1)
Not in school	41.0	32.9 (27.6 to 38.2)	–11.6 (–19.4 to –3.8)
Age, y			
15-21, baseline	60.0	14.3 (11.7 to 17.0)	9.5 (4.7 to 14.3)
<18	27.0	8.5 (5.4 to 11.6)	4.8 (1.9 to 7.7)
18 (<21)	25.0	20.4 (16.1 to 24.8	17.1 (5.7 to 28.5)
21 (<23)	16.0	42.1 (31.5 to 52.7)	–8.8 (–23.4 to 5.7)
23-26	32.0	29.1 (24.3 to 33.8)	–6.8 (–14.3 to 0.6)
Television market advertising expenditures per capita			
<2	20.9	24.3 (18.0 to 30.6)	–5.4 (–13.4 to 2.7)
2-5.9	29.0	24.4 (18.8 to 30.0)	–2.3 (–9.7 to 5.1)
6-9.9	25.0	18.4 (14.4 to 22.4)	5.3 (–0.3 to 11.0)
≥10	25.1	26.3 (20.9 to 31.8)	12.7 (1.7 to 23.7)
Advertising exposure, baseline			
<8	15.7	18.5 (11.2 to 25.9)	.7 (–8.4 to 9.9)
8-29	55.6	23.3 (19.8 to 26.8)	1.2 (–3.3 to 5.6)
30-51	24.1	24.6 (19.4 to 29.8)	8.0 (–3.5 to 19.5)
≥52	4.6	34.9 (17.7 to 52.1)	–5.2 (–24.9 to 14.5)

Abbreviation: CI, confidence interval.
*Among those younger than 21 years.

The results in **Table 2** show that advertising exposure was positively related to an increase in drinking. Holding other factors constant, individuals who saw 1 more advertisement average than other individuals had 1% more alcoholic drinks per month (event rate ratio, 1.01; 95% CI, 1.01-1.02). Within-individual variation in advertising exposure was not a statistically significant factor in drinking, so whether a youth saw more or fewer advertisements in a particular month than he or she typically saw was not as important a determinant of drinking as that person's average level of advertising exposure over time.

Market advertising expenditures per capita were related to drinking levels and to growth in drinking over time. For every additional dollar per capita spent on advertising in the market, individuals consumed 3% more alcoholic beverages per month (event rate ratio, 1.03; 95% CI, 1.01-1.05), holding constant other factors, including time. There was an interaction effect between time and age and market advertising expenditures. In markets with high levels of advertising expenditures per capita, growth in drinking over time is steepest among older youth, reaching close to 50 drinks a month for 25-year-olds (**Figure 1**). In markets with low levels of advertising expenditures per capita, the initial drinking rates were lower than in markets with high levels of advertising expenditures per capita (**Figure 2**). Younger age groups show an increase in drinking over time but at a slower rate than peers in markets with high levels of advertising expenditures per capita. Around the age of 22 years, growth flattens out, with little increase in drinking over time. Above age 23 years, drinking declines over time in the markets with low levels of advertising expenditures per capita, declining most steeply in older age groups. (The figures depict growth curves, assuming mean levels of continuous factors and zero values for dummy variables, including male, not in school, not black, and not Hispanic.)

To better illustrate the effects of the main variables of interest, **Figure 3** depicts the relationship among alcohol use, mean levels of advertising exposure, advertising expenditures per capita, and gender. We held constant the other factors in the model; therefore, the figure shows predicted drinking levels for a 20-year-old who is not currently a student, neither African American nor Hispanic, and living in a market with an average amount of alcohol sales per capita measured at the mean date of the study and who reported, in the prior month, exposure to his or her average number of advertisements. The results indicate that

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Table 2. Hierarchical Linear Modeling Parameter Estimates Predicting Alcohol Use for the Total Sample

	Event Rate Ratio (95% CI)
Intercept	9.56 (7.21 to 12.67)
Alcohol sales per capita	1.002 (0.999 to 1.006)
Market-level advertising expenditures per capita	1.027 (1.010 to 1.045)
Female	0.49 (0.41 to 0.59)
Age	1.07 (1.03 to 1.12)
African American	0.23 (0.12 to 0.44)
Hispanic	0.47 (0.21 to 1.06)
Mean advertising exposure	1.01 (1.01 to 1.04)
Time	1.02 (1.01 to 1.04)
Time × age	1.00 (0.99 to 1.00)
Time × age × market advertising expenditures per capita	1.001 (1.000 to 1.001)
Advertising exposure, within individual	1.00 (1.00 to 1.00)
High school student	0.46 (0.2 to 0.73)
College student	0.99 (0.86 to 1.13)

Abbreviation: CI, confidence interval.

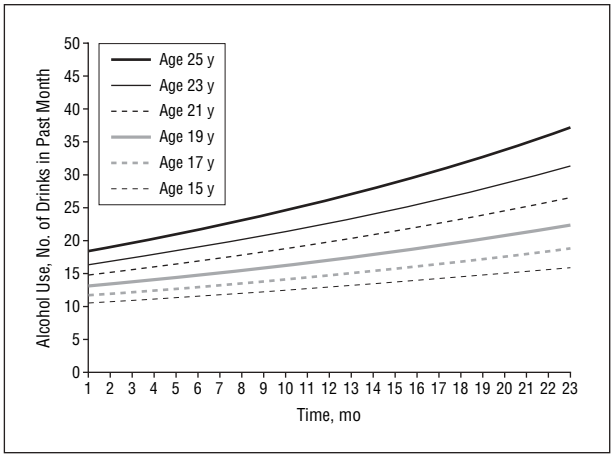

Figure 1. Alcohol use over time by age in markets with high alcohol advertising expenditures per capita.

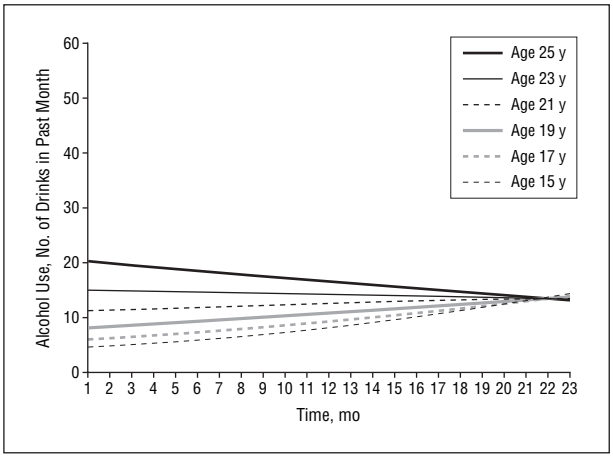

Figure 2. Alcohol use over time by age in markets with low alcohol advertising expenditures per capita.

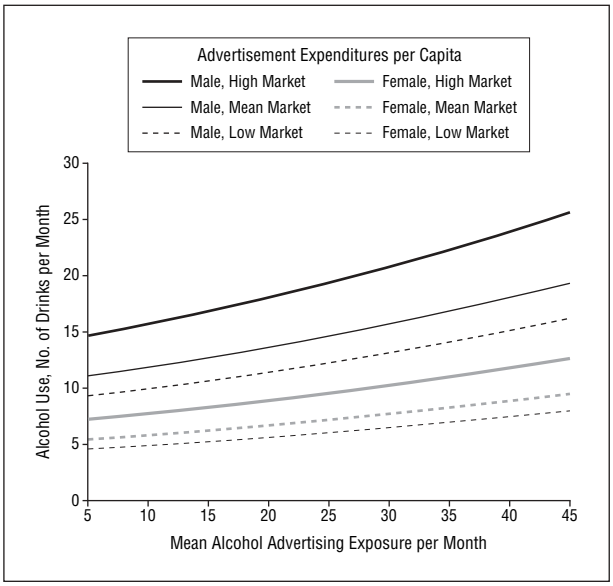

Figure 3. Alcohol use by mean advertising exposure, market advertising expenditures per capita, and gender.

a 20-year-old man who saw few alcohol advertisements (5) and lived in a market with minimal alcohol advertising expenditures per capita was predicted to have 9 alcoholic drinks in the past month compared with 16 drinks if he saw many advertisements (45). A man with the same profile but living in a market with the highest advertising spending per capita was predicted to have 15 drinks if he reported little advertising exposure and 26 drinks if he saw many advertisements.

We tested the same hierarchical linear model for the subset of the sample younger than the legal drinking age. The results were similar to those for the sample as a whole. Drinking was greater among underage youth who reported higher mean levels of alcohol advertising exposure (**Table 3**). Each additional average advertisement exposure was associated with an increase of 1% in drinks consumed in the past month (event rate ratio, 1.01; 95% CI, 1.001-1.021), holding constant other factors. Drinking levels were higher among underage youth living in markets with greater per capita advertising expenditures (event rate ratio, 1.03; 95% CI, 1.00-1.06), holding constant other factors. A 3-way interaction effect still occurred among time, age, and market advertising expenditures, following similar growth curves to those in Figure 1 and Figure 2.

COMMENT

The results of the present large-scale national longitudinal study provide evidence that the amount of advertising expenditures in 15- to 26-year-olds' media environment and the amount of advertising recalled related to greater youth drinking. Youth younger than the legal drinking age displayed a similar pattern of advertising effects as the entire age range, which is important because there is often a greater policy interest in protecting underage youth from harmful communications than in protecting youth older than 21 years.

Greater alcohol advertising expenditures in a market were related to both greater levels of youth drinking and steeper increases in drinking over time. Youth who lived

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in markets with more alcohol advertising drank more, increased their drinking levels more over time, and continued to increase drinking levels into their late 20s. Youth who lived in markets with less alcohol advertising drank less and showed a pattern of increasing their drinking modestly until their early 20s, when their drinking levels started to decline. The results are consistent with findings from studies of advertising bans[31,32] and extend them by linking alcohol advertising expenditures per capita directly with individual youth behavior. The effect of market advertising spending on youth drinking was not attributable to differences in alcohol sales, which was controlled for statistically in the model.

The relationship between market-level advertising expenditures and youth drinking is all the more striking because it assesses the effect of the "added value" of advertising in a market, over and above national advertisements appearing in all markets. Of the more than $1 billion a year spent on alcohol advertising at the time of the study, approximately one fifth was placed on local television, radio, and billboards.[50] To the extent that additional communication produces diminishing returns, the added value of market-level advertising may underestimate the total effect of alcohol advertising.

The results are consistent with theories of cumulative effects of media exposure. Youth reporting greater amounts of exposure to alcohol advertising over the long term drank more than youth who saw fewer ads. Alcohol consumption was less sensitive to short-term differences in alcohol advertising exposure than to the long-term effects of exposure.

Given that there was an impact on drinking using an objective measure of advertising expenditures, the results are inconsistent with the hypothesis that a correlation between advertising exposure and drinking could be caused entirely by selective attention on the part of drinkers. The results also contradict claims that advertising is unrelated to youth drinking amounts: that advertising at best causes brand switching, only affects those older than the legal drinking age, or is effectively countered by current educational efforts. Alcohol advertising was a contributing factor to youth drinking quantities over time.

The strength of the study was the relatively large national sample, the use of an objective measure of advertising expenditures to complement the subjective measure of advertising exposure, and the matching of expenditure data with individual behavior. The study was limited by the industry data used to measure advertising exposure, which largely reflects the most expensive medium for advertising—television. During this period, data on outdoor advertising was spotty and may have been incomplete in some markets. It is also possible that using a measure of likely advertising exposures (such as gross rating points) would increase effects. There may also be variation in the national advertising expenditures in markets, through differences in cable systems and presence of national stations or programming, that were not measured. Note, too, that other forms of marketing were not included here (such as product placements in programming, promotions, sports sponsorships, and stadium advertising) that could affect youth drinking. Future research could examine the impact of different forms of advertising and the consumption of various alcoholic products. Other limitations of the study were the sample attrition and the fact that those who drank more at baseline were more likely to drop out of the study. Future research should also control for the effects of parent and peer influences on drinking. Finally, the study does not explain the process by which advertising affects youth.

Table 3. Hierarchical Linear Modeling Parameter Estimates Predicting Alcohol Use Among 15- to 20-Year-Olds

	Event Rate Ratio (95% CI)
Intercept	8.69 (4.01 to 18.49)
Alcohol sales per capita	1.001 (0.996 to 1.006)
Market-level advertising expenditures per capita	1.028 (1.002 to 1.056)
Female	0.56 (0.41 to 0.76)
Age	1.30 (1.16 to 1.44)
African American	0.19 (0.07 to 0.53)
Hispanic	0.37 (0.18 to .75)
Mean advertising exposure	1.01 (1.001 to 1.021)
Time	1.04 (1.01 to 1.06)
Time × age	1.00 (0.99 to 1.00)
Time × age × market advertising expenditures per capita	1.002 (1.001 to 1.003)
Advertising exposure, within individual	1.002 (1.001 to 1.003)
High school student	0.53 (0.27 to 1.02)
College student	0.95 (0.56 to 1.59)

Abbreviation: CI, confidence interval.

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Correspondence: Leslie B. Snyder, PhD, Department of Communication Sciences, University of Connecticut, Storrs, CT 06269-1085 (leslie.snyder@uconn.edu).
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