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ORIGINAL ARTICLE

The relationship between exposure to brand-specific alcohol advertising and brand-specific consumption among underage drinkers – United States, 2011–2012

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ABSTRACT

Background: Marketing is increasingly recognized as a potentially important contributor to youth drinking, yet few studies have examined the relationship between advertising exposure and alcohol consumption among underage youth at the brand level. **Objectives:** To examine the relationship between brand-specific exposure to alcohol advertising among underage youth and the consumption prevalence of each brand in a national sample of underage drinkers. **Methods:** We analyzed the relationship between population-level exposure of underage youth ages 12–20 to brand-specific alcohol advertising in national magazines and television programs and the 30-day consumption prevalence – by brand – among a national sample of underage drinkers ages 13–20. Underage youth exposure to alcohol advertising by brand for each month in 2011, measured in gross rating points (GRPs, a standard measure of advertising exposure), was obtained from GfK MRI (a media consumer research company) and Nielsen for all measured national issues of magazines and all national television programs, respectively. The 30-day consumption prevalence for each brand was obtained from a national survey of 1031 underage drinkers conducted between December 2011 and May 2012. **Results:** Underage youth were more than five times more likely to consume brands that advertise on national television and 36% more likely to consume brands that advertise in national magazines. The consumption prevalence of a brand increased by 36% for each 1.5 standard deviation (50 GRPs) increase in television adstock among underage youth and by 23% for each 1.5 standard deviation (10 GRPs) increase in magazine adstock. **Conclusion:** These findings suggest that alcohol advertising influences an important aspect of drinking behavior – brand choice – among youth who consume alcohol.

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Introduction

Alcohol use among youth is a major public health problem (1–3). Despite slight declines in the past decade, 37.4% of high school seniors in 2014 reported having consumed alcohol in the past month (4). Marketing has been increasingly recognized as a potentially important contributor to youth drinking (5,6). In 2011, the alcohol industry spent at least \$3.5 billion in advertising and promotional expenditures (7), much of it in media venues in which youth comprise a disproportionate share of the audience. Even so, studies on the effect of alcohol marketing on youth alcohol consumption have been inconsistent.

The econometric literature that examines the effect of aggregate alcohol advertising on demand is mixed, with some studies showing an effect (8–11) and others

not (12–32). A recent study of alcohol advertising expenditures and alcohol consumption during the period 1971–2012 failed to find any effect of advertising on consumption (33).

A major weakness in these econometric studies is that they examine the relationship between advertising and consumption at the aggregate level, considering all alcohol together or examining separately the broad categories of beer, wine, and spirits. We recently conducted the first national survey of brand preferences among underage drinkers (ages 13–20) in the US and showed that underage youth alcohol consumption is concentrated among a small number of brands (34). Aggregating the few brands that youth consume with hundreds of brands that they do not consume may therefore mask any true advertising effect.

In addition to collecting the first data on underage youth alcohol consumption at the brand level, we also licensed data on underage youth exposure to alcohol advertising at the brand level in magazines and on television (35). This allowed us, for the first time, to examine the relationship between youth exposure to alcohol brand advertising and youth alcohol consumption at the brand level. Thus, we now have the ability to test directly the hypothesis that the discrepancies among previous studies linking alcohol advertising exposure and alcohol consumption arose from the failure to analyze this relationship at the brand level.

The most compelling evidence linking alcohol marketing and youth drinking behavior originates from a series of longitudinal studies that document a link between either alcohol marketing receptivity (36–45) or alcohol advertising exposure (46–50) and initiation of youth drinking. A limitation of these studies is that they examined overall alcohol advertising exposure and aggregate consumption, and thus were unable to determine whether the brands consumed by these youth were indeed the brands to whose advertisements they had been most heavily exposed. To interpret the potential impact of advertising exposure more fully, we need to know whether youth are actually consuming the alcohol brands to whose advertisements they are most heavily exposed. Consequently, a full elucidation of the relationship between alcohol marketing and youth alcohol consumption is not possible unless brand-specific marketing data are examined in combination with contemporaneous data on brand-specific consumption among underage youth.

The assertion that there was a relationship between cigarette marketing and youth cigarette consumption was controversial at first, but a subsequent line of research on brand-specific cigarette advertising and brand-specific consumption demonstrated that youth were more likely to consume cigarette brands with heavy advertising exposure (51). One of the most compelling pieces of evidence was a study showing that the implementation of the Joe Camel advertising campaign between 1988 and 1991 was associated with an increase in the proportion of youth smokers who preferred Camel cigarettes from 0.5–32.8%, while there was only a small increase in the adult market share for Camel during that time (52). A longitudinal study found that that exposure to brand-specific advertising at baseline was highly correlated with the brand of smoking initiation (53). Taken together, these studies had substantial policy relevance and led to improved federal regulation of cigarette advertising.

Only two previous studies have examined the link between brand-specific exposure to alcohol advertising

and brand-specific alcohol consumption among underage drinkers (54,55). In both studies, we estimated advertising exposure by asking a national sample of underage youth whether they had viewed 20 specific television shows in the past month and then linking their responses to Nielsen data on underage youth exposure to brand-specific alcohol advertising on those programs. In the first study, we examined individual-level data (54), and in the second, we examined aggregated population-level data (55). In both studies, even after controlling for each brand's price and overall market share, we found a significant relationship between respondents' estimated exposure to brand-specific advertising and their past 30-day brand-specific alcohol consumption.

What remains to be examined is whether *overall* youth exposure to brand-specific advertising is significantly related to brand-specific alcohol consumption. Note that our two previous studies assessed advertising exposure for the survey respondents themselves rather than for the general population, and did so for only the limited set of brands advertised on 20 television shows. In the present study, we estimated overall underage youth exposure to brand-specific alcohol advertising for 898 alcohol brands by using industry-supplied data for a complete set of national magazines and television programs, and then related each brand's total exposure level to the survey respondents' past 30-day consumption prevalence for those brands, while again controlling for the price and overall market share of each of these brands.

Our rationale for focusing on television and magazine ad exposure is three-fold. First, despite the increase in youth use of digital media and an associated decrease in television viewing time, television remains the dominant source of advertising exposure among youth (56). During the fourth quarter of 2014, youth ages 12–17 watched an average of 84 hours of television per month, compared to just seven hours using the internet (56). Second, although youth magazine audiences have been declining, magazines remain the most efficient medium for reaching girls and young women. Moreover, some alcohol companies rely heavily on magazine advertising to increase the reach of their advertising relative to cable television, which has smaller audiences. In fact, the FTC reported that in 2011, one alcohol company spent 19% of its advertising budget in magazines (7). Finally, there is currently no commercially available tracking of youth exposure to advertising in digital media, so television is the dominant media source of alcohol ad exposure for which brand-specific data are available.

Methods

Design overview

We analyzed the relationship between population-level exposure of underage youth ages 12–20 to brand-specific alcohol advertising in national magazines and television programs and the 30-day consumption prevalence – by brand – among a national sample of underage drinkers ages 13–20, while controlling for each brand’s average price per ounce of ethanol and overall market share, as determined from wholesale shipment data. We obtained brand-specific price data from a total of 179 online alcohol stores throughout the US in 2011 (57). We estimated overall market shares for each brand using 2011 wholesale shipment data provided by Impact Databank (58–61). In our analysis, we used negative binomial regression models to estimate the association between consumption prevalence and underage youth advertising exposure for the 898 brands in our data set.

Measurement of brand-specific alcohol advertising exposure

Nielsen conducts the most comprehensive monitoring of age-specific alcohol advertising exposures during US cable and broadcast television programs (35) and is considered the gold standard in the advertising industry. GfK MRI provides age-specific audience data for the advertisements appearing in more than 200 US magazines (62). Under license agreements with these services, we obtained monthly data for 2011 on the brand-specific alcohol advertising exposure of underage youth ages 12–20 (35). We limited our analysis to advertisements that appeared in issues of national magazines and on nationally televised programs, and we excluded ads for general categories of alcohol (e.g. beer, wine, or spirits) or for industry “responsibility” messages.

The standard measure of per capita advertising exposure is called Gross Rating Points (GRPs). GRPs are the total number of advertisements seen by a given age group divided by the size of that age group’s population, times 100. Thus, 200 GRPs represents, for example, approximately two advertisements seen by every member of the target population. The GRP is an average measure. For example, 100 GRPs could represent each person seeing one ad, or half of the population seeing two ads and half seeing none, and so forth. In short, a GRP score represents the average potential exposure for a given population during a specified time period.

Following accepted marketing practice, to estimate youth exposure to each brand’s advertising in a given month, we summed the GRPs achieved by that brand among the 12- to 20-year-old population across all national television shows and, separately, across all national magazines.

Advertising is known to have a cumulative effect, with current advertisements influencing behavior more than past advertisements (63). To account for this, advertisers developed a measure of cumulative advertising exposure – called *adstock* – that sums current advertising exposure levels with discounted levels of prior exposure, (63) using a “depreciation rate” typically expressed as an advertisement’s “half-life” (i.e. defined as the time period over which half of an advertisement’s effect will decay). From a public health perspective, adstock can be thought of as the active “dose” of alcohol advertising exposure at a given time. The half-life of advertising for most products is approximately four weeks (64). Thus, to estimate a brand’s adstock value at the end of 2011, we summed December’s GRPs with a depreciating proportion of prior months’ GRPs, using a decay rate of 50% per month. This procedure produced end-of-year adstock values – one for television, the other for magazines – for each of the 898 alcohol brands in our data set. These were the primary predictor variables we used in our analyses.

Measurement of brand-specific consumption prevalence

Data on past 30-day alcohol consumption among 13- to 20-year-olds came from our national youth alcohol brand survey, whose methodology has been summarized previously (34). Briefly, this internet-based survey of 1031 underage drinkers, conducted between December 2011 and May 2012, assessed respondents’ use of each of 898 alcohol brands during the past 30 days. The respondents were recruited from a pre-existing, probability-based internet panel maintained by GfK Knowledge Networks (Menlo Park, CA, USA). Initial data weighting reflected selection probabilities, non-response to panel recruitment, and panel attrition. Post-stratification weights based on the Current Population Survey adjusted for sex, age, race/ethnicity, census region, household income, home ownership status, metropolitan area, and household size. The end result, our primary outcome variable, was an estimate of past 30-day consumption prevalence for each of the 898 brands among underage youth drinkers.

Measurement of brand-specific average alcohol prices

We estimated the average price per ounce of ethanol in 2011 for each of the 898 brands using data from 15 control states and 164 online alcohol stores (or stores that list their prices online) located across 28 license states (57). We attempted to identify all online alcohol stores that either list prices for all of their brands or have a searchable database with online price information. We calculated the average of each brand's price per ounce of ethanol across all the stores.

In addition to average price, youth brand choices may also be influenced by the minimum financial outlay required to purchase each brand. Specifically, the availability of smaller container sizes that require a lower outlay of money may increase the appeal of that brand to underage drinkers who tend to have less spending money. Hence, for each brand, we determined its minimum container size and the minimum financial outlay required to purchase that particular product during the period January–March 2012 (65). Using these figures, we estimated the number of standard drinks of each brand that could be purchased for five dollars and used this as an additional control variable.

Measurement of overall brand market shares

We estimated the overall market share for each alcohol brand in 2011 using wholesale shipment data from Impact Databank (58–60). The methodology is described in detail elsewhere (61). Briefly, Impact Databank (New York, NY, USA) issues annual reports that summarize national market shares for the top 50 beer brands, top 200 spirits brands, top 100 wine brands, and top 15 flavored alcoholic beverage brands based on the total volume of wholesale shipments.

To generate overall market share estimates across all categories, we converted the reported shipment volume of each brand into the number of standard drinks (14 grams of pure ethanol) of that brand. To do this, we converted the number of gallons to ounces and then divided by the number of ounces per standard drink (12.0 for beer, 1.5 for spirits, 5.0 for wine, and 8.5 for flavored alcoholic beverages). To estimate overall market shares, the number of standard drinks of each brand was divided by the total number of standard drinks for all brands combined.

The market shares for the brands not listed are lower than the market share for the lowest listed brand. For these brands, we imputed the market share to be half way between zero and the lowest listed market share for

that category (0.12% for beer, 0.014% for spirits, 0.016% for wine, and 0.004% for flavored alcoholic beverages). The top 50 beer brands accounted for 87.6% of all beer shipments, the top 200 spirits brands accounted for 86.2% of all spirits shipments, the top 100 wine brands accounted for 68.6% of all wine shipments, and the top 15 flavored alcoholic beverage brands accounted for 94.6% of all flavored alcoholic beverage shipments.

It is important to note that the overall market shares from Impact Databank represent the volume of alcohol sold into distribution by manufacturers, not the volume sold at the retail level.

Internet alcohol advertising

To assess the presence of each alcohol brand on the internet, at least in social media, we conducted extensive internet searches to estimate the total number of company-sponsored Facebook™ sites and the total number of “likes” on these sites for each of the 898 brands in 2012 (66). We used the number of “likes” for each brand as an additional predictor variable.

Descriptive statistics for each variable are presented in Table 1.

Analytic approach

Our data consisted of 898 brand-specific records, each with a value for: (i) that brand's estimated 30-day consumption prevalence among underage drinkers; (ii) the total national television adstock for that brand; (iii) the total national magazine adstock for that brand; (iv) the average price per ounce of ethanol for that brand; (v) the number of standard drinks of that brand that could be purchased for five dollars; (vi) the overall market share for that brand; and (vii) the number of “likes” on all company Facebook sites for that brand.

The main outcome variable – brand consumption prevalence – was not normally distributed. Many brands had a consumption prevalence of zero, and there was a rapidly decreasing number of brands as the level of consumption prevalence increased. Therefore, we modeled consumption prevalence as a negative binomial function, consistent with other analytic studies of alcohol consumption (67–71). Using this negative binomial model, we examined the relationship between brand-specific advertising exposure and brand-specific consumption among underage youth drinkers, while controlling for brand-specific price and overall brand market share.

To report the results of the negative binomial model, we present the incidence rate ratio (IRR) corresponding to approximately a 1.5 standard deviation increase in

Table 1. Descriptive statistics for key variables.

Variable	Number of brands	Percent of all brands
Youth consumption prevalence ^a (range: 0–27.9%)		
0%	340	37.9%
> 0–0.5%	357	39.8%
> 0.5–1.0%	87	9.7%
> 1.0–2.0%	48	5.3%
> 2.0–5.0%	41	4.6%
> 5.0%	25	2.8%
Youth television advertising exposure (range: 0–536 adstock GRPs ^b)		
0 GRPs	824	91.8%
> 0–50 GRPs	44	4.9%
> 50–150 GRPs	19	2.1%
> 150 GRPs	11	1.2%
Youth magazine advertising exposure (range: 0–104 adstock GRPs ^b)		
0 GRPs	676	75.3%
> 0–5 GRPs	182	20.3%
> 5–25 GRPs	27	3.0%
> 25 GRPs	13	1.4%
Number of “likes” on company Facebook™ sites ^c (range: 0–6.4 million)		
0	484	53.9%
1–50 000	292	32.5%
50 001–1 000 000	107	11.9%
> 1 000 000	15	1.7%
Average price per ounce of ethanol ^d (range: \$0.51–86.18)		
< \$1.00	118	13.1%
\$1.00–2.00	215	23.9%
\$2.00–3.00	245	27.3%
\$3.00–5.00	217	24.2%
> \$5.00	103	11.5%
Number of standard drinks for \$5.00 ^e (range: 0–43)		
0	421	46.9%
> 0–2	82	9.1%
> 2–4	213	23.7%
> 4	182	20.3%
Overall market share ^f (range: 0.002–12.7%)		
< 0.01%	548	61.0%
0.01–0.1%	231	25.7%
0.1–0.5%	95	10.6%
> 0.5%	24	2.7%

^aBased on past 30-day consumption prevalence of each of 898 brands among a national sample of underage youth drinkers survey between December 2011 and May 2012.

^bThe standard measure of per capita advertising exposure is called a Gross Rating Point (GRP). GRPs are the total number of advertisements seen by a given age group divided by the size of that age group's population, times 100. The adstock for each brand at the end of 2011 was estimated by summing the December 2011 GRPs with GRPs from the 11 prior months, with a depreciation factor of 50% per month.

^cThe number of “likes” for each brand on company-sponsored Facebook sites in 2012 was used to gauge each brand's popularity on Facebook.

^dThe average price per ounce of ethanol in 2011 for each brand was estimated using data from 15 control states and 164 online alcohol stores (or stores that list their prices online) located across 28 license states.

^eFor each brand, the number of standard drinks that could be purchased for five dollars was estimated by identifying its minimum container size and the minimum financial outlay required to purchase that particular product between January and March 2012.

^fThe overall market share for each alcohol brand was estimated using data from Impact Databank on annual wholesale shipments in 2011, presented as the number of standard drinks of each brand divided by the total number of standard drinks for all brands combined.

television or magazine adstock. The standard deviation for television adstock was 32, and we present results in terms of an increase of 50 GRPs in television advertising exposure. The standard deviation for magazine adstock was 7, and we present results in terms of an increase of 10 GRPs in magazine advertising exposure. We chose to report results in terms of 1.5 standard

deviations instead of just one standard deviation since the adstock distributions are skewed with a long right-sided tail.

Results

In a bivariate analysis, average brand-specific consumption prevalence increased steadily with both television and magazine alcohol advertising exposure (Table 2). The mean brand consumption prevalence increased from 0.3% for brands with no advertising exposure to 2.6% for brands with more than zero but less than 50 GRPs of television adstock, to 4.4% for brands with between 50 and 150 GRPs of television adstock, and to 8.7% for brands with greater than 150 GRPs of television adstock. Similarly, the mean brand consumption prevalence increased from 0.4% for brands with no magazine advertising exposure to 0.7% for brands with between more than zero but less than 5 GRPs of magazine adstock, to 2.3% for brands with between 5 and 25 GRPs of magazine adstock, and to 6.3% for brands with greater than 25 GRPs of magazine adstock.

In an initial analysis, we treated advertising exposure as a dichotomous variable to examine the relationship between brand consumption and whether a brand is advertised or not. After controlling for brand price and overall market share, any advertising on television was associated with more than a five-fold increase in underage youth consumption prevalence (incidence rate ratio [IRR] = 5.39; 95% confidence interval [CI] = 3.95–7.35), and any advertising in magazines was associated with a 36% increase in consumption prevalence (IRR = 1.36; 95% CI = 1.03–1.79) (Table 3). Significant positive

Table 2. Average 30-day prevalence^a of brand-specific youth alcohol consumption by level of brand-specific advertising exposure.

Exposure group (adstock GRPs ^b)	Mean exposure for group (adstock GRPs ^b)	Number of brands	Mean brand consumption prevalence
Television advertising exposure			
0	0	824	0.3%
> 0–50	12.8	44	2.6%
> 50–150	93.8	19	4.4%
> 150	239.5	11	8.7%
Magazine advertising exposure			
0	0	676	0.4%
> 0–5	0.4	182	0.7%
> 5–25	9.7	27	2.3%
> 25	55.9	13	6.3%

^aBased on past 30-day consumption prevalence of each of 898 brands among a national sample of underage youth drinkers.

^bThe standard measure of per capita advertising exposure is called a Gross Rating Point (GRP). GRPs are the total number of advertisements seen by a given age group divided by the size of that age group's population, times 100. The adstock for each brand at the end of 2011 was estimated by summing the December 2011 GRPs with GRPs from the 11 prior months, with a depreciation factor of 50% per month.

Table 3. Incidence rate ratio (IRR) for 30-day prevalence of brand-specific youth alcohol consumption by brand-specific advertising exposure (dichotomous), total “likes” on brand company Facebook™ sites, brand price, and overall brand market share^a.

Variable	IRR	95% confidence interval	p-value
Television advertising exposure (any vs. none)	5.39 ^b	3.95–7.35	<0.0001
Magazine advertising exposure (any vs. none)	1.36 ^c	1.03–1.79	0.0310
“Likes” on company Facebook sites (per increase of 1 million)	1.45 ^d	1.14–1.85	0.0023
Average brand price (in dollars)	0.71 ^e	0.63–0.79	<0.0001
Number of standard drinks per five dollars	1.06 ^f	1.03–1.08	<0.0001
Overall brand market share (per percentage point increase)	1.28 ^g	1.09–1.51	0.0028

^aBased on a negative binomial regression with past 30-day prevalence of brand-specific youth alcohol consumption as the outcome variable and advertising exposure as a dichotomous predictor variable. Other predictors are the brand’s average price per ounce of alcohol, the number of standard drinks of the brand that can be purchased for five dollars, and its estimated overall market share, including both youth and adult consumers, based on 2011 estimates of annual wholesale shipments for each alcohol brand (see Table 1).

^bIndicates that youth consumption prevalence increases by a factor of 5.39 if there is any television advertising for that brand.

^cIndicates that youth consumption prevalence increases by 36% if there is any magazine advertising for that brand.

^dIndicates that youth consumption prevalence increases by 45% for each increase of 1 million in the brand’s total “likes” on company Facebook sites.

^eIndicates that youth consumption prevalence decreases by 29% for each 1 dollar increase in the average price per ounce of ethanol for that brand.

^fIndicates that youth consumption prevalence increases by 6% for each increase of 1 in the number of standard drinks that can be purchased for five dollars.

^gIndicates that youth consumption prevalence increases by 28% for each 1 percentage point increase in the overall market share for that brand.

relationships with consumption prevalence were also found for the number of standard drinks that could be purchased for five dollars, the number of “likes” for all company Facebook sites, and the overall brand market share. For each one percentage point increase in a brand’s overall market share, its underage youth consumption prevalence increased by 28%. For each \$1.00 increase in average price per ounce of alcohol, a brand’s underage youth consumption prevalence declined by 29%.

To examine the linearity of the relationship between advertising exposure and consumption prevalence, we constructed a Lowess curve of the crude association between total brand-specific alcohol advertising exposure and brand-specific consumption among underage drinkers (Figure 1). This curve suggested a linear relationship between total advertising exposure and consumption prevalence over the full range of exposure seen in the data set.

Based on a negative binomial regression with advertising exposure entered as a continuous variable, and again controlling for brand price and overall brand market shares, we found that underage youth consumption

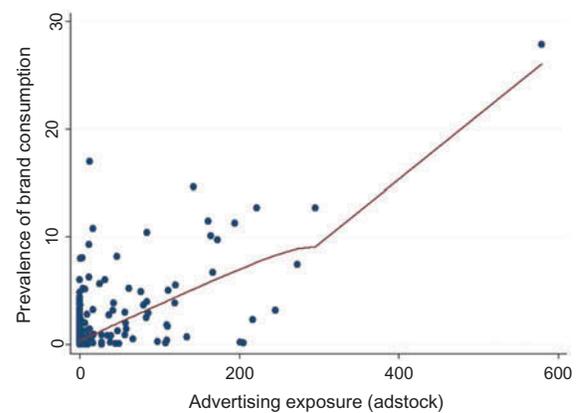


Figure 1. Lowess association between total brand-specific advertising exposure (adstock) among youth (ages 12–20) and the prevalence of brand consumption among underage drinkers ages 13–20.

prevalence increased by 36% for each increase of 50 GRPs in a brand’s television adstock among underage youth (IRR = 1.36; 95% CI = 1.13–1.66), and that consumption prevalence increased by 23% for each increase of 10 GRPs in a brand’s magazine adstock (IRR = 1.23; 95% CI = 1.09–1.38) (Table 4). Significant positive associations

Table 4. Incidence rate ratio (IRR) for 30-day prevalence of brand-specific youth alcohol consumption by brand-specific advertising exposure (continuous), total “likes” on brand company Facebook™ sites, brand price, and overall brand market share^a.

Variable	IRR	95% confidence interval	p-value
Television advertising exposure (per increase of 50 adstock GRPs)	1.36 ^b	1.13–1.66	0.0016
Magazine advertising exposure (per increase of 10 adstock GRPs)	1.23 ^c	1.09–1.38	0.0006
“Likes” on company Facebook sites (per increase of 1 million)	2.31 ^d	1.63–3.26	<0.0001
Average brand price (in dollars)	0.72 ^e	0.64–0.80	<0.0001
Standard drinks per five dollars	1.06 ^f	1.03–1.09	0.0003
Overall brand market share (per percentage point increase)	1.68 ^g	1.19–2.36	0.0030

^aBased on a negative binomial regression with past 30-day prevalence of brand-specific youth alcohol consumption as the outcome variable and advertising exposure measured in adstock GRPs as a continuous predictor variable. Other predictors are the brand’s average price per ounce of alcohol, the number of standard drinks of the brand that can be purchased for five dollars, and its estimated overall market share, including both youth and adult consumers, based on 2011 estimates of annual wholesale shipments for each alcohol brand (see Table 1).

^bIndicates that youth consumption prevalence increases by 36% for each increase of 50 GRPs in a brand’s television adstock.

^cIndicates that youth consumption prevalence increases by 23% for each increase of 10 GRPs in a brand’s magazine adstock.

^dIndicates that youth consumption prevalence increases by a factor of 2.31 for each increase of 1 million in a brand’s total number of “likes” on company Facebook sites.

^eIndicates that youth consumption prevalence decreases by 28% for each one dollar increase in the average price per ounce of ethanol for that brand.

^fIndicates that youth consumption prevalence increases by 6% for each increase of one in the number of standard drinks that can be purchased for five dollars.

^gIndicates that youth consumption prevalence increases by 68% for each one percentage point increase in the overall market share for that brand.

with consumption prevalence were found for the total number of “likes” on company Facebook sites, the number of standard drinks that could be purchased for five dollars, and the overall brand market share. As before, a significant negative association with consumption prevalence was found for increases in a brand’s average price per ounce of ethanol.

In sensitivity analyses, underage youth exposure to brand-specific advertising continued to be a significant predictor of underage youth brand consumption prevalence when the advertising depreciation rate was changed to 75% or 25% per month instead of 50%, when the analysis was restricted to advertised brands, and when the analysis was restricted to brands consumed by underage youth drinkers (Table 5).

Because overall market shares for unpopular brands were not listed by Impact Databank, our main analysis imputed these values as 50% of the distance between the brand with the lowest market share in each category and zero. To test the sensitivity of this imputation, we repeated the analysis with the overall market share for missing brands at 75% of the distance between the lowest brand and zero, at 25% of the distance, and with zero for all unlisted brands. These analyses demonstrated that the imputation values for these missing data had virtually no effect on the regression coefficients. In addition, when the analysis was restricted to only those brands whose overall market shares are listed by Impact Databank, television and magazine advertising exposures were still positively related to consumption prevalence, but these associations were not statistically significant.

Because the brands with missing market share data were unpopular, missingness itself could be associated with lower youth consumption prevalence. We conducted an additional analysis in which we modeled missingness (including it as a term in the model) so that we could ascertain the relationship between advertising exposure and consumption after accounting for the effect of missingness. The regression coefficients for both television and magazine exposure were still positive and significant, although the magnitude of the associations was somewhat attenuated.

Finally, when we excluded the most extreme observation (the outlying observation in Figure 1, Bud Light) from the analysis, television and magazine advertising were still significantly and positively associated with consumption prevalence and the incidence rate ratios were essentially unchanged (Table 5).

Discussion

This is the first study to examine the relationship between brand-specific advertising and brand-specific

consumption of alcohol among underage drinkers using all 898 brands for which youth consumption data are available. We found a robust relationship between documented underage youth exposure to alcohol brand advertising and the prevalence of past 30-day consumption of those brands among a national sample of underage drinkers. Underage youth were more than five times more likely to consume brands that advertised on national television and 36% more likely to consume brands that advertised in national magazines. A brand’s consumption prevalence increased by 36% for each increase of 50 GRPs (1.5 standard deviations) in television adstock among underage youth and by 23% for each increase of 10 GRPs (1.5 standard deviations) in magazine adstock. These findings strongly suggest that alcohol advertising influences an important aspect of drinking behavior – brand choice – among underage youth who consume alcohol.

The chief limitation of this study is that, even though our analyses controlled for both brand price and overall market shares, the possibility remains that an unknown confounder could explain the observed relationship. It may also be that we did not adequately control for overall brand market shares: we had to rely on data on the volume of alcohol sold into distribution by manufacturers since data on the volume sold at the retail level are not readily available.

A second potential limitation is potential endogeneity bias (72). It is possible that the intensity of brand advertising could be a function of already established levels of youth brand consumption, rather than consumption being driven by youth exposure to brand-specific advertising. The cross-sectional nature of this study precludes our ability to draw causal inferences.

Third, this study only assessed television and magazine advertising exposure. Several studies have documented the potential for heavy exposure of underage youth to alcohol advertising through social media and the internet (66,73,74). Unfortunately, there is currently no source that tracks youth exposure to brand-specific alcohol advertising through social media or the internet.

Fourth, we note that any effect of alcohol advertising on youth drinking would depend not only on overall advertising exposure, but also on how the specific messages are perceived and interpreted (75). We did not measure youth reactions to alcohol advertisements in this study.

Finally, we excluded industry “responsibility” ads from our analysis. Future research is necessary to

Table 5. Sensitivity analyses – Incidence rate ratios (IRR) for past 30-day prevalence of brand-specific youth alcohol consumption associated with an increase in brand-specific advertising exposure (continuous) under varying conditions^a.

Conditions	IRR	95% confidence interval	p-value
Depreciation rate of 75% per month			
Television advertising exposure (per 50 adstock GRP increase)	1.44	1.13–1.84	0.0035
Magazine advertising exposure (per 10 adstock GRP increase)	1.31	1.12–1.54	0.0010
Depreciation rate of 25% per month			
Television advertising exposure (per 50 GRP adstock increase)	1.30	1.16–1.48	<0.0001
Magazine advertising exposure (per 10 GRP adstock increase)	1.15	1.07–1.23	<0.0001
Analysis restricted to advertised brands (N = 252)			
Television advertising exposure (per 50 adstock GRP increase)	1.36	1.11–1.67	0.0039
Magazine advertising exposure (per 10 adstock GRP increase)	1.15	1.02–1.30	0.0274
Analysis restricted to brands consumed by youth (N = 558)			
Television advertising exposure (per 50 adstock GRP increase)	1.28	1.08–1.51	0.0046
Magazine advertising exposure (per 10 adstock GRP increase)	1.16	1.05–1.28	0.0040
Market share for missing brands in Impact Databank is 75% of the distance between lowest brand and zero			
Television advertising exposure (per 50 adstock GRP increase)	1.37	1.13–1.67	0.0014
Magazine advertising exposure (per 10 adstock GRP increase)	1.23	1.09–1.38	0.0006
Market share for missing brands in Impact Databank is 25% of the distance between lowest brand and zero			
Television advertising exposure (per 50 adstock GRP increase)	1.36	1.12–1.65	0.0018
Magazine advertising exposure (per 10 adstock GRP increase)	1.23	1.09–1.38	0.0006
Market share for missing brands in Impact Databank is 0			
Television advertising exposure (per 50 adstock GRP increase)	1.36	1.12–1.65	0.0020
Magazine advertising exposure (per 10 adstock GRP increase)	1.23	1.09–1.38	0.0006
Analysis restricted to brands listed by Impact Databank (N = 267)			
Television advertising exposure (per 50 adstock GRP increase)	1.19	0.99–1.43	0.0646
Magazine advertising exposure (per 10 adstock GRP increase)	1.11	1.00–1.24	0.0614
Analysis includes separate term for missing Impact Databank data			
Television advertising exposure (per 50 adstock GRP increase)	1.23	1.05–1.45	0.0110
Magazine advertising exposure (per 10 adstock GRP increase)	1.12	1.01–1.23	0.0246
Television exposure only (per 50 adstock GRP increase)	1.40	1.14–1.71	0.0009
Magazine exposure only (per 10 adstock GRP increase)	1.24	1.10–1.40	0.0004
Analysis excludes outlying observation (Bud Light)			
Television advertising exposure (per 50 adstock GRP increase)	1.39	1.14–1.69	0.0012
Magazine advertising exposure (per 10 adstock GRP increase)	1.23	1.09–1.38	0.0005

^aBased on a negative binomial regression with brand-specific youth alcohol consumption prevalence in the past 30 days as the outcome variable and advertising exposure measured in adstock GRPs as a continuous predictor variable. Other predictors are the brand's average price per ounce of alcohol, the total number of "likes" on the brand's company Facebook™ sites, the number of standard drinks of the brand that can be purchased for five dollars, and its estimated overall market share, including both youth and adult consumers, based on 2011 estimates of annual wholesale shipments for each alcohol brand (see Table 1).

assess the impact of these ads on youth alcohol consumption.

To address these potential limitations, confirmation of these findings is needed from future studies, especially those using a longitudinal design. Despite these limitations, however, we have shown that underage youth advertising exposure is strongly related to alcohol consumption at the brand level, which adds additional evidence to the literature suggesting that alcohol advertising influences youth drinking behavior.

This study focused on the relationship between advertising exposure and brand consumption among current youth drinkers and did not address the relationship between advertising exposure and drinking initiation. Even so, the finding of a robust relationship between the brands to whose advertising underage youth are most exposed and the brands most popular

among underage drinkers increases the plausibility of a relationship between alcohol advertising exposure and youth drinking initiation. The next question to be answered is whether alcohol advertising merely affects youth brand choices or whether it influences drinking initiation itself. A clear priority is a longitudinal study that examines this question.

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