

1-1-2004

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Recommended Citation

Stacy, A. W., Zogg, J.B., Unger, J. B., & Dent, C. W. Exposure to televised alcohol ads and subsequent adolescent alcohol use. *Amer. J. Health Beh*, 28(6), 498-509, 2004.

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Exposure to Televised Alcohol Ads and Subsequent Adolescent Alcohol Use

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Objective: To assess the impact of televised alcohol commercials on adolescents' alcohol use. **Methods:** Adolescents completed questionnaires about alcohol commercials and alcohol use in a prospective study. **Results:** A one standard deviation increase in viewing television programs containing alcohol commercials in seventh grade was associated with an excess risk of beer use (44%), wine/liquor use (34%), and 3-drink episodes (26%)

in eighth grade. The strength of associations varied across exposure measures and was most consistent for beer. **Conclusions:** Although replication is warranted, results showed that exposure was associated with an increased risk of subsequent beer consumption and possibly other consumption variables.

Key words: alcohol, advertising, adolescence, longitudinal

Am J Health Behav. 2004;28(6):498-509

The prevalence of alcohol use increases dramatically during the middle school years. The most rapid increase in prevalence occurs between 12 and 15 years of age.¹ The present study investigates one of the many possible precursors of this problem health behavior by evaluating the hypothesis that exposure to alcohol commercials in youth predicts subsequent drinking.^{2,3}

Most research on this issue has not been prospective. When prospective findings have been available, interpretation

still has not always been clear-cut. In one important longitudinal study, recall of alcohol commercials predicted later beer consumption in male but not female youth.⁴ However, no reports were provided on effects adjusting for previous levels of alcohol consumption in these data. In a second important longitudinal study from the same population, liking of alcohol advertising and brand allegiance were found to predict later alcohol consumption in young adults, adjusting for effects of previous alcohol consumption.⁵ However, liking for alcohol commercials and brand preference could imply product liking, exposure to others who drink, or intentions for future behavior that promote future alcohol consumption, without implying that alcohol commercials themselves influence consumption.

A scientific approach to this topic must explicitly address fundamental methodological issues in assessment, confounding, and alternative interpretations. Only then can public health policy be shaped by reasoned arguments, one way or the other. Regarding assessments of exposure to

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alcohol commercials, there are simply no "gold standards." The primary difficulty with exposure assessments involves intertwined problems of construct validity and confounding. That is, existing exposure assessments may assess something else in addition to, or instead of, exposure to alcohol commercials, underlying any apparent effects on consumption over time. One recourse is to evaluate the predictive effects of multiple measures of exposure, varying in assessment method. Systematic biases in assessment (confounding) may be limited across a pattern of findings, if the methods of exposure assessment differ enough to minimize common method-related (systematic) biases.⁶ Another related strategy is a more focused attempt at adjusting for likely confounders of exposure assessments. With such efforts, inferences about potential effects of exposure to alcohol commercials on consumption in youth may be improved substantially. At minimum, such an attempt would contribute by investigating previously untested alternative hypotheses.

Addressing Fundamental Prerequisites for Inference

There has been much debate about assessments of exposure to alcohol commercials,^{7,8} a central issue for inference. The present study uses multiple, distinct assessments as predictors, examines the pattern of findings across assessments, and takes into account the different meanings and limitations of the measures in interpreting the pattern of findings. The authors focus on this approach rather than alternatives on the basis of the rationale for multiple methods of assessment as well as on Strickland's criticism of some other available approaches.⁸ The present approach avoids combining fairly heterogeneous constructs into composite scales or factors, which can make interpretation of the meaning of exposure factors difficult; the present approach also uses assessments differing in methods and likely biases.

This study's multiple exposure assessments can be classified as *opportunity-based* and *memory-based* measures. Opportunity-based measures assess adolescents' self-reported behaviors that increase their likelihood of being exposed to alcohol advertisements, such as viewing TV programs that contain numerous al-

cohol advertisements. Most memory-based measures, in contrast, assess adolescents' recall or recognition of specific elements of specific alcohol advertisements or their memory of seeing alcohol advertising in general.

One type of *opportunity-based* measure focuses on exposure to television programs that show alcohol commercials. One influential example addresses viewing of televised sports events.^{9,10} Exposure to televised sports is a promising assessment, but it is not without limitations. For example, greater exposure could imply a greater interest or participation in team sports (itself a risk factor for alcohol use¹¹⁻¹³), a greater exposure to drinking role models in the home who also view these events, or variation on other possible third-variables that may co-occur both with exposure to commercials and with alcohol consumption. Longitudinal research needs to investigate third-variable explanations and also use some assessments that do not share the same limitations.

Another example of a viable opportunity-based assessment is a weighted index that samples exposure to many different types of television programs.¹⁴ Viewing frequency of television programs is assessed, and the index weights each program with respect to the frequency with which that program showed alcohol commercials. One of the distinctive features of this type of index is that it may help limit the plausibility of certain alternative explanations, such as some of the third-variable confounders of viewing televised sports. However, it also is not a panacea, because any measure of program exposure measures only the opportunity to be exposed to the target commercials,^{10,15} not verified commercial exposure or processing.

The *memory-based* assessments of exposure are quite different. Although memory is sometimes seen as an intermediate (intervening) variable,¹⁰ the present simpler use of memory tests is appropriate for a 2-wave prospective analysis that views different measures of advertising processing as imperfect indexes of exposure. The 2 memory tests used in the present study are based on quite different methods that each test for memory and include steps that minimize false positives. A third memory-based assessment is best described as an index

of "meta-memory" because it asks respondents to self-report frequency of observations of commercials. Each measure of memory has somewhat different strengths and limitations, but perhaps the most likely limitation of the recall measures concerns false negatives. For example, some respondents may be exposed to ads even though their responses to memory tests do not reveal an ability to name, draw, or recognize specific messages, characters, or scenarios from the ads. The "Method" section outlines additional support for use of various assessments of exposure as well as possible confounders, which also must be investigated.

The present study investigates the effects of televised alcohol commercials on the subsequent use of alcohol in a cohort of adolescent public school students, focusing on 2 time points that are critical for understanding influences on early consumption patterns: 7th to 8th grade. Assessments using divergent methods and measures of multiple confounders help address a variety of alternative explanations.

METHOD

Study Sample

The baseline respondents were 2998 seventh-grade students in 20 middle schools in the Los Angeles area in the spring of 2000. The schools were selected randomly from a list of all public middle schools in Los Angeles County. All seventh-grade students in the selected schools were invited to participate in the survey. Fewer than 3% of the students or their parent declined participation. One year later, students were invited to participate in the follow-up survey; 2250 (75%) of the students participated. These students compose the analytic sample. The sample was 51% female, 55% Hispanic, 19% Asian, 14% non-Hispanic white, 2% African American, 1% Pacific Islander, 1% Native American, 5% multi-ethnic, and 3% did not report their ethnic background. This ethnic distribution is similar to the ethnic composition of Los Angeles County Public Schools, which in 2000 was 59% Hispanic, 10% Asian, 19% non-Hispanic white, 11% African American, 1% Pacific Islander, and <1% Native American. Students were an average of 12.5 years old at baseline.

Procedure

Respondents completed paper-and-pen-

cil questionnaires in school during their regularly scheduled classes. Students received, randomized by school, one of 2 questionnaire forms that were identical in content with the exception of one section that contained alternative versions of ad-recall memory tests (described below). Prior written or phone-log-verified verbal parental consent was required for each participating student. Student assent at the time of testing was also required. The study protocol and survey contents were approved by the University of Southern California's Institutional Review Board and by the schools' research committees.

Measures of Advertising Exposure

Watched TV shows index. Respondents were given a list of 20 popular television series and asked to indicate how many times they watched each program during the past month on a 6-point scale from "never" to "every day." The shows, such as *Friends* and *The Drew Carey Show*, were chosen on the basis of the number of advertisements aired on the program during the 6-month interval prior to survey administration and teen audience size per program, as determined by data from Nielsen Media research. Following Strickland's strategy,¹⁴ viewing frequency responses for each show were weighted by the show's average monthly alcohol advertising frequency. For example, if a specific television program showed 5 alcohol ads per month, the respondents' viewing frequency score for this program would be multiplied by 5. The number of alcohol ads aired per month varied widely across the television programs in the scale, ranging from a low of 0.8 alcohol ads per month (*That 70's Show*) to a high of 68.9 alcohol ads per month (*Behind the Music* on VH1). Thus, the weights applied to the respondents' self-reported watching frequencies also ranged from 0.8 to 68.9. The weighted frequency scores were then averaged to create an overall index, similar to the method used by Strickland.¹⁴ The mean score on the weighted index was 15.7, with a standard deviation of 9.6 (median=14.1, interquartile range=11.1).

Watched TV sports index. Because televised alcohol advertising occurs much more frequently during televised sporting events than serial television shows,^{9,10} a separate scale was constructed to reflect exposure to televised sports. Using items

adapted from Bloom et al,¹⁶ respondents were asked how frequently they watched televised professional baseball, college and professional basketball, professional soccer and hockey, and ESPN SportsCenter in the last month. Football was not included in the list of sports because the study was conducted in the springtime, not during football season. Respondents rated each of these items on a 6-point scale ranging from "never" to "every day." As with the watch-TV shows index, viewing frequency responses were weighted with the average monthly alcohol advertising frequencies per event type and averaged together to create an index. The monthly ad airing frequencies ranged from 32.1 for professional soccer to 542.5 for ESPN SportsCenter. The weighted scale mean was 238.3 with a standard deviation of 258.9 (median=145.1, inter-quartile range=333.6).

Self-reported frequency. Three questions adapted from Schooler et al¹⁷ were used to assess self-reported frequency of exposure to alcohol commercials: "In the past week, how many TV commercials have you seen for alcohol drinks, like beer, wine, or liquor?"; "About how often did you see a beer commercial on TV in the last 6 months?"; and "About how often did you see wine or liquor advertised on TV?" Responses were rated on 7-point Likert-type scales. The mean of the 3 items represented the respondent's score (Cronbach's $\alpha=.79$). The scale mean was 5.05, and standard deviation was 1.68.

Cued-recall memory test. One of the most common measures of the memorability of an advertisement is cued recall.¹⁸ Approximately two thirds of the distributed questionnaires contained a memory-based cued-recall measure. Students were shown 13 still pictures of scenes electronically captured from 13 different television commercials. Nine of the commercials were beer commercials known to have been aired with relatively high frequency on programs popular with teens during the 3 to 6 months prior to testing. The remaining 4 commercials were control ads consisting of 3 current soft drink ads (beverage controls) and one nonbeverage product (a product control). For each commercial, respondents were asked to write the type of product being advertised. Product responses were computer coded for variations on the words *beer* or *alcohol* (yes/no). A cued-recall

index for beer ads was computed as the number of recent beer commercials correctly identified as beer commercials (0-9). The mean of this scale was 2.7 (SD=2.0), and the Cronbach's α was .69. Analysis involving the cued-recall index contained 2 additional adjustment (potential confounder) variables in the models outlined below: one for false positive identification of control ads as alcohol ads and the other for individual differences in memory ability. Control-ad product responses were coded yes/no for false positive beer or alcohol responses and summed as a false-positives index (0-4). The measure of individual differences in memory (ie, better memory for advertisements in general) was the number of nonalcohol ads that the respondent identified correctly (0-4).

Draw-an-Event memory test. As an alternate form of memory-based ad-recall measurement, we used a series of 3 "draw-an-event" tests in which students were instructed to think of the first TV commercial that came to mind and to draw a sketch of it.¹⁹ Students also were asked to label the product featured in the imagined ad, and the product response words were computer coded as indicating a student's self-report of recalling/intending to draw an ad for an alcohol product (yes/no) if the words contained variations on the words *beer* or *alcohol* and/or beer or alcohol brand names.

Two additional draw-an-event tests instructed respondents to think quickly of the first 2 *alcohol* commercials that came to mind and draw them. The 2 questions were, respectively, "Can you think of an alcohol commercial you saw on TV?" and "Try to think of a *different* TV commercial about alcohol; does a different one come to mind?" Students circled "yes" or "no." The draw-an-event score was the number of alcohol ads the student could recall (0-3) across these 3 tests. The mean of this scale was 1.64, with a standard deviation of 0.67.

Measures of Alcohol Use

Current alcohol use. The alcohol use questions were preceded by the following definition: "The next questions ask about drinking alcohol. This includes drinking beer, wine, wine coolers, and liquor such as rum, gin, vodka, or whiskey. For these questions, drinking alcohol does not include drinking a few sips of wine for religious purposes." In line with Kann,²⁰

Table 1
Alcohol Use Prevalence in 7th and 8th Grade

	<u>Beer</u>		<u>Wine/Liquor</u>		<u>3-Drink Episodes</u>	
	7 th grade N (%)	8 th grade N (%)	7 th grade N (%)	8 th grade N (%)	7 th grade N (%)	8 th grade N (%)
Never used	1259(55%)	1070(48%)	1427(63%)	1161(52%)	1919(85%)	1740(77%)
Used but not in past month	640(28%)	772(34%)	479(21%)	644(29%)	151(7%)	237(11%)
Used in past month	351(16%)	408(18%)	344(15%)	445(20%)	180(8%)	272(12%)

current use of beer, wine, and liquor at eighth grade were assessed with the following items, each with same stem: "During the last 30 days, on how many days did you....", "...have at least one drink of beer?", "...and "... have at least one drink of wine or liquor?" In most surveys of high school students and adults, binge drinking is defined as 5 or more drinks on one occasion.²⁰ Because this study assessed alcohol use in eighth grade, we set a lower criteria of 3 drinks per occasion as a measure of heavy drinking episodes. The question on binge drinking from the Youth Risk Behavior Surveillance Survey²⁰ was modified to read, "During the last 30 days, on how many days did you have 3 or more drinks of beer or wine or liquor in a row, that is, within a couple of hours?" This modified measure was labeled "3-drink episodes," even though for the lower weight (and hence blood alcohol level) of this age group it is essentially synonymous with binge drinking. The word *drink* was defined in the instructions as a typical serving size. Responses were given as the number of days (0 to 30), but were recoded to binary as 0 vs 1 or more for the present analysis because the distributions were extremely skewed toward zero.

Prior alcohol use. Prior use of beer, wine, and liquor, and 3-drink episodes were assessed with 3 indexes containing the full scale responses to the current use items above, plus similar questions about the frequency of alcohol use in the last 6 months and lifetime. Cronbach's alphas were .85 (beer index), .88 (wine/liquor), and .91 (3-drink episodes).

Measures of Confounders

In addition to the memory covariates already outlined, psychosocial and behavioral variables that have been associated with advertising exposure and/or alcohol

consumption in previous studies were included as covariates. These included general television viewing frequency,^{10,21-23} participation in team sports,^{17,22} perception of friends' alcohol use,^{14,21} perceived peer approval of alcohol use, intentions to use alcohol, perceptions of adults' alcohol use,²⁵ gender,^{4,26-28} ethnicity, and school.

Follow-up propensity. Because the students lost to attrition may differ in risk-behavior profiles from those who are followed up successfully, we included a follow-up propensity score²⁹ as an additional adjustment variable. The propensity score was predicted in a logistic regression from baseline alcohol use and all other confounding variables listed above and is included in all analyses.

Data Analysis

To determine the effects of alcohol advertising exposure on subsequent alcohol use, a series of logistic regression models were used. The models predicted each of the three eighth grade current alcohol use variables from: (a) each of the seventh-grade advertising exposure measures alone (the "unadjusted" model); and (b) advertising exposure, prior use, and all potentially confounding variables listed above (confounder adjusted model). A third set of models examined the 2-way interactions between exposure and prior alcohol use, gender, and ethnicity, in the context of the confounder adjusted model. Exposure measures and all confounders with the exception of demographic variables were standardized to a mean of 0 and a standard deviation of 1 to allow for comparison of coefficients across exposure measures.

RESULTS

Prevalence of Alcohol Use

The prevalence of lifetime and past-

Table 2
Correlations Among Measures of Alcohol Advertising Exposure

	Watched TV Shows Index	Watched TV Sports Index	Self- reported Frequency	Cued-Recall Memory Test	Draw-an- Event Memory Test
Watched TV Shows Index	1	.29*	.10*	-.03	.03
Watched Sports	.33*	1	.07*	.13*	.00
Self-reported Frequency	.19*	.14*	1	.24*	.29*
Cued-Recall Memory Test	.01	.22*	.27*	1	a
Draw-an-Event Memory Test	.08*	.08*	.32*	a	1
N	2250	2250	2250	1433*	817*

Note.

Unadjusted correlations appear in the lower half of the matrix. Partial correlations, partialling all listed confound variables, appear in the upper half of the matrix.

* $P < .05$

a These exposure measures cannot be correlated because they appeared on alternate versions of the questionnaire.

month alcohol use is shown in Table 1. In seventh grade, 16% of the respondents reported drinking beer in the past month, 15% reported drinking wine in the past month, and 8% reported 3-drink episodes in the past month. By eighth grade, these prevalence rates had increased to 18% for beer, 20% for wine, and 12% for 3-drink episodes.

Correlations Among Exposure Measures

Table 2 shows the correlations among the various measures of alcohol advertising exposure. Although some of the correlations were statistically significant, most were modest (all $\leq .33$). Because each measure had unique variance and was conceptually distinct, the measures were investigated as separate independent variables rather than combined into an index.

Relevance of Potential Confounders

To assess the relevance of potential confounders of our exposure measures, we computed the Pearson correlation coefficients between each exposure measure and each set of confounders. As shown in Table 3, with few exceptions the measures of TV alcohol ad exposures have modest, but significant, concurrent associations with prior alcohol use and intentions (range $-.02$ to $.17$), peer and familiar

adult use (range $.00$ to $.23$), peer norms (range $.03$ to $.14$), and the activities of general TV viewing and sports participation (range $.06$ to $.44$). The cued-recall memory test measure exhibited the least amount of confounding among this set, with 7 of the 13 correlations being nonsignificant.

Males had higher levels of ad exposure as measured by TV sports watching ($r = .31$) and higher scores on the memory-based exposure measures ($r = .23$ with cued-recall test, $.09$ with the draw-an-event test) than those of females. Hispanics appeared to have higher levels of ad exposures than non-Hispanics as measured by all but the draw-an-event memory test (range $.09$ to $.15$), whereas non-Hispanic whites had higher levels of ad exposure as measured only by the draw-an-event test ($r = .10$). Asians tended to have lower levels of ad exposures than others as measured by all but the draw-an-event test (range $-.08$ to $-.15$). Other ethnic groups, including multi-ethnic youth, did not show any evidence of differential ad exposures on any of the measures (range $-.05$ to $.03$).

Logistic Regressions of Alcohol Use on Advertising Exposure

Odds ratios, confidence intervals, and p -values for ad exposure measures in the various logistic regression models are provided in Table 4. Because the expo-

Table 3
Correlations Between Measures of Televised Alcohol Ad
Exposures and Potentially Confounding Variables

	Self-reported Frequency	Watched TV Shows Index	Watched TV Sports Index	Cued-Recall Memory Test	Draw-an- Event Memory Test
Confounder					
Prior Beer Use	.14*	.11*	.08*	.01	.13*
Prior Wine/Liquor Use	.13*	.09*	.06*	-.01	.11*
Prior 3-drink episodes	.09*	.07*	.06*	-.01	.10*
Intentions to Drink	.17*	.13*	.07*	.09*	.14*
General TV Viewing	.20*	.21*	.08*	.14*	.06*
Sports Participation	.15*	.21*	.44*	.11*	.10*
Peer Alcohol Use	.21*	.17*	.10*	.00	.13*
Adult Alcohol Use	.23*	.16*	.10*	.05	.14*
Drinking Norms	.14*	.12*	.09*	.03	.12*
Male (vs female) Gender	.02	.00	.31*	.23*	.09*
White (vs Nonwhite)					
Ethnicity	-.03	-.02	-.02	-.02	.10*
Hispanic (vs Non-Hispanic)					
Ethnicity	.11*	.15*	.09*	.13*	-.03
Asian (vs Non-Asian)					
Ethnicity	-.12*	-.15*	-.08*	-.10*	-.02
Mixed (vs Non-Mixed)					
Ethnicity	.01	-.02	-.00	-.01	.00
N	2250	2250	2250	1433 ^a	817 ^a

Note.* $P < .05$ ^a These exposure measures appeared on alternating forms.

sure measures were standardized, the odd ratios represent changes in odds for one standard deviation unit increase, relative to the average exposure.

Opportunity-based exposure measures. The watched TV shows exposure index showed a consistent association with subsequent alcohol use across levels of confounder adjustment and types of outcome. In the fully adjusted model, each one standard deviation increase in alcohol advertising exposure as measured by the watched TV shows index was associated with a 44% increase in odds of beer drinking (95% CI=27%-61%), a 34% increase in odds of wine or hard liquor drinking (95% CI=17%-54%), and a 26% increase in odds of 3-drink episodes (95% CI=8%-48%). The watched TV sports index was associated only with subsequent

beer drinking in the fully adjusted models, with a 20% (95% CI=5%-37%) estimated increase in odds per standard deviation unit. Prior use and confounder variable adjustments had relatively little impact on the estimates of the opportunity based ad exposure measures, with the possible exception of the association between watched TV sports and subsequent 3-drink episodes where the unadjusted model showed a small but significant association, but the coefficients in adjusted models were not significant.

Memory based exposure measures. The self-reported frequency of alcohol TV ads measure showed significant associations with all 3 subsequent alcohol use measures in the unadjusted models (odds ratio range 1.22 to 1.47), but only with subsequent beer drinking in the fully adjusted model (OR=1.21, 95% CI=1.04-

Table 4
Logistic Regression Results Predicting 8th Grade Alcohol Use
from Seventh-Grade Alcohol Ad Exposures

Exposure Measure	Beer Use			Wine/Liquor Use			3-drink Episodes		
	OR	(95%CI)	P	OR	(95%CI)	P	OR	(95%CI)	P
Watched TV Shows Index									
Unadjusted	1.46	(1.30,1.66)	<.001	1.34	(1.21,1.47)	<.001	1.33	(1.18,1.49)	<.001
Confounder Adjusted	1.44	(1.27,1.61)	<.001	1.34	(1.17,1.52)	<.001	1.26	(1.08,1.48)	.002
Watched TV Sports Index									
Unadjusted	1.22	(1.10,1.35)	<.001	1.05	(0.94,1.16)	.339	1.14	(1.01,1.28)	.028
Confounder Adjusted	1.20	(1.05,1.37)	.006	1.00	(0.88,1.15)	.910	1.07	(0.91,1.26)	.383
Self-reported Frequency									
Unadjusted	1.47	(1.30,1.66)	<.001	1.32	(1.19,1.49)	<.001	1.32	(1.15,1.52)	<.001
Confounder Adjusted	1.21	(1.04,1.41)	.012	1.18	(0.98,1.32)	.081	1.06	(0.89,1.27)	.464
Cued-Recall Memory Test									
Unadjusted	1.15	(1.00,1.31)	.068	1.13	(0.99,1.29)	.059	1.20	(1.02,1.41)	.022
Confounder Adjusted	1.17	(0.97,1.38)	.106	1.07	(0.91,1.26)	.406	1.17	(0.91,1.44)	.109
Draw-an-Event Memory Test									
Unadjusted	1.01	(0.90,1.13)	.856	0.99	(0.88,1.10)	.862	1.00	(0.88,1.15)	.895
Confounder Adjusted	0.86	(0.75,0.99)	.036	0.92	(0.81,1.03)	.226	0.91	(0.78,1.06)	.265

Note.

The most conservative, *a priori* analysis is shown. An anonymous reviewer suggested an analysis of a composite of the 2 opportunity-based measures. Because of Strickland's⁸ concerns about this practice and the lack of strong evidence that they should be combined, the primary analysis did not rely on a composite score. Nevertheless, a supplementary analysis of this composite score showed that it was a significant, positive predictor of all three dependent variables, revealed in both unadjusted and confounder-adjusted results (odds ratios in adjusted results ranged from 1.20 to 1.40).

1.41), although the association with wine/liquor use was only trivially smaller (OR=1.18) but did not achieve statistical significance (P=.081). In general, self reported frequency of ad exposure appears to be confounded with other predictors of subsequent alcohol use as evidenced by the reductions in exposure coefficients when confounders were added to the models.

The cued-recall memory test measure showed a different pattern across models and outcomes to that seen with self-reported frequency. Exposure coefficients were less affected by adjustments, indicating less confounding between this exposure measure and the adjustment variables. The cued-recall measure was clearly insensitive to subsequent wine/liquor use (OR=1.07, p=.406) and 3-drink episodes (OR=1.17, P=.106). The magnitude of association to beer drinking for the cued-recall measure (OR=1.17) was similar to that of self-reported frequency measure (OR=1.21), but was not statistically significant (P=.106) in the fully ad-

justed model.

The draw-an-event memory test showed no relationship to subsequent wine/liquor use or 3-drink episodes in any of the models (odds ratio range .092 to 1.00). For beer use, the odds ratios in unadjusted models were also nonsignificant (OR of 1.01, P=.856). However, in the fully adjusted model, an odds ratio of 0.86 (95% CI, 0.75-0.99, P=.036) indicated that those who scored one standard deviation above the mean on this exposure measure were 14% less likely to subsequently drink beer a year later.

Interactions of Advertising Exposure With Gender, Ethnicity, and Prior Alcohol Use

All potential variations in the level of association between the alcohol advertising exposure measures and subsequent alcohol use across gender, ethnicity, and level of prior alcohol use were tested by entering interaction terms between these variables to the fully adjusted models above. None of the interaction terms were

significant at $P < .10$, indicating there was no evidence of reliable variation in the odds ratios reported in Table 4 across these subgroups.

DISCUSSION

This study investigated predictive effects of a diversity of measures of exposure to televised alcohol commercials, as well as a host of potential confounders of the association between exposure and adolescent alcohol use. Any possible measure of exposure has some limitations. Thus, the assessment strategy used measures diverging in limitations such as likelihood of false positives and confounding. The present research is one of the most comprehensive prospective studies on this issue to date, because of the range of measures and confounders investigated. Such an approach is necessary for improved inference.

Inferences about effects in any observational study must take into account the overall pattern of findings, as well as limitations and confounders involved in each of the different exposure assessments. First, when predictive effects of exposure on consumption variables were uncovered, it is clear that they occurred primarily for beer consumption and more rarely for wine/liquor consumption and 3-drink episodes. This general pattern is consistent with several observations from the literature. Most televised alcohol commercials are for beer,⁹ and beer is a more frequent alcoholic beverage of choice for youth.³⁰ Also, binge drinking in eighth grade is a relatively rare event.³¹

Both of the opportunity measures of exposure predicted subsequent beer consumption. These measures assessed the likelihood of exposure to alcohol commercials on the basis of television viewing habits targeting either sports events or popular shows weighted by probability of appearance of alcohol commercials. Importantly, the effects of likely confounders of these assessments were adjusted in the analysis, including sports activity and general levels of television viewing. The analysis also adjusted for numerous other confounders, including prior alcohol use, intentions, peer and adult alcohol use, and other variables. Although in some instances the prospective effects of exposure were slightly diminished, they were still statistically significant and similar in magnitude. The same pattern

of findings was obtained for the self-reported frequency, meta-memory measure of exposure, with significant prospective effects on beer consumption even when effects of all confounders were adjusted for. Predictive effects of the 2 recall tests of exposure were nearly always nonsignificant in confounder-adjusted analyses, except for one counterintuitive instance in which exposure predicted less beer consumption. In advertising research, memory for specific commercials has a far less than perfect association with brand choice.³² Less is known about memory for commercials across a product class, although some tests have shown reliability and convergent validity in alcohol advertising research.¹⁹

One of the exposure measures, the watched TV shows index, showed significant predictive effects on all consumption variables, even when adjusting for all confounders. This index was similar in rationale and design to that first found effective by Strickland.¹⁴ It is important to note that this is an indirect measure that does not ask respondents directly about alcohol commercials. It merely assesses frequency of viewing popular television programs and weights these scores by the number of commercials shown on these programs. It is hard to explain a predictive effect of this variable through such alternative explanations as hypothesis guessing or demand characteristics. It is also difficult to imagine more proximal confounders of this relationship that were not already controlled for in the analysis, such as previous use, intentions, peer use, adult use, or general television viewing.

Another feature of the general pattern of results is that a great majority of the odds ratios were positive, even though most for wine and liquor consumption and 3-drink episodes were not significant. Taken together, the findings argue for effects on beer consumption and trends toward effects on wine and liquor consumption and 3-drink episodes in most comparisons. This is a somewhat mixed picture, but nevertheless it leans toward the view that alcohol commercials have some effects on alcohol consumption in this age group.

In the confounder-adjusted model, the draw-an-event memory was associated with a lower odds ratio of subsequent monthly beer drinking. Although specu-

lative, one possibility is that this nonverbal sketch test is more than a memory assessment. In addition to revealing nonverbal images of remembered scenes, the test may engage the student in beneficial, image-based elaborative processing of the commercial—that is, students who provide sketches of an ad may process its content in some ways that have preventive effects in the future. Nonverbal processing and memory constitute a fundamental area of basic memory research and cognitive neuroscience that is very seldom applied to health behavior or prevention.³³ Because links to preventive effects were not considered beforehand in the present study and have not been evaluated in previous research, this post hoc explanation should be considered tentative but worthy of evaluation in future research.

These results should be judged in the context of several limitations of the current study. First, it is probably impossible for any observational study to assess every possible confounder that might explain away effects of assessed exposure. This is the major limitation of an observational design. Although the authors believe that most unmeasured variables would have operated through the confounders that were assessed, future research might evaluate several possibilities. For example, future studies might assess adolescents' involvement in prosocial extracurricular activities in general, which may be associated with fewer opportunities to watch TV and associated with a lower risk of alcohol use; however, at least one type of activity (involvement in sports) was assessed in the present study. Similarly, antisocial activities or general propensity toward deviance (problem proneness) needs to be considered in future investigations, although these variables also may be manifested in our confounder set (eg, previous alcohol use, intentions, hours of TV watched); in any case, the link between deviance and alcohol commercial exposure has not been demonstrated prospectively to our knowledge. Other potentially confounding variables uncontrolled for here include depression and parental monitoring practices, which also are likely to be mediated through the variables in the confounder set (eg, hours of TV watched) if they have effects on exposure. The present study did adjust for the

strongest known longitudinal predictors of future alcohol consumption, including previous consumption, peer use, intentions, and other proximal variables that should at least partially index the omitted variables.

Second, the study is limited in generalizability, because the sample is only from adolescents in public school from only one region of the United States. Compared with the overall US population, this sample was more ethnically diverse and contained a larger proportion of Hispanic students. Nevertheless, the complete absence of interactions of obtained effects with major demographic variables such as gender and ethnicity shows the results are generalizable at least across some diverse groups. Third, these findings are based on adolescents' self-reports of alcohol use; biochemical validation was not conducted. Finally, although the results show some consistent patterns, not all measures of exposure converge on the same findings. This was particularly true of the differences in findings between the memory-based measures and the opportunity-based measures. The present state of the validation literature on exposure assessment does not show which tests are optimal. Although the limited generalizability of the sample and inherent uncertainties in observational designs imply that results should be replicated, the present findings are consistent with conclusions from previous longitudinal studies.

Effects of advertising have implications for the prevention of alcohol use among adolescents. Although alcohol marketing efforts ostensibly target an adult audience, these findings indicate that young adolescents have numerous opportunities to view alcohol advertisements on television; and youth do notice and recall these advertisements. Furthermore, adolescents who are exposed to alcohol advertisements may have a higher risk of experimenting with alcohol in subsequent years. Although the magnitude of the association between alcohol-ad exposure and alcohol use varied according to the ad exposure measure used, the weight of the evidence from this study is consistent with that of some other studies suggesting that exposure to alcohol advertising increases the risk of subsequent alcohol use.^{4,7,9,10,14} Even if the risk attributable to advertising is small relative to other in-

fluences such as peers and social norms, limiting adolescents' exposure to proalcohol media messages could be an important part of a comprehensive strategy to prevent adolescent alcohol use. Given the potential public health benefits of reducing adolescent alcohol use, increased attention to this issue is warranted.

Acknowledgments

This research was supported by grant AA 12128 from the National Institutes of Health. We thank Nielsen Media Research for providing information on alcohol commercials shown during specific television programs and the viewing ratings of those programs. ■

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