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Reducing Youth Access to Alcohol: Findings from a Community-Based Randomized Trial*

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Abstract

Underage drinking continues to be an important public health problem and a challenge to the substance abuse prevention field. Community-based interventions designed to more rigorously control underage access to alcohol through retailer education and greater enforcement of underage drinking laws have been advocated as potentially effective strategies to help address this problem, but studies designed to evaluate such interventions are sparse. To address this issue we conducted a randomized trial involving 36 communities to test the combined effectiveness of five interrelated intervention components designed to reduce underage access to alcohol. The intervention was found to be effective in reducing the likelihood that retail clerks would sell alcohol to underage-looking buyers, but did not reduce underage drinking or the perceived availability of alcohol among high school students. *Post hoc* analyses, however, revealed significant associations between the level of underage drinking law enforcement in the intervention communities and reductions in both 30-day use of alcohol and binge drinking. The findings highlight the difficulty in reducing youth drinking even when efforts to curtail retail access are successful. Study findings also suggest that high intensity implementation of underage drinking law enforcement can reduce underage drinking. Any such effects of enhanced enforcement on underage drinking appear to be more directly attributable to an increase in perceived likelihood of enforcement and the resultant perceived inconveniences and/or sanctions to potential drinkers, than to a reduction in access to alcohol *per se*.

Keywords

Environmental prevention strategies; underage drinking; enforcing underage drinking laws; underage access to alcohol; reward and reminder

Introduction

Alcohol is the most commonly used and abused drug by youth in the U.S. Although rates of adolescent alcohol use have fallen since the 1980s, the prevalence of underage drinking remains unacceptably high, and reducing underage drinking and its consequences is a public health priority (U.S. DHHS, 2007). Data from the 2010 Monitoring the Future (MTF) survey indicate that 71% of all high school seniors have consumed alcohol at some time in their lives, 65% report drinking in the past year, and 41% report doing so in the past 30 days (Johnston, O'Malley, Bachman, & Schulenberg, 2011). The consumption patterns of young

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drinkers are particularly problematic, as survey data consistently show that underage persons who drink are likely to drink large amounts (Flewelling, Paschall, and Ringwalt, 2004). Drinking by young people is associated with an array of problems. Each year, as many as 5,000 youth under the age of 21 in the U.S. die as a result of drinking-related motor vehicle crashes, homicides, suicide, and other injuries such as falls, burns, and drowning (Hingson & Kenkel, 2004; National Highway Traffic Safety Administration, 2007; National Institute on Alcoholism and Alcohol Abuse, 2007). Early onset of drinking is also associated with an increased likelihood of a broad range of negative consequences later in life such as dependence and abuse, drinking and driving, unwanted or unplanned sex, unintended pregnancy, sexually transmitted infections, violence, and unintentional injury (e.g., Hingson & Kenkel, 2004). Overall, the estimated costs of underage drinking in the U.S. reach \$61.9 billion annually (Miller, Levy, Spicer, & Taylor, 2006). Given these statistics, preventing drinking and drinking problems among youth remains a high priority.

Traditionally, alcohol prevention programming for adolescents has focused on school-based education curricula that also address other substance use behaviors. School-based programs, however, should not be expected to provide a complete answer to the problem of underage drinking, in part because young people are immersed in a broader social context in which alcohol is readily available and glamorized (NRC/IOM, 2004). Environmental approaches to preventing drinking and drinking problems among youth focus on modifying the context in which drinking occurs. Alcohol policy can be a particularly useful environmental strategy. Broadly defined, alcohol policy includes (a) formal legal and regulatory mechanisms, rules, and procedures for reducing the consumption of alcohol or risky drinking behaviors and (b) enforcement of these measures (Grube, 2009; Grube & Nygaard, 2005). Alcohol policy can be implemented at many levels including national (e.g., excise taxes), state (e.g., limitations on retail or wholesale distribution), local (e.g., zoning ordinances), or institutional (e.g., school policies, responsible service practices in stores, bars, and restaurants). More recently, prevention-oriented policies have begun to focus on harm-reduction approaches that attempt to reduce risky drinking rather than overall consumption (Marlatt & Witkiewitz, 2002; Riley & O'Hare, 2000). The primary goal of alcohol policies intended to reduce underage drinking is to increase the full costs of the acquisition and use of alcohol by young people, or the provision of alcohol to young people, beyond just the purchase price. These costs include the effort required to obtain it, the potential legal sanctions for possessing or consuming it, and the potential sanctions and liabilities incurred by adults for selling or supplying alcohol to youth (Grube, 2009; Grube & Nygaard, 2001, 2005). Regulatory policies, practices, and enforcement may also reinforce norms against underage drinking or supplying alcohol to underage drinkers (Perry et al., 1996; Toomey, Lenk, & Wagenaar, 2007).

Despite nationwide adoption of a 21-year-old minimum legal drinking age, alcohol remains readily available to youth, who procure it from a variety of retail and social sources. Although community-level restrictions on alcohol availability to youth have been advocated as local intervention strategies, few studies have investigated the effects of interventions designed to reduce underage alcohol availability at the local level on consumption by young people (cf. Saltz, et al., 2010; Treno, Gruenewald, Lee, & Remer, 2007; Wagenaar, Toomey, & Erickson, 2005). To address this issue we undertook a randomized community trial to investigate the combined effectiveness of five promising environmentally-focused intervention strategies recommended as best practices for reducing access to alcohol among youth: (a) a “*reward & reminder*” program for retail clerks and merchants, (b) increased enforcement of retail sales laws through *compliance checks*, *shoulder taps*, and *third party purchase surveillance* (c) increased general enforcement of underage drinking laws (e.g., minor in possession, DUI), (d) increased enforcement efforts to reduce and prevent underage drinking at parties through a *party dispersal (party patrol) program*, and (e) *strategic media advocacy* to increase public awareness of the problems associated with underage drinking

and to increase public awareness of, and support for, the interventions. Both retail and social access were targeted, with components (a) and (b) focused specifically on retail access, component (d) on social access, and components (c) and (e) on both retail and social access. Although reducing access to alcohol was intended as the primary mechanism underlying the intervention, other factors that influence underage drinking behaviors were also addressed. In particular, increased enforcement activities were also expected to constrain opportunities to drink and to exert a deterrent effect due to the increased visibility of enforcement and perceived likelihood of detection and consequent legal sanctions. Likewise, media advocacy was intended to help raise awareness and change community norms regarding the acceptability of underage drinking. The study tested the combined effectiveness of these interventions on underage drinking and several intermediate outcomes targeted by the interventions. The study went beyond previous research by implementing and evaluating a combination of commonly recommended environmental interventions, focusing on reducing both commercial and social access to alcohol and more intensively enforcing underage drinking laws, which have not been implemented in concert or adequately evaluated in previous studies.

Methods

Study Design

Thirty-six Oregon communities defined by public school districts were selected for inclusion in the study. The high schools that served these communities had previously agreed to conduct annual in-school surveys of 8th and 11th grade students as part of the ongoing Oregon Healthy Teens (OHT) Study (Oregon Health Authority, 2011). Excluded from study eligibility were the three largest school districts in the greater Portland area. Communities were stratified by region and population size and then randomly assigned within each stratum to the intervention or control condition, thereby yielding two groups of 18 communities each. The total population size of the study communities ranged from slightly over one thousand to just under fifty thousand; the mean population size was 9,750.

The communities were randomized to condition in 2005. Due to the level of coordination necessary to prepare for and begin implementation across 18 sites, three cohorts of 6 intervention communities each were identified based on their readiness to begin and proximity to one another. Intervention activities in the first cohort commenced in calendar year 2006, with communities in cohorts 2 and 3 initiating their interventions in 2007 and 2008, respectively. Intervention activities in each community were implemented for a period of two years. Pre- and post-intervention outcome measures from 11th grade students were obtained from cross-sectional OHT surveys conducted annually from 2004 through 2010. For each cohort, the post-intervention time period was defined as all years following the year in which the intervention activities were initiated. That decision was based upon the recognition that intervention activities were initiated at various times throughout the calendar year, that student survey data were collected relatively early in the calendar year, and that some time is required in which to build public awareness of (or exposure to) ongoing intervention activities.

Data from all years of the student surveys were used for every community, regardless of cohort, thereby creating variation across cohorts in the number of pre-intervention and post-intervention years used in the analysis. For example, the pre-intervention period for cohort 1 communities were defined as 2003 through 2006, and the post-intervention period as 2007 through 2010, whereas cohort 2 communities had one additional year of pre-intervention measurement and one less year of post-intervention measurement. Due to a substantial and unanticipated reduction in the number of middle schools participating in the OHT survey in 2009 and 2010, intervention effects on 8th grade students could only be assessed using data

through 2008. Consequently, the findings presented here focus on the 11th grade student survey data. In addition to the student survey data, underage purchase surveys to assess retail noncompliance were conducted annually in a sample of stores in each study community from 2005 to 2009.

Intervention

The intervention included a mix of law enforcement and other community-based activities. The intervention, which we refer to as Reducing Youth Access to Alcohol (RYAA), was initiated in collaboration with the Addictions and Mental Health Division (AMHD) of Oregon's Department of Health and Human Services. The Prevention Services Manager and the Director of Oregon's Enforcing Underage Drinking Laws (EUDL) grant provided an entrée for project staff into the intervention communities. Project staff then met face-to-face with county prevention coordinators. Often in conjunction with the county prevention coordinators, project staff also met with local law enforcement agencies to introduce the project activities and secure buy-in.

Community Mobilization—During the initial phase of intervention implementation, project staff, along with community prevention coordinators, were charged with securing community support and endorsement of the project activities. Presentations highlighting local underage drinking data, education to increase awareness of the risks of underage alcohol consumption, and an overview of project activities were offered to community stakeholders in each community. Community members were invited to show their support of laws targeting underage drinking prevention by signing a community proclamation. Endorsers included city councils, chambers of commerce, school boards, community coalitions, business owners, including alcohol merchants, and individual residents.

Reward and Reminder—Following community mobilization efforts, reward & reminder visits were conducted. In each intervention community, a random sample of 20 off-premise outlets was selected for visits; in communities with fewer than 20 outlets they were all visited. Two rounds of reward & reminder visits per year for two years were conducted in each outlet. These visits were designed to positively reinforce alcohol merchants for asking to see identification when a young-looking volunteer attempted to purchase alcohol. This strategy was patterned after similar efforts that have shown to be effective in reducing retail tobacco sales to minors (Biglan et al., 2000). In the weeks preceding these visits, merchant education visits were conducted to each alcohol outlet. Packets were distributed that included a description of project activities, signage and other resources for the store, and a copy of the community proclamation. During reward & reminder visits, trained 21 year old volunteers attempted to purchase alcohol at off-premise outlets and provided clerks with a congratulatory letter and gift certificate “reward” if they were asked to show identification or a “reminder” notice if they failed to ask for proof of legal age before selling alcohol. Management personnel at each outlet were notified when their employees received a reward, but reminders were given only to the offending employee so as not to jeopardize their employment status.

Media Advocacy—Additionally, the project intervention included a media advocacy component. A series of educational articles were submitted to local newspapers and community/school newsletters. Article topics included a project introduction with county-specific underage drinking statistics, underage drinking during prom and graduation, the dangers of underage drinking at home, social host liability, reward & reminder results, proclamation affirmations, and a description of project law enforcement activities. Each article was tailored to be community-specific and was submitted to local media sources. The information shared with the media included reports on ongoing enforcement activities,

including citations issued for infraction of alcohol laws, in order to draw attention to the consequences of breaking those laws.

Enforcement—A substantial component of the project intervention comprised law enforcement activities. Project staff collaborated with Oregon Liquor Control Commission and the local police departments to conduct compliance checks, which were completed once per year for two years in each of the off-premise alcohol outlets in the project communities. Personnel from local law enforcement agencies were invited to participate in training concerning how to conduct compliance checks with alcohol merchants, shoulder tap operations and third party purchase surveillance, and controlled party dispersal¹. Other enforcement activities implemented by local law enforcement included general surveillance and enforcement of minor in possession laws, and traffic detail focused on DUI. To help promote local police department cooperation, a retired state trooper was hired as the project law enforcement liaison midway into the project. Furthermore, additional funds were secured to support project-related enforcement activities. The coordination of the liaison coupled with additional funding significantly enhanced the quantity of project-related enforcement efforts. Even with these supports, however, the frequency and intensity of project-related enforcement activities other than compliance checks varied across the intervention communities, depending on the level of cooperation from the local police.

Coordination and Community Outreach—Throughout the intervention period, county prevention coordinators and community coalition members proved invaluable as implementation partners and performed duties including conducting community presentations, collaborating in the provision of law enforcement training, and coordinating local reward & reminder efforts. Additionally, ongoing project-sponsored networking meetings were offered for project collaborators, including prevention coordinators and law enforcement. Preliminary data presentations, idea-sharing, and funding opportunities were frequent meeting topics.

Data Collection Procedures

Data collection and confidentiality protection procedures for the project were approved by the Institutional Review Boards of the Pacific Institute for Research and Evaluation and the Oregon Research Institute.

Student Surveys—Anonymous data were collected annually from 11th grade students in participating Oregon communities using the Oregon Healthy Teens Survey, a written 30-minute questionnaire that has been conducted by the Oregon Research Institute and the State of Oregon since 2000. Schools in study communities did not necessarily participate every year between 2004 and 2010 (the years included in the analyses reported here), but all schools from which data were used for this study participated in at least one pre-intervention and one post-intervention year.

The questionnaire asked about alcohol, tobacco and other drug use, safety and violence-related behavior, diet, exercise, and sexual activity, and community, family and peer factors. Parents were notified by mail about the survey and given the opportunity to refuse to allow their children to participate by returning a postcard. Approximately two weeks after parents were notified, eligible students were invited to participate in the survey by classroom teachers. Students were assured that the survey was voluntary, that they could refuse to participate or to answer specific questions, or end their participation at any time.

¹Publications describing law enforcement procedures for implementing these strategies may be found at the Underage Drinking Enforcement Training Center web site: <http://www.udetc.org/>.

Underage Alcohol Purchase Surveys—Purchase surveys were conducted annually in all study communities to determine their level of retail compliance with underage sales laws. Drawing from a list of current licensees maintained by the Oregon Liquor Control Commission, a random sample of 20 off-premise establishments was selected from each community in the spring of 2005. For communities with fewer than 20 establishments, all establishments in the file were included in the sample. The number of stores surveyed per community in 2005 ranged from 3 to 20, with a mean of 14 stores. The same sample of stores was surveyed each of the following years, although in 2008 and 2009 the sample was augmented with randomly selected replacements for those stores that had gone out of business or could not be surveyed for any other reason. The purchase surveys were conducted by field teams composed of two individuals, one of whom was a “decoy buyer” of legal age but judged by a panel of study consultants to appear to be underage. The purchase attempts were conducted during the summer months, on weekends and weekday evenings, when underage buyers were likely to be making alcohol purchases. At each selected site the decoy buyer attempted to purchase a six pack of beer. If asked their age, buyers answered truthfully, and if asked for age identification, buyers indicated they had none with them. Upon leaving the store, the buyer recorded whether or not the sale was consummated, whether ID was requested, and details about the clerk and the outlet. Store clerks were not made aware of the survey activity nor were stores given feedback about the outcome. Sample sizes produced by the data collection procedures described above are shown separately for the intervention and control conditions in Table 1. With respect to the student survey data, both the number of schools and the number of 11th grade students participating each year are displayed. As indicated in the table, there was a slight decrease in survey participation in 2009. For all communities and schools, however, survey data were available for at least one pre-intervention and one post-intervention year, as determined by their cohort.

Measures

Four primary outcome measures were identified. Three of these were derived from the student survey data and include self-reported use of any alcohol in the past 30 days and self-reported drinking five or more drinks on one occasion in the past 30 days (i.e., “binge” drinking). The third was a general measure of perceived availability of alcohol, which was defined as whether or not students reported that alcohol was “very easy” to get. The fourth primary outcome measure was a direct measure of retail availability, based on whether alcohol was successfully purchased in each of the underage alcohol purchase attempts conducted for the retail alcohol purchase survey.

In addition to these primary outcomes we also examined four measures pertaining to perceptions of the likelihood of underage alcohol law enforcement in specific situations. These measures were also derived from the student surveys, and each one assesses perceptions that were expected to change as a result of specific enforcement-related components of the intervention.² These measures were dichotomized prior to analysis by selecting cut points closest to the median split of each measure.

All analysis variables except those pertaining to intervention intensity are listed in Table 2, which displays their pre-intervention and post-intervention means and standard errors separately for the intervention and control conditions. Included in Table 2 are student- and school-level demographic characteristics entered as covariates in the logistic regression

²The fourth measure (likelihood of an adult purchasing alcohol for a minor) could also be influenced by greater public awareness and concern regarding underage drinking, in addition to enhanced enforcement.

models used to analyze the student survey-based outcomes, and the store-level characteristics included as covariates in the analysis of the purchase survey results.

Because the level of enforcement effort exerted by local police departments was highly variable across communities, we developed and used in our *post hoc* exploratory analyses two measures of underage drinking law enforcement intensity. The first was the total number of citations and warnings issued for underage drinking-related violations by the local police department over the two-year intervention period when conducting project-supported underage drinking and underage access enforcement efforts. The second measure was the number of person-hours worked by local police officers in conducting these activities. For each measure, a per capita version was also calculated based on the total number of public school students (all grades k-12) in the community. Although other intervention activities were also tracked, the measures of implementation intensity for these activities were much less variable. Furthermore, in the *post hoc* analyses they showed no significant associations with any study outcomes and therefore are not discussed further.

Analysis Strategy

All analyses were conducted with SAS 9.2. Intervention effects were assessed by employing generalized linear mixed models, using a logistic link function, on the binary outcomes of interest (using PROC GLIMMIX). In analyzing the student survey data, observations were nested within schools to accommodate clustering effects and to reduce potential biases that could otherwise occur due to the variability in the number of years in which each school participated in the OHT. In analyzing the purchase survey data, observations were nested within community. Adding an additional level of nesting at the store level did not affect statistical power nor meaningfully alter the findings, and therefore they are not reported here.

Time was defined as a binary variable to distinguish pre-intervention from post-intervention years (as explained in the Study Design section above). The intervention effect was captured in the time by condition interaction term included in each model. We also assessed models that either: a) defined the post intervention time as starting in the same year as the intervention activities (rather than the year after), or b) reflected a return to baseline following either the first or second post-intervention year. The application of these alternative models did not substantively affect the findings, nor did they improve the fit of the models as indicated by Bayesian Information Criterion (BIC) values. We therefore present the findings from the models in which time is treated as a binary (pre- vs. post-intervention) effect only, with the post-intervention period beginning with the first year following the initiation of intervention activities.

Student-level covariates included in all models used to test effects on outcome measures obtained from the student survey data were gender, grade level, and minority status. Also included were community-level measures of percent of students eligible for free or reduced price lunch and percent of students who were minority race/ethnicity. Covariates included in the models examining whether alcohol was successfully purchased in the underage purchase attempts were age of the clerk and the number of employees in the store at the time of the attempt, both of which have been identified in prior analyses as significant predictors of noncompliance (Freisthler et al., 2003; Paschall et al., 2007a).

In addition to comparing the intervention and control groups as initially assigned, we also examined the association between the level of enforcement intensity within the intervention communities and the outcome measures. Each intensity measure (i.e., the number of citations/warnings issued and the number of person-hours) was entered, in separate models, in place of the condition term in the mixed models described above. The effect of these

measures was captured in the time by intensity interaction term included in each model. The per capita versions of these measures were analyzed in the same manner. Subsequent models for the drinking behavior measures were then run both with and without inclusion of selected intervening variables (i.e., perceptions of availability and enforcement) to identify mediating mechanisms through which enforcement intensity might operate in reducing underage drinking.

Results

Descriptive Statistics

A total of 22,711 11th grade students were surveyed in the study communities between 2004 and 2010. As indicated in Table 2, survey respondents were evenly divided between males and females, and between 21 and 30% of students were non-white (depending on time and condition). The prevalence rates for current alcohol use (i.e., any use in the past 30 days) and binge drinking in the control group at baseline were 45% and 27%, respectively. Rates in the intervention condition at baseline were almost identical. Both current alcohol use and binge drinking decreased in the post-intervention years of the study, for both the intervention and control conditions. In both the intervention and control communities, 55% of 11th grade students perceived alcohol to be “very easy” to obtain in the pre-intervention years. This measure was also lower in the post-intervention years for both conditions. Perceptions of enforcement derived from the student survey data also revealed equivalence between the intervention and control conditions, with some measures also exhibiting slight changes from pre- to post-intervention. Successful underage purchase attempts in retail outlets constituted over 20% of all attempts in the pre-intervention phase (22.9% for the intervention condition and 19.8% for control), but decreased substantially for both conditions in the post-intervention years.

As shown in Table 3, enforcement intensity varied widely across communities. The process data on enforcement indicated that enforcement activity was essentially absent in a few communities, and extensive in others. A breakdown of the citations and warnings measure showed that the measure was dominated by citations, as on average there were 6 times more citations than warnings reported. The component categories of citations and warnings included underage alcohol violations (primarily minor in possession, not connected with party dispersal operations, mean per community = 77.0), followed by party dispersal (40.8), compliance checks (5.0), and third-party surveillance (3.0). The component categories for person-hours included party dispersal (mean per community = 28.3), compliance checks (15.3), other underage drinking surveillance activities (13.0), and third-party surveillance (9.0). Traffic detail citations/warnings and person-hours focused on DUI were inconsistently tracked and did not always specifically target underage drivers, and therefore are not included in the overall intensity measures.

Assessment of Intervention Effects

The logistic regression modeling results for the four primary outcome measures are displayed in Table 4. For these models, parameters for all predictors in each model are shown, including their standard errors and levels of statistical significance³. The reference category for all categorical predictors is also displayed. The model-adjusted prevalence rates for each outcome measure, calibrated to the mean-centered values of all covariates in each model, are provided for each possible combination of time and condition at the bottom of the table.

³All significance levels reported are based on a two-tailed test. Statistical significance is noted for all tests for which the probability of a type I error was found to be less than .10, .05, or .01.

Statistically significant intervention effects were found only for the underage sales outcome measure ($p < .01$). The effect was in the expected direction, and is illustrated in the plot of the adjusted marginal rates of successful purchase attempts shown in Figure 1. Effects on the other three primary outcome measures were not statistically significant and were not suggestive of a positive intervention effect. As reflected in the descriptive data in Table 2, the modeling results indicate a significant main effect of time for all four outcome measures assessed, with the prevalence of any alcohol use, binge drinking, perceived availability, and underage sales all decreasing between the pre- and post-intervention phases of the study.

Similar models run on the four enforcement perception measures produced only one marginally significant ($p < .10$) intervention effect (data not shown). That effect was a relative increase among the intervention communities in the percentage of students who perceived that persons over aged 21 would *not* buy alcohol for a minor.

Relationship between Enforcement Intensity and Outcomes

Table 5 presents the results of analyses used to examine the relationship between the two measures of enforcement intensity and changes in outcome measures between pre- and post-intervention. Each measure was examined separately, and the models included the same covariates as used in the main effects analysis. Only the coefficient, SE, and statistical significance level for the time by enforcement intensity interaction term for each model are shown in the table. The number of citations and warnings was found to have a statistically significant dampening effect on both current use of alcohol and binge drinking among 11th grade students. The model-adjusted prevalence rates for these outcomes are displayed in Figures 2 and 3, with the rates estimated for enforcement intensity values of one standard deviation above the mean (high intensity) and one standard deviation below the mean (low intensity). The effects on perceived availability of alcohol and successful purchase attempts as measured through the purchase surveys were not statistically significant. The effects on three of the four perceptions regarding likelihood of enforcement/compliance were significant and were all in the expected direction (i.e., greater perceived likelihood of enforcement in communities with a high number of citations issued).

Effects of the other intervention intensity measure, based on the number of police officer hours expended on intervention activities, exhibited a similar pattern. Significant associates were again observed with 30-day alcohol use and binge drinking (see Figures 4 and 5 for the model-adjusted prevalence rates), as well as all four measures of perceived likelihood of enforcement.

Results from the analyses of the per capita versions of the intensity measures revealed very similar patterns, and therefore are not reported. Further investigation revealed moderate correlations (at the community level, $N=18$) between the raw number version of each enforcement intensity measure and the per capita version (.69 for citations and warnings, .52 for person-hours).

A subsequent step in the analysis was implemented in order to help explicate the significant effects of the enforcement intensity measures on any alcohol use and binge drinking. We first conducted an analysis in which the time by enforcement intensity interaction terms for both intensity measures were simultaneously included in the same model. We found that the effect of citations/warnings remained statistically significant and similar in magnitude for both 30-day alcohol use and binge drinking, whereas the effect of person-hours was substantially reduced and no longer statistically significant. Additional analyses then focused on the total number of citations and warnings issued as the more proximal predictor of changes in drinking rates. In these analyses, the same models that generated the results shown in Table 5 for the effect of citations/warnings were again analyzed, but this time they

also included terms for the interaction of time with perceived availability of alcohol and each of the four measures regarding perceived enforcement of underage drinking laws. Each perception item was entered in a separate model. Changes in the magnitude and statistical significance of the effect of citations/warnings were used as indicators of the degree to which the effects were mediated by changes in perception. The parameter estimates for the effect of citations/warnings, with and without inclusion of the perception items, are displayed in Table 6. As shown in the table, inclusion of each of the perception item separately generated small reductions in the coefficient reflecting the effect of citations/warnings on any use of alcohol. The perception of availability made the smallest difference, thereby indicating only a very slight mediating role for this variable. The perceived enforcement items made somewhat larger differences, although their role as mediators was still relatively small. Collectively, the four enforcement perception questions reduced the effect of citations/warning on any alcohol use from $-.0017$ to $-.0013$, thereby indicating that only a modest amount of mediation can be attributed to this set of variables.

In examining possible mediation effects on binge drinking, the role of enforcement perceptions was more pronounced. The inclusion of perceived availability again had only a negligible impact on the citations/warning effect, but several of the perception items did make a notable difference and therefore can be considered as potentially important mediators. In particular, the perception regarding the likelihood that police would break up underage drinking parties was shown to explain about half of the overall main effect of enforcement. Collectively, all four enforcement perception measures suggest an even more potent mediation effect.

Discussion

Of the four primary outcomes assessed, the RYAA intervention was found to have a significant effect in the expected direction on off-premise underage alcohol sales as measured through the underage purchase surveys. No evidence was found to support an overall intervention effect on any of the other primary outcomes, which included 30-day alcohol use, binge drinking, and perceived availability of alcohol. There also were no overall intervention effects detected for perceptions of underage drinking law enforcement, with the exception of a marginally significant effect in the expected direction on the perception that persons over age 21 would not buy alcohol for a minor.

The significant effect observed for reducing underage sales is encouraging, as it indicates that RYAA was successful in influencing the behavior of retail clerks – specifically, their willingness to sell alcohol to youthful appearing buyers with no age identification. It is especially notable that the effect was detected even though the rate of successful purchase attempts dropped substantially over the study period in the control as well as the intervention condition. As noted by Bauman and colleagues (Bauman, Suchindran and Murray, 1999), intervention effects are generally more difficult to detect in the context of a secular trend driving the outcome in the desired direction. The apparent secular trend observed here could be attributable to any number of factors, including concurrent statewide efforts to curtail underage drinking and access to alcohol. Data from the Oregon Liquor Control Commission (OLCC) statewide compliance check program also show that retail non-compliance rates decreased from 28% to 17% during the time frame of the study (OLCC, 2005–2009). Another possible explanation for the declines in successful purchases in the control communities is that the influence of the intervention, and particularly media attention to the intervention, may have spread beyond the target communities into nearby communities. In addition, store managers and employees, and even alcohol distributors as they travel from store to store, are likely to have shared perceptions regarding increased attention to underage drinking in their communities – including increased enforcement of

underage sales laws. To the extent that such spillover effects occurred, the strength of the intervention is likely to be even stronger than indicated in our analysis.

The lack of an intervention effect on measures of alcohol use and perceptions regarding ease of obtaining alcohol, especially given the significant impact found on underage sales, is disappointing but explicable. As shown in previous studies (Wagenaar and Toomey et al., 1996) and supported by our data as well (Paschall, Grube, Black, and Ringwalt, 2007b), social sources are typically the more common venue through which alcohol is obtained by high school students. Without concomitant reductions in social access, it may be unrealistic to expect that reducing retail access could have a substantial impact on overall availability, either actual or perceived, or on underage drinking. Although RYAA did attempt to address both retail and social access, the efforts to reduce social access were apparently not sufficiently strong or robust to make a significant impact on perceived availability. Social access involves multiple potential sources of alcohol for minors, including friends, siblings, and parents (either with or without their permission), and therefore presents a more diffuse target for intervention activities, including media advocacy. Additionally, the implementation intensity of the one intervention component that specifically targeted social access (i.e., controlled party dispersal) varied widely across the intervention communities, whereas the components that specifically targeted retail access (reward and reminder, compliance checks) were implemented much more consistently across communities.

Although the variability in intensity of several enforcement components of the intervention may have lessened the likelihood of detecting intervention main effects, it did provide an opportunity to explore whether stronger enforcement is associated with better outcomes – i.e., whether there is a dose-response relationship between enforcement level and outcomes. Inadequate implementation is often an underlying reason why promising interventions fail to fully achieve desired outcomes (Rossi, Freeman, and Lipsey, 1999). In pursuing this issue, we observed that enforcement intensity, as measured by either the number of underage drinking related citations and warnings issued or the number of law enforcement person-hours expended on underage drinking enforcement, was significantly associated with reductions in the prevalence of self-reported 30-day use of alcohol and binge drinking. Both measures also were significantly associated with changes in measures of perceived likelihood of enforcement. Although levels of enforcement activity were not experimentally manipulated, the results of this exploratory analysis suggest that strategies like RYAA could be effective interventions for reducing underage drinking if the enforcement components were implemented at levels of intensity comparable to those observed for the higher implementing communities in this study.

The finding regarding the mediating role of perceived enforcement in the association between enforcement intensity and underage drinking (binge drinking in particular) supports the importance of the visibility of enforcement activities in efforts to reduce underage drinking rates. Highly visible enforcement provides a deterrent effect by making the possibility of legal sanctions more salient, and may also reduce opportunities for underage drinking (e.g., by breaking up a drinking party before it is in full swing). Of equal interest was the finding that the relationship between enforcement and underage drinking, in this study, was not mediated by the perceived availability of alcohol. As noted earlier, unless intervention efforts can effectively constrain both retail and multiple social sources of alcohol, their effectiveness in reducing the perceived availability of alcohol will likely be limited. This does not mean that efforts to reduce underage drinking by seeking to limit access to alcohol should be abandoned, but it does point out the importance of effectively addressing both retail and social sources simultaneously. Fortunately some enforcement efforts intended to reduce underage access also appear to have a more generalized effect of

increasing the visibility of underage drinking enforcement activities, which in turn does appear to help curtail underage drinking behavior.

Study limitations

This study was based on a diverse sample of communities from across the state of Oregon, but the sample did not include large cities. Although the extent to which study findings may be generalized beyond the 36 participating communities is unknown, there do not appear to be any compelling reasons to expect that the findings from this study would be dramatically different if conducted in other settings across the U.S. Second, even though student self-reports of alcohol and drug use has long been used and accepted as outcomes in prevention research, we recognize that self-reported measures are subject to possible bias or error. It seems unlikely, however, that sources of measurement error would differ across intervention and control communities. Third, our measure of perceived availability (i.e., how easy would it be to obtain alcohol) does not distinguish among sources of alcohol and may not have been a particularly sensitive indicator of underage access to alcohol. Another dimension of access that might have served as a more appropriate measure is frequency of opportunities to engage in drinking behavior. Fourth, possible biases in the effects estimates may have been created by the variation in school participation and student response rates in the OHT survey over the study period that could not be mitigated completely by the study design and statistical models employed. Fifth, as discussed previously, the downward trends in the primary outcome measures in the control communities are likely to have made the intervention effects less apparent. Sixth, the underage alcohol purchase surveys conducted for this study used a specific protocol that reflects only one (i.e., underage-looking buyer with no ID) of numerous scenarios under which underage purchase attempts are made, and therefore may underestimate the success rate of purchase attempts using other strategies (e.g., using a fake or borrowed ID). Finally, substantial variability in the level of intervention implementation across the 18 intervention communities is likely to have attenuated the magnitude of intervention effects relative to what might have been achieved through intense implementation in all communities. The *post hoc* level of enforcement analysis in the 18 intervention communities does provide evidence for dosage effects, suggesting that the law enforcement components of RYAA when intensively implemented have the potential to achieve meaningful reductions in underage drinking. That implication, however, must be viewed with caution because enforcement level was not experimentally manipulated and could be confounded with other characteristics of the study communities, such as changing norms concerning adolescent alcohol consumption.

Conclusions and implications

Although the findings regarding the main effects of the RYAA intervention were disappointing, except for the significant reduction of successful underage purchase attempts, the *post hoc* exploration of the variability in outcomes across the 18 intervention communities was enlightening. Findings from those analyses suggest that interventions like RYAA, when implemented with high levels of enforcement, can be effective community-based strategies for reducing underage drinking. Although enhanced enforcement strategies have been questioned by some as being heavy handed, there is a growing appreciation of the role of law enforcement as an important partner in comprehensive community-based prevention efforts to address important public health and safety issues such as underage drinking (PIRE, 2009). Furthermore, adjudication for breaking underage drinking laws does not necessarily need to involve harsh penalties or require that infractions, first offenses in particular, be placed in the offenders' permanent records. Procedures do, in fact, vary widely across jurisdictions. Many milder sanctions are available, including court diversion, probation, brief suspension of driving licenses, and community service. Diversion programs may include screening for alcohol abuse and therefore facilitate the identification and

treatment of underage persons who might otherwise remain under the radar and progress to more problematic patterns and levels of use.

Because the findings regarding the effects of enforcement intensity from this study were based on exploratory analyses, without the benefit of experimental control, further research is needed to more firmly establish the effectiveness of policy- and enforcement-based strategies to reduce and prevent underage drinking. Such studies could either assign communities to different levels of enforcement intensity, or they could plan and implement interventions in a manner that ensures that most or all communities will, in fact, conduct the enforcement activities at the prescribed level. In the study described here, the cooperation and buy-in from local law enforcement was insufficient to produce an acceptably high level of enforcement in all 18 intervention communities. With additional planning and incentives, however, including encouragement and support from state government, we expect that this type of intervention could achieve consistently high levels of enforcement and is certainly worthy of further study.

Further research may help to confirm that RYAA, when modified to ensure more consistent levels of enforcement, is effective in addressing underage drinking. If so, a noteworthy feature of this intervention is that it was implemented by local practitioners in collaboration with their local police departments, with some technical assistance from the state. In other words, the intervention was implemented in a “real world” setting, in a manner that was not substantively affected or altered by the fact that it was conducted as part of a research study. The research grant did provide training and some modest financial support to the study communities, but at levels that could realistically be assumed in the future by state and local prevention systems and the communities they serve. RYAA thus constitutes an intervention that can be implemented in communities without being prohibitively expensive or requiring extensive oversight and control, and therefore could be widely disseminated. A clear benefit of this study is that it helped develop an empirically-grounded practice infrastructure that can remain in place now that the research is completed. Thus, the study did not simply develop knowledge; it also helped develop the capacity of the state and the intervention communities to implement and sustain a promising strategy to reduce an important public health problem at the same time.

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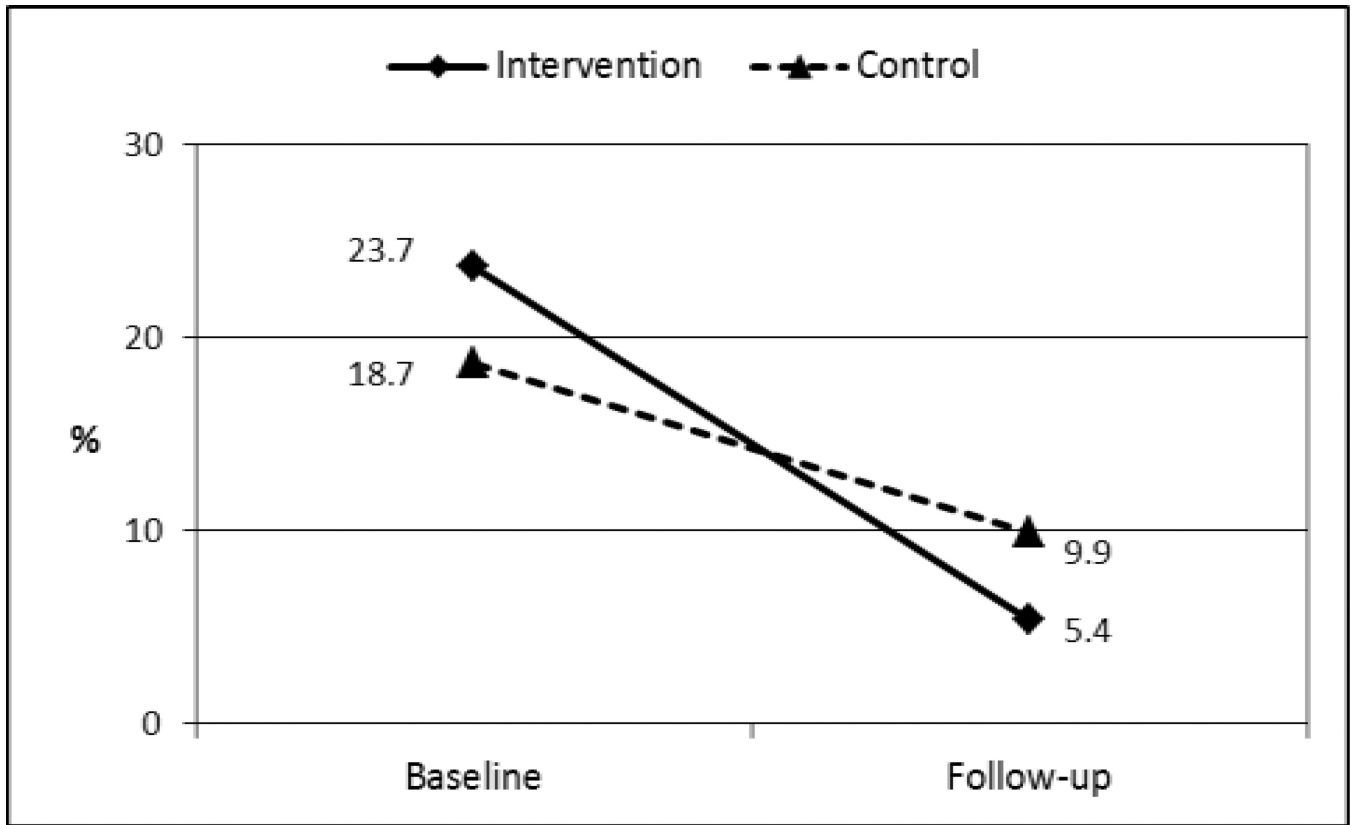


Figure 1.
Adjusted rates of successful purchase attempts: Main effects

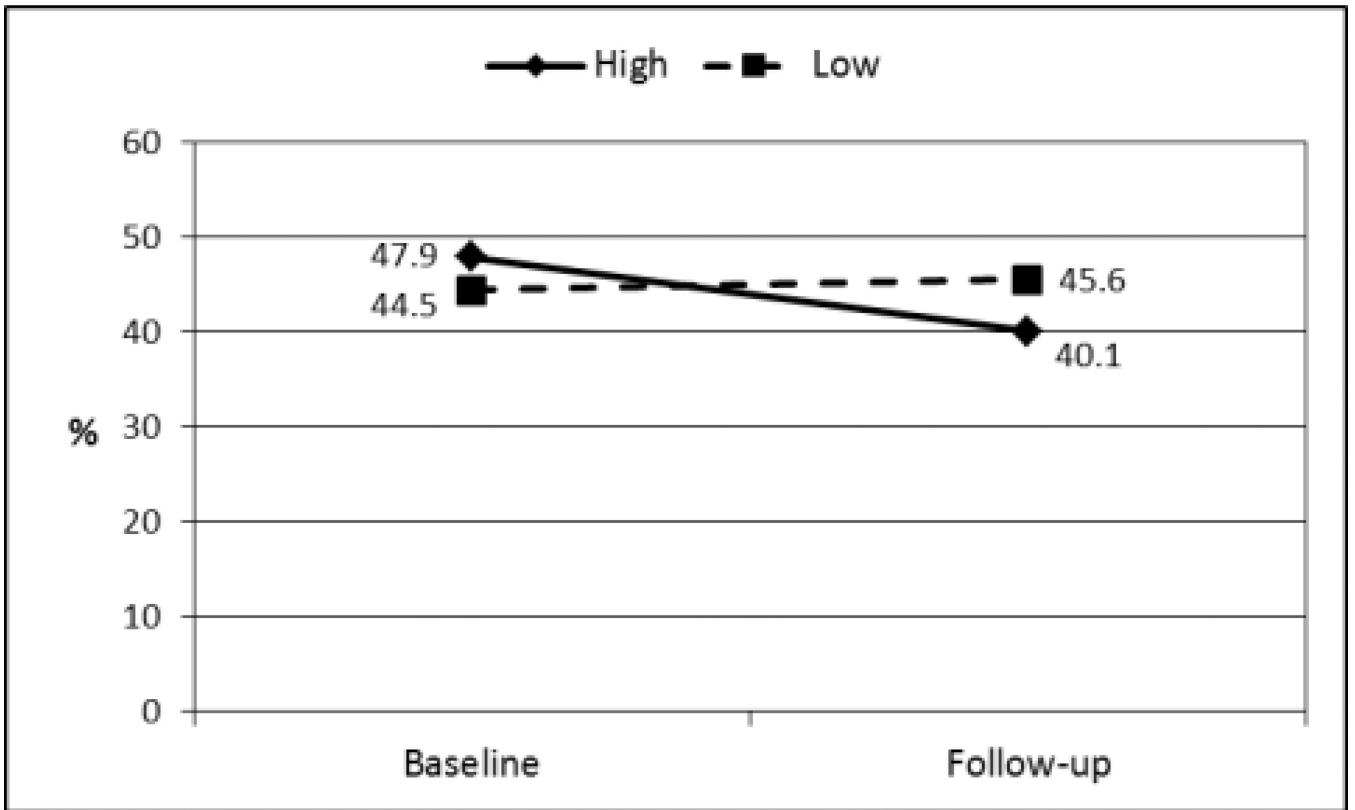


Figure 2. Adjusted rates of current use of alcohol: Enforcement intensity effects as measured by warnings/citations

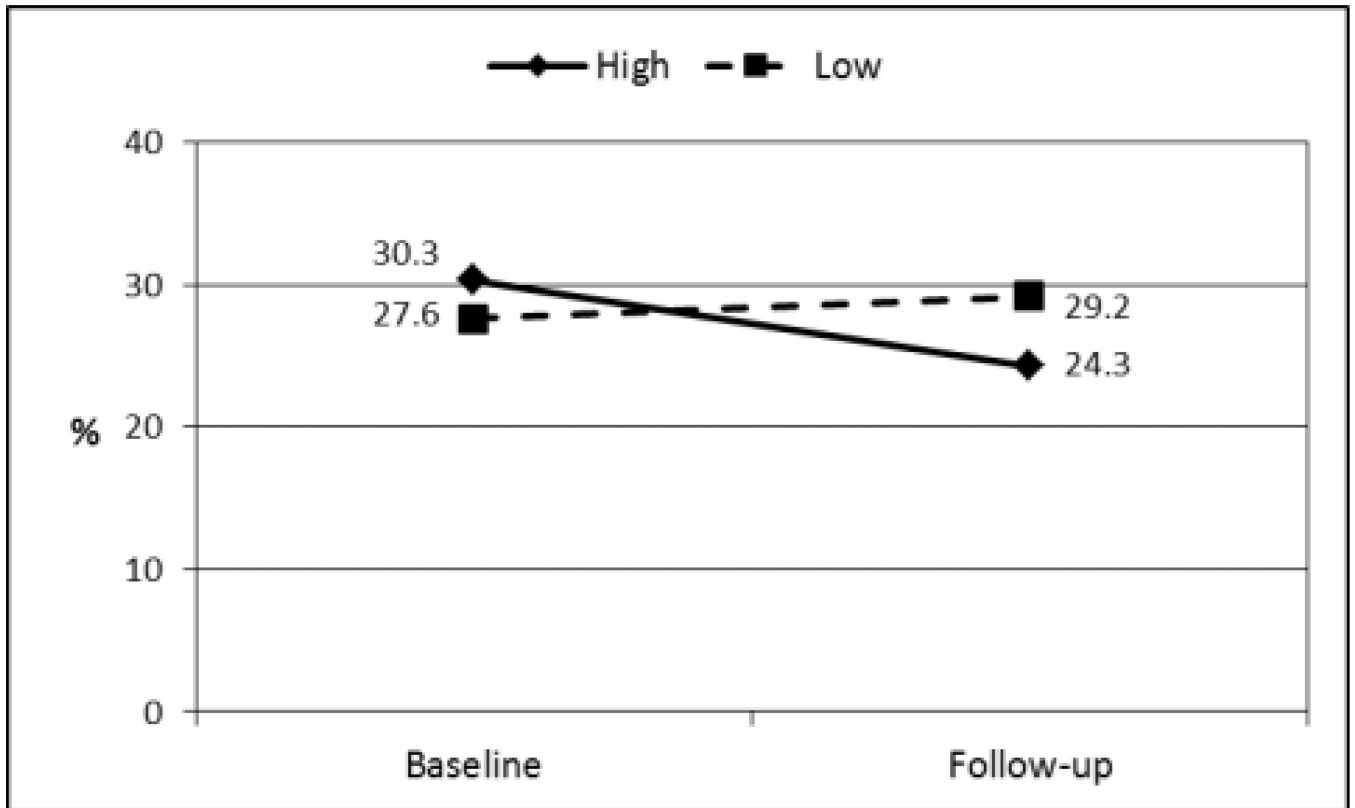


Figure 3. Adjusted rates of binge drinking: Enforcement intensity effects as measured by warnings/citations

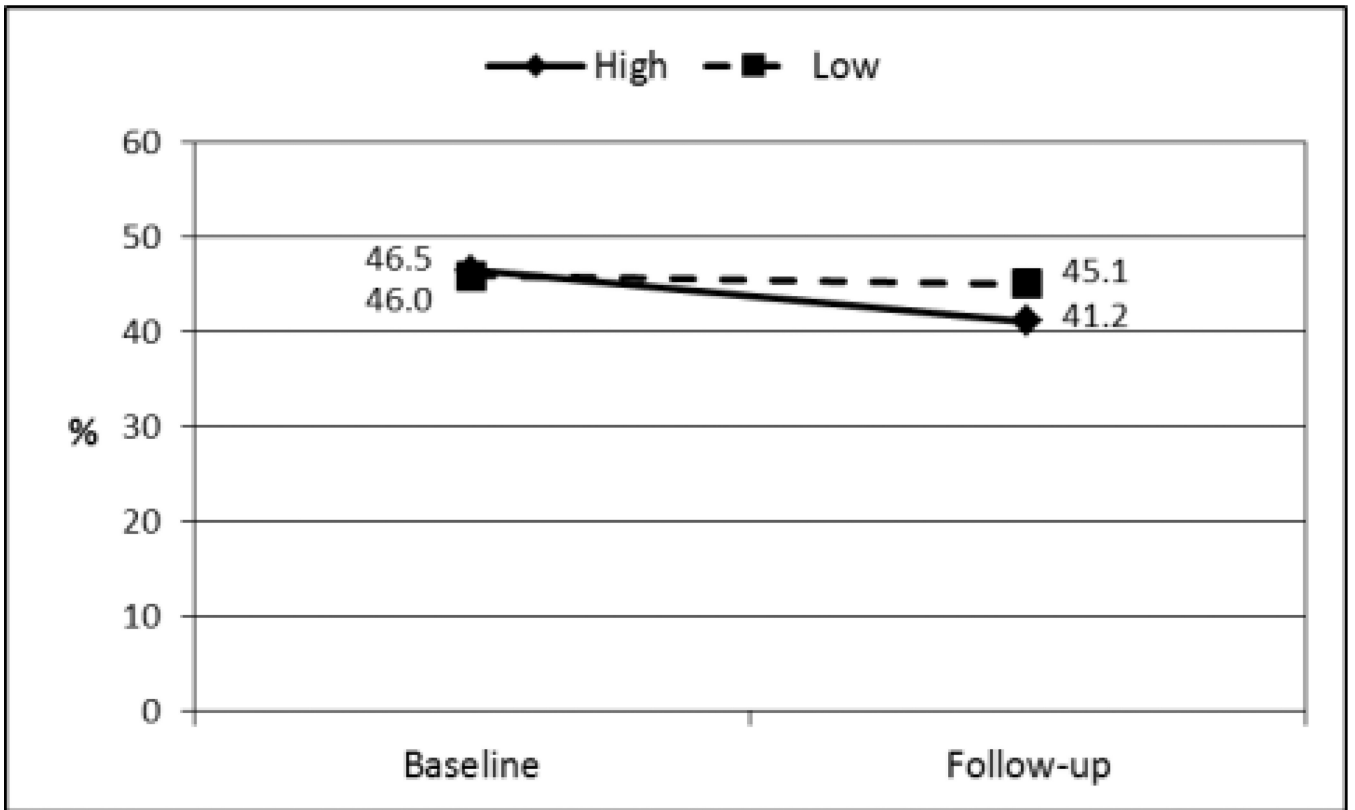


Figure 4. Adjusted rates of current use of alcohol: Enforcement intensity effects as measured by person-hours

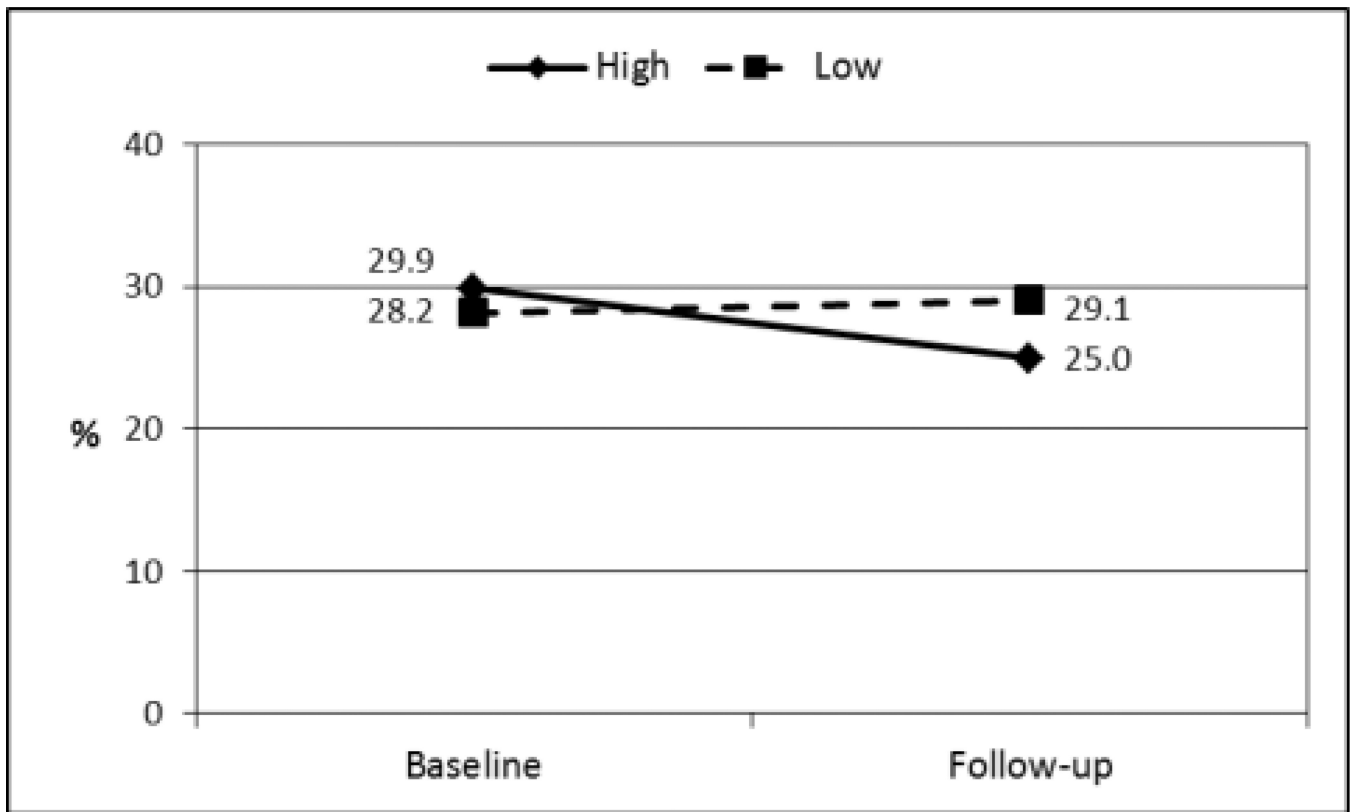


Figure 5. Adjusted rates for binge use of alcohol: Enforcement intensity effects as measured by person-hours

Table 1

Sample sizes by year and condition

	Year									
	2004	2005	2006	2007 ^a	2008 ^b	2009 ^c	2010			
Intervention										
Schools (n)	17	19	19	19	19	13	14			
Students (n)	1247	1554	1864	2022	1814	1012	1500			
Stores (n)	--	243	225	227	244	255	--			
Control										
Schools (n)	17	23	23	22	22	15	14			
Students (n)	1316	1652	1735	2032	2269	1072	1622			
Stores (n)	--	253	232	240	257	270	--			

^aFirst year of post-intervention for Cohort 1^bFirst year of post-intervention for Cohort 2^cFirst year of post-intervention for Cohort 3

Table 2

Descriptive statistics for analysis variables, by intervention phase and condition

	Pre mean or % (SE)		Post mean or % (SE)	
	Intervention	Control	Intervention	Control
Student^a demographics				
N of students	7229	7108	3784	4590
Gender (%)				
Male	49.0 (0.7)	48.7 (0.8)	48.9 (1.1)	49.4 (0.7)
Female	51.1 (0.7)	51.3 (0.8)	51.1 (1.1)	50.6 (0.7)
Non-white (%)	27.6 (3.3)	21.0 (3.4)	30.0 (3.5)	26.1 (3.3)
Students in school district eligible for free or reduced-price-lunch (mean %)	46.5 (2.7)	43.9 (3.9)	49.4 (2.9)	46.8 (3.5)
Non-white students in school district (mean %)	26.0 (3.9)	20.0 (5.0)	26.4 (3.8)	22.3 (4.1)
Student survey outcomes				
Alcohol (%)				
Current use	45.7 (1.3)	44.8 (1.4)	42.4 (0.9)	40.4 (2.1)
Current binge use	28.0 (1.3)	27.4 (1.4)	25.8 (0.8)	23.8 (1.5)
Perceived alcohol availability (% reporting alcohol would be “very easy” to get)	54.6 (0.8)	54.7 (0.8)	49.2 (1.2)	47.5 (1.1)
Perceptions of enforcement in neighborhood:				
Would be caught by police if drinking (% reporting “very much true” or “pretty much true”)	22.9 (1.1)	21.6 (1.2)	25.1 (1.0)	25.4 (1.6)
Would be asked for ID if purchasing alcohol (% reporting “very much true”)	50.4 (1.6)	49.7 (2.1)	50.2 (1.5)	48.4 (1.9)
Police would break up an underage drinking party (% reporting “very much true” or “pretty much true”)	44.1 (1.5)	43.0 (2.6)	43.2 (2.2)	43.4 (2.8)
Nobody over 21 would buy alcohol for minor (% reporting “very much true” or “pretty much true”)	41.0 (1.3)	41.5 (2.0)	41.8 (2.0)	39.7 (3.5)
Store characteristics				
N of purchase surveys conducted	741	773	453	479
Age of clerk (mean)	37.1 (0.7)	37.2 (0.6)	38.5 (1.0)	39.3 (0.8)
Number of clerks in store (mean)	2.3 (0.1)	2.3 (0.1)	1.8 (0.1)	2.0 (0.1)
Purchase outcomes				
Successful alcohol sale (%)	22.9 (2.9)	19.8 (2.6)	7.1 (1.6)	10.8 (2.6)

^aAll student data are for 11th grade students.

Note: Sample sizes are aggregated across all years of each intervention phase (i.e., pre- or post-intervention)

Table 3

Descriptive statistics for community-level enforcement intensity variables (N=18)

Intensity measure	Mean (SD)	Range
Count-based measures		
Citations and warnings	125.8 (113.2)	0–428
Person-hours	66.2 (76.1)	0–313
Rate-based measures ^{<i>I</i>}		
Citations and warnings	82.9 (103.0)	0–387.2
Person-hours	41.2 (54.7)	0–238.3

^{*I*}Per 1000 students in the community

Table 4Results of logistic regression models examining main effects of the intervention¹ on primary outcomes.

Fixed Effects (referent category)	Current use	Binge use	Perceived Availability	Compliance sales
	B (95% CI)	B (95% CI)	B (95% CI)	B (95% CI)
Intercept	-0.178 (-0.276, -0.080) ***	-0.930 (-1.040, -0.820) ***	0.198 (0.135, 0.261) ***	-1.477 (-1.834, -1.120) ***
Gender (female)	0.080 (0.025, 0.135) ***	0.258 (0.195, 0.321) ***	-0.018 (-0.073, 0.037)	--
Minority status (white)	0.055 (-0.012, 0.122) *	0.041 (-0.033, 0.115)	0.029 (-0.036, 0.094)	--
% FRPL	0.000 (-0.004, 0.004)	0.002 (-0.004, 0.008)	0.000 (-0.004, 0.004)	--
% minority	-0.005 (-0.011, 0.000) **	-0.007 (-0.013, -0.001) **	-0.001 (-0.005, 0.003)	--
Clerk age	--	--	--	-0.020 (-0.030, -0.010) ***
Number of clerks	--	--	--	-0.173 (-0.255, -0.091) ***
Time (pre-intervention)	-0.175 (-0.261, -0.089) ***	-0.200 (-0.298, -0.102) ***	-0.303 (-0.385, -0.221) ***	-0.737 (-1.125, -0.349) ***
Condition (control)	0.056 (-0.083, 0.195)	0.055 (-0.098, 0.208)	-0.004 (-0.092, 0.084)	0.304 (-0.200, 0.808)
Time*condition	0.037 (-0.083, 0.157)	0.067 (-0.068, 0.202)	0.096 (-0.020, 0.212)	-0.952 (-1.556, -0.348) ***
Adjusted means	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)
Control at baseline	0.451 (0.426, 0.476)	0.280 (0.256, 0.304)	0.549 (0.533, 0.565)	0.187 (0.132, 0.242)
Control at follow-up	0.408 (0.383, 0.433)	0.241 (0.219, 0.263)	0.473 (0.455, 0.491)	0.099 (0.060, 0.138)
Intervention at baseline	0.465 (0.441, 0.489)	0.291 (0.269, 0.313)	0.548 (0.532, 0.564)	0.237 (0.172, 0.302)
Intervention at follow-up	0.431 (0.406, 0.456)	0.264 (0.240, 0.288)	0.496 (0.476, 0.516)	0.054 (0.029, 0.079)

¹ Intervention effects are captured in the regression coefficient (B) for the time by condition interaction term.

* p<.10

** p<.05

*** p<.01

Note. Covariates not in the model are indicated by blank cells in the table.

Table 5

Results of logistic regression models examining effects of intervention intensity on primary and secondary outcomes.

Outcome	Citations ¹	Person hours ²
	Time × Intensity B (95% CI)	Time × Intensity B (95% CI)
Use		
Current use	-0.0017 (-0.0025, -0.0009) ***	-0.0011 (-0.0021, -0.0001) **
Binge use	-0.0018 (-0.0028, -0.0008) ***	-0.0018 (-0.0030, -0.0006) ***
Perceived alcohol availability	-0.0007 (-0.0015, 0.0001)	0.0000 (-0.0010, 0.0010)
Likelihood of enforcement		
Would be caught by police if drinking	0.0011 (0.0001, 0.0021) **	0.0026 (0.0014, 0.0038) ***
Would be asked for proof of age	0.0002 (-0.0010, 0.0014)	0.0017 (0.0003, 0.0031) **
Police would break up underage drinking party	0.0013 (0.0001, 0.0025) **	0.0029 (0.0015, 0.0043) ***
Adult would not purchase alcohol for minor	0.0012 (0.0000, 0.0024) **	0.0022 (0.0008, 0.0036) ***
Compliance sales	0.0021 (-0.0046, 0.0088)	-0.0034 (-0.0105, 0.0037)

¹ As measured by the number of citations and verbal and written warnings issued for underage alcohol law violations.

² As measured by the number of person hours devoted to enforcement of underage drinking laws.

* p<.10

** p<.05

*** p<.01

Note: the two measures were analyzed in separate models.

Table 6

Results of logistic regression models examining effects of intervention intensity (citations and warnings) on any alcohol use and binge drinking, with and without selected intervening variables.¹

Intervening variables included:	Time × Intensity B	
	Any Alcohol use	Binge Drinking
None	-.0017 ***	-.0018 ***
Perceived alcohol availability	-.0016 ***	-.0018 ***
Perceived likelihood of being caught by police if drinking	-.0015 ***	-.0016 ***
Perceived likelihood of being asked for ID if purchasing alcohol	-.0015 **	-.0014 **
Perceived likelihood of drinking party being broken up by police	-.0014 **	-.0010
Perceived likelihood of adults buying alcohol for minor if asked	-.0015 **	-.0012 *
All four perceived enforcement items	-.0013 **	-.0085

¹ All other covariates used in previous models were included.

* p<.10

** p<.05

*** p<.01