Do Alcohol Compliance Checks Decrease Underage Sales at Neighboring Establishments?

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ABSTRACT. Objective: Underage alcohol compliance checks conducted by law enforcement agencies can reduce the likelihood of illegal alcohol sales at checked alcohol establishments, and theory suggests that an alcohol establishment that is checked may warn nearby establishments that compliance checks are being conducted in the area. In this study, we examined whether the effects of compliance checks diffuse to neighboring establishments. **Method:** We used data from the Complying with the Minimum Drinking Age trial, which included more than 2,000 compliance checks conducted at more than 900 alcohol establishments. The primary outcome was the sale of alcohol to a pseudo-underage buyer without the need for age identification. A multilevel logistic regression was used to model the effect of a compliance check at each establishment as well as the effect of compliance checks at neighboring establishments within 500 m (stratified into four equal-radius concentric rings), after buyer, license, establishment, and community-level variables were controlled for. **Results:** We observed a decrease in the likelihood of establishments selling alcohol to underage youth after they had been checked by law enforcement, but these effects quickly decayed over time. Establishments that had a close neighbor (within 125 m) checked in the past 90 days were also less likely to sell alcohol to young-appearing buyers. The spatial effect of compliance checks on other establishments decayed rapidly with increasing distance. **Conclusions:** Results confirm the hypothesis that the effects of police compliance checks do spill over to neighboring establishments. These findings have implications for the development of an optimal schedule of police compliance checks. (*J. Stud. Alcohol Drugs, 74,* 852–858, 2013)

ALCOHOL USE IS RELATED TO MANY PROBLEMS among youth, including traffic crashes, suicides, and assaults (National Highway Traffic Safety Administration, 2011; Sher and Zalsman, 2005; Sheppard et al., 2008). A promising approach for preventing youth from consuming alcohol and experiencing these problems is to prevent youth from obtaining alcohol. However, youth have easy access to alcohol from both commercial sources (i.e., licensed alcohol establishments such as bars and liquor stores) and social sources (e.g., friends, siblings) despite laws prohibiting the sale and provision of alcohol to individuals younger than age 21 (Cremeens et al., 2009; Harrison et al., 2000; Hearst et al., 2007).

To reduce access to alcohol from commercial sources, many communities conduct law enforcement compliance checks (Montgomery et al., 2006). As part of compliance checks, individuals younger than age 21 attempt to purchase alcohol under the supervision of law enforcement agents; if there is an alcohol sale, a penalty is applied to the server/seller and/or the license holder. Several studies have found that compliance checks can reduce the likelihood of alcohol sales to minors (Centers for Disease Control and Prevention, 2004; Grube, 1997; Preusser et al., 1994; Wagenaar et al., 2005).

Deterrence theory provides a framework for understanding the mechanism by which compliance checks may influence establishment behavior. Deterrence theory (Gibbs, 1975) proposes that behavior change occurs through the threat of punishment, with greater perceived threat if the penalty is certain, swift, and severe. Specific deterrence effects are those sanctions imposed directly on an offender, and general deterrence effects are those on the general public. Within this theoretical context, the effects of a compliance check on the targeted establishment represent specific deterrence, whereas any spillover effects to neighboring establishments represent general deterrent effects. Empirical support for the theory has been shown in a variety of enforcement domains (Pratt et al., 2008).

As studies have shown the potential effectiveness of compliance checks to have a deterrent effect, community leaders began to ask for guidance on optimal implementation of compliance checks (e.g., how frequently they should be conducted). In the Complying with the Minimum Drinking Age (CMDA) study, Wagenaar et al. (2005) assessed the

short- and long-term effects of police compliance checks and found an immediate 17% reduction in the likelihood of sales to underage youth in on-premise (e.g., bars, restaurants) and off-premise establishments (e.g., liquor stores, convenience stores) that had been checked by law enforcement. Within 3 months, these effects decayed to an 8.2% long-term reduction in on-premise establishments; no long-term effects were observed among off-premise establishments. Compliance checks also did not appear to have a spillover (i.e., general deterrent) effect on establishments that had not been checked that were located throughout the same community. It is worth noting, however, that the entire community was the unit of spillover in these analyses, and the large size of the geographic space may have masked any spillover effects occurring at much smaller distances.

Based on the findings from this study, the authors recommended that communities conduct compliance checks at all establishments—not just a random sample of establishments—and conduct the checks more than once or twice per year to maintain a long-term reduction in the likelihood of alcohol sales to underage youth. However, for some communities with a large number of alcohol establishments, it may not be feasible with limited resources to conduct compliance checks of all establishments more than once or twice per year. Research is needed to identify ways to make compliance checks maximally effective with limited resources.

Anecdotal data collected through our work with hundreds of alcohol establishments show that establishments communicate with each other when they believe law enforcement compliance checks occur in their establishments (Wagenaar et al., 2005). These communication networks are complex, likely involving the concepts of proximity, similarity of individuals and establishments, friendships, shared ownership, and reciprocity, to name a few. Integrating multiple theoretical streams, Monge and Contractor (2003) illustrate how these social networks facilitating communication may develop, survive, and change.

It may be possible for law enforcement agencies to use communication networks among alcohol establishments to maximize the effects of compliance checks to help decrease the likelihood of alcohol sales to minors in their communities. If an establishment that has been checked as part of a compliance-check campaign communicates through its network to other establishments that law enforcement agents are in the community conducting checks, the likelihood of an illegal sale may be diminished within those establishments in the communication network even if they have not been checked themselves. If a law enforcement agency has limited resources and can only conduct compliance checks at a subsample of alcohol establishments, it may be possible to use the communication networks to maximize the effects of compliance checks.

In this article, we used secondary data from the CMDA study to evaluate whether one potential factor that may affect communication between establishments—proximity—predicts diffusion of the deterrent effects of compliance checks to other establishments. We hypothesized that communication was more likely to occur with establishments located geographically close to establishments that had been checked by law enforcement (e.g., in the same block or neighborhood) rather than those located in other parts of the community. Thus, the deterrent effects of compliance checks may also be more likely to diffuse to those geographically closest to the targeted establishment. The results of this study can guide jurisdictions in strategically targeting their alcohol compliance checks, particularly with limited resources.

Method

The current study used data collected originally as part of the CMDA study, which was a 4-year, quasi-experimental, community trial with both a time-series component and a cohort component (Wagenaar et al., 2005). Twenty urban and suburban communities from a large, midwestern metropolitan area were selected, with 11 of the communities (1 large urban city and 10 surrounding suburbs) assigned to an intervention group and the other 9 (1 large urban city and 8 surrounding suburbs) assigned to a comparison group. Two interventions were examined in the original study aimed at reducing alcohol sales to underage patrons at retail establishments: law enforcement compliance checks and owner/manager training. The current proposed analyses examine the effects of the compliance-check intervention (a previous analysis [Wagenaar et al., 2005] found no effects for the training program, and the spillover effects are only hypothesized for the compliance checks). The law enforcement compliance-check intervention consisted of youth younger than age 21 attempting to purchase alcohol from licensed establishments under the supervision of law enforcement agents within each community. The intervention period was 2 years (Years 2 and 3 of the study).

Intervention communities determined the number of compliance checks conducted each year as well as the implementation schedule but were encouraged to conduct rounds of compliance checks within specified periods during the 2-year intervention period. In general, compliance checks were conducted in four rounds, two in the first year of the intervention period and two in the second year. In most of the suburban communities, all establishments were checked at least twice. In the urban area, all establishments were checked in the first round of each year, and those that failed were checked in the second round of that year. Law enforcement and licensing agencies in each intervention community agreed to complete a form immediately following each compliance check indicating the outcome (sold alcohol, alcohol request refused), date and time of purchase attempt, and identification number of the buyer implementing the compliance check. The total number of compliance checks conducted in the intervention

communities was 959. The number of checks for individual establishments in the intervention communities ranged from 0 to 6, with a mean of 2.1.

Although not encouraged to conduct checks, some comparison communities on their own conducted compliance checks during the study period. The date of the compliance check and the outcome of each check were obtained through law enforcement and licensing records in each community. The total number of checks conducted in the comparison communities was 894. The number of checks for individual establishments in the comparison communities ranged from 0 to 8, with a mean of 1.8. Most important, although the overall levels of enforcement activity were comparable in the intervention and comparison communities, the temporal patterns were quite different. As noted above, the intervention communities did the majority of their compliance checks in rounds during the 2-year intervention period. In contrast, compliance checks in the comparison communities were spread out more evenly over the entire 4 years of the study (including the approximately 1-year baseline and the 1-year follow-up periods).

Pseudo-underage purchase attempts

To assess the effects of the compliance-check intervention, we conducted pseudo-underage alcohol purchase attempts, using buyers who were 21 years of age or older but who appeared to a panel of judges to be 17–20 years old. These purchase attempts were conducted by our research team for research and evaluation only and kept strictly separate from the intervention side of the project, which included compliance checks conducted by law enforcement using underage individuals.

Pseudo-underage purchase attempts were conducted by same-gender teams of two, a buyer and an observer. We trained buyers and observers on the research protocol and safety measures. For off-premise establishments, buyers entered the establishment alone, carrying only money for the purchase attempt and no age identification. Buyers went to the shortest line in the establishment and attempted to purchase a six-pack of beer. If asked how old they were, buyers answered honestly. If asked for identification, buyers stated they did not have identification with them. If the sale was refused or the seller asked buyers to get their identification, buyers exited the establishment. The observers remained in the car out of view of the seller. For on-premise establishments, the protocol was similar, although observers accompanied buyers into the establishment. Buyers ordered a beer, and observers ordered a soda. Buyers gave similar responses to requests for identification as noted for off-premise establishments. If served, observers drank their soda but buyers did not consume the beer.

In total, 77 buyers (55 females, 22 males) and 83 observers (64 females, 19 males) conducted 7,242 purchase attempts at 942 establishments. Although all buyers and observers were age 21 or older (maximum actual age = 26 years), their median perceived age as judged by age-assessment panels ranged from 17 to 20. The number of purchase attempts made by individual buyers ranged from 12 to 442 ($M = 93.6$, $SD = 103.5$), with very little missing data (less than 3% of scheduled eligible purchase attempts).

Measures

Our core outcome measure was the propensity of alcohol retail establishments to sell alcohol to underage youth, measured using the pseudo-underage purchase attempts. This outcome was dichotomous—alcohol sold or not sold.

The primary predictors pertained to whether law enforcement compliance checks were conducted at the establishment itself (referred to as the targeted establishment) and at neighboring establishments. To determine the neighbor status of establishments, establishments were geocoded (100% success), and this geolocation information was used to place establishments within buffer areas surrounding an establishment. We restricted the maximum buffer size to 500 m (based on examination of semivariograms), and distances of zero were excluded because these values could represent the same establishment undergoing changes in name and/or ownership over the duration of the study, or they could represent venues in the same location but that differ vertically. We subdivided the 500-m distance into four concentric, mutually exclusive distance bands of equal radius (1 m–125 m, 126 m–250 m, 251 m–375 m, and 376 m–500 m; 125 m represents approximately one city block in our study area) to examine attenuation in the strength of association of any neighboring effects as a function of increasing distance. Within each distance band and for each targeted establishment, the dates of law enforcement compliance checks at the neighboring establishments were cross-referenced against the dates of pseudo-underage purchase attempts at the targeted establishment to identify neighboring law enforcement compliance checks that occurred within 90 days before a pseudo-underage purchase attempt. A total of 798 establishments (87% of the sample) had at least one neighboring establishment within 500 m. Our four primary predictor variables were the binary indicators for the presence or absence of a law enforcement compliance check at a neighboring establishment over each of the four concentric distance bands. Additional predictor variables included two indicators for a law enforcement compliance check at the targeted establishment, 1–30 days and 31–90 days before the pseudo-underage purchase attempt.

Based on previous research (Forster et al., 1994; Paschall et al., 2007; Wolfson et al., 1996), we included a number of establishment and buyer characteristics as covariates in all analyses to control for their effects on the outcome. Establishment characteristics included license type (full

liquor vs. wine- and/or beer-only) and type of establishment (on-premise vs. off-premise). Buyer characteristics included gender and age (in years). Additional covariates were city type (urban vs. suburban), study condition (intervention vs. comparison), and a continuous term to account for temporal trends since study initiation.

Overview of analyses

For all measures, we computed descriptive statistics. Before statistical modeling, we examined spatial autocorrelation in the propensity of sales to underage individuals (based on research purchase attempts) to assess the presence and magnitude of autocorrelation in the data unconditional on any fixed effects or covariates. As pointed out by Cressie (1993), the degree of spatial autocorrelation reduces the effective sample size, and the standard errors and confidence intervals associated with the parameter estimates increase. After estimating our statistical model, we also examined spatial autocorrelation in the residuals to determine if autocorrelation was present after accounting for the fixed effects of the explanatory variables included in the model. We found no evidence of spatial autocorrelation in the data, negating the need for spatially correlated residuals (Britt et al., 2005); note that our statistical model remained "spatial" in that many of our predictor variables were spatially associated.

We used a conditional multilevel logistic regression model to estimate the effects of law enforcement compliance checks at targeted and neighboring establishments (within 90 days) on subsequent pseudo-underage purchase attempts at the targeted establishments. Covariates were modeled as fixed effects, and random effects were included for both targeted establishment ($n = 798$) and buyer ($n = 77$). A natural log transformation of the total number of neighboring establishments within 500 m of each targeted establishment was included as an offset to account for potential differences in the probability of exposure to a neighboring law enforcement compliance check. The model was estimated both overall and stratified by the number of neighboring establishments to examine a differential association of neighboring compliance checks as a function of the number of neighboring establishments.

Results

Table 1 provides descriptive statistics. The number of neighboring establishments within 500 m of each targeted establishment ranged from 1 to 32, with a mean of 6.28. Approximately half of the establishments were located in the intervention communities, were located in an urban area, and had a full liquor license. Approximately one third were off-premise establishments.

Results from the regression models (overall and stratified by the number of neighboring establishments) are reported in Table 2. After we controlled for a number of significant covariates and included random effects for establishment and buyer, we saw statistically significant protective effects of law enforcement checks for both checks at the targeted

TABLE 1.   Descriptive statistics for all measures

Variable	M (SD)	Range
No. of pseudo-underage purchase attempts	7.97 (3.35)	1–15
No. of neighboring establishments	6.28 (6.14)	1–32
	% of establishments	
Alcohol purchased by pseudo-underage buyer	18.72	
Predictors		
Law enforcement check at *targeted* establishment (before pseudo-underage purchase attempt)		
1–30 days prior	4.36	
31–90 days prior	9.53	
Law enforcement check at *neighboring* establishment (1–90 days before pseudo-underage purchase attempt)		
1–125 m	13.18	
126–250 m	12.19	
251–375 m	11.89	
376–500 m	10.05	
Covariates		
Full liquor license vs. other	50.88	
Off premise vs. on premise	34.71	
Urban vs. suburban	55.14	
Intervention vs. comparison	47.37	
Buyer gender: Male	21.47	
	M (SD)	Range
Buyer age, years	22.90 (1.03)	21–26

Note: No. = number.

TABLE 2.   Effect of law enforcement compliance checks on purchase attempt outcome (among all establishments and stratified by number of neighboring establishments)

| | Odds of sale to pseudo-underage buyer | | |
| | | No. of neighboring establishments | |
Fixed effects	All establishments ($n = 798$) OR [95% CI]	1–3 ($n = 375$) OR [95% CI]	≥4 ($n = 423$) OR [95% CI]
Predictors			
Law enforcement check at *targeted* establishment			
1–30 days prior	**0.39 [0.24, 0.64]**	**0.40 [0.20, 0.77]**	**0.34 [0.17, 0.69]**
31–90 days prior	0.82 [0.60, 1.11]	**0.58 [0.37, 0.90]**	0.97 [0.65, 1.46]
Law enforcement check at *neighboring* establishment (1–90 days prior)			
1–125 m	**0.69 [0.52, 0.91]**	0.93 [0.60, 1.44]	**0.61 [0.43, 0.85]**
126–250 m	0.94 [0.71, 1.24]	0.86 [0.50, 1.47]	1.13 [0.82, 1.55]
251–375 m	1.00 [0.75, 1.31]	1.33 [0.76, 2.35]	0.98 [0.71, 1.36]
376–500 m	0.93 [0.70, 1.25]	0.96 [0.52, 1.77]	1.05 [0.75, 1.47]
Covariates			
Full liquor license vs. other	**0.30 [0.24, 0.38]**	**0.40 [0.30, 0.53]**	**0.37 [0.28, 0.50]**
Off premise vs. on premise	**2.06 [1.62, 2.62]**	**1.36 [1.04, 1.78]**	**1.80 [1.30, 2.49]**
Urban vs. suburban	**0.70 [0.55, 0.89]**	0.98 [0.73, 1.30]	0.92 [0.67, 1.28]
Intervention vs. comparison	**1.35 [1.06, 1.71]**	0.97 [0.74, 1.28]	1.24 [0.91, 1.69]
Buyer gender: Male	1.03 [0.91, 1.16]	1.01 [0.88, 1.17]	1.11 [0.95, 1.30]
Buyer age	**1.42 [1.00, 2.00]**	1.24 [0.86, 1.77]	**1.78 [1.18, 2.68]**
Time since study initiation, years	**0.76 [0.69, 0.84]**	**0.82 [0.73, 0.92]**	**0.69 [0.61, 0.79]**
Random intercepts	s^2 [95% CI]	s^2 [95% CI]	s^2 [95% CI]
Establishment	1.36 [1.11, 1.67]	0.65 [0.44, 0.97]	0.96 [0.69, 1.34]
Buyer	0.27 [0.15, 0.49]	0.18 [0.08, 0.43]	0.30 [0.15, 0.60]
Variable	AIC	AIC	AIC
Model fit	5,898.80	2,870.27	2,893.22

Notes: **Bold** = statistically significant ($p < .05$). AIC = Akaike Information Criterion.

establishment and checks conducted at neighboring establishments. Consistent with our previously reported findings (Wagenaar et al., 2005), law enforcement checks at an establishment led to a reduction in pseudo-underage sales. Specifically, a law enforcement check in the prior 30 days at the targeted establishment was associated with a 61% reduction in the odds of sales, and this did not appear to differ greatly in terms of the number of neighboring establishments (60% vs. 66% reduction). Also consistent with our prior analyses, the effects of compliance checks decay over the few months following a check. In the current analyses, effect estimates were attenuated when the checks occurred between 31 and 90 days prior, only reaching significance for establishments located in lower density areas (42% reduction, $p < .05$).

Controlling for the effects of compliance checks conducted at the targeted establishment, we also observed a statistically significant 31% reduction in the odds of an alcohol sale to a pseudo-underage buyer for establishments that had one or more neighbors within 1 m–125 m that had a law enforcement compliance check within 90 days (Table 2). The odds ratios for the remaining three distance bands were of small magnitude and not statistically significant. On stratification, we observed that a statistically significant protective asso-

ciation of the neighbor compliance check in the 1 m–125 m distance band was restricted to those establishments with a higher density (≥4) of neighboring establishments (estimated odds reduction = 39%). A likelihood ratio test of an interaction product term to test this difference was not statistically significant ($p = .19$). However, given the multiplicative scale of the model and the moderate overlap in the 95% confidence intervals for the odds ratio, we concluded that effect measure modification of this association is plausible.

Discussion

Consistent with previous research, we saw a strong and consistent effect of compliance checks on the likelihood of establishments selling alcohol to underage youth. Compliance checks reduced the odds of sales to a young-looking patron without age identification by more than 60% in the month following the check. This effect was consistent across establishments in areas with both higher and lower alcohol establishment density. This is crucial because reducing the availability of alcohol is an important way to reduce alcohol use and related problems among youth (National Research Council and Institute of Medicine, 2004). Illegal alcohol

sales contribute directly to the availability of alcohol to youth who purchase alcohol and indirectly when those youth supply the purchased alcohol to other underage youth. Unfortunately, the majority of law enforcement agencies do not conduct compliance checks frequently enough to maintain these effects (Erickson et al., under review), likely because of budgetary, time, and personnel limitations.

This study confirms our previous findings (Wagenaar et al., 2005) that the effects of the compliance checks decay fairly rapidly over time and now adds the finding of a similar rapid decay of the effect by distance. The effects decayed quickly over time, although there was still a significant effect for up to 90 days for establishments in lower density areas. Note that the estimates in this study differ somewhat from our previous study, likely because of a number of differences in the models, including how the temporal decay function was modeled and inclusion of a spatial function.

Results from the current study provide the first evidence that law enforcement compliance checks not only affect the behavior of the targeted establishment but also have a general deterrent effect on nearby neighbors. As hypothesized, the protective effects of law enforcement compliance checks appear to spill over to neighboring establishments. Among all establishments, having a close neighbor (within 125 m) checked in the past 90 days reduced the odds of sales by more than 30%. This reduction is in addition to or on top of the direct effect of an establishment itself being checked.

An interesting finding is that the spillover effect to neighboring establishments occurs within a very limited geographic distance. The spatial effects show that the spillover effect of compliance checks decay abruptly with increasing distance, with no significant effects of checks conducted in neighboring establishments located beyond 125 m (about one city block in the study area). In addition, the spatial effects appear to be mostly driven by effects in areas of higher alcohol establishment density. We have hypothesized that these spatial diffusion effects are delivered via communication networks that exist between alcohol establishments. If correct, our results suggest that these networks are likely very sensitive to proximity and that they are more likely to exist in areas with a higher density. Stronger effects in high-density areas are consistent with research in social network analysis that has shown information can flow more readily when nodes are more closely linked or more interlinked with other nodes. For example, Gulati (1999), studying alliances among industrial firms, found that firms that are embedded in dense clusters of firms form more new alliances that can facilitate information sharing and communication.

Other possible mechanisms may be responsible for the spillover effects. Law enforcement agencies frequently provide letters describing these activities to alcohol retailers shortly before or after conducting compliance checks. Some communities in the current study used these letters, and

they may be driving the general spillover effects. Similarly, local media will sometimes report recent law enforcement compliance-check activity, and this may be another conduit for these effects. Further empirical research designed to specifically examine communication networks between alcohol establishments and specific information flow regarding compliance checks is needed to better understand these mechanisms.

Spatial diffusion effects provide a possible opportunity to maximize the enforcement effects of compliance checks. By recognizing that the effects of the compliance checks decay over time but spill over to neighboring establishments, a law enforcement department could tailor the schedule of compliance checks to maximize the effects of their limited resources. For example, real-world constraints may limit an agency to check each establishment only one time per year. In areas with a higher density of alcohol establishments, it may be more effective to conduct compliance-check campaigns every few weeks or months but check only a subset of the establishments each round. This way, it may be possible to maintain the general deterrent effect across all of the establishments in these areas throughout the year. By decreasing the number of compliance checks being conducted in the more dense areas, it may be possible for the agencies to use their resources to check all of the establishments in less dense areas more frequently than once per year. Given that the specific effects of compliance checks decay less rapidly in establishments that are located in less dense areas, checks may need to be conducted less frequently to maintain the effects in these areas.

Although this study provides interesting findings, it is not without limitations. First, the opportunity to fully parse the spatial and temporal effects is limited by the available data. The original study was not designed to examine spatial diffusion effects, and the data become sparse when attempting to simultaneously model the effects of both time and space. As a result, we could not fully explore the joint effects at a resolution where we could examine them separately. However, the results nevertheless provide evidence that the spatial diffusion effects exist and are of a magnitude that may be practically important. Second, the study was conducted in one metropolitan area in the midwestern United States and may not be generalizable to other regions, countries, or areas. However, there are no a priori reasons to consider the study area unrepresentative of U.S. metropolitan areas. Generalizability is potentially a concern when considering nonurban areas, where the physical proximity of alcohol establishments can be quite different from that seen in a large metropolitan city. For example, in smaller communities where there may only be one or two alcohol establishments, the communication networks hypothesized to deliver these spatial diffusion effects may not exist or may be substantially enhanced from that seen in a larger community with many alcohol establishments. Third, we used proximity as a crude

proxy for this communication network. Ideally, we would have directly assessed the existence and nature of each establishment's communication network. This information was not collected as part of the original data collection and, with the passage of time, was not collectable retrospectively.

Despite these limitations, this study provides the first evidence that law enforcement compliance checks do have spillover effects on other alcohol establishments. This information can be used by law enforcement to develop improved schedules of enforcement to maximize the beneficial effects of limited resources.

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