

## ORIGINAL ARTICLE

### Alcohol Outlet Density and Violence: The Role of Risky Retailers and Alcohol-Related Expenditures

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**Abstract** — **Aims:** The aim of the study was to assess the association between alcohol outlet density and violence controlling for alcohol expenditures and the density of other retailers. **Methods:** Cross-sectional ecological study of 1816 block groups in Philadelphia. We obtained 2010 data for aggravated assaults, alcohol outlets, alcohol expenditures, business points, land use and socioeconomic and demographic characteristics. We mapped the spatial distribution of alcohol outlets and aggravated assaults using a geographic information system. We estimated the association between assault density and total, on-premise and off-premise alcohol outlet densities using spatial regression models and controlling for the covariates of urban crime rates, alcohol expenditures, and the presence of other general and risky commercial retail outlets. **Results:** The strong and positive association between alcohol outlet density and violence remained after controlling for alcohol expenditures and the density of other retailers. **Conclusion:** Findings support the concept that off-premise alcohol outlets in the neighborhood environment may impact health and social outcomes. The positive outlet–violence association in the face of these controls means it is not an association due solely to alcohol availability or to retail density. It also suggests that there is something unique about alcohol outlets or their density that makes them crime generators and links them to violence.

## INTRODUCTION

There is considerable evidence that alcohol outlet density is associated with negative health outcomes (Popova *et al.*, 2009; Theall *et al.*, 2009) and increased rates of violence (Britt *et al.*, 2005; Gruenewald and Remer, 2006; Livingston, 2006). Recent research showed not only that this association remains when controlling for other ecological features of neighborhoods, but that community characteristics like social organization (Pridemore and Grubestic, 2012a), land use (Pridemore and Grubestic, 2012b) and ethnic composition (Gruenewald *et al.*, 2006) moderate the strength of the harmful effect of outlet density on violence. Nevertheless, questions remain as to whether outlet density is truly responsible for increased crime, or if the outlet–violence association is only the result of alcohol availability (Stockwell and Gruenewald, 2004). Similarly, there are concerns that the outlet–violence association may also be the result of routine activity, where neighborhoods with outlets and other businesses simply bring potential victims and offenders together (Briscoe and Donnelly, 2001; Gruenewald, 2007; Freisthler *et al.*, 2008; Parker *et al.*, 2011).

The argument that the association between alcohol outlet density and violence is primarily driven by alcohol availability is a reasonable one. Simply put, the argument is that alcohol *itself* is to blame, not alcohol outlets. It is widely acknowledged that a significant dose–response relationship exists between blood alcohol level and aggression/violence (McDonald *et al.*, 2005; Duke *et al.*, 2011). Thus, greater alcohol outlet density increases alcohol availability, encourages niche drinking environments, increases consumption and clusters violence-prone drinkers together (Gruenewald, 2007; Grubestic and Pridemore, 2011; Livingston, 2011). One way to account for this relationship, albeit imperfect, would be to include a control for the volume of alcohol sales within a community. Although sales do not necessarily correspond to consumption, if a relationship between outlet density and violence remained after controlling for the amount of alcohol sold, this would suggest there is

something unique about outlets themselves, or their density, that contributes to the generation of crime. Unfortunately, in the USA alcohol sales data are rarely available for geographic units smaller than states (Gruenewald, 2011). With some exceptions (Stevenson *et al.*, 1999; Norstrom, 2000; Bye, 2007; Stockwell *et al.*, 2009; Liang and Chikritzhs, 2011), this lack of sales data is true for other nations as well.

It is also possible that the connections between alcohol outlet density and violence are simply driven by routine activities (Cohen and Felson, 1979). In this context, alcohol outlets function no differently than any other commercial outlet. Regardless of the product being sold, outlets (alcohol or otherwise) tend to cluster in commercial districts within cities because of land-use and zoning regulations (Grubestic *et al.*, 2012; Pridemore and Grubestic, 2012b). As a result, these agglomerations bring together a steady stream of people (i.e. potential victims and offenders) in the same space. In other words, there is nothing special about being an *alcohol* retailer or about the density of alcohol outlets. What matters for higher crime is simply being a *retailer* or the greater density of commercial retail outlets (Felson, 1987). Further, even if alcohol outlets are potentially risky, their density covaries with other types of risky retailers associated with higher crime rates (Ford and Beveridge, 2004; Rengert *et al.*, 2005) such as check-cashing stores (Kubrin *et al.*, 2011) and pawn shops (Miles, 2008). Interestingly, although a handful of prior studies have controlled for the density of commercial retailers (Gruenewald and Remer, 2006; Gruenewald *et al.*, 2006; Freisthler *et al.*, 2008), none have explicitly controlled for the presence of risky retailers.

Collectively, these are valid arguments and they represent two major remaining limitations that leave statements about the relationship between alcohol outlet density and violence vulnerable to criticism. In this study, we contribute to the existing literature by being the first to address each of these limitations by controlling for an indicator of local alcohol expenditures and for the presence of other retailers, including risky retailers. If an association between alcohol outlet density

and violence remains after controlling for these characteristics, this would substantially strengthen evidence that the outlet–violence association is valid. It would also suggest there is something unique about alcohol outlets or their concentration that helps generate crime.

## METHODS

### *Study area*

Philadelphia, Pennsylvania, was our study area, and our unit of analysis was the block group. In 2010 Philadelphia had a population of about 1.5 million residents in 1816 block groups. Block groups are the smallest unit for which socio-economic data are available for public use from the Census Bureau.

### *Measures*

Our dependent variable was aggravated assault, which the Uniform Crime Report defines as an unlawful attack by one person on another, often with a weapon, for the purpose of inflicting severe bodily injury (FBI, 2010). We obtained geocoded assault data from the Philadelphia Police Department (PPD). As described below, we estimated models using both spatial and negative binomial regression. For the latter, we used assault counts as the dependent variable. For the former, we used assault density (i.e. assaults per square mile). As detailed by Pridemore and Grubestic (2013), the use of assault density can offer advantages over a per capita measure. In short, a per capita measure where the denominator is the population size makes a somewhat unrealistic assumption that all assault victims and offenders are residents of the index block group,  $i$  (or tract, ZIP code, etc.). Conversely, the spatial measure provides a more standardized and geographically meaningful comparison of assaults between units, and thus a better gauge of any local association between alcohol outlets and assaults. For example, if block groups A and B have the same number of residents (1000) and outlets (12) and block group A is 0.10 square miles and B is 2.5 square miles (a common range in cities), a per capita measure provides the same score for A and B. This fails to capture residents' spatial proximity to outlets. Conversely, the spatial metric provides scores of 120 and 4.8 outlets per square mile for block groups A and B, respectively, providing a more meaningful measure of spatial exposure to outlets. Further, because the Census Bureau attempts to maintain the average population of block groups at 1500, there is some level of exposure standardization within block groups as well.

The main independent variables were total, on-premise and off-premise alcohol outlet densities. Off-premise outlets were defined as the 52 state-controlled liquor stores plus establishments—usually delis and convenience stores—with an 'E' license (allowing them to sell beer for off-premise use) or a 'D' license (distributors allowed to sell beer for off-premise use). Outlet locations were obtained from the Pennsylvania Liquor Control Board for November 2010. We excluded airports, distilleries, large-scale distributors and sacramental wine vendors, leaving a total of 2016 outlets. All outlets were geocoded successfully using the ArcGIS software (ESRI, 2012).

The two key control variables in this study were alcohol expenditures and the presence of non-alcohol retailers. Alcohol sales data, especially at small units of analysis, are

generally unavailable in the USA, and so we used a proxy: *household alcohol expenditures* as a proportion of household income. This measure is derived from the Bureau of Labor Statistics' Consumer Expenditure Surveys (CEX) and provided by ESRI (2010a). To compensate for the relatively small CEX survey bases and the variability of single-year data, expenditures are averaged over 2 years.

There are several compelling reasons for using the expenditures data. First, the CEX data provide a viable snapshot of money exchanged for alcoholic beverages, by households, at a very fine geographic scale. Thus, regardless of the accuracy with which these data represent consumption or local sales, expenditures data do reflect varying levels of alcohol-related commerce within a region. Second, CEX data are driven by *choices*. The products that consumers decide to purchase are influenced by local market characteristics, lifestyles and preferences. Thus, the expenditures data reflect local preferences and provide one way to track an important facet of consumer activity within a region. From an operational perspective, we chose to standardize the expenditures variable by dividing by the number of households in a block group to get spending per household, then dividing by household income to get the proportion of household income spent on alcohol. While it might be tempting to suggest that this is simply an adjusted measure of wealth and/or poverty, again, we suggest that it is a viable reflection of alcohol-related commerce for a region.

The presence of non-alcohol retailers was captured in two ways. Using land use data acquired from the city of Philadelphia, we created a location quotient (LQ) (Hildebrand and Mace, 1950) for general commercial retailers. The advantage of using an LQ is that it compares the proportion of commercial land use in each block group to the proportion of commercial land use in the entire city. The LQ is estimated as follows:

$$LQ_i = \frac{b_i/b}{B_i/B}$$

where  $b_i$  = square footage of land use in category  $i$ ,  $b$  = square footage of land use for all categories in the block group,  $B_i$  = square footage of land use for category  $i$  in the city and  $B$  = square footage of land use for all categories in the city. The second indicator was a measure of businesses that may also increase crime risk. This was measured as an LQ for check cashing stores, pawn shops and convenience stores (combined) for each block group.

We controlled for several other covariates of urban crime rates. These included the proportion of all households that were female-headed and had at least one child under the age of 18, the proportion of households with an income below \$15,000 (a measure of poverty), the proportion of the population aged 15–29, the proportion of the population that were African Americans, population density, a diversity index to measure ethnic heterogeneity, the proportion of all housing units that were vacant, a residential land use LQ and the density of public transportation nodes. All variables are for 2010 and were obtained from ESRI (2010b), with the exception of the latter two, which came from the city of Philadelphia.

## ANALYSIS

We estimated spatially lagged regression models with a queen's contiguity matrix, allowing us to model spatial dependence

between units and account for geographic influence of nearby observations (Anselin, 1988; Millar and Gruenewald, 1997; Pridemore and Grubestic, 2013). To ensure normality, a square root transformation of the dependent variable, assault density, was implemented. To remedy hints of multicollinearity in the independent variables, we created a factor containing female-headed households and percent black, each of which loaded at  $>0.70$ . We also estimated models using negative binomial regression to gauge stability of our results. This is because aggravated assault is rare and some block group populations are small, resulting in low assault counts. Under these conditions, a negative binomial estimator is most appropriate (Gardner *et al.*, 1995). All models were estimated with Anselin *et al.*, 2006 and Stata (2013).

## RESULTS

Figure 1 displays the geographical distribution of aggravated assault and alcohol outlet density by block group in Philadelphia. The map on the left is shaded light to dark with increasing assault density and shows the location of all outlets. The map on the right is shaded light to dark with increasing alcohol outlet density. There is wide variation in both. Aggravated assault density ranged from 0 to 1235 per square mile, with a mean of 135, a median of 91 and an interquartile range of 25% = 26.57, 50% = 91.60 and 75% = 202.02. Alcohol outlet density ranged from 0 to 1035 per square mile, with a mean of 28, a median of 0 and an interquartile range of 25% = 0, 50% = 0 and 75% = 37. A defining characteristic of the spatial distribution of assault density is the ring of violence

around Center City, Philadelphia's focal point for dining, entertainment and cultural events. The Moran's  $I$  for assault density was 0.44 ( $P < 0.001$ ), suggesting assaults are spatially clustered. Figure 2 identifies this clustering of assaults more precisely by showing the local indicator of spatial association (Anselin, 1995), which corroborates the visual patterns in Fig. 1. Center City is not devoid of violence, but the city's most violent regions are elsewhere. The highest concentration of alcohol outlets is in Center City, although there are pockets of higher densities in North, South and West Philadelphia. Again, this is corroborated by a Moran's  $I$  of 0.42 and local clustering of outlet densities throughout the city (not shown).

Table 1 shows descriptive statistics for dependent, key independent and control variables. Table 2 displays results for spatial regression models estimating the association between aggravated assault density and total, on-premise and off-premise alcohol outlet densities. Each model explained about 48% of the variance in assault density. The spatial autoregressive coefficient was significant in all models, although the strength of its impact was marginal. The association with aggravated assault density was significant for total outlet density ( $b = 0.004$ ,  $P = 0.04$ ) and off-premise outlet density ( $b = 0.018$ ,  $P = 0.04$ ). The  $P$ -value for on-premise outlet density ( $b = 0.003$ ,  $P = 0.07$ ) suggested an association but did not allow for strong conclusions to be drawn. Thus, even after controlling for alcohol expenditures and for the densities of other retailers and other potentially risky retailers, there remains a positive and significant association between aggravated assault density and total and off-premise alcohol outlet density, and probably for on-premise outlet density.

Looking at the results for our key control variables, the effect of our proxy for alcohol sales, the proportion of

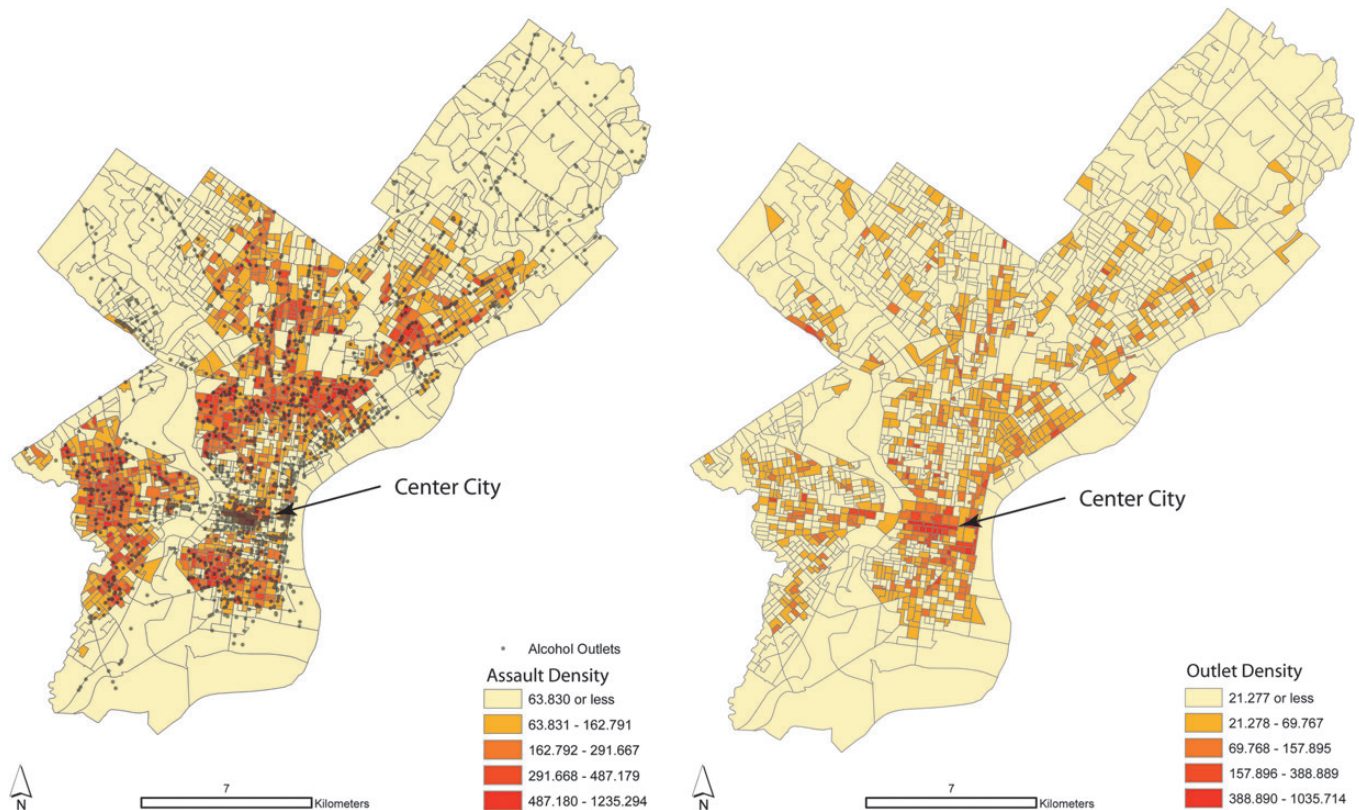


Fig. 1. The spatial distribution of alcohol outlets and assaultive violence in Philadelphia, 2010.



household income spent on alcohol for each block group, was positively and significantly associated with assault density in all models. The measure of the presence of other retailers, the commercial LQ, was also positively and significantly associated with aggravated assault density in all models. We found no association between the density of potentially risky retailers and aggravated assault density. Results for the negative binomial models using count data were identical.

Finally, for the purpose of sensitivity analysis, we estimated three additional models that included (a) only alcohol outlets, (b) alcohol outlets and main control variables and (c) alcohol outlets, main and additional control variables. The results fall in line with those found in Table 2, and clearly illustrate that alcohol outlet density is strongly associated with violence, population density and socioeconomic deprivation.

METHODOLOGICAL LIMITATIONS

There are a number of methodological limitations that need to be mentioned. First, the consumer expenditure data (CEX) are not an ideal proxy for alcohol consumption or sales. Three potential problems exist with the expenditures variable. First, household expenditures data for high-quality alcohol (e.g. fine spirits) may far exceed those for low-quality beverages (e.g. malt liquor) because of pricing differences. Unfortunately, this does not reflect alcohol consumption levels. Second, the CEX surveys rely on accurate self-reporting, and alcohol expenditures may not engender accuracy because of the social stigmas associated with heavy alcohol consumption (Room, 2005). Third, residents spend some of this money in other block groups. Nevertheless, the measure behaved as expected: it was positively and significantly associated with aggravated assault density in all models.

A second limitation to this study is that there is no clear definition of off-premise outlets for Philadelphia. Pennsylvania has a wine and liquor monopoly (Grubestic et al., 2012), and in 2010 there were 52 state-operated liquor stores in Philadelphia. Beyond this, things are less clear. In our disaggregated models, in addition to state stores we included off-premise outlets with D and E licenses. D licensees are allowed to sell beer to the public for off-premise use. Still, they are not traditional liquor stores and do not bring the same traffic. E licensees are allowed to sell beer for off-premise use, but these are mostly delis and corner stores. By law their main business must be food preparation and service and they must have table places for at least

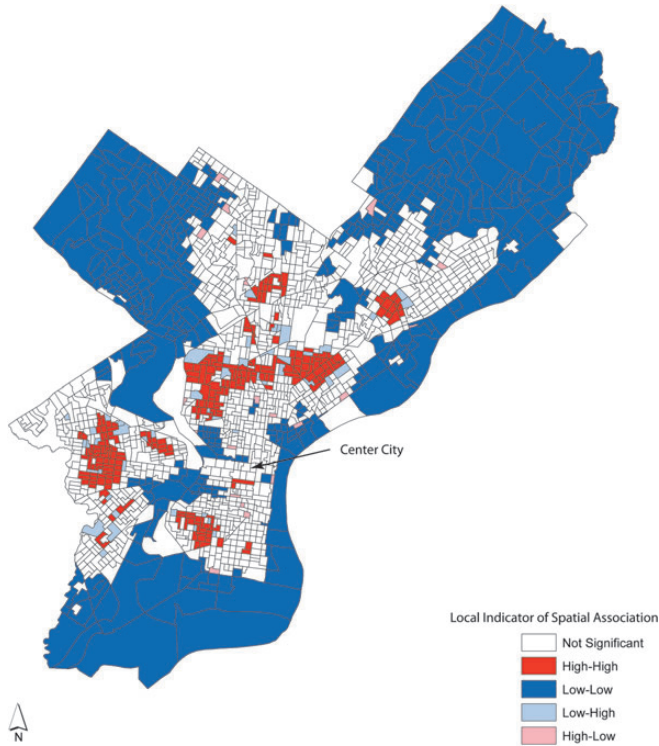


Fig. 2. Hot spots of aggravated assaults in Philadelphia, by block group (2010).

Table 1. Descriptive statistics for Philadelphia block groups (n = 1816)

	Minimum	Maximum	Mean	Standard deviation
Dependent variable				
Aggravated assault density	0	1235.29	134.7	142.52
Square root assault	0	35.15	9.7	6.37
Independent variables				
Alcohol outlet density	0	1035.71	27.86	63.25
Off-premise outlet density	0	142.85	3.89	12.28
On-premise outlet density	0	964.28	24.55	59.76
Main control variables				
Alcohol sales as a percent of median HH income	0	0.174	0.010	0.006
Commercial LQ	0	9.85	1.08	1.29
Additional control variables				
Potentially risky retailers LQ	0	8.66	0.05	0.48
Transit stop density	0	1293.32	144.41	142.58
% income below \$15,000	0	1	0.21	0.15
% of vacant units	0	1	0.09	0.09
Factor (% black and % female-headed households)	-1.77	2.13	0	0.99
Diversity index	0	100	40.3	28.9
Population density index	0	91,242.2	19,857	11,982.4
Residential medium LQ	0	1.54	0.92	0.48
% age 15–29 years old	0	1	0.22	0.1
Factor variables				
% of population black	0	1	0.47	0.39
% female-headed households	0	0.89	0.38	0.18

Table 2. Spatial regression model results

	Spatial regression models (queen contiguity)		
	Model 1	Model 2	Model 3
Constant	(1.238) [2.555]**	(1.276) [2.637]**	(1.355) [2.864]**
W_SQRTASDEN (spatial autoregressive coefficient)	(0.081) [2.641]*	(0.080) [2.628]**	(0.080) [2.627]**
Alcohol outlet density	(0.003) [2.101]*	–	–
On-premise alcohol outlet density	–	(0.003) [1.814] <sup>a</sup>	–
Off-premise alcohol outlet density	–	–	(0.018) [2.054]*
Main control variables			
Alcohol expenditures as percent median HH income	(40.023) [2.190]*	(39.517) [2.162]*	(38.735) [2.123]**
Commercial LQ	(0.594) [6.738]***	(0.595) [6.750]***	(0.599) [6.803]***
Additional control variables			
Potentially risky retailers LQ	(–0.000) [–1.542]	(–0.000) [–1.548]	(–0.000) [–1.592]
Public transport stop density	(0.008) [0.047]	(0.006) [0.033]	(0.003) [0.019]
% household income below \$15,000	(3.549) [3.982]***	(3.554) [3.988]***	(3.549) [3.983]***
% of vacant units	(5.529) [3.788]***	(5.558) [3.807]***	(5.468) [3.743]***
Factor (% black, % female-headed households)	(2.266) [14.903]	(2.263) [14.874]***	(2.246) [14.814]***
Diversity index	(0.000) [4.338]***	(0.018) [4.311]***	(0.018) [4.283]***
Population density index	(0.000) [15.136]***	(0.000) [15.133]***	(0.000) [15.110]***
Residential medium LQ	(2.060) [7.019]***	(2.056) [7.004]***	(2.044) [6.968]***
Percent age 15–29	(–3.061) [–2.595]**	(–3.080) [–2.610]**	(–3.194) [–2.713]**
R-squared	0.481	0.480	0.481
Rho	0.081	0.081	0.081
Standard error	4.592	4.592	4.592
AIC	10,719.9	10,721.0	10,720.1
Breusch–Pagan test	150.199*	149.767*	151.208*

(coefficient) [z-value].

\* $P < 0.05$ .\*\* $P < 0.01$ .\*\*\* $P < 0.001$ .<sup>a</sup>Significant at  $P < 0.07$ .

30 people (PLLC, 2012). Finally, R licensees are traditional on-premise outlets like bars and restaurants, but they are also allowed to sell small quantities of beer for off-premise use. This system makes it difficult to disaggregate cleanly into on- and off-premise outlets, and measurement decisions other than the ones we made are possible. This is likely partially responsible for the on-premise outlet density result, where a  $P$ -value of 0.07 suggests an association but does not allow for strong conclusions to be drawn. A large number of our off-premise outlets (those delis and corner markets with an ‘E’ license) can also be considered on-premise outlets.

## DISCUSSION

There is a consistent association between alcohol outlet density and violence in the empirical literature, even after controlling for a number of other community characteristics suspected to influence crime rates or to be confounded with outlet density (Britt *et al.*, 2005; Gruenewald and Remer, 2006; Livingston, 2006). One critique of this literature is that studies that fail to control for sales volume and for the density of other retailers obscure the true connection between outlets and violence.

Other factors that are also usually absent from these models, such as proximity to public transportation hubs that attract heavy foot traffic and may host other illicit activities like drug sales that increase the risk of violence (Block and Block, 1995, 2000), are also important to control for when testing an association between alcohol outlet density and violence.

In this study, we found that transportation nodes and potentially risky retailers had *no* association with violence.

However, our measure of local alcohol expenditures and the measure of general commercial activity were both positively and significantly associated with assault density. The first association provides general support for the hypothesis that the outlet–violence association is partially due to alcohol availability and alcohol-related commerce in a community. The second association supports the hypothesis of routine activity theorists, in that commercial clusters bring together potential offenders and victims, generating crime. However, the real value of the analysis presented in this paper is that even after controlling for these confounders and alternative explanations, the positive and significant association between aggravated assault density and total and off-premise (and probably on-premise) alcohol outlet density remained. Thus, our results are consistent with findings that show (a) an association between alcohol outlet density and violence in other US cities (Speer *et al.*, 1998; Nielsen and Martinez, 2003; Zhu *et al.*, 2004; Pridemore and Grubestic, 2013), (b) a stronger association for off- relative to on-premise outlets (Gruenewald *et al.*, 2006; Pridemore and Grubestic, 2012a,b, 2013) and (c) an association between outlet density and harm remained after controlling for alcohol expenditures, mimicking the results when one controls for local sales in the rare situations in which sales data are available (Gruenewald *et al.*, 1999; Stevenson *et al.*, 1999; Liang and Chikritzhs, 2011).

## IMPLICATIONS

If alcohol itself is not the sole cause of the association between outlets and violence, and if being in a commercially

dense area is not wholly to blame, then what is it about alcohol outlets that lead to higher violence rates? Again, evidence is growing that greater outlet density has a strong connection to crime. This association has been addressed at length for bars and clubs, including important contextual effects, but less is known about off-premise outlets even though several recent studies have shown them to be more strongly associated with violence than bars (Gruenewald et al., 2006; Branas et al., 2009; Pridemore and Grubestic, 2013).

Part of the effect may have little to do with outlets but instead may be due to patrons consuming alcohol in, or coming (home) drunk to, private settings where there is little regulation over their behavior. This is shown, for example, in the association between outlet density and intimate partner violence (Livingston, 2011; Cunradi et al., 2012). Some of the effect of off-premise outlets, however, is likely due to the nature of these outlets. Especially in urban areas, off-premise outlets often serve as social gathering places and even de facto taverns (Block and Block, 1995). In Philadelphia, they are usually delis and corner stores, and Branas et al. (2009) describe them like islands in the night: 'bright but unattended spaces' and activity centers that often provide 'the only well-lit spaces among nonworking street lamps, vacant properties, and dark residences'. Relative to bars, with bouncers and staff nearby and on alert, the spaces around off-premise outlets are largely unregulated.

It is also important to recognize that not all outlets are equally troublesome. As with bars, there are likely characteristics of off-premise outlets that put some at higher risk for violence than others (Graham, 2006; Snowden, 2012). For example, when discussing hot spots of crime, Sherman et al. (1989) ask if certain places 'vary in their capacity to help cause crime, or merely in their frequency of hosting crime that was going to occur some place inevitably...?' In this sense, the mounting evidence suggests that alcohol outlets do not simply host or attract crime that would occur somewhere else anyway, but that they generate crime that would not otherwise take place. This might be partially due to the nature of the surrounding neighborhood (Pridemore and Grubestic, 2012a), as disorganized communities are less able to make demands for responsible retailing practices. Still, outlet, staff, patron and environmental characteristics could play a role (Snowden, 2012). Does the off-premise outlet sell single cans of beer? How much shelf space is devoted to alcohol relative to other goods? How old is the staff and how many are working at the most dangerous times? Is there an alley or vacant lot nearby where patrons might gather after buying alcohol?

Regardless of the mechanisms, at this stage it is difficult to believe that alcohol outlet density is not causally related to violence. While the results of this paper cannot infer this relationship with absolute certainty, we are among the first (especially in the USA) to estimate a model that controls for a proxy for sales and for potentially important confounders like commercial activity, risky retailers and transportation nodes, and our findings suggest that alcohol outlets not only attract crime but likely generate crime that otherwise would not occur.

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## REFERENCES

- Anselin L. (1988) *Spatial Econometrics: Methods and Models*. Boston: Kluwer Academic Publishers.
- Anselin L. (1995) Local Indicators of Spatial Association—LISA. *Geogr Anal* 27:93–115.
- Anselin L, Syabri I, Kho Y. (2006) GeoDa: an introduction to spatial data analysis. *Geographical Analysis* 38:5–22.
- Block RL, Block CR. (1995) Space, place and crime: hot spot areas and hot places of liquor-related crime. *Crime Prev Stud* 4:145–83.
- Block RL, Block CR. (2000) The Bronx and Chicago: street robbery in the environs of rapid transit stations. In Mollenkopf JH (ed). *Analyzing Crime Patterns: Frontiers in Practice*. London: Sage, 137–52.
- Branas CC, Elliott MR, Richmond TS et al. (2009) Alcohol consumption, alcohol outlets, and the risk of being assaulted with a gun. *Alcohol Clin Exp Res* 33:906–15.
- Briscoe S, Donnelly N. (2001) Temporal and regional aspects of alcohol-related violence and disorder. *Alcohol Stud Bull* 1.
- Britt HR, Carlin BP, Toomey TL et al. (2005) Neighborhood level spatial analysis of the relationship between alcohol outlet density and criminal violence. *Environ Ecol Stat* 12:411–26.
- Bye EK. (2007) Alcohol and violence: use of possible confounders in a time-series analysis. *Addiction* 102:369–76.
- Cohen LE, Felton M. (1979) Social change and crime rate trends: a routine activity approach. *Am Socio Rev* 44:588–608.
- Cunradi CB, Mair C, Ponicki W et al. (2012) Alcohol outlet density and intimate partner violence-related emergency department visits. *Alcohol Clin Exp Res* 36:847–53.
- Duke AA, Giancola PR, Morris DH et al. (2011) Alcohol does and aggression: another reason why drinking more is a bad idea. *J Stud Alcohol Drugs* 72:34–43.
- ESRI. (2010a) *Consumer Expenditures Data*. Available online at [http://www.esri.com/data/esri\\_data/consumer-spending.html](http://www.esri.com/data/esri_data/consumer-spending.html).
- ESRI. (2010b) *Demographic Data*. Available online at [http://www.esri.com/data/esri\\_data/demographic.html](http://www.esri.com/data/esri_data/demographic.html).
- ESRI. (2012) *ArcGIS 10*. Available online at <http://www.esri.com>.
- Federal Bureau of Investigation. (2010) Uniform Crime Reports. Available online at <http://www.fbi.gov/about-us/cjis/ucr/ucr> (27 November 2012, date last accessed).
- Felson M. (1987) Routine activities and crime prevention in the developing metropolis. *Criminology* 25:911–31.
- Ford JM, Beveridge AA. (2004) 'Bad' neighborhoods, fast food, 'sleazy' businesses, and drug dealers: relations between the location of licit and illicit businesses in the urban environment. *J Drug Issues* 34:51–76.
- Freisthler BF, Gruenewald PJ, Ring L et al. (2008) An ecological assessment of the population and environmental correlates of childhood accident, assault and child abuse injuries. *Alcohol Clin Exp Res* 32:1969–75.
- Gardner W, Mulvey EP, Shaw EC. (1995) Regression analyses of counts and rates: Poisson, overdispersed Poisson, and negative binomial models. *Psychol Bull* 118:392–404.
- Graham K. (2006) Isn't it time we found out more about what the heck happens around American liquor stores? *Addiction* 101:619–20.
- Grubestic TH, Pridemore WA. (2011) Alcohol outlets and clusters of violence. *Int J Health Geogr* 10:30.
- Grubestic TH, Murray AT, Pridemore WA et al. (2012) Alcohol beverage control, privatization and the geographic distribution of alcohol outlets. *BMC Public Health* 12:1015.
- Gruenewald PJ. (2007) The spatial ecology of alcohol problems: niche theory and assortative drinking. *Addiction* 102:870–8.
- Gruenewald PJ. (2011) Regulating availability: how access to alcohol reflects drinking and problems in youth and adults. *Alcohol Res Health* 34:248–56.
- Gruenewald PJ, Remer L. (2006) Changes in outlet densities affect violence rates. *Alcohol Clin Exp Res* 30:1184–93.



- Gruenewald PJ, Stockwell T, Beel A *et al.* (1999) Beverage sales and drinking and driving: the role of on-premise drinking places. *J Stud Alcohol* **60**:47–53.
- Gruenewald PJ, Freisthler B, Remer L *et al.* (2006) Ecological models of alcohol outlets and violent assaults: crime potentials and geospatial analysis. *Addiction* **101**:666–77.
- Hildebrand G, Mace A. (1950) The employment multiplier in an expanding industrial market: Los Angeles County, 1940–1947. *Rev Econ Stat* **32**:241–9.
- Kubrin CE, Squires GD, Graves SM *et al.* (2011) Does fringe banking exacerbate neighborhood crime rates? *Criminol Public Policy* **10**:437–66.
- Liang W, Chikritzhs T. (2011) Revealing the link between licensed outlets and violence: counting venues versus measuring alcohol availability. *Drug Alcohol Rev* **30**:524–35.
- Livingston M. (2006) Alcohol outlet density and assault: a spatial analysis. *Addiction* **103**:619–28.
- Livingston M. (2011) A longitudinal analysis of alcohol outlet density and domestic violence. *Addiction* **106**:919–25.
- Mcdonald S, Cherpitel CJ, Borges G *et al.* (2005) The criteria for causation of alcohol in violent injuries based on emergency room data from six countries. *Addict Behav* **40**:103–13.
- Miles TJ. (2008) *Markets for Stolen Property: Pawnshops and Crime*. Available online at <http://www.law.umich.edu/centersandprograms/lawandeconomics/workshops/Documents/Winter2008/miles.pdf>. (27 November 2012, date last accessed).
- Millar AB, Gruenewald PJ. (1997) Use of spatial models for community program evaluation of changes in alcohol outlet distribution. *Addiction* **92**(s2):273–83.
- Nielsen AL, Martinez R, Jr. (2003) Reassessing the alcohol-violence linkage: results from a multiethnic city. *Justice Q* **20**:445–69.
- Norström T. (2000) Outlet density and criminal violence in Norway, 1960–1995. *J Stud Alcohol* **61**:907–11.
- Parker RN, McCaffree KJ, Skiles D. (2011) The impact of retail practices on violence: the case of single serve alcohol beverage containers. *Drug Alcohol Rev* **30**:496–504.
- Popova S, Giesbrecht N, Bekmuradov D *et al.* (2009) House and days of sale and density of alcohol outlets: impacts on alcohol consumption and damage: a systematic review. *Alcohol Alcohol* **44**:500–16.
- Pridemore WA, Grubestic TH. (2012a) Community organization moderates the effect of alcohol outlet density on violence. *Br J Sociol* **63**:680–703.
- Pridemore WA, Grubestic TH. (2012b) A spatial analysis of the moderating effects of land use on the association between alcohol outlet density and violence in urban areas. *Drug Alcohol Rev* **31**:385–93.
- Pridemore WA, Grubestic TH. (2013) Alcohol outlets and community levels of interpersonal violence: Spatial density, outlet type, and seriousness of assault. *J Res Crime Delinquen* **50**:132–59.
- Rengert R, Ratcliffe J, Chakravorty S. (2005) *Policing Illegal Drug Markets: Mapping the Socio-Economic Environments of Drug Dealing*. Monsey: Criminal Justice Press.
- Room R. (2005) Stigma, social inequality and alcohol and drug use. *Drug Alcohol Rev* **24**:143–55.
- Sherman LW, Gartin PR, Buerger MR. (1989) Hot spots of predatory crime: Routine activities and the criminology of place. *Criminology* **27**:27–55.
- Snowden AJ. (2012) Moving beyond density in the association between alcohol outlets and violence: the role of social disorganization, land use, and environment, outlet, staff, and patron characteristics. Dissertation. Department of Criminal Justice, Indiana University.
- Speer PW, Gorman DM, Labouvie EW *et al.* (1998) Violent crime and alcohol availability: relationships in an urban community. *J Public Health Policy* **19**:303–18.
- StataCorp. (2011) Stata statistical Software: release 12. College Station, TX: StataCorp LP.
- Stevenson RJ, Lind B, Weatherburn D. (1999) The relationship between alcohol sales and assault in New South Wales, Australia. *Addiction* **94**:397–410.
- Stockwell T, Gruenewald PJ. (2004) Controls on the physical availability of alcohol. In Heather N, Stockwell T (eds). *The Essential Handbook of Treatment and Prevention of Alcohol Problems*. New York: John Wiley, 213–34.
- Stockwell T, Zhao J, Macdonald S *et al.* (2009) Changes in per capita alcohol sales during the partial privatization of British Columbia's retail alcohol monopoly 2003–2008: a multilevel local area analysis. *Addiction* **104**:1827–36.
- The Pennsylvania Liquor License Company. *Types of Licenses*. Available online at <http://pennsylvania.liquorlicense.com/typesoflicenses.asp>. (27 November 2012, date last accessed).
- Theall KP, Scribner R, Cohen D *et al.* (2009) The neighborhood alcohol environment and alcohol-related morbidity. *Alcohol Alcohol* **44**:491–9.
- Zhu L, Gorman DM, Horel S. (2004) Alcohol outlet density and violence: a geospatial analysis. *Alcohol Alcohol* **39**:369–75.