The Geography of Violence, Alcohol Outlets, and Drug Arrests in Boston

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Objectives. We examined the relationship between alcohol outlets, drug markets (approximated by arrests for possession and trafficking), and violence in Boston, Massachusetts, in 2006. We analyzed geographic and environmental versus individual factors related to violence and identified areas high in violent crime.

Methods. We used data from the Boston Police Department, US Census, and Massachusetts State Alcohol Beverage Control Commission. Spatial modeling was employed at the block group level, and violent crime, alcohol outlets, and drug markets were mapped.

Results. Relative to other block groups, block groups in the highest decile of violent crime (n = 55) were found to be poorer (e.g., lower incomes, higher percentages of vacant homes), and they had greater numbers of alcohol outlets and higher drug arrest rates. Alcohol outlets and drug possession and trafficking arrests were predictive of violent crime. Also, spatial effects resulting from neighboring block groups were related to violent crime. Both alcohol outlet density and type were associated with violent crime in a differentiated and complex way.

Conclusions. With drug possession and trafficking arrests as a proxy for drug markets, spatial relationships between alcohol outlets and violence were found in addition to typical sociodemographic predictors. (*Am J Public Health.* 2013; 103:657–664. doi:10.2105/AJPH.2012.300927)

Understanding the environmental and social contexts in which violence occurs has been an increasingly important area of research, one that has broad applicability to public policies on violence mitigation far beyond purely research issues. Increased theoretical understanding of the spatial and environmental contexts of violence, such as theories relating alcohol outlets to violence, have gone hand in hand with improvements in spatial techniques and computing power, transforming this area of research. Furthermore, although there have been studies on violence related to types and densities of alcohol outlets,[1–5] there has been less research attempting to include measures of drug arrests and to more fully incorporate spatial features such as characteristics of adjacent geographic areas.

Locations of alcohol outlets are frequently related to occurrence of violence. The incidence of interpersonal violence appears to increase in and around locations with alcohol outlets, particularly bars and liquor stores.[1,3–5] There are several possible mechanisms. First, bars and liquor stores often attract individuals likely to be involved in violent interactions, such as young males (alcohol availability theory).[6] Second, these retail alcohol outlets are often located in areas with less guardianship than others (social disorganization theory).[1,3,7] Third, these types of outlets provide opportunities for social interactions that may lead to violence (alcohol availability and niche theory).

Finally, establishments serving alcohol can foster increased expressions of aggression.[6] Empirical studies have shown a correlation between higher rates of violence and increased proximity to bars and liquor stores[1,8–10] as well as sales through alcohol outlets.[11] Similar arguments have been suggested to support empirically observed cross-sectional relationships between rates of violence and locations of off-premise establishments.[9,12]

Establishment effects, however, may be related to other crime-related aspects of the environments of off-premise outlets, such as illegal drug activity and prostitution.[13] Questions remain as to whether effects related to alcohol outlets are due to the outlets themselves or the general characteristics of the areas in which they are located. Recent criminological research on bars and taverns suggests that managers of these establishments create environments that suppress or facilitate violence through business-related choices such as types of activities and entertainment, staff and training, and property characteristics.[14]

Two theoretical concerns have guided much of the empirical work over the past 2 decades. First, alcohol outlets might serve as markers for other population or environmental features that are related to violence. These markers could consist of specific population characteristics related to greater levels of violence (e.g., poverty, female-headed households)[10] or place-based characteristics related to lower levels of police enforcement and surveillance (e.g., vacant retail establishments).[15]

Second, violence and alcohol outlets are part of the continuous spatial fabric of communities, and thus standard statistical analyses of data, which assume independence of observations, are complicated by spatial autocorrelation between observations.[16] Spatial models have been applied to help correct for bias or increased sampling variation of effect estimates arising from a lack of spatial independence in modeling violence outcomes.[17]

We examined the relationship between alcohol outlets and violent crime in an analytical framework that treats alcohol outlets as potentially both "producers" of violent behavior and markers or attractors of violence. Our initial assessments of the effects of typical sociodemographic measures demonstrated that there remained effects of alcohol outlet presence not accounted for by these features. Subsequently, to capture more spatial and environmental characteristics and to illustrate the presence of spatial effects that were distinct from the 2 types

of effects just mentioned, we assessed how adjacent area characteristics relate to violent crime in the target area. To deal with the different ways in which outlets are posited to be related to violence, we accounted for outlet density and type and whether a violent crime occurred on a weekend or weekday.

In addition, we included information on drug arrests for trafficking and possession (as estimators of drug markets) to properly account for the relationship between violence and drug markets when assessing the effects of alcohol outlets. Although Martinez et al.[18] found a significant relationship between drug markets and violence when accounting for social disorganization, our analysis is the first, to our knowledge, to also include alcohol outlet type and density.

METHODS

We conducted a cross-sectional investigation of the relationship between violent crime and types and densities of alcohol outlets in the city of Boston, Massachusetts, in 2006. We included drug arrest data and objective, census-based measures of neighborhood social disorder in our analysis. The city of Boston consists of 544 census block groups that served as the units of analysis in our study.

Data Elements and Outcome Variables

We derived our data from 3 sources: Boston Police Department (BPD) data from 2006 on homicides and aggravated assault incidents, drug arrests, and 911 citizen emergency calls for service; 2000 US Census data, including population estimates; and 2009 alcohol outlet data from the Massachusetts Alcohol Beverage Control Commission.

Our outcome of interest was the number of violent crimes (homicide, robbery, aggravated assault) occurring in each census block group in 2006. We combined them into a single violent crime measure. Although the distribution of violent crime counts was skewed toward zero, the Poisson modeling used in this analysis did not require normality. These data were geocoded to the address level and then aggregated up to the census block group. In compiling official data on aggravated assaults and homicides, BPD follows Federal Bureau of Investigation Uniform Crime Report standards. These data include information on type of violent assault, specific location of the assault, and the time and date of the assault. Figure 1 displays violent crime densities along with alcohol outlet and drug arrest densities (ArcGIS[19] was used in creating the maps in Figure 1). Forcible rape was not included in the data set because, owing to privacy considerations, the geographic level needed for our analysis was not available.

Neighborhood Social Structure

In line with the existing ecological literature, we used a broad spectrum of census-based information to characterize neighborhood structures at the census block group level. Ten variables pertaining to neighborhood structural characteristics were extracted from the 2000 census to broadly represent poverty, affluence, residential stability, age structure, family disruption, and racial composition.

The 2 variables describing poverty were the percentage of households with incomes below $25 000 per year and the percentage of unemployed individuals in the civil labor force. The 2 variables capturing affluence were the percentage of households with incomes above $75 000 per year and the percentage of adults with an associate degree or higher. The 2 variables measuring residential stability were the percentage of occupied housing units that are occupied by renters and the percentage of vacant housing units. The 2 variables measuring age structure were the percentage of the population aged 16 years and younger and the percentage of the population aged 65 years and older. Finally, family disruption was defined as the percentage of female-headed families, and racial composition was defined as the percentage of the population within the census block group that was non-White.

Alcohol Outlet Density

Data on alcohol outlet locations (obtained from the Massachusetts Alcohol Beverage Control Commission) in 2006 were geocoded to the street address of the establishment. Of

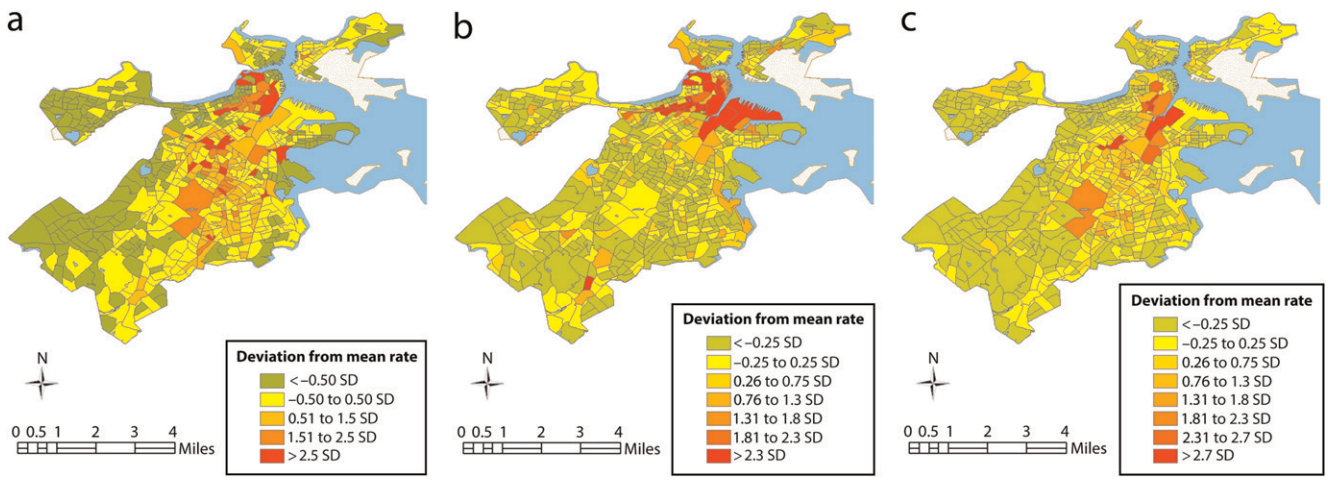

FIGURE 1—Density per 1000 population, by census block group, for (a) violent crimes, (b) alcohol outlets, and (c) drug arrests: Boston, MA, 2006.

the 1232 alcohol outlet license records, 2 had no address and 11 included a street name but no building number. Of the remaining 1219 records, 1086 addresses were geocoded, for an overall geocoding matching rate of 89%.

Among all licenses registered in the city of Boston, 29 alcohol outlets fell outside of Boston's city limit or were located at Boston's Logan International Airport. The census block group containing Logan International Airport was not included because the area consists mostly of airport facilities, which have a different security and population structure than the rest of the study area. Thus, of the 1086 alcohol outlets geocoded, 1057 fell in the 544 census blocks that formed the study area. The number of alcohol outlets by census block group was tabulated for restaurants that sold only wine and malt alcohol (n = 480), restaurants that sold all types of alcohol (n = 286), package alcohol outlets (n = 182), and all other types of outlets (n = 109; Figure 1).

Drug Market Activity

Measuring drug market activity may help disentangle the importance of alcohol outlets from that of other place-based activities or features that produce or attract violence. We used 2 different types of official BPD data to approximate drug market activity at the census block group level: 2006 arrest reports for illegal drug possession and sales, transport, or distribution (these latter 3 are summarized as drug "trafficking" offenses in these analyses) and 911 calls in 2006 from citizens reporting illegal drug sales and use. Both sources of data are commonly used to measure drug market activity.

Although BPD arrest data represent a measure of police activity to control street-level drug problems, they are limited by bias in police decisions to patrol certain areas, investigate particular complaints, and make arrests. Data on citizen 911 calls for service are not affected by police decision-making bias, and criminologists claim that these data provide "the widest ongoing data collection net for criminal events in the city."[20(p35)] However, this information can be limited by citizens' willingness to call the police to report crimes and their ability to comprehend accurately the legal character of the events they witness.[21]

Despite these shortcomings, our complementary but distinct data sources provide defensible measures of the spatial distribution of street-level drug markets in Boston. To examine the spatial relationship between the 2 distinct measures, we used Pearson correlation coefficients to compare variations in counts of BPD drug arrests with variations in counts of 911 drug calls for service in Boston census block groups. There was a moderate, significant positive correlation between the 2 data sources ($r = 0.49$; $P < .01$). We substituted these measurements with each other in 2 different regression models while leaving all other independent variables unchanged. Comparing outputs from these 2 models, we found that no covariate changed with respect to its significance level and no significant covariate changed direction. Indices of fit for police arrests and 911 call data were similar in the 2 models ($R^2 = 0.59$ and 0.58, respectively).

Data Analysis

On the basis of our violent crime incident data, we calculated the number of violent crimes per 1000 population (Figure 1), which provided us with a measurement not confounded by population size. We calculated this crime rate for each of the block groups included, divided the sample into the top decile (in terms of crime rates) and the bottom 90%, and compared the 2 groups on each of the independent measures. We did so to obtain a baseline understanding of the univariate relationships between crime and each of the variables.

For the statistical modeling component, the dependent variable was the number of crimes occurring in each block group. The basic analysis tool used was Poisson regression with the additional inclusion of a parameter, φ, to account for potential overdispersion so that inference would not be biased by erroneously specifying $\varphi = 1$ as in ordinary Poisson regressions. We treated the number of violent crimes occurring in block group i, Y_i, as having a Poisson(λ_i) distribution with overdispersion parameter φ. In the basic model, we took the standard approach and modeled the mean, λ_i, with a log-linear model:

$$(1)\quad \log(\lambda_i) = \log(P_i) + \beta_0 + \sum_{j=1}^{p} \beta_j X_{ij}$$

P_i is the population size of block group i multiplied by the number of hours over which crime was monitored, and X_{ij} is the value of covariate j in block group i. We included an offset, $\log(P_i)$, so that λ_i was interpreted as the expected number of crimes per person and per hour. The per hour distinction was made so that the models fit at various time scales (all crime, weekday crime, weekend crime) were comparable. The exponentiated parameter estimates ($e^{\hat{\beta}j}$) should be interpreted as the estimated multiplicative effect of a one unit increase in the predictor on the expected number of crimes.

We began by fitting model 1 using only census-based variables for which alcohol outlets have been shown to act as markers, including percentage of the population aged 16 years or younger and percentage aged 65 years or older, percentage minority population, percentage of families below the poverty line, percentage of unemployed individuals, percentage of female-headed households, percentage of households with incomes below $25 000, percentage of adults without an associate degree, percentage of houses that are vacant, and percentage of housing occupied by renters.

In a second model, we fit model 1 variables and then included the number of alcohol outlets, drug possession arrests, and drug trafficking arrests that occurred in the block group. A significantly improved fit in this second model would suggest potential effects of alcohol outlets not subsumed by their impact on the environmental variables included in the initial model. Given explicit arguments in the literature,[1,10] we were aware that variables entered in the second-level model might be collinear with those entered at the first level. This collinearity, however, did not affect inferences at the group level, given that we were examining whether the second group of outlet and drug arrest measures, as a whole, contributed information once the first group of measures had been taken into account.

To account for spatial dependence in our data, we defined a set of "lagged" predictors: linear combinations of the predictor values in surrounding block groups. To define connectivity between block groups i and k, denoted by W_{ik}, we used the "queen-contiguity" structure, which means $W_{ik} = 1$ if block groups i and k are adjacent and

$W_{ik} = 0$ otherwise. The lagged predictor was then defined as

$$(2)\quad L_{ij} = \sum_{k \neq i} W_{ik} X_{kj}$$

To restate, L_{ij} is the sum of the values of covariate j in the block groups adjacent to i. To assess whether there were spatial dependencies in the data distinct from those effects already included in the model, we fit the following model:

$$(3)\quad \log(\lambda_i) = \log(P_i) + \beta_0 + \sum_{j=1}^{p} \beta_{1j} X_{ij} + \sum_{j=1}^{p} \beta_{2j} L_{ij}$$

We included lagged predictors for all of the variables included in the first 2 models in model 3. We defined spatial dependence in these data as arising from correlations in predictor values between block groups. After conditioning on the predictor values in adjacent block groups, we believed that there were no remaining residual sources of correlation that had not been taken into account and therefore did not include any additional structure, such as random effects, to account for spatial autocorrelation.

Finally, to assess the day-of-week context dependence of the relationship between violent crime and alcohol outlets, we fit model 3 to the count of violent crimes occurring on weekends (9 PM Friday until 9 AM Sunday) relative to the count of violent crimes during the rest of the week. Because the time frames were of different lengths, the offset term, log (P_i), was different in each model and thus the units were comparable; expected counts were interpreted as number of crimes per person and per hour. For each model fitted, measures of fit such as the percentage of deviance explained and the pseudo R^2 value, defined as the squared correlation between the observed counts and the counts expected under the model, are reported. Nested models were compared with χ^2 test results based on the difference in deviances in the 2 models, scaled by the estimated dispersion parameter.

RESULTS

In 2006, the overall mean number of violent crimes in Boston per 1000 population was 11.45 (SD = 12.53). The crime rate (incidents per 1000 population) at the block group level ranged from a low of 0 to a high of 99. When we compared the highest decile block groups (n = 55) with all other groups (n = 489) with respect to violent crime rates (Table 1), we found that the highest decile block groups had significantly higher mean values than the other groups for most independent variables. This was true for sociodemographic measures, place-based measures (alcohol outlets and drug arrests), and both sociodemographic and place-based spatially lagged measures.

In areas adjacent to the target area, these measures were found to be significantly higher in the highest decile. In this regard, alcohol outlets, in almost all categories, were significantly more prevalent in the highest decile. Furthermore, drug-related arrests, for both possession and trafficking, were significantly higher in this decile.

TABLE 1—Comparison of Block Groups in the Highest Decile and All Other Deciles With Respect to Aggravated Assaults and Homicides: Boston, MA, 2006

Variable	Top Decile (n = 55), Mean (SD)	Remaining Deciles (n = 489), Mean (SD)
% aged ≤ 16 y	20.440 (6.483)	18.065 (4.530)
% aged ≥ 65 y[a]	11.988 (7.180)	11.139 (6.280)
% minority	57.888 (26.522)	34.174 (28.702)
% households below poverty line	73.655 (4.592)	70.783 (7.118)
% unemployed	17.302 (16.841)	10.106 (13.478)
% female-headed households	43.433 (24.172)	29.616 (18.426)
% households with income < $25 000	40.319 (18.392)	28.296 (15.578)
% aged ≥ 25 y with ≥ associate degree	23.933 (19.318)	40.803 (23.832)
% vacant housing	8.988 (12.878)	4.648 (4.163)
% housing occupied by renters	71.922 (17.290)	61.304 (21.290)
No. of restaurants selling all types of alcohol	2.909 (6.053)	0.654 (1.587)
No. of restaurants selling wine and malt[a]	0.636 (1.682)	0.513 (1.667)
No. of package alcohol outlets	0.527 (0.766)	0.313 (0.606)
Total 2009 population (estimated)	850.145 (393.420)	1187.305 (568.429)
No. of drug incidents (possession)	14.945 (17.884)	3.996 (5.802)
No. of drug distribution incidents	11.145 (14.701)	2.937 (4.530)
No. of nonstore/nonrestaurant alcohol outlets	0.691 (1.632)	0.143 (0.453)
Lag: % housing occupied by renters	68.900 (8.548)	61.983 (15.619)
Lag: % vacant housing	7.321 (2.782)	4.766 (2.902)
Lag: % aged ≥ 25 y with ≥ associate degree	30.021 (17.964)	39.864 (19.952)
Lag: % households with income < $25 000	35.774 (8.339)	29.012 (10.099)
Lag: % female-headed families	41.049 (17.136)	29.573 (13.761)
Lag: % unemployed	16.867 (6.390)	9.992 (7.242)
Lag: % households below poverty line	73.469 (2.572)	70.826 (3.065)
Lag: % minority	56.462 (25.971)	34.121 (25.888)
Lag: % aged ≥ 65 y[a]	10.596 (3.084)	11.623 (4.418)
Lag: % aged ≤ 16 y	20.361 (4.783)	17.809 (3.640)
Lag: drug distribution incidents	8.235 (6.449)	3.598 (4.103)
Lag: drug incidents (possession)	11.361 (7.664)	4.918 (4.924)
Lag: nonstore/nonrestaurant alcohol outlets	0.360 (0.628)	0.233 (0.414)
Lag: package alcohol outlets[a]	0.419 (0.290)	0.356 (0.308)
Lag: restaurants selling all types of alcohol	1.740 (2.919)	0.961 (1.704)
Lag: restaurants selling wine and malt	0.775 (1.525)	0.518 (0.791)

Note. Except as noted, all comparisons are significantly different at $P < .05$ (pooled t test).
[a]Comparison not significant.

Both alcohol outlets and drug arrests were found be related to violent crimes, within a given block group as well as in adjacent block groups. Two notable exceptions were found: total population and the lagged value of the percentage of the population aged 25 years or older with at least an associate degree were lower in this top decile. Four measures were not found to be significant: percentage of the population aged 65 years or older, density of restaurants selling wine and malt alcohol, and the 2 related lagged measures (lagged value of the percentage of the population aged 65 years or older and lagged value of package stores). The statistical inference here is not theoretically justified because, as a result of uncontrolled spatial autocorrelation in the units, the units may be dependent; that is, the standard errors were too small, assuming positive autocorrelation, because spatial dependence was not taken into account in this initial analysis. The purpose of this more descriptive analysis, however, was to provide suggestive evidence of relationships rather than to formally test hypotheses.

We developed nested quasi-Poisson regression models (Table 2) in which we initially assessed sociodemographic measures, then included first-order environmental measures (alcohol outlets and illicit drug arrests), and finally included spatially lagged measures for all variables in the first 2 models. In the first sociodemographic model, we found negative relationships for percentage of the population aged 16 years or younger and percentage of the population with at least an associate degree. We found positive relationships for percentage minority population, vacant housing, renter-occupied housing, and percentage of unemployed individuals. None of the other results were statistically significant.

When we included environmental variables (model 2), we found additional positive relationships for restaurants selling any type of alcohol and drug possession arrests. A negative relationship was found for drug distribution arrests. Interestingly, percentage of female-headed households was significant in this model and percentage of the population below the poverty line changed signs; however, interpretation of these findings is difficult because collinearity may have affected these individual measures. Nevertheless, interpretation of the individual estimates should not obscure the overall finding that the set of environmental and place-based variables added in model 2 were significant, as a group, according to the deviance test ($\chi^2_6 = 98.10$; $P < .001$); this result indicates that there were substantial effects in the second group of variables that were not subsumed by the first model.

When including lagged variables for the previous 2 models in model 3, we found positive relationships for percentage of female-headed households, percentage of the population aged 16 years or younger, and restaurants selling all types of alcohol. Negative relationships were found for percentage of the population with at least an associate degree, percentage of households with incomes below $25 000, and drug distribution incidents. As a whole, model 3 represented a significant improvement over model 2 ($\chi^2_{16} = 102.53$; $P < .001$), indicating that characteristics of surrounding areas contribute distinct effects above and beyond sociodemographic measures.

We also compared 2 full models (including the same variables as model 3) for weekend and weekday violent crime counts (Table 2) and found that the intercept for the weekend model was higher than that for the weekday model, indicating a higher baseline expected number of crimes on weekends. Census measures found to be significant in the complete model were, not surprisingly, found to be significant for at least one of the weekday or weekend categories. Indeed, the nondifferentiated complete model estimate was always found to lie between the 2 day-of-week estimates. In the case of alcohol outlets, we found higher estimates for the weekend measure with the exception of restaurants selling beer or wine (or both).

When we examined lagged weekend–weekday differences (Table 2), we found that the effect of restaurant (beer and wine) alcohol outlets changed in direction and significance; on weekdays the effect was not significant ($P = .442$) and was negative, whereas on weekends the effect was positive and significant ($P = .036$). In this last case, the undifferentiated model did not yield a significant effect, indicating that there is some unaccounted for residual effect modification. This result is in contrast to the nonlagged effects of beer and wine restaurant outlets, which were not found to be very different between the weekend and weekday models. A number of effects were significant on weekdays but not on weekends; most prominently, lagged number of restaurants selling all types of alcohol conferred much more risk on weekdays. The lagged value of percentage of the population aged 16 years or younger was found to be more of a risk factor on weekends than on weekdays.

DISCUSSION

Both densities and types of alcohol outlets were found to be related to violent crime in a differentiated and complex way. The impact of alcohol outlets on crime is often viewed as a marker for other population or environmental features related to violence; our study provides evidence that a sizeable effect attributable to alcohol outlets cannot be explained solely by such features. In addition, we found that spatial effects due to the environmental characteristics of neighboring block groups were significantly related to violent crime after control for drug trafficking and drug possession arrests (and ours is one of the few such analyses in the literature).

Alcohol outlets within a given area as well as in adjacent areas were found to be related to violent crime after control for illicit drug arrests and census-based measures. This relationship was not homogeneous; for example, there is suggestive evidence (with demographic characteristics taken into account) of a positive relationship between violent crime and the presence of package stores and a negative relationship between violent crime and the presence of restaurants selling beer and wine. In contrast to restaurants selling only beer and wine, restaurants selling any type of alcohol were positively associated with violent crime. Interestingly, drug distribution was found to be negatively related to violent crime, whereas drug possession exhibited a positive relationship.

Unlike the violence associated with the crack-cocaine epidemic of the late 1980s and early 1990s, Boston drug markets, now clearly defined and the focal points of ongoing police suppression activity, generated a small share of serious violence in Boston in 2006.[22] By contrast, areas with high concentrations

TABLE 2—Nested Quasi-Poisson Regression Models Predicting Violent Crime Rates: Boston, MA, 2006

Variable	Model 1		Model 2 (Drug/Alcohol Variables Added)		Model 3 (All Violence)		Mode 4 (Weekday Violence)		Model 5 (Weekend Violence)	
	Estimate	*P*	Estimate	*P*	Estimate	*P*	Estimate	*P*	Estimate	*P*
Intercept	−10.552	<.001	−10.269	<.001	−12.26	<.001	−12.48	<.001	−11.57	<.001
% aged ≤ 16 y	−0.042	<.001	−0.018	.111	−0.035	.004	−0.031	.014	−0.046	.005
% aged ≥ 65 y	0.010	.198	0.009	.204	0.004	.573	0.004	.624	0.006	.568
% minority	0.015	<.001	0.012	<.001	0.004	.194	0.003	.388	0.008	.06
% below poverty line	0.006	.331	−0.005	.355	−0.008	.177	−0.007	.225	−0.009	.256
% unemployed	0.005	.042	0.003	.262	0.003	.167	0.003	.119	0.002	.594
% female-headed households	0.000	.884	0.006	.021	0.004	.183	0.003	.35	0.007	.081
% households with income < $25 000	0.001	.756	−0.002	.533	0.004	.215	0.004	.268	0.004	.327
% with ≥ associate degree	−0.013	<.001	−0.011	<.001	−0.007	.011	−0.008	.009	−0.005	.173
% vacant housing	0.035	<.001	0.030	<.001	0.021	<.001	0.02	.001	0.024	.002
% housing occupied by renters	0.009	.003	0.008	.003	0.007	.016	0.008	.013	0.005	.187
No. of restaurants selling any type of alcohol	. . .	. . .	0.082	<.001	0.079	<.001	0.071	<.001	0.091	<.001
No. of restaurants selling beer and wine (or both)	. . .	. . .	−0.023	.327	−0.021	.269	−0.018	.378	−0.026	.292
No. of package alcohol outlets	. . .	. . .	0.058	.215	0.067	.129	0.063	.173	0.076	.205
No. of nonstore/nonrestaurant alcohol outlets	. . .	. . .	−0.069	.236	−0.035	.148	−0.036	.511	−0.014	.829
No. of drug distribution incidents	. . .	. . .	−0.021	.005	−0.014	.053	−0.013	.078	−0.014	.167
No. of drug possession incidents	. . .	. . .	0.026	<.001	0.022	<.001	0.021	<.001	0.023	.003
Lag: % housing occupied by renters	. . .	. . .	. . .	. . .	0.007	.151	0.006	.273	0.011	.109
Lag: % vacant housing	. . .	. . .	. . .	. . .	0.009	.405	0.01	.406	0.008	.595
Lag: % with ≥ associate degree	. . .	. . .	. . .	. . .	−0.009	.031	−0.01	.026	−0.007	.192
Lag: % households with income < $25 000	. . .	. . .	. . .	. . .	−0.016	.016	−0.016	.029	−0.017	.068
Lag: % female-headed households	. . .	. . .	. . .	. . .	0.015	.009	0.016	.007	0.01	.171
Lag: % unemployed	. . .	. . .	. . .	. . .	0.004	.502	0.005	.427	−0.001	.89
Lag: % below poverty line	. . .	. . .	. . .	. . .	0.018	.252	0.025	.148	0.004	.857
Lag: % minority	. . .	. . .	. . .	. . .	0.002	.536	0.005	.196	−0.006	.237
Lag: % aged ≥ 65 y	. . .	. . .	. . .	. . .	0.004	.771	0.003	.837	0.006	.774
Lag: % aged ≤ 16 y	. . .	. . .	. . .	. . .	0.053	.017	0.037	.109	0.094	.003
Lag: drug distribution incidents	. . .	. . .	. . .	. . .	−0.056	.003	−0.07	<.001	−0.014	.618
Lag: drug possession incidents	. . .	. . .	. . .	. . .	0.021	.171	0.031	.054	−0.009	.692
Lag: nonstore/nonrestaurant alcohol outlets	. . .	. . .	. . .	. . .	−0.118	.442	−0.217	.185	0.137	.504
Lag: package alcohol outlets	. . .	. . .	. . .	. . .	0.009	.944	0.035	.787	−0.068	.69
Lag: restaurants selling all types of alcohol	. . .	. . .	. . .	. . .	0.158	<.001	0.195	<.001	0.066	.314
Lag: restaurants selling beer and wine	. . .	. . .	. . .	. . .	0.014	.801	−0.046	.442	0.14	.036
R^2	0.389133		0.5164503		0.6043909		0.5825809		0.5219536	
% deviance explained	46.02		55.32		63.34		62.76		45.22	

of drug users, reflected by elevated levels of arrests for drug possession, may also be characterized by disorderly street environments conducive to violent behavior.[23]

Furthermore, areas high in levels of violent crime were found to also be significantly poorer areas (i.e., lower incomes, and higher percentages of vacant homes and female-headed households) with greater numbers of alcohol outlets and higher drug arrest rates (for both possession and trafficking). Identification of such "hot spots" may help in identifying micro-environments: blocks or intersections whose characteristics facilitate violent behavior. Our study helps identify such micro-environments, an emerging area of criminology research, in Boston.[24,25]

When we included adjacent areas in the model (spatial lags), we found a positive association between restaurants in adjacent areas selling all types of alcohol and violent crime. Illicit drug arrests maintained the same relationships as in the nonlagged model. These spatial results help to differentiate and contextualize alcohol outlets and drug arrests, allowing us to not only identify a specific target area for violent crime but more dynamically capture information for naturally related nearby areas.

In our attempt to more accurately capture possible differences between weekend and

weekday drinking, we found that weekends, after including a model offset to account for fewer weekend than weekday hours, had higher intercepts, suggesting that the weekday model provided a better fit. Furthermore, we found interesting differences in sign for restaurants selling beer and wine. There was a negative relationship ($P = .442$) for the weekday model and a positive one for the weekend model ($P = .036$). This finding might indicate that, on weekends, restaurants have a different clientele or become more like bars.

Outlet differentiation may lead to the attraction of certain types of customers later on weekday nights who are substantively different than customers who visit the outlets earlier in the evening or patrons who dine at restaurants on weekdays. This niche approach toward interpretation posits that greater numbers of outlets present more choices of places to drink, encourage the segregation of drinkers into drinking subgroups, and provide attractive venues for problem drinking. Conceptually, this approach gains force in its assertion that alcohol outlets compete for drinkers, market to specific subgroups, and maximize profits by selling to specific niche groups (i.e., subgroups of consumers who share common characteristics). Thus, the origin of violent bars, often the focus of studies on drinking contexts, is viewed as a natural consequence of the interaction of commercial alcohol markets and social systems.[6,26]

Furthermore, alcohol availability and social disorganization constructs can be included within such an approach because it accounts for the density of alcohol outlets. The differences seen in our findings between types of alcohol outlets, although not decisive, suggest that greater elaborations of outlet differentiation are needed in future research.

Limitations

It should be noted that our positive restaurant effects contrast with previous work in which negative relationships were found between violence and restaurant density.[1] There appears to be both a secular trend and city-specific issues related to restaurant use. Lipton and Gruenewald[1] found a positive relationship between violence and the presence of bars and off-premise liquor stores in California and a negative relationship between violence and the presence of restaurants.

Earlier we surmised that areas with high restaurant densities are of a different character than areas with high densities of bars and liquor stores (i.e., restaurant-dense areas in any particular city might exclude more violent areas with higher densities of bars and liquor stores). This may not be the case in Boston. There may be a more hybrid nature to restaurants wherein they function as restaurants before a certain hour and function more like bars or clubs later in the evening. To some extent, we captured a greater amount of this kind of information by analyzing violent crime during both weekends and weekdays. Nevertheless, this mixing of outlet types in any single location complicates efforts to assess their impact on the occurrence of violence in such areas from both a research and data analysis perspective and a policy perspective.

Conclusions

Notwithstanding such issues, we differentiated alcohol outlets in a manner that allows for more careful study of their role in neighborhoods both as places that exacerbate or focus violence and as general neighborhood markers. Regardless of the specific alcohol outlet or drug relationships observed here, we have shown that place-based factors contribute to a more comprehensive and useful understanding of the contexts in which violent crime occurs. States and cities can build on such information to strengthen their alcohol control and policing policies. Future research efforts will also benefit from this more nuanced understanding of alcohol outlets when addressing changes in violent crime and outlets through time. ■

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Contributors

R. Lipton originated and directed the research and wrote the bulk of the article. X. Yang contributed to data collection and analysis. A. A. Braga helped to conceptualize the research direction and contributed to the writing and editing of the article. J. Goldstick was responsible for the final analysis and contributed to the writing and editing of the article. M. Newton contributed to the writing and editing of the article. M. Rura helped in clarifying analyses and contributed to the writing and editing of the article.

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Human Participant Protection

This study was approved by the institutional review board of the Beth Israel Deaconess Medical Center. Informed consent was not needed because all of the data used were publicly available, and all personal identifiers were removed.

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