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Aleksandra J. Snowden

Marquette University, aleksandra.snowden@marqutte.edu

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Aleksandra J. Snowden
Marquette University, Milwaukee, WI

Abstract

There is substantial evidence of an ecological association between off-premise alcohol outlets and violence. We know less, however, about how specific beverage types that are sold in the outlets might explain the difference in violence rates across different alcohol outlets. Data on alcohol beverage types were collected for all off-premise alcohol outlets in Milwaukee, Wisconsin, using a systematic social observation instrument. Spatially lagged regression models were estimated to determine whether the variation in alcohol beverage types is related to robbery density net of important neighborhood predictors of crime rates. Availability of all alcohol beverage types (beer, wine, spirits, premixed, single beer, single spirits, single premixed) was positively associated with the density of robberies, net of neighborhood characteristics. Reducing alcohol beverages, regardless of the beverage type, sold at off-premise alcohol outlets may reduce violence in communities.

Keywords

Introduction

The prevalence of interpersonal violence is very high in the United States. The U.S. homicide rate of 5/100,000 population and equally troubling U.S. suicide rate of 14.3/100,000 population present a serious public health problem with high social and economic costs ([World Health Organization, 2015](#)). When interpersonal violence patterns are examined across space, it seems that certain areas and cities within the United States experience a disproportionate amount of violence. In other words, the U.S. violent crime rate of 386.3/100,000 population is somewhat deceiving because for some large U.S. cities, the violent crime rate is many times higher. For example, the Detroit, Michigan, crime rate is more than 5 times higher than the national crime rate (2,047/100,000 population) and the crime rate of other U.S. cities is nearly as high (e.g., Memphis, Tennessee, violent crime rate is 1,820/100,000 population; Baltimore, Maryland, violent crime rate is 1,780/100,000 population; and Milwaukee, Wisconsin, violent crime rate is 1,533/100,000 population) ([U.S. Department of Justice, 2016](#)).

Considering area-level violence rates, one could explain the variation in violence based on the neighborhood characteristics of the area, as well as the types of places that are licensed to operate in the area. Drawing from the social disorganization theory framework, it is to be expected that some areas have higher violence rates as a result of poverty, ethnic heterogeneity, and population turnover in the areas ([Shaw & McKay, 1942](#)). These characteristics create reduced collective efficacy and affect the ability of community residents to organize and control undesirable behavior, including crime ([Sampson & Groves, 1989](#); [Sampson, Morenoff, & Gannon-Rowley, 2002](#); [Sampson, Raudenbush, & Earls, 1997](#)). Importantly, socially disorganized areas seem to have disproportionately higher availability of alcohol outlets ([Snowden, 2016](#)), and, therefore, any investigation of area-level violence rates warrants including not only neighborhood characteristics but also alcohol availability measures in the analyses. Area-level violence rates may be related to the extent to which the areas also host particular places (such as alcohol outlets) that attract motivated offenders in search of vulnerable victims, and which lack capable guardians ([Cohen & Felson, 1979](#)). For example, on-premise alcohol outlets may serve as crime attractors ([Brantingham & Brantingham, 1995](#)) in late night hours, when motivated offenders look for robbery opportunities at a time when bar or club patrons leave the guarded premises of the outlet, and off-premise outlets may generate crime ([Brantingham & Brantingham, 1995](#)) in early evening hours, when these outlets experience most patron traffic, and provide a suitable time and place for criminal opportunities ([Snowden, 2018](#)).

To be sure, area-level (i.e., zip code, census tract, or block group) examinations of violence suggest that alcohol outlets are the type of places that are important predictors of violence (for a summary of the recent alcohol-violence literature, see [Snowden & Pridemore, 2017](#)). Examining the relationship between alcohol outlets (both on-premise and off-premise) and violence in zip code areas in California and controlling for neighborhood characteristics, Gruenewald and colleagues found that high assault rates were positively and significantly related to off-premise outlet density ([Gruenewald, Freisthler, Remer, LaScala, & Treno, 2006](#)). In addition, a recent study of small area units in the Canadian region of Waterloo, Ontario, found that both on-premise and off-premise alcohol outlets were positively associated with violence, net of socioeconomic indicators commonly associated with violence ([Quick, Law, & Luan, 2017](#)). This finding was echoed by a study of Cincinnati, Ohio, block groups that found the density of off-premise outlets to be more strongly related to simple and aggravated assaults, relative to on-premise density ([Pridemore & Grubesic, 2013](#)). Net of neighborhood characteristics, a positive relationship between off-premise alcohol outlets and aggravated assaults was also found in a study of Little Rock, Arkansas, census block groups ([Berthelot, Brown, & Drawve, 2015](#)). In addition, on-premise outlets were positively associated with both aggravated assault and strong-arm aggravated assault, controlling for neighborhood characteristics ([Berthelot, Brown, & Drawve, 2015](#)).

When alcohol outlet types are further disaggregated, such as when on-premises are classified as bars or as restaurants and off-premises are classified as convenience, grocery, or liquor stores, it seems that the different subtypes of on- and off-premise alcohol outlets have different associations with violence. First, it seems that

bars matter more for violence, relative to other on-premise subtypes. For example, a recent study of New Zealand census area units found that both bars/night clubs density and sports clubs density were positively associated with violent incidents, but the effect of bars/night clubs on crime was stronger than that of sports clubs (e.g., each additional bar/night club was associated with 5.3 additional violent crime incidents, whereas each additional sports club was associated with 0.8 additional violent crime incidents) (Cameron, Cochrane, Gordon, & Livingston, 2016). In addition, although bar density was associated with both simple and aggravated assault density, the density of restaurants was only associated with simple assault density and not with aggravated assault density, suggesting that different on-premise outlets matter in different ways for violence (Pridemore & Grubesic, 2013).

Second, off-premise outlet subtypes (such as liquor, convenience, or grocery stores) also have different associations with violence. A study of off-premise alcohol outlets found that liquor stores attract more violent crimes to their vicinity than convenience or corner stores (Furr-Holden et al., 2016), although in another study, the convenience stores were associated with aggravated assaults, whereas liquor stores were not (Berthelot et al., 2015). Similarly, a study that used a risk terrain modeling approach to identify specific criminogenic places, including alcohol outlets, within the built environment found that the risk of violent crime was higher for convenience stores, relative to liquor stores (Drawve, Thomas, & Walker, 2016). In addition, the study also found that being within 432 feet (equivalent of one city block) of a convenience store and being within 1,712 feet (equivalent of about three city blocks) of a liquor store puts individuals at an increased risk of being a victim of violent crime (Drawve et al., 2016), suggesting a spatially close-ranging influence of convenience stores on violence, and a far-ranging influence of liquor stores on violence.

Yet, with some notable exceptions (e.g., Morrison, Smith, Gruenewald, Ponicki, Lee, & Cameron, 2016; Parker, McCaffree, & Skiles, 2011; Snowden & Pridemore, 2014), we know less about what it is about off-premise alcohol outlets that makes them generators or attractors of crime (Brantingham & Brantingham, 1995), and how their characteristics (such as size of the outlet, pricing, or the selection of alcohol beverages available for purchase) can help explain their influence on violence. For example, Morrison, Smith, Gruenewald, Ponicki, Lee, and Cameron (2016) investigated whether intentional and unintentional injuries occur more frequently in areas with higher availability of off-premise outlets, and whether the size and type (i.e., large and chain vs. small and independent outlets) contribute more substantially to the risk of injury. They found that off-premise outlet density was positively associated with both injury types, and that large, chain off-premise outlets contribute more to the risk of injury relative to independent outlets, most likely because chain outlets were both larger in size (providing greater availability of beverages) and sold alcohol at lower prices than independent outlets. This finding confirms that not all off-premise alcohol outlets have an equal contribution to violent outcomes in communities. In addition, Parker, McCaffree, and Skiles (2011) systematically measured the relative proportion of shelf space in each liquor outlet in a Californian city, to approximate the amount of retail sales that are attributed to single-serve beverages, and subsequently examined the impact of single-serve alcohol beverage availability on neighborhood violence rates. They found that the average amount of shelf space devoted to single-serve beverages aggregated to census block groups was positively associated with violent crime rate in census block groups. Their finding suggests that off-premise outlets that offer high availability of single-serve beverages are important for any policy consideration that aims to reduce neighborhood crime rates, as these beverages are aimed for immediate consumption, and are often cheaper to purchase than other beverage types.

Other additional characteristics may help explain how and why off-premise outlets contribute to neighborhood crime rates, so Snowden and Pridemore (2014) examined a set of immediate environment characteristics of areas where off-premises are located, the outlet business practices of the outlets, and the staff and patron characteristics of those who work and purchase items at the outlets. They aggregated observable off-premise characteristics to census block groups, and noted a presence or absence of such characteristics and related them to violent crimes in the block groups. They found that the most important predictor of violent crimes in the block groups was off-premise density, rather than the observable characteristics of off-premises that they

analyzed. The insignificant relationship between off-premise outlet characteristics and neighborhood crimes may be due to their methodological approach, which included off-premise density measure in the models that also included off-premise outlet characteristics, which may have been correlated and resulted in overestimation of the standard error and insignificant findings for the characteristics they analyzed.

Taken together, the studies that approached the relationship between alcohol availability and crime from a more nuanced perspective consistently suggest that areas that have higher availability of off-premise alcohol outlets have higher level of crimes, including female and male victimization rates (Snowden, Hockin, & Pridemore, 2017), higher rates of evening and late-night assaults, as well as higher rates of daytime and evening robberies (Snowden, 2018). The nuances of these relationships are little understood as we continue to learn what it is about off-premise outlets that creates these associations.

Drawing from a rich body of literature that advances our understanding of the characteristics of bars as a way to understand aggression in drinking settings and prevent barroom violence (e.g., Graham, Bernards, Abbey, Dumas, & Wells, 2017; Graham, Bernards, Osgood, & Wells, 2006; Graham et al., 2004; Miller et al., 2016; Wilson, Graham, & Taft, 2014), this study aims to better understand how the little studied off-premise characteristic—the availability of particular alcohol beverages available for sale in off-premise alcohol outlets—can inform our understanding of violence occurring in the neighborhoods. Prior studies that examined alcohol beverage types focused only on the availability of single-serve beverages (Parker et al., 2011), but this study examines not only single-serve beverage availability but also availability of other alcohol beverage types, which may also influence violence. This is especially important because violent injuries occur more frequently in areas with higher availability of off-premise alcohol outlets, and there is some indication that some off-premise alcohol outlet characteristics (the size of alcohol outlets or the amount of their sales devoted to single-serve beverages, discussed above) are positively related with the degree of violent injury risk (Morrison et al., 2016; Parker et al., 2011). Clearly, a better understanding of why off-premise alcohol outlets matter for violence is necessary, and this research examines how different alcohol beverage types available in neighborhoods can inform why these places seem to be crime generators or attractors (Brantingham & Brantingham, 1995).

Given this literature review, this study is designed to fill the current gap in the alcohol–violence studies. It examined whether alcohol beverage types, including beer, wine, spirits, premixed, single beer, single spirits, and single premixed, are associated with robbery density. It controlled for the variables that measure neighborhood characteristics and routine activities theories frameworks, and for spatial autocorrelation of robberies occurring in the nearby areas. It tested the following hypotheses:

> **Hypothesis 1:** Neighborhood characteristics and population density will be associated with robbery density.
> **Hypothesis 2:** Alcohol outlet density will be associated with robbery density.
> **Hypothesis 3:** Beer, wine, and spirits densities will be associated with robbery density.
> **Hypothesis 4:** Single-serve beverage densities will be associated with robbery density.

Method

Research Site and Units of Analysis

Milwaukee, Wisconsin, is the largest city in the state, covering a land area of about 96 square miles with an estimated population of 595,047 individuals (U.S. Census Bureau, 2016). Relative to the rest of the state, Milwaukee is an exceptionally diverse city, with Whites comprising 46% of the city population, African Americans comprising another 39.2% of the city population, Hispanic or Latino population comprising 18.2% of the city population, and the 9.7% of the population that is foreign born is twice as high as that for the entire state (U.S. Census Bureau, 2016). Like many other urban American cities, Milwaukee also experiences challenging conditions. For example, 41.7% of homes in the city are owner occupied, which is much lower than

the rate for the state of Wisconsin of 67% ([U.S. Census Bureau, 2016](#)). Perhaps more troubling is the fact that the median value of owner-occupied housing units of US$115,000 is more than two thirds lower than the median value of owner-occupied housing units of US$167,000 for the rest of the state ([U.S. Census Bureau, 2016](#)), suggesting that the city's owner-occupants are less likely to generate wealth as a result of owning a home. In addition, Milwaukee's median household income of US$36,801 is much lower than the state median household income of US$54,610.

Finally, a greater percentage of the city's population lives in poverty, relative to the rest of the state. In fact, almost a third of the city residents live in poverty, whereas the percent of population living in poverty for the state of Wisconsin is about 12% ([U.S. Census Bureau, 2016](#)). These conditions create an important context within which to examine Milwaukee's violence rate.

In addition, the state of Wisconsin and the city of Milwaukee have a long history of alcohol production, owing partly to the state's and the city's German heritage. Wisconsin alcohol consumption consistently ranks higher than most of the states in the union, with an estimated 2016 average consumption of 2.98 gallons of ethanol consumed in the form of alcoholic beverages per capita, most of it consumed in the form of beer (1.36 gallons), followed by spirits (1.22 gallons), and wine (0.40 gallons) ([Haughwout & Slater, 2018](#)). As noted earlier, Milwaukee also has high violence rates. The city's violent crime rate is 1,533/100,000 population, and about 4 times higher than the U.S. national crime rate of 383.6/100,000 population ([U.S. Department of Justice, 2016](#)). Milwaukee's robbery rate of 547/100,000 population is equally troubling as it is more than 5 times higher than the U.S. national robbery rate of 102.8/100,000 population, and Milwaukee's aggravated assault rate of 883/100,000 population is more than 4 times higher than the U.S. national aggravated assault rate of 248.5/100,000 population ([U.S. Department of Justice, 2016](#)).

To approximate Milwaukee neighborhoods, the units of analysis for this study are 572 census block groups that are within the city of Milwaukee boundaries. In criminological literature, census block groups are commonly used for neighborhood boundaries, and are the smallest units of analysis for which socioeconomic data are publicly released.

Dependent Variable

Data on robbery incidents were obtained from the City of Milwaukee Community Mapping and Analysis for Safety Strategies public applications website. Data on these incidents were based on those that occurred between January 1, 2016, and December 31, 2016. The data included incident number, date, time, and location of the incident, which were geocoded using ArcMap 10.4 with a 99% successful match. Using these data, robbery density per square mile was calculated for each block group, and the density was calculated per square mile of the area rather than population size of the area to take into account the fact that victims and offenders travel to and from their block groups in the course of their everyday activities.

Main Independent Variables

Data on all active alcohol outlet licenses for 2015/2016 were obtained from the Wisconsin Department of Revenue. The data included license address, which were geocoded using ArcMap 10.4 with 99.7% successful match, and license type (e.g., on-premise, such as bars and restaurants, or off-premise, such as liquor and convenience stores). Using these data, I disaggregated all alcohol outlets into two broad types (i.e., on premise and off premise), and subsequently calculated on-premise alcohol outlet density based on the number of on-premise outlets per square mile for each block group, and off-premise alcohol outlet density as the number of off-premise outlets per square mile for each block group.

Between February and May 2016, eight trained research observers visited and recorded on a systematic social observation instrument the observable off-premise characteristics, including alcohol beverage types. The

observers noted availability of the following alcohol beverage types: beer, wine, spirits, premixed drinks, single beer, single spirits, and single premixed drinks. To create beverage type densities, the number of off-premises that sold a particular beverage type was calculated for each census block group (using ArcGIS software and spatial join function). This process created a raw count of the number of off-premises with such characteristic for each unit of analysis, and subsequently this number was divided by the size of the census block group to create appropriate beverage type density measures. For example, if a census block group had three off-premises that sold spirits, then the spirits density measure was calculated as three divided by the size of the block group in which the three off-premise outlets that sold spirits were located, to create the density measure and account for the fact that some block groups may have many such characteristics due to their area size. So, using this approach, the availabilities of seven beverage types within each unit of analysis were first identified and then aggregated to the census block group, and standardized per square mile.

Control Variables

To control for the influence of neighborhood characteristics on robbery rates, the 2011-2015 American Community Survey 5-year estimates data were queried to obtain neighborhood characteristics data. The neighborhood measures included concentrated disadvantage, concentrated immigration, residential stability, ethnic heterogeneity, population density, and proportion Black population. In line with prior studies on neighborhood–violence literature (e.g., Sampson & Groves, 1989; Sampson et al., 2002; Sampson et al., 1997; Snowden, 2018) and to reduce multicollinearity between control variables, the data were analyzed for underlying latent structures, and principal component analyses were carried out to reduce multicollinearity and identify structural components, such as concentrated disadvantage, concentrated immigration, and residential stability. Concentrated disadvantage measure (Cronbach's α = .74) included proportions of households receiving Supplemental Security Income, households receiving public assistance income, population that is 16 years and above that is unemployed, households with income below poverty level, and single-parent households that have children below the age of 18 years living in them. Concentrated immigration measure (Cronbach's α = .73) included proportions of population that is foreign born and population that is of Hispanic or Latino origin. Residential stability measure (Cronbach's α = .65) included proportions of population that resided in the same house 1 year ago and owner-occupied housing units. Ethnic heterogeneity measure was calculated by using the Herfindahl index (Gibbs & Martin, 1962; Osgood & Chambers, 2000). For this measure, first the proportions of White, African American, American Indian/Alaska Native, Asian, Hawaiian/Other Pacific Islander, and Other populations were calculated, and subsequently, each proportion was squared, the squared proportions were summed, and then subtracted from 1, with higher scores indicating a greater diversity in the neighborhood (Osgood & Chambers, 2000). Population density was calculated as the number of individuals residing in each block group divided by the block group area size in square miles, to account for the likelihood of robbery rates occurring in areas with higher population numbers. Proportion Black population measure was calculated as the total number of Black or African American population in each block group divided by the block group total population, to account for the likelihood of higher robbery victimization or offending occurring in areas with higher proportion of Black or African American population (see Hindelang, 1976, 1978; Messner, 1983). All of the neighborhood measures were standardized prior to analyses.

I used ArcMap 10.4 software to clean, geocode, and manage data and employed GeoDa software (Anselin, Syabri, & Kho, 2006) to estimate all models using maximum likelihood estimation of spatial lag function to account for spatial autocorrelation of robberies across neighboring block groups. I conducted nine sets of analyses. The first two sets of analyses examined (a) baseline relationship between neighborhood characteristics and robbery density and (b) the relationship between on- and off-premise alcohol outlet densities and robbery density (Models 1 and 2). The following seven sets of analyses examined separately the relationship between (c) beer density (Model 3), (d) wine density (Model 4), (e) spirits density (Model 5), (f) premixed density (Model 6), (g) single beer density (Model 7), (h) single spirits density (Model 8), and (i) single premixed density (Model 9) and robbery density, net of important neighborhood characteristics.

Results

Descriptive statistics for standardized dependent, main independent, and control variables used in regression models are presented in Table 1.

Table 1. Descriptive Statistics for Standardized Variables for Milwaukee Block Groups (N = 572).

	Minimum	Maximum	M	SD
Robbery density	−0.97	5.38	0.00	1.00
Concentrated disadvantage	−2.96	3.14	0.00	1.00
Concentrated immigration	−1.30	3.66	0.00	1.00
Residential stability	−4.72	1.99	0.00	1.00
Ethnic heterogeneity	−1.76	2.37	0.00	1.00
Population density	−1.59	5.55	0.00	1.00
Proportion Black	−1.15	1.54	0.00	1.00
On-premise density	−0.44	9.85	0.00	1.00
Off-premise density	−0.53	5.53	0.00	1.00
Beer density	−0.52	5.76	0.00	1.00
Wine density	−0.42	6.52	0.00	1.00
Spirits density	−0.40	6.52	0.00	1.00
Premixed density	−0.42	7.02	0.00	1.00
Single beer density	−0.51	6.02	0.00	1.00
Single spirits density	−0.40	6.82	0.00	1.00
Single premixed density	−0.40	7.23	0.00	1.00

Table 2 shows the correlation matrix for Milwaukee block groups. As expected, robbery density was positively and significantly associated with the neighborhood characteristics variables of concentrated disadvantage (r = .348), concentrated immigration (r = .282), ethnic heterogeneity (r = .143), population density (r = .531), and proportion Black (r = .149). The only exception to this pattern was residential stability (r = −.311), which was negatively but significantly associated with robbery density. In addition, also as expected, robbery density was positively and significantly associated with alcohol availability measures and alcohol beverage types. That is, robbery density was associated with on-premise density (r = .184), off-premise density (r = .415), beer density (r = .389), wine density (r = .330), spirits density (r = .272), premixed density (r = .350), single beer density (r = .381), single spirits density (r = .254), and single premixed density (r = .326).

Table 2. Correlation Matrix for Milwaukee Block Groups (N = 572).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Robbery density	|															
2. Concentrated disadvantage	.348**	|														
3. Concentrated immigration	.282**	.000	|													
4. Residential stability	-.311**	.000	.000	|												
5. Ethnic heterogeneity	.143**	.069	.460**	-.092*	|											
6. Population density	.531**	.068	.428**	-.318**	.181**	|										
7. Proportion Black	.149**	.574**	-.500**	-.037	-.185**	-.198**	|									
8. On-premise density	.184**	-.253**	0133**	-.325**	.048	.344**	-.293**	|								
9. Off-premise density	.415**	.182**	.203**	-.182**	.058	.321**	.030	.214**	|							
10. Beer density	.389**	.193**	.143**	-.181**	.034	.286**	.067	.206**	.943**	|						
11. Wine density	.330**	.151**	.108*	-.107*	.060	.134**	.044	.131**	.691**	.750**	|					
12. Spirits density	.272**	.113**	.084*	-.107*	.028	.150**	.028	.233**	.626**	.669**	.804**	|				
13. Premixed density	.350**	.140**	-.047	-.207**	-.022	.125**	.154**	.124**	.630**	.684**	.629**	.624**	|			
14. Single beer density	.381**	.215**	.145**	-.172**	.034	.263**	.088*	.135**	.924**	.972**	.738**	.615**	.706**	|		
15. Single spirits density	.254**	.142**	.062	-.095*	.015	.083*	.074	.094*	.600**	.640**	.831**	.904**	.674**	.667**	|	
16. Single premixed density	.326**	.131**	-.057	-.200**	-.028	.122**	.166**	.116**	.567**	.631**	.576**	.586**	.953**	.659**	.623**	|

*Correlation is significant at the .05 level (two tailed).

**Correlation is significant at the .01 level (two tailed).

Because the data used in this study are spatially referenced data, which bring special problems (i.e., spatial dependence and spatial heterogeneity) to linear regression (see Anselin, 2013), I estimated spatial regression models with first-order queen contiguity spatial weight matrix. Table 3 shows the results of robbery density regressed on neighborhood characteristics, alcohol availability, and alcohol beverage types for Milwaukee block groups. The baseline model, Model 1, was estimated to test the first hypothesis and examined the association between neighborhood characteristics and robbery density. Results of Model 1 suggest that concentrated disadvantage, concentrated immigration, population density, and proportion Black were significantly and positively associated with robbery density ($B = 0.11$, $p = .01$; $B = 0.11$, $p = .01$; $B = 0.28$, $p < .01$; and $B = 0.13$, $p = .01$, respectively), and residential stability was significantly and negatively associated with robbery density ($B = -0.11$, $p < .01$). The spatial lag term (rho) associated with robbery density was a positive and significant contributor to the model ($B = 0.47$, $p < .01$). The model explained 53% of the variance in robbery density.

Table 3. Robbery Density Regressed on Neighborhood Characteristics, Alcohol Availability, and Alcohol Beverage Types for Milwaukee Block Groups ($N = 572$).

	Coefficient	SE	Probability
Model 1: Baseline			
Ethnic heterogeneity	−0.02	0.03	.46
Concentrated disadvantage	0.11	0.04	.01
Concentrated immigration	0.11	0.04	.01
Residential stability	−0.11	0.03	.00
Population density	0.28	0.04	.00
Proportion Black	0.13	0.05	.01
Rho robbery density	0.47	0.05	.00
Constant	0.01	0.03	.83
R^2		.53	
Log likelihood		−608.07	
Akaike information criterion		1,232.15	
Schwarz criterion		1,266.95	
Number of observations		572	
Number of variables		8	
Degrees of freedom		564	
Multicollinearity condition number		2.99	
Model 2: Alcohol availability			
Ethnic heterogeneity	−0.01	0.03	.68
Concentrated disadvantage	0.10	0.04	.01
Concentrated immigration	0.10	0.04	.02
Residential stability	−0.09	0.03	.01
Population density	0.24	0.04	.00
Proportion Black	0.13	0.05	.01
Rho robbery density	0.44	0.05	.00
On-premise density	0.03	0.03	.32
Off-premise density	0.15	0.03	.00
Constant	0.01	0.03	.84
R^2		.55	
Log likelihood		−594.54	
Akaike information criterion		1,209.09	
Schwarz criterion		1,252.58	
Number of observations		572	

Number of variables		10	
Degrees of freedom		562	
Multicollinearity condition number		3.21	
Model 3: Beer availability			
Ethnic heterogeneity	−0.02	0.03	.64
Concentrated disadvantage	0.10	0.04	.02
Concentrated immigration	0.11	0.04	.01
Residential stability	−0.10	0.03	.00
Population density	0.25	0.04	.00
Proportion Black	0.12	0.05	.01
Rho robbery density	0.44	0.05	.00
Beer density	0.14	0.03	.00
Constant	0.01	0.03	.84
R^2		.54	
Log likelihood		−598.18	
Akaike information criterion		1,214.36	
Schwarz criterion		1,253.51	
Number of observations		572	
Number of variables		9	
Degrees of freedom		563	
Multicollinearity condition number		3.02	
Model 4: Wine availability			
Ethnic heterogeneity	−0.02	0.03	.47
Concentrated disadvantage	0.09	0.04	.02
Concentrated immigration	0.11	0.04	.01
Residential stability	−0.10	0.03	.00
Population density	0.28	0.04	.00
Proportion Black	0.13	0.05	.00
Rho robbery density	0.43	0.05	.00
Wine density	0.16	0.03	.00
Constant	0.01	0.03	.84
R^2		.55	
Log likelihood		−592.75	
Akaike information criterion		1,203.49	
Schwarz criterion		1,242.63	
Number of observations		572	
Number of variables		9	
Degrees of freedom		563	
Multicollinearity condition number		3.00	
Model 5: Spirit availability			
Ethnic heterogeneity	−0.02	0.03	.52
Concentrated disadvantage	0.10	0.04	.01
Concentrated immigration	0.11	0.04	.01
Residential stability	−0.10	0.03	.00
Population density	0.27	0.04	.00
Proportion Black	0.13	0.05	.00
Rho robbery density	0.45	0.05	.00
Spirit density	0.12	0.03	.00

Constant	0.01	0.03	.83
R^2		.55	
Log likelihood		−599.43	
Akaike information criterion		1,216.87	
Schwarz criterion		1,256.01	
Number of observations		572	
Number of variables		9	
Degrees of freedom		563	
Multicollinearity condition number		3.00	
Model 6: Premixed availability			
Ethnic heterogeneity	−0.02	0.03	.56
Concentrated disadvantage	0.10	0.04	.01
Concentrated immigration	0.13	0.04	.00
Residential stability	−0.08	0.03	.01
Population density	0.26	0.03	.00
Proportion Black	0.11	0.04	.01
Rho robbery density	0.44	0.05	.00
Premixed density	0.20	0.03	.00
Constant	0.01	0.03	.83
R^2		.56	
Log likelihood		−585.90	
Akaike information criterion		1,189.79	
Schwarz criterion		1,228.94	
Number of observations		572	
Number of variables		9	
Degrees of freedom		563	
Multicollinearity condition number		3.00	
Model 7: Single beer availability			
Ethnic heterogeneity	−0.02	0.03	.63
Concentrated disadvantage	0.09	0.04	.02
Concentrated immigration	0.10	0.04	.02
Residential stability	−0.10	0.03	.00
Population density	0.26	0.04	.00
Proportion Black	0.12	0.05	.01
Rho robbery density	0.44	0.05	.00
Single beer density	0.13	0.03	.00
Constant	0.01	0.03	.84
R^2		.54	
Log likelihood		−599.53	
Akaike information criterion		1,217.06	
Schwarz criterion		1,256.2	
Number of observations		572	
Number of variables		9	
Degrees of freedom		563	
Multicollinearity condition number		3.01	

Model 8: Single spirit availability			
Ethnic heterogeneity	−0.02	0.03	.54
Concentrated disadvantage	0.10	0.04	.01
Concentrated immigration	0.11	0.04	.01
Residential stability	−0.10	0.03	.00
Population density	0.28	0.04	.00
Proportion Black	0.13	0.05	.01
Rho robbery density	0.45	0.05	.00
Single spirit density	0.12	0.03	.00
Constant	0.01	0.03	.83
R^2		.54	
Log likelihood		−600.22	
Akaike information criterion		1,218.44	
Schwarz criterion		1,257.58	
Number of observations		572	
Number of variables		9	
Degrees of freedom		563	
Multicollinearity condition number		3.00	
Model 9: Single premixed availability			
Ethnic heterogeneity	−0.02	0.03	.56
Concentrated disadvantage	0.10	0.04	.01
Concentrated immigration	0.12	0.04	.00
Residential stability	−0.08	0.03	.01
Population density	0.26	0.03	.00
Proportion Black	0.11	0.05	.02
Rho robbery density	0.45	0.05	.00
Single premixed density	0.18	0.03	.00
Constant	0.01	0.03	.82
R^2		.56	
Log likelihood		−588.93	
Akaike information criterion		1,195.86	
Schwarz criterion		1,235.00	
Number of observations		572	
Number of variables		9	
Degrees of freedom		563	
Multicollinearity condition number		3.00	

Model 2 was estimated to test the second hypothesis and examine the association between alcohol availability and robbery density, net of neighborhood characteristics. Results of Model 2 suggest that whereas on-premise density was not associated with robbery density, off-premise was positively and significantly associated with robbery density ($B = 0.03$, $p = .32$, and $B = 0.15$, $p < .01$, respectively). The model explained 55% of the variance in robbery density.

Models 3 to 9 were estimated to provide a more disaggregated analysis of the relationship between robberies and different alcohol beverage types and to test the remaining hypotheses. Model 3 examined the association

between beer availability and robbery density net of control variables. In Model 3, we see that beer availability was positively and significantly associated with robbery density ($B = 0.14$, $p < .01$). Model 4 examined the association between wine availability and robbery density, net of control variables. The results of Model 4 suggest that wine availability was positively and significantly associated with robbery density ($B = 0.16$, $p < .01$). Model 5 was estimated to examine the association between spirits availability and robbery density, and the results suggest that availability of spirits was positively and significantly related to robbery density ($B = 0.12$, $p < .01$). In addition, Model 6 examined the relationship between availability of premixed alcohol beverages and robbery density. Model 6 results suggest that availability of premixed drinks was positively and significantly associated with robbery density ($B = 0.20$, $p < .01$).

The following three models, Models 7 to 9, examined the relationship between single drink availability and robbery density. Model 7 was estimated to test the association between single beer availability and robbery density, and the results suggest that single beer availability was positively and significantly related to robbery density ($B = 0.13$, $p < .01$). Model 8 examined the relationship between single spirits availability and robbery density, net of control variables. Results of Model 8 suggest that availability of single spirits was also positively and significantly associated with robbery density ($B = 0.12$, $p < .01$). Last, Model 9 examined the relationship between single premixed beverages and robbery density, and the results of Model 9 suggest a positive and significant association between single premixed availability and robbery density ($B = 0.18$, $p < .01$). Models 3 to 9 explained between 55% and 56% of variance in robbery density, and the regression diagnostics suggested that wine availability (Model 4) and premixed availability models (Models 6 and 9) best estimated the influence of these variables on robbery density.

A set of sensitivity analyses were carried out to ensure the stability of the models estimated above. Although off-premise density was a significant predictor of robbery density (Model 2), this variable was not included in the beverage type models (Models 3-9) because of high correlations between off-premise density and the density of alcoholic beverage types. Alternative models (available on request) also included off-premise alcohol outlet density measure in the beverage type models (Models 3-9), and the beverage type densities were statistically insignificant, most likely because the standard errors on the alcohol beverage type variables were likely overestimated due to the collinearity between beverage types and off-premise availability. Therefore, the analyses carried out and reported above include alcoholic beverage type models (Models 3-9) that include beverage type densities one at a time.

To better understand which beverage type density was the most important predictor of robbery density and to disentangle the simultaneous impact of beverage types and of off-premise outlets on robbery density, random forests estimations were carried out using R software package *randomForest* and the results are presented below in Figure 1. Random forests allow for a more thorough exploration of the data and provide additional insight into the explanation for variable processes, relative to linear regression analysis (see Strobl, Malley, & Tutz, 2009), and the results of the random forests show the relative importance of the predictor variables for the dependent variable. In this case, Figure 1 shows that the spatial lag term (rho) associated with robbery density is by far the most important predictor of robbery density, a finding also suggested in the tables above. The next most important predictor of robbery density is population density, followed by off-premise density, concentrated disadvantage, proportion Black, and concentrated immigration. Figure 1 also shows that certain beverage types were more important variables to predict robbery density, relative to others. Specifically, premixed beverage density is the most important alcohol beverage type predictor of robbery density, followed by beer density, wine density, single premixed density, and single beer density. Spirit density measures, including single spirits, were least important predictors of robbery density, relative to other variables.
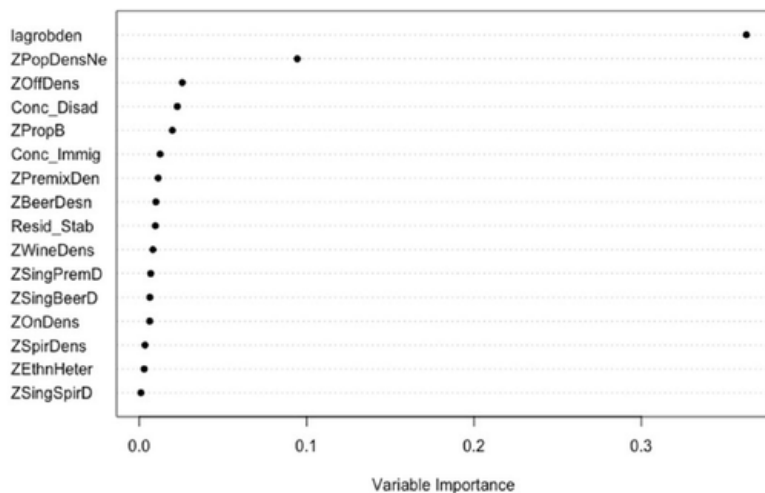
Figure 1. Random forest estimations for variable importance for Milwaukee block groups (N = 572).

Discussion

Violence presents a social and public health threat in the United States and especially in the city of Milwaukee, Wisconsin. Milwaukee is not only among one of the most violent cities in the nation, but it is also a city that has a long history of beer production and consumption, located in a state whose alcohol consumption patterns are rather high. Therefore, it is an ideal research site within which to carry out the examination of alcohol–violence connection and focus on how different beverages can explain violence in Milwaukee's neighborhoods.

Using Milwaukee, Wisconsin, block groups as the units of analysis, crime data from the Milwaukee Police Department, and controlling for several neighborhood characteristics associated with crime, a set of spatially lagged regression models were estimated to determine whether (a) neighborhood characteristics are associated with robbery density; (b) the association exists between alcohol outlet density and robbery density; (c) the availability of beer, wine, and spirits is associated with robbery density; and (d) the availability of single-serve beverages is associated with robbery density. The findings of this study show support for the proposed hypotheses. Areas that are socially disorganized have higher densities of robberies. In addition, areas with higher densities of off-premise alcohol outlets appear to have higher densities of robberies even after controlling for neighborhood characteristics that are often found to be associated with crimes (i.e., population density, concentrated disadvantage, etc.). Last, areas that have higher alcohol beverage densities (regardless of beverage types) also appear to have higher densities of robberies, net of control variables.

The results of this study suggest that although all alcohol beverages (regardless of the type) were related to robberies in Milwaukee, the importance of certain alcohol beverages in predicting robberies was higher for some beverages than others. In sum, it was the premixed drinks, followed by beer, wine, single premixed drinks, and single beer that were more important beverage type variables for robberies, whereas spirits and single spirits were less important. These findings may reflect the drinking patterns of Wisconsinites, who consume most of their alcohol through beer consumption (Haughwout & Slater, 2018) and alcohol outlets may provide higher availability of beers to respond to consumption patterns of their customers. The consumption of spirits in Wisconsin is almost as high as that of beer (Haughwout & Slater, 2018), and although spirit availability predicts robberies across Milwaukee neighborhoods, it was not as important of a variable as beer availability was, suggesting that in spite of Wisconsinites' high spirits consumption, the role of spirits was less important for robberies than that of beer. Beverage drinking preferences may vary across age groups, with younger individuals preferring beer over spirits, and their lifestyle could explain their experiences of violence or involvement in violent offending. As youth spend more time in public places, among people they do not know (Hindelang, 1976), they may become vulnerable targets in areas where alcohol availability of beer is higher, especially because increased availability of alcohol is followed by an increase in alcohol consumption, which is followed by

an increase in violence (Gruenewald, Remer, & Treno, 2009). In addition, beverage drinking preferences differ across drinking settings, with spirits consumption more likely to be carried out in private settings, where the risk of robbery victimization is very low, and beer consumption is more common in public settings (Norstrom, 1998), which provide ample opportunities for robbery victimization.

These findings are similar to previous studies that examined the associations between neighborhood characteristics, alcohol outlet density, and violence (e.g., Drawve et al., 2016; Gruenewald et al., 2006; Snowden, 2018; Snowden et al., 2017). In terms of the alcohol beverage characteristics, the findings of this study that single-serve beverages matter for violence are supported by the findings of a prior study in this area. Parker et al. (2011) also found that areas that had higher average percentage of single-serve availability also had higher violence rate. The association found in the present study between premixed drinks (including single serve) and robberies may be helpful in light of prior studies that suggested that not only are these high alcohol content drinks ready for immediate consumption but also they are particularly targeted at increasing consumption among young females (Huckle et al., 2008; Jones-Webb et al., 2008), who may be at a higher risk of robbery victimization in areas where higher availability of premixed beverages exists.

Limitations

There are a few limitations to consider in light of these findings. First, I used data that included incidents that were actually reported to the police, and a large proportion of robberies possibly go unreported. An additional limitation is associated with the unit of analysis (i.e., census block group) used in this study. Although the census block group is a commonly used unit of analysis in neighborhood-level studies of crimes and is better theoretically grounded than the use of census tracts, zip codes, or counties, it contains artificially imposed boundaries that are used to capture neighborhood boundaries, which are typically organically defined. The use of street segments that are comprised of street blocks, or street corners and block faces (e.g., Braga, Hureau, & Papachristos, 2011; Groff & Lockwood, 2014) might better represent natural neighborhood boundaries and be a more appropriate spatial unit of analysis. In addition, the alcohol beverage type observations were carried out at only one point in time (i.e., the observers noted the beverages once at each outlet during the observation period), but the robbery data analyzed here include the incidents that occurred during the entire year. Finally, this study does not examine the influence of other characteristics of off-premise alcohol outlets that could also contribute to neighborhood-level robberies. In spite of these limitations, however, this study is carefully designed to advance our understanding of the relationship between alcohol outlets and violence using data from a large urban city. This study does so by using spatially informed models, controlling for several neighborhood characteristics, disaggregating alcohol outlets into different types for the purposes of analyses, and directly examining the role that particular alcohol beverage types play in neighborhood rates of violence.

Conclusion

Most of the recent empirical studies have examined the role of alcohol outlets and various alcohol outlet types on violent crime (e.g., Livingston, 2008; Sparks, 2011), and less is known about the particular characteristics of off-premise alcohol outlets that may generate or attract crime to their locations and immediate surroundings. This study controlled for several structural variables associated with two major theoretical explanations of crime, and examined whether alcohol beverage types were associated with robbery density. These findings of a consistent relationship between all alcohol beverages (regardless of the type) and robbery have clear policy implications for local jurisdictions. This is especially important because the accumulation of empirical evidence consistently suggests that off-premise alcohol outlets are associated with violent crimes. One way to reduce violence is to influence geographical availability of off-premise alcohol outlets via policy mechanisms, such as reducing the number of outlets that are licensed to operate in the area, limiting new alcohol licenses to operate in close proximity to already existing alcohol outlets, or limiting the hours and days during which off-premise alcohol outlets are licensed to operate. In addition, a prior study of a Little Rock, Arkansas city ordinance that required late-operating bars to employ a minimum of two law enforcement officers in and around the outlet

suggested that providing an additional level of place managers can reduce crime even in most risky alcohol outlets (Burgason, Drawve, Brown, & Eassey, 2017). Most important, although all types of alcohol beverages are related to robbery rates in neighborhoods, availability of premixed drinks, beer, and wine, as well as that of single premixed drinks and single beers is more important for robberies than spirits. Alcohol policy mechanisms that aim to reduce availability of alcohol drinks in the neighborhoods may be especially important to implement and enforce in areas where there is a high availability of beer and ready-to-drink beverages, which influence consumption patterns among population at a risk of robbery victimization and offending.

Declaration of Conflicting Interests

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