ORIGINAL PAPER

A Spatial Analysis of Alcohol Outlet Density and Abandoned Properties on Violent Crime in Paterson New Jersey

David T. Lardier Jr.[1,2] · Robert J. Reid[3] · Danlin Yu[4] · Pauline Garcia-Reid[3]

Abstract

Alcohol outlet density (AOD) and abandoned or vacant properties in under-served urban communities has received increased attention and has been linked to community violence. While previous research has examined the AOD and violent crime association, less research has investigated the relationship between abandoned properties and violent crime. Those studies that are present examining the AOD-abandoned properties-violent crime link have been plagued by flaws that include statistical weaknesses and aggregated datasets that investigated larger units such as states or countries. The present study, using Geographic Information Systems (GIS) mapping, spatial analysis techniques, and a regression-based approach examines the association between AOD and abandoned properties on violent crime, controlling for demographic characteristics, in Paterson, New Jersey. Results provide some evidence on the association between AOD and abandoned properties on violent crime, drawing conclusions for policy and practice.

Keywords Alcohol outlet density · Abandoned or vacant properties · Violent crime · GIS mapping · Spatial filtering techniques

Introduction

Community-based research and prevention scholarship has shown a growing interest in examining the impact of the ecological structure of neighborhoods on community violence. Traditionally, crime and community violence research have focused on individual characteristics or environmental conditions, which include sociodemographic variables (e.g., population density, poverty, racial inequality) [1]. Although sociodemographic variables are often correlated predictors of crime and violence [2], these are not necessarily active contributors. Instead, determinants such as AOD [3–6] and abandoned or vacant properties [7, 8], have been associated with both poverty and ecological circumstances including community violence. Specifically, AOD and abandoned properties in under-served urban communities has received increased attention with community violence.

Early investigations into the association between AOD, abandoned properties, and violent crimes in urban communities were plagued by flaws that include statistical weaknesses and aggregated datasets that investigated larger units such as states or countries [9]. While some addressed these concerns by using city-level data [10–12], more recent studies have used census track data as the geographic unit of analysis, as well as employed spatial analysis techniques, which have resulted in more rigorous findings [6–8, 13]. These investigations have further supported the relationship between AOD and violent crime [6, 14], as well as the connection between the density of abandoned properties in a neighborhood and violent crime [8, 15, 16]. Few have, however, considered the association the density of abandoned or vacant properties have with the "alcohol-crime" link [2, 17], and even less have

✉ David T. Lardier Jr.
dlardier@unm.edu; dalardier@salud.unm.edu

✉ Danlin Yu
yud@montclair.edu

1 Department of Individual, Family, and Community Education, The University of New Mexico, Albuquerque, NM 87131, USA

2 Department of Psychiatry and Behavioral Sciences, University of New Mexico School of Medicine, The University of New Mexico, Albuquerque, NM 87131, USA

3 Department of Family Science and Human Development, Montclair State University, Montclair, NJ 07043, USA

4 Department of Earth and Environmental Sciences, Montclair State University, Montclair, NJ 07043, USA

examined potential model misspecification or residual spatial autocorrelation due to the existence of spatial effects to examine these associations [9].

Alcohol outlet density (AOD) is defined as "the number of physical location in which alcoholic beverages are available for purchase either per area or per population" [4, p. 556]. A high density of alcohol retailers has been associated with a variety of negative individual health outcomes such as adolescent substance use [9, 18, 19], negative substance abuse treatment outcomes [20], as well as harmful social outcomes including traffic accidents, drinking and driving, and physical injuries [9]. Studies have also shown that higher AOD are associated with violent crime [5, 14]. For example, Jennings et al. [5] identified that the addition of liquor stores in a geographic area significantly increased the probability of violent crime, overtime. Similarly, Zhang et al. [14] showed that reductions in AOD between 1997 and 2007 reduced exposure to violent crime among community members in Atlanta, Georgia.

A sizable corpus of literature has also indicated for over 70 years the influence community stability and infrastructure have on crime and criminality. Shaw and McCay [21] argued that neighborhood poverty and instability lead to weak social bonds, resulting in the probability for increased criminality, violence, and unhealthy behaviors. Recent studies support that vacant or abandoned properties are likely to offer a location to those engaged in illegal activity and are symbolic of community deterioration [22]. Some have even described vacant or abandoned properties have been identified as "crime attracters" [16], influencing community well-being [23] and provoking certain types of crimes including drug dealing, robberies, and assaults [24]. Therefore, the structural and built environmental circumstances may assist in identifying and designing effective strategies to limit community violence, as well as reduce other negative outcomes related to health and community well-being.

It is reasonable to conclude that there is a significant association between vacant or abandoned properties and crime, and similarly AOD and community crime; yet, less understood is the occurrences of violent crimes, when connected with both AOD and the density of abandoned or vacant properties from a spatial analysis standpoint. Therefore, the present study extends previous research by assessing the association between violent crime, AOD, and the density of abandoned properties in an under-served urban community, Paterson, New Jersey, using spatial analysis techniques at the census tract-level. Given the emphasis on reducing violent crime, preventing alcohol abuse, and creating safer communities by eliminating abandoned properties that detrimentally impact the well-being of a community, the objective is to test the validity of the AOD-abandoned properties-crime link using spatial analyses. For geographically referenced data, incorporating spatial effects explicitly in the model may help model the AOD-abandoned properties-crime link more reliably [25–27].

Community Context

Paterson, New Jersey is the third largest city in New Jersey (8.4 square miles) with a 2010 population of just over 146,000 [28]. As the third largest city, Paterson has a rich and dynamic history of being one of the first industrial hubs of industry; however, recent history has been shaped by white-flight, urban decline, the loss of manufacturing jobs, racial segregation, and poverty. Racially, the city is 60.7% Hispanic or Latina/o, 27.8% Black/African American, and 30% White alone, with 37% of the city's population foreign born [28]. Nearly one-third (26.6%) of the population is below 18 years of age. Economically, the median household income in 2017 dollars was $36,106, with 29% of the city's population living in poverty [28]. Only 10.6% of the population 25 years of age and older holds a bachelor's degree or higher. Social problems are entrenched in Paterson with disproportionately high rates of substance abuse and HIV/AIDS [29], particularly among the youth population between 13 and 18 years of age. As of 2013, when data were collected, there were 197 alcohol selling establishments and 6196 crimes committed, with 1554 violent crimes [30]. The violent crime rate is 10 times higher than the nearest suburban community [30].

Methods

To investigate *the association between occurrences of violent crimes and sociodemographic factors, distribution of alcohol selling facilities, and abandoned properties in Paterson New Jersey,* we collected cross-section data at the census block group level from publicly available sources. Our analysis specifically focused on 107 census block groups in which demographics were recorded. Based on previous research [3] examining both AOD and abandoned properties, three demographic factors were selected: (1) percentage of African American residents; (2) percentage of Hispanic residents; and (3) median household income. All measures are available at census block group level and were obtained from the 2010 census data. Map 1 summarize the data tabularly and spatially.

Violent Crime information, including both aggravated assaults and armed robbery from 2013, were procured from the Paterson Police Department ($n = 1554$). These crime offenses are two of the four indexes (e.g., rape, aggravated assault, homicide/manslaughter, and armed robbery) of violent crime in the Federal Bureau of Investigation's Uniform Crime Report (UCR). Assaultive violence locations
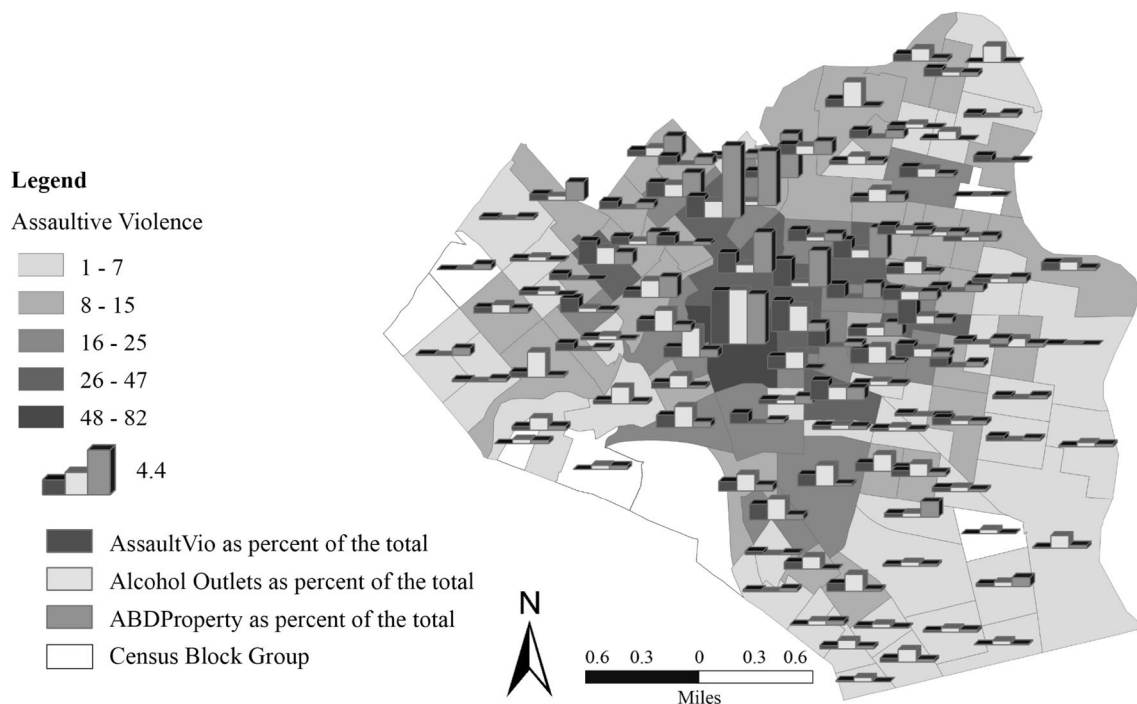
Map 1 Counts of assaultive violence, alcohol outlets, and abandoned/vacant properties in Paterson, NJ, census block group. *AssaultVio* assaultive violence, *Alcohol Outlets* alcohol outlets, *ABDProperty* abandoned property

were geocoded then integrated (via spatial join) to the census block group. The count of violent crimes for each census block group were produced and serve as our outcome variable.

Abandoned property locations were obtained from Paterson's Housing Authority (*n*=769). Similar to assaultive violence, locations were also geocoded then integrated. *Alcohol selling establishments* (*N*=197) present in the city were obtained from the city's ABC (Alcohol and Beverage Control) board, with actual addresses geocoded and integrated (via spatial join in a GIS) to the census block. The count information of the alcohol selling establishments and abandoned properties is used in an attempt to establish association between the presence of alcohol selling facilities, abandoned properties and violent crimes, controlling demographic factors.

To investigate the association between the occurrence of violent crimes, AOD and the presence of abandoned or vacant properties, a regression-based approach is employed. This approach is the most frequently used statistical technique to investigate the relationship between a given observation and set of factors [31]. Since the dependent variable, occurrence of violent crimes, is a count variable, our preliminary data analyses suggest a negative binomial specification produces good modeling results. In addition, due to data being collected and organized in census block groups, spatial effects were included in modeling strategy [25, 32]. Among

the various techniques that address spatial effects, we found a semiparametric eigenfunction based spatial filtering technique provided the best results [33, 34].

With the spatial filtering technique, we assume that, as is consistent with spatial data, the independence assumption of the regression residual will not hold. Through building a binary spatial link matrix in which the elements are either 1 or 0, with 1 identifying that two spatial units are neighbors (i.e., sharing a border) and 0 otherwise, we are able to create a quantitative spatial structure (***C***) in which the data is generated and collected. By centralizing the spatial link matrix ***C*** to ***MCM***, where $M = I - 11'/N$ (**I** is the identity matrix; **1** is a vector of 1s; and *N* is the number of spatial units). The spatial filtering technique essentially decomposes this centralized spatial link matrix into *N* eigenvectors that represent *N* potential map patterns that can be produced from the spatial structure ***C***. These eigenvectors are called spatial filters and can be used as auxiliary covariates in a regression model to effectively control for spatial effects (spatial autocorrelation in the regression residuals) [35]. Demographic factors were controlled for as covariates.

Since our models are negative binomial specification and estimated via maximum likelihood approaches, the Akaike Information Criterion (AIC) is used to compare nested models. A lower AIC tends to indicate better model-to-data fit [35]. Specifically, a reduction of three in the AIC value is deemed an acceptable model improvement [35]. All

calculations were conducted using the SPDEP package in the *R* environment. To this end, three models were proposed to assess how alcohol selling establishment and abandoned properties are related to the occurrence of violent crime at census block group level.

Model 1 examined the relationship between occurrences of violent crimes and sociodemographic factors alone (this is our base model that does not consider the influence of alcohol selling establishments and abandoned properties);

Model 2 added alcohol-selling facilities in each block group to assess whether locations of alcohol selling outlets increased occurrences of violent crimes;

Model 3 included both the count of alcohol selling establishments and abandoned properties to assess whether these predicted and increased occurrences of violent crimes.

Results

The results of the three models are reported in Table 1. Comparing the Null and Residual deviances of all three models, we can see that the added variables reduce the amount of deviance significantly with only marginal reduction of degrees of freedom. This suggests the variables indeed explain the variation of violent crimes in Paterson, NJ. The data fit statistic, AIC score suggests an increasingly better fit from model 1 to model 3, which is expected as more relevant exploratory variables are added to the models. Demographic results (model 1) indicated similar to previous studies [3] that occurrences of violent crimes tends to concentrate in poorer regions with more ethnic-racial minority groups. Furthermore, adding alcohol selling establishments in model 2 as an explanatory variable increased the explanatory power of the model. The AIC

score drops from 680.39 to 647.2. This finding indicates that alcohol selling establishments directly influenced assaultive violence occurrences. Last, adding abandoned properties count in model 3 was also found to significantly predict violent occurrences. The AIC scored also dropped from 647.20 to 643.57. As for the spatial filters, however, except for the base model (model 1), the added spatial filters for models 2 and 3 only show marginal significance. One potential explanation for the marginally significant spatial filters in models 2 and 3 might be that we included the highly spatially auto-correlated alcohol selling outlets and abandoned properties in the model specification. In the base model, when these two variables are omitted, the residuals captured the spatial autocorrelation, which leads to a significant spatial filter.

Coefficient estimates for previously examined variables stayed consistent and in the appropriate direction. Model 3 findings illustrate that the presence of abandoned properties is associated with violent crimes in the community. Controlling for spatial effects in all three models helped increase the explaining power present (the spatial filter of all three models are significant/marginally significant). Map 1 illustrates that as assaultive violence rates increase (designated by darker shading in census block groups), there is an increase in the total of alcohol outlets as percent of the total and an increase in abandoned properties. This is illustrated by the bars in the map wherein greater percent total increase of both alcohol outlets and abandoned properties indicates an increase of the percent total increase of assaultive violence in census blocks with greater assaultive violence, or darker shading of census blocks. Overall, these findings show a direct link between violent crime occurrences and sociodemographic factors, concentration of alcohol selling facilities and abandoned properties. Adding alcohol selling distribution and abandoned properties information improves model performance, as evident by the decreasing AICs.

Table 1 Linear regression models assessing the relationship between alcohol outlet density, abandoned properties, and violent crime in Paterson, New Jersey, 2013

	Model 1		Model 2		Model 3	
	B (SE)	*z*-score	*B* (SE)	*z*-score	*B* (SE)	*z*-score
Population	.01*** (.001)	5.24	.01*** (.001)	5.86	.01*** (.001)	6.08
Percent Hispanic	1.92** (.59)	3.23	1.62** (.59)	3.06	1.77** * (.53)	3.38
Median household income	.01*** (.001)	−6.79	.01*** (.001)	−4.85	.01*** (.001)	−4.47
Percent African American/Black	2.37*** (.51)	4.68	2.57*** (.51)	6.05	2.28*** (.43)	5.31
Alcohol outlet density			.19*** (.03)	6.16	.16*** (.03)	5.09
Abandoned property count					.01** (.02)	2.53
Spatial filter	1.84* (.71)	2.64	−1.25* (.63)	−1.95	−1.20* (.61)	−1.95
Null deviance (*df*)	237.22 (106)		332.87 (106)		355.81 (106)	
Residual deviance (*df*)	116.77 (101)		120.45 (100)		121.80 (99)	
AIC	680.39		647.2		643.56	

AIC akaike-information criterion, *SE* standard error, *df* degrees of freedom

Discussion

The link between AOD, abandoned properties, and violent crime is a critical public health concern, which is why understanding the environmental and social contexts that contribute to this relationship are so important. The connection between AOD and violent crime in urban communities is well documented in the extant substance abuse and public health literature [5, 14, 36, 37]. The common theme among these studies is the idea that AOD contributes to community disadvantage and increases the probability of violence in communities [6, 9]. There are also investigations that document when alcohol outlets are removed from a community, crime in these locations reduces over-time [14], providing additional support on the role the built-environment and businesses such as alcohol outlets have on a community.

Similarly, the research connecting abandoned properties with community violence, like AOD and community violence is well established. These studies indicate that as abandoned property density increases so does the probability for violent crime, as well as other social concerns including substance use, the illicit sale of drugs, and prostitution [1, 7, 8, 16, 22]. Despite such scholarship, less research has examined the association AOD and the density of abandoned or vacant properties have on violent crime [2]. This is an important area of inquiry when we consider the influence built environment has on community well-being.

This investigation, using spatial analyses techniques, investigated the relationship AOD and the density of abandoned or vacant properties have on violent crime, controlling for demographic variables. Our first model supports the assertion that violent crime occurs at higher rates in census blocks with populations that are more impoverished and have a larger number of persons of color. These findings are in overall agreement with previous research indicating that due to White flight, social and racial segregation, and city-level neglect, minoritized persons of color—i.e., largely Hispanic and African American—are more likely to not only live in poverty but experience disproportionate rates of violence [1, 22]. High-dense urban communities with concentrated economic and social disadvantage produce negative outcomes for individuals, often persons of color, living in these communities [38, 39]. These effects are often further augmented when we consider structural concerns that negatively contribute to community ecology, such as alcohol outlets [3, 9, 14] and abandoned properties [22].

Our second model provides additional support in relation to the idea that selected place characteristics, such as AOD, are related to violent crime rates. The density

of alcohol outlets in this study was positively associated with rates of violence, independent of population characteristics. Consistent with previous research, AOD are often located in poor communities of color [3, 9, 13, 14], which were controlled for as covariates in this study, thus excluding as an explanation for effects related to AOD on violent crime.

Our final model indicated that significant statistical effects on violent crime were present in census blocks with increased AOD and the density of abandoned or vacant properties. These findings are supported by previous studies indicating that the presence of abandoned properties not only increases rates of violent crime [7, 8], but that AOD continues to also have a robust effect. This may point toward the compounding influence of structural concerns in impoverished urban communities. The combination of these potentials, or structural issues, increases the probability of violence [40]. The intersection of these community structures needs to be considered by both violence and substance abuse prevention programs and regulatory efforts alike that control not only the growth of alcohol outlets but consider ways to reduce abandoned or vacant properties—although not through gentrification.

Limitations

This study has several limitations. First, our analyses relied on cross-sectional data, which does not allow us to make claims of causality. Prior longitudinal studies have provided some evidence on the association between AOD [5], the density of vacant or abandoned properties [16, 24], and violent crime in a community, separately. However, as far as these authors are aware there are no studies examining violent crime effects of introducing both alcohol outlets and abandoned properties into a community over-time.

Other important limitations of the current study include: (1) absence of controls for other local environmental characteristics that may be associated with violence; and (2) the focus on violence from one source of data (i.e., police department). Other characteristics of the community and population may be related to violence experienced by residents of various communities. Among these may be the presence of illegal drug markets and the association with community violence [41]. Another point of interest may be the presence and increase of recent foreclosures in a community, which contributes to the number of vacant properties [42].

In addition, the current study focused on a measure of violence based on police-incidence reports. While this measure is supported by previous research and the definition put forward by the UCR it may limit the accuracy of violent crime counts in a community. Some evidence indicates that

simple assaults that involve little or no physical contact are either under-reported or not reported at all [6, 43]. Further, communities of color tend to be distrustful of police and may underreport certain crimes in their community [44, 45]. To address this limitation, studies elsewhere have utilized data of victims of violent crime appearing in hospitals [46], which in tandem with police-incidence reports may begin to provide a more holistic understanding of violent crime in a target community.

A final limitation concerns the politically defined geographic units used in this study—i.e., census blocks. These geographic units vary in shape and size and may even influence the outcomes of studies [47]. Although there is some consistency in findings across studies identifying the association between AOD, the density of vacant or abandoned properties in a community, and violent crime, this limitation should be considered when interpreting findings, as it may have some unobserved biases on analyses.

Conclusion

The findings from this study may be important to the city of Paterson, New Jersey, as well as those cities with similar demographic and socio-ecological features. Findings generated from this study indicate that there may be a link between the density of vacant or abandoned property, the AOD, and violent crime. Building on the urban planning literature, land-use policies may need to be explored, which provide guidelines on the number of alcohol establishments allowed in a designated community and through zoning restrict access to alcohol outlets [48]. These authors are not suggesting a ban on alcohol products but instead that both state and local-level policymakers assess policies related to AOD and how these existing policies may negatively contribute to the health, well-being, and safety of the public. Such a task may be particularly critical in communities already experiencing additional socio-ecological concerns, such as a high density of vacant properties [1, 22].

Similarly, partnerships need to be created and supported between city policymakers, agencies, and community members (e.g., a community coalition). Through these community partnerships, strategic plans can be developed that address socio-ecological and public health concerns related to both alcohol outlets and abandoned or vacant properties. One such project for abandoned or vacant properties may be vacant lot greening, wherein through city buyback programs of abandoned properties, city policymakers place monies toward greening vacant lands, which has been associated with crime reductions [1]. Other community coalitions have implemented demolition plans to address the problem of abandoned or vacant properties and limit crime in already impoverished and oppressed communities, as exemplified in Camden, New Jersey [49].

Communities elsewhere have addressed AOD concerns through the creation of ordinances that designate "hot-spots" or locations where the association between AOD and violent crime is the greatest. As designated "hot-spots", community coalitions and policymakers can develop place-based interventions that utilize community-based policing practices [50] and simultaneously curb issues associated with AOD without over policing communities that are often poor and 'of-color'. It is however critical that community members, coalitions, and policy-makers work collaboratively with police to monitor and support such strategies to limit the potential for over-policing and abuses by police on the public [50]. Multisector and community-based initiatives have the potential to stimulate robust community changes that honor the voices and perceptions of community members from various sociodemographic backgrounds.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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