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Do neighborhood attributes moderate the relationship between alcohol establishment density and crime?

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Abstract

Although numerous studies have found a positive association between density of alcohol establishments and various types of crime, few have examined how neighborhood attributes (e.g., schools, parks) could moderate this association. We used data from Minneapolis, Minnesota with neighborhood as the unit of analysis (n = 83). We examined eight types of crime (assault, rape, robbery, vandalism, nuisance crime, public alcohol consumption, driving while intoxicated, underage alcohol possession/consumption) and measured density as total number of establishments per roadway mile. Neighborhood attributes assessed as potential moderators included non-alcohol businesses, schools, parks, religious institutions, neighborhood activism, neighborhood quality, and number of condemned houses. Using Bayesian techniques, we created a model for each crime outcome (accounting for spatial auto-correlation and controlling for relevant demographics) with an interaction term (moderator × density) to test each potential moderating effect. Few interaction terms were statistically significant. Presence of at least one college was the only neighborhood attribute that consistently moderated the density-crime association, with presence of a college attenuating the association between density and three types of crime (assaults, nuisance crime, and public consumption). However, caution should be used when interpreting the moderating effect of college presence because of the small number of colleges in our sample. The lack of moderating effects of neighborhood attributes except for presence of a college suggests that the addition of alcohol establishments to any neighborhood regardless of its other attributes could result in an increase in a wide range of crime.

Keywords

Alcohol outlets; violent crime; neighborhood

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Introduction

Many studies have found a positive association between density of alcohol establishments and various types of crime, including violent crime (e.g., Gruenewald et al., 2006; Liang and Chikritzhs, 2011; Livingston, 2008; Nielsen & Martinez, 2003; Reid et al., 2003), vandalism, and nuisance crime (Donnelly et al., 2006; Wechsler et al., 2002). Based on current research findings, the Task Force on Community Prevention Services recommends limiting alcohol establishment density to prevent excessive alcohol use and related problems (http://www.thecommunityguide.org/alcohol/outletdensity.html). This type of recommendation can be useful to community leaders as they develop their communities and attempt to reduce costs.

However, the association between density of alcohol establishments and crime may vary across neighborhoods within communities. In other words, specific neighborhood attributes could moderate the associations between number of alcohol establishments and crime within a neighborhood and these attributes may vary across neighborhoods. For example, other businesses may put pressure on alcohol establishments to responsibly serve alcohol so that these other businesses are not negatively affected by intoxicated customers leaving the alcohol establishments. The non-alcohol businesses could thus serve as inhibitors of alcohol-related crime. A high number of alcohol establishments may be associated with increased crime only for those areas where the density of non-alcohol businesses is low. In this study we assessed whether non-alcohol businesses and several other neighborhood attributes moderate the relationships between density of alcohol establishments and several types of crime. We focused on neighborhood attributes that can be modified and that may directly influence the behavior of alcohol establishments or that influence the environment in which alcohol sales and use occur.

Given the scarcity of empirical studies assessing neighborhood-level factors that may moderate the relationship between density of alcohol establishments and crime, we used social capital theory to help identify neighborhood attributes that could be potential moderators. A variety of definitions for social capital exist and most of these definitions focus on the importance of social connections between individuals within neighborhoods and communities (Carpiano, 2006; Putnam, 2000; Messner et al., 2004). Social participation may include political participation, civic participation, religious participation, workplace connections, and informal social ties. Although social capital is typically measured at the individual level, Putnam (2001) has recognized that the presence of formal institutions in a community that foster individual-level networking also contribute to social capital. For instance, presence of religious institutions may increase religious participation among individuals within the neighborhood and increase the formal and informal connections and trust among its members. Similarly, schools, parks, and neighborhood associations may increase social connections and political and civic participation among neighborhood residents. These types of institutions symbolically and physically represent community characteristics that promote social networking (Hays & Kogl, 2007; Putnam, 2001; Shortt, 2004).

Putnam (2000) also hypothesized that crime is higher in neighborhoods that have less social capital, with the primary mechanism occurring through social disorganization (Sampson & Groves, 1989; Bursik, 1988). The basic premise of social disorganization is that likelihood of crime increases in communities with lack of informal social controls such as surveillance and communication among individuals and subsequent lack of active intervention to prevent crime (Kasarda & Janowitz, 1974; Sampson & Groves, 1989). Wilcox and associates (2004) theorized that social control may be influenced by the physical-structural qualities of a neighborhood. For example, neighborhoods with large amounts of public land use for businesses or public areas may have differing levels of social control than neighborhoods with primarily residential land use. Neighborhoods with more businesses could also bring more strangers into the neighborhood, decreasing the likelihood that residents will notice or be able to control individuals who do not belong in the neighborhood. Some type of businesses may even attract customers to the neighborhood that are more likely to commit crime (e.g., pawnbrokers, etc.; Brantingham & Brantingham, 1995). On the other hand "resident-centered" physical structures such as schools, religious institutions, and parks may increase connections among residents and thereby increase level of social control in a neighborhood.

We have identified only a few previous studies that assessed potential factors that could moderate the association between alcohol establishment density and crime. A few studies found that the association between alcohol establishment density and crime rates may be moderated by differences in neighborhood social, economic and demographic characteristics (Gruenewald et al., 2006; Smith et al., 2000). Higher associations between density of alcohol establishments and street robberies were found in areas with more single parent households in one U.S. city (Smith et al., 2000). Gruenewald and associates (2006) found the association between density of bars and violence was higher in unstable poor areas and rural middle income majority areas in California (Gruenewald et al., 2006). However, Livingston (2008) found no such moderating effects for socioeconomic status in Melbourne, Australia. Pridemore and Grubesic (2011) found that land use moderated the relationship between alcohol establishment density and assaults in Cincinnati, Ohio, with the direction of the moderating effect varying by type of land use. For example, the association between total establishment density and simple assaults was higher in block groups that had land use designated for heavy industry and public housing, but was lower in block groups designated for single- and multi-family residential and general commercial use. Moderating effects also varied by type of assault (simple versus aggravated assault) and type of establishment (bar vs. off-premise establishments).

In previous analyses, we assessed the association between neighborhood alcohol establishment density and crime in Minneapolis, Minnesota and found a statistically significant, positive association between total alcohol establishment density and each type of crime (Toomey et al., 2012a; 2012b). The present exploratory study builds on our previous analyses by assessing whether several types of neighborhood attributes moderate these associations. Although this is primarily an exploratory study, we hypothesize that some neighborhood attributes may be potential assets (e.g., neighborhood political activism, neighborhood cohesion and stability, religious institutions, schools) and hence neighborhoods with these attributes would have lower associations between alcohol

establishments and crime compared to neighborhoods without these features; similarly, other attributes may be liabilities (e.g., unsafe parks, vacant buildings), so neighborhoods with these attributes would have higher associations between establishments and crime compared to neighborhoods without these features.

Methods

This two-year study was conducted in Minneapolis, Minnesota.

Neighborhoods

Neighborhood, as designated by the city of Minneapolis, was used as the geographic unit of analysis. Minneapolis has defined 87 neighborhoods. We excluded four neighborhoods (three industrial neighborhoods and one that had a 96% decline in residents 1990-2000). Population size across the final 83 neighborhoods ranged from 128 to 15,247 (mean = 4,607). The percentage of the neighborhood population that is Caucasian ranged from 15.0% to 94.9%.

Because neighborhood is the unit of analysis, all study variables were aggregated to that level. For all variables linked to an address (i.e., alcohol establishments, crimes, businesses, schools, religious institutions, condemned buildings), we used an address locator in ArcGIS and 2009 street address data from the Twin Cities Metropolitan Council to geocode addresses and then assign them to the neighborhood. Neighborhood area, used for density calculations, was measured using geospatial tools. Park area was measured similarly, with the exception that if a park was located in more than one neighborhood, data for this park were replicated for each of the neighborhoods it was located in. Neighborhood demographic data were based on Census blocks groups aggregated to the neighborhood, raising the issue of boundary misalignment. Using ArcMap spatial analysis tools, we calculated this misalignment. We found that most of the misalignment occurred primarily in industrial areas that did not have residents. Excluding these areas, we found misalignment in less than 1% of residential areas, suggesting there is negligible bias in our Census estimates resulting from misalignment.

Alcohol Establishments

We received a 2009 list of licensed alcohol establishments (n = 663) from the Minneapolis Department of Regulatory Services. After removing 40 duplicates, we had a final list of 623 establishments (503 on-premise establishments, 120 off-premise establishments). For the 14 establishment addresses that did not have a 100% geocoding accuracy score, we used other sources (i.e., Google Maps, Bing Maps, etc.) to confirm the accuracy of the address before assigning the establishment to a neighborhood. We calculated total alcohol establishment density as the number of establishments per roadway mile (for more detail see Toomey et al., 2012a; 2012b), which presents establishment density in terms of the functional paths people take in their community (Gruenewald et al., 1996; Lipton & Gruenewald, 2002).

Crime

Research staff received Uniform Crime Report (UCR) Part I and Part II crime data from the Minneapolis Police Department (MPD) for the time period from October 1, 2008 to September 30, 2009, which was the most recent data available at the start of the study. This dataset included the primary offense for each crime event. When available, we used coordinates from the MPD to assign crime incidents to the appropriate neighborhood. If a reported crime did not include coordinate information, we geocoded the address. We successfully mapped and assigned 99% of the crime incidents. Approximately one percent (1.04%) of the crime incidents fell on neighborhood boundaries; we randomly distributed these incidents into the neighborhoods that shared these boundaries.

We used eight crime types that we had used in our previous studies (Toomey et al., 2012a; 2012b), five non-violent types including vandalism, nuisance crime, public alcohol consumption, driving while intoxicated (DWI), underage alcohol possession/consumption, and three violent types including assault, rape, and robbery. All of these outcomes had a positive association with alcohol establishment density.

Neighborhood Demographics

Based on two key studies on neighborhood-level crime (Kikuchi and Desmond, 2010, Morenoff et al., 2001), we created an index measuring socioeconomic and racial characteristics. This composite index included seven U.S. 2000 Census measures (we obtained all Census data from the City of Minneapolis at http://www.ci.minneapolis.mn.us/citywork/planning/census2000/): (1) percent female-headed households; (2) percent rental housing units; (3) percent of families below poverty; (4) percent unemployment; (5) median household income; (6) median home value; and (7) percent white. These seven variables were all coded in the same direction (higher value = higher socioeconomic status and higher percent white) and standardized (mean = 0, standard deviation = 1). The variables were then summed to create the index (range of index values: −13.14 to 10.688), with an alpha coefficient of 0.87. We also included two other neighborhood demographic variables in our analyses: total persons aged 15-24 years and population density (total population divided by roadway miles). Percentage of males was also considered, but showed very little variability across neighborhoods and was not included in these analyses.

Potential Moderating Variables

We originally identified 20 neighborhood variables in five domains (five for non-alcohol businesses, six for schools, three for parks, two for religious institutions, and four for other neighborhood attributes) to assess as potential moderating variables. To reduce redundancy and create a more manageable number of potential moderators, we conducted analyses to retain a subset of these variables for examination as possible moderators. We estimated regression models for each crime outcome/potential moderator pair, allowing for evaluation of the association between each potential moderator and the outcome without adjusting for other potentially collinear variables. From these models, we chose variables based on the number of statistically significant associations between each potential moderator and crime across the eight crime outcomes, and also reduced the number of variables based on conceptual similarity (e.g., number of schools and school enrollment) and collinearity. This

variable reduction process resulted in a final list of 11 potential moderators included in the primary analyses (four for non-alcohol businesses, two for schools, one for parks, one for religious institutions, and three for other neighborhood attributes).

Non-alcohol businesses.—A list of 30,466 businesses for December 2009 was obtained through InfoUSA Infogroup based on Minneapolis zip codes. From this list we selected non-alcohol businesses that have the most likelihood of either influencing the serving practices of alcohol businesses, bringing a large number of people into the neighborhood, or influencing crime rates (i.e., retail and service businesses). We eliminated 3,128 businesses including those that were not retail or service industries, were service industries that largely conducted business outside the neighborhood (e.g., contractors), were alcohol and catering businesses, or were duplicates. This resulted in a final list of 3,671 non-alcohol businesses that were assigned to neighborhoods based on coordinates included in the InfoUSA list.

In part based on the work of Gruenewald and associates (2006), we created four categories of non-alcohol businesses: (1) food retailers (e.g., fast food restaurants), (2) non-food retailers (e.g., clothing stores), (3) non-healthcare services (e.g., motels, movie theatres), and (4) healthcare services (e.g., medical offices). For each of the four categories, we created one neighborhood-level measure representing the total number of businesses per neighborhood: (1) food retailers (0-201; recoded to 0, 1-4, 5-9, >9); (2) non-food retailers (0-196; recoded to 0-3, 4-12, >12); (3) non-healthcare service industries (0-91; recoded to 0-2, 3-4, 5-9, >9); and (4) healthcare service industries (0-39; recoded to 0, 1-3, 4-8, >8). These counts, like most of the potential moderators, were heavily skewed. We chose to recode these variables into categories to account for skewness, and also to limit model complexity for these interactions and to ease interpretation of effects. Recoding was based on frequency distributions.

Parks—We obtained a list of 253 Minneapolis public parks, triangles (i.e., small public green spaces) and community gardens from the Minneapolis Park Board and the city of Minneapolis website (http://www.ci.minneapolis.mn.us/dhfs/resgardens.pdf). After eliminating 28 due to not meeting criteria (e.g., closed, part of a larger park), trained field staff collected observational data at 225 parks during fall 2009. Observers walked through the park during weekday daytime hours and recorded types of recreational opportunities and condition of the park. Data were collected from two independent observers at 43 parks; inter-rater consistency was high (78-100%). Given the high degree of consistency across observers, we sent out only one observer to each of the remaining parks.

Five items were used to create a single variable describing the overall condition of the park: (1) is there litter and trash on ground?; (2) is grass mowed? (3) is there graffiti present?; (4) are there alcohol cans/bottles visible?; and (5) overall condition of park (response options for each were 0= not/somewhat sketchy vs.1= very sketchy; “sketchy” was a subjective impression of general park maintenance). A dichotomous item describing the overall safety of the park was created by summing these five conditions and splitting parks into “good” condition (0-2) and “poor” condition (3-5). To translate this measure to the neighborhood level, we calculated the area of each neighborhood that is park area that is in “good condition” (ranging from 0 to 19.5%; recoded to 0, 0 to 1.99%, 2-7.99% and ≥8%).

Schools—We obtained a list of 144 Minneapolis elementary schools, middle schools, high schools and colleges from the Minnesota Department of Education. We created two school neighborhood-level variables: (1) total number of elementary schools (0 to 6; recoded to 0, 1, >1) and (2) total number of colleges (0 to 2; recoded to 0, ≥1). Enrollment levels and number of high schools were excluded as a result of the variable reduction analyses.

Religious institutions.—We obtained a list from InfoUSA of 431 religious institutions located in Minneapolis. After eliminating 110 institutions that were either not actually religious institutions, lacked complete information, fell outside the Minneapolis neighborhood boundaries, or were not able to be geocoded, we geocoded the resulting 321 and assigned each to a neighborhood. We created one neighborhood-level measure for religious institutions: total number of institutions per neighborhood (0 to 15, recoded as 0, 1-3, >3).

Other neighborhood attributes.—We measured three other neighborhood attributes—neighborhood activism and neighborhood quality based on a survey of neighborhood associations, and number of condemned buildings based on City and County records.

We obtained a list of 70 neighborhood associations from the Minneapolis Neighborhood Revitalization Program and recruited an individual from each association to complete the survey (either the listed contact person, the executive director, or the "person most knowledgeable about the neighborhood organization"). Three neighborhood associations refused to participate in the study, yielding a 96% (67/70) participation rate. One neighborhood (University of Minnesota) did not have a neighborhood association. Neighborhood activism was measured based on responses to: "In the last twelve months, how often has a representative of your neighborhood organization (such as yourself, someone on staff, or a resident) participated in....[each of eight activity types (e.g., attended a city council meeting, written a letter to the editor)]. Six response options ranging from "weekly" to "never" were dichotomized for each activity type to "once/never" (coded as 0) vs. "more frequently" (coded as 1) and summed to create a score (range 0 to 8; mean = 3.4). Overall neighborhood quality was measured based on a series of questions regarding *cohesion*, *stability*, and *political involvement* (definition of these concepts were: cohesion = degree to which residents interact with each other, identify with their neighborhood, and value neighborhood institutions and norms; stability = tendency for residents—both home owners and renters—to remain in their homes for longer than a few years; and political involvement = working together as a neighborhood to change local and state policies and procedures that may affect your neighborhood). Each of these three concepts were measured on a 5-point scale (5=high, 3=medium, 1=low). The fourth neighborhood quality was *resident involvement* based on the survey item "Looking across all residents of your neighborhood, how would you rate political involvement regarding neighborhood issues?" measured on a 5-point scale (5=high involvement, 1=little involvement). These four neighborhood quality measures were averaged to create an index of neighborhood quality (α = 0.72; range = 1-5; mean = 3.4 (sd = 1.1)).

We received a list of 234 condemned buildings in Minneapolis from the Department of Regulatory Services for the period 10/1/2008 to 9/10/2009. The condemned buildings were

geocoded and then assigned to a neighborhood. The number of condemned buildings per neighborhoods ranged from zero to 35 (recoded to 0, 1-4, >4).

Analyses

The analyses were conducted at the neighborhood level (n=83) and involved separately regressing each crime outcome on alcohol establishment density, neighborhood attributes (potential moderators), and the interaction between each potential moderator and alcohol establishment density. Covariates in each model included population density, the socioeconomic/racial index, total population, and population aged 15-24. The crime outcomes were counts and were modeled using a Poisson distribution with mean equal to the expected crime count under the assumption of homogeneity of risk across neighborhoods times the relative risk accounting for the covariates mentioned above. Each of the 11 potential moderators was first modeled separately for each crime outcome, and only those reaching statistical significance ($p \leq 0.05$) were included in the final multivariate model for each of the eight crime outcomes. This approach limits inclusion of unrelated covariates, important for managing model size and collinearity among predictors. Given the modest number of variables to reach significance and the limited number of neighborhoods, all variables passed to the multivariate model were retained regardless of significance in the multivariate model.

We used a Bayesian approach to estimate the models. This approach differs from the more common frequentist approach in that it treats model effects as random variables (instead of fixed) that have a distribution and can incorporate prior knowledge of these distributions. This works particularly well in models where additional random effects are included to model any spatial correlation (i.e., crime counts in adjacent neighborhoods are more similar than crime counts in nonadjacent neighborhoods). Specifically, we used the conditional autoregressive model developed by Besag et al. (1991). We analyzed all models using the OpenBUGS software package, Version 3.1.1 (Lunn et al., 2009).

Because the coefficients describing the association between each predictor and the crime outcome can be challenging to interpret in these types of models, we also calculated the percent change in model-predicted crime associated with a 20% increase in alcohol establishment density in a neighborhood of average alcohol establishment density. For reference, a 20% increase in alcohol establishment density is approximately equal to adding 1.5 establishments to a neighborhood with average number of roadway miles (i.e., average “size”). For those models that included a statistically significant moderator of the association between alcohol establishment density and crime, we also calculated the percent change in model-predicted crime associated with a 20% increase in alcohol establishment density for each level of the moderator.

Results

Table 1 shows descriptive statistics for all variables included in the analyses. The average neighborhood frequency of the eight crime outcomes varied widely, from an average of 5.5 underage possession/consumption occurrences to an average of 58 vandalism occurrences during the 12-month period. The average number of alcohol establishments per

neighborhood was 7.5, with a range from 0 (9 of the 83 neighborhoods [11%]) to 124. When converted to a density measure, the average establishment density was 0.56 establishments per roadway mile.

Multivariate model results are shown in Tables 2 (violent crime) and 3 (nonviolent crime). The main effect for alcohol establishment density was positive and statistically significant for all of the crime outcomes except DWI. Of the neighborhood demographics included as covariates, population density and the socioeconomic/racial index were most consistently associated with crime. The socioeconomic/racial index was negatively associated with all crime outcomes and significant for all except underage alcohol possession/consumption. Population density was positively and significantly associated with six of the crime outcomes; it was not associated with nuisance crime, DWI, or underage alcohol possession/consumption.

The effects of the potential moderating variables were examined by inclusion of main effects, and as interactions with alcohol establishment density. In terms of main effects, there were a few significant associations between the potential moderators and crime, although there was no obvious pattern to these results and the proportion of significant associations was not larger than what might be expected by chance (Tables 2 & 3). Specifically, the number of healthcare services was positively associated with rape, the number of food retailers and condemned buildings were positively associated with robbery, the percent of neighborhood area that is park area in “good condition” was negatively associated with robbery, the number of condemned buildings was positively associated with vandalism, the number of food retailers and colleges were positively associated with nuisance crime, and neighborhood activism was positively associated with public alcohol consumption and underage alcohol possession/consumption.

In general, the amount of moderation as tested by interaction terms was also limited (Tables 2 & 3). For five of the crime types (rape, robbery, vandalism, DWI, and underage alcohol possession/consumption), no significant moderation is seen for the 11 variables tested. Of the remaining three crime types (assault, nuisance crime, public consumption), the only variable that moderates the association between alcohol establishment density and crime is the presence of at least one college in the neighborhood. For each of these crime incidents, the positive association between alcohol establishment density and crime is attenuated for neighborhoods that include one or more colleges.

To facilitate interpretation of the magnitude of the associations between establishment density and crime, we scaled the parameter estimates to determine the model-estimated effect (based on the final multivariate model) on each crime associated with a 20% increase in alcohol establishment density (assuming average alcohol establishment density). For the models with no interaction terms, this resulted in a single estimate. Specifically, a 20% increase in alcohol establishment density was associated with a 3.1% increase in rape, a 3.6% increase in robbery, a 3.4% increase in vandalism, and a 6.3% increase in underage alcohol possession/consumption. These estimates are similar to those we have reported in previous papers but not identical given that in previous papers we did not examine moderation and therefore used different types of models (Toomey et al., 2012a; 2012b).

For crime types where interactions were indicated, the model provided estimates for each level of the moderator. For assaults, nuisance crime, and public alcohol consumption, the only statistically significant interactions were with the college variable - having at least one college or university in the neighborhood moderated the association between establishment density and crime. For assaults, a 20% increase in alcohol establishment density was associated with a 5.1% increase in assaults in neighborhoods without a college and a 3.7% decrease in neighborhoods with at least one college. For nuisance crime a 20% increase in establishment density was associated with a 6.5% increase in neighborhoods without a college and a 3.3% decrease in neighborhoods with at least one college. For public alcohol consumption a 20% increase in establishment density was associated with an 11.0% increase in neighborhoods without a college and a 5.8% decrease in neighborhoods with at least one college. Note that for DWI, neither alcohol establishment density nor any of the interactions were statistically significant, so no estimates were calculated.

Discussion

The body of evidence linking alcohol establishment density and crime now includes multiple studies conducted across diverse geographic regions, using varied measures of establishment density, numerous types of crime, and model and analytic differences (e.g., Gruenewald et al., 2006; Liang and Chikritzhs, 2011; Livingston, 2008; Toomey et al., 2012a; 2012b). While these findings are important, community leaders may be interested in more nuanced information. Specifically, would the association between alcohol establishments and neighborhood alcohol-related crime be higher in neighborhoods with more establishments, regardless of the neighborhood's attributes? A few previous studies found that neighborhood demographics and socioeconomic factors moderate the relationship between establishment density and violence (e.g., Gruenewald et al., 2006; Smith et al., 2000). However, it is possible that those demographic and socioeconomic characteristics are indicative of other differences (e.g., more or fewer neighborhood positive or negative attributes) across neighborhoods that may explain the observed moderating effects.

In the current study, we assessed a wide range of neighborhood attributes that vary across neighborhoods and that theoretically could increase or decrease the associations between density of alcohol establishments and crime. We assessed potential moderating effects of neighborhood attributes that could be altered or taken into account as community leaders assess whether to add additional alcohol establishments to different neighborhoods.

Overall we found very little evidence of heterogeneity of the alcohol establishment density and crime association by neighborhood attributes. The only factor we examined that consistently moderated the density-crime association was having a college in the neighborhood, with presence of a college attenuating the association between establishment density and crime. For assaults, nuisance crime, and public alcohol consumption, a 20% increase in establishment density was associated with an average crime increase of over 6% in neighborhoods without a college and an average decrease of over 3% in neighborhoods with at least one college.

A number of possible explanations exist for this seeming protective effect of colleges. First, although seen across a number of types of crime, the results may be spurious. We tested a large number of interactions (11 potential moderators across eight crime outcomes), and so one would expect at least a few significant effects due to chance. Second, our sample included only six neighborhoods with a college (seven colleges with one neighborhood having two colleges). The types and sizes of colleges varied considerably, including one very large urban university (that has commuter students and students living on/near campus) and several small technical and vocational colleges that have only commuter students. All of the neighborhoods with colleges are also in the central part of the city and the population residing in these neighborhoods may be unique and lead to different factors associated with increased crime. Even with included control variables in the model, unobserved characteristics of these neighborhoods may be responsible for these findings. Third, these neighborhoods may have differential enforcement. College campuses typically have police or security that specifically enforce crime occurring on campus and student housing areas (if applicable), and the city's enforcement efforts may be different around colleges than in other areas of the city because of concerns related to college student drinking. Unfortunately, measures regarding enforcement practices and levels by neighborhood were not available. Regardless, these findings further highlight the need to examine college campuses and surrounding areas to better understand the effects of alcohol establishment density and possible mechanisms between density and crime.

We hypothesized that neighborhoods with more churches, schools, and parks, and neighborhoods with stronger cohesion/stability would have more social capital or connectivity, and thus, a lower association between alcohol establishment density and crime than neighborhoods with fewer of these attributes. However, we found no moderating effects for any of the crime outcomes for these neighborhood attributes. We also hypothesized that additional businesses in a neighborhood could create a moderating effect in either direction. Businesses could either put pressure on alcohol establishments to more responsibly serve/sell alcohol, and thus attenuate the association between crime and alcohol establishment density; or other businesses could draw more people into the neighborhoods which could be related to a higher association between crime and establishment density. We did not find either positive or negative moderating effects for any of our categories of other businesses.

We identified several possible reasons why we did not observe many moderating effects of these neighborhood assets. First, we had a modest sample size (n=83 neighborhoods) that may have contributed to the lack of significant moderating effects. Second, it is possible that moderating effects of some of our variables were confounded by potential mediating effects. For example, alcohol establishment density may mediate the relationship between neighborhood activism and crime. Third, two causal hypotheses for the observed relationship between alcohol establishment density and crime are: (1) that the overall availability of alcohol increases rates of alcohol use and related problems (Bruun et al., 1975; Gruenewald, 2007) and (2) that a higher density of alcohol establishments leads to specialization of establishments—with some of these establishments attracting more heavy alcohol users to the neighborhood and subsequently also increasing the likelihood of more crime in these areas (Gruenewald, 2007). It is possible that the ability of neighborhood

assets to moderate the relationship between alcohol establishment density and crime may be more or less depending on whether a small number of establishments are contributing to the crime rate rather than the crime rate being driven by an overall increase in alcohol availability across a neighborhood. Further longitudinal research is needed to assess these complex relationships.

Understanding these relationships is important, because a lack of moderating effects of neighborhood attributes would suggest that community leaders should carefully consider the costs of adding additional establishments to any neighborhood—that regardless of the strengths or weaknesses of a given neighborhood, the addition of alcohol establishments to the neighborhood could result in an increase in a wide range of crime types and related costs.

The lack of a significant association between alcohol establishment density and DWI is somewhat surprising. In previous analyses using a simpler model that only controlled for population density, SES, and population aged 15 to 24, we found significant associations between DWI and overall alcohol establishment density, off-premise establishment density, and on-premise establishment density (Toomey et al., 2012a). Compared to those models, the current analysis included four additional main effects and three additional interactions, and, although none of these were statistically significant, a few had modest estimates with credible intervals just including zero. Also, the estimate for alcohol establishment density is positive and larger than estimates for some of the other crimes, but includes a wide credible interval. Thus, although not significant, the direction and magnitude of the association is consistent with previous analyses and the inclusion of a number of additional predictors, including three alcohol establishment density interactions, may have explained some of the overall association.

An obvious limitation of this study is the cross-sectional design, preventing the testing of causal mechanisms between alcohol establishment density and crime. However, this exploratory study is one of the first to assess whether neighborhood attributes might moderate the relationship between alcohol establishment density and crime. Additionally, this study was conducted in only one city, limiting the generalizability of the findings. However, a strength of this study is that we assessed potential moderating effects across eight crime outcomes; the fact that we did this assessment within the same city allows for direct comparison of effects across these crime outcomes. Future research that expands the geographic area beyond neighborhoods in a single city would have numerous advantages. The generalizability would be improved, particularly with the inclusion of rural and small town areas. The increased sample size would increase the likelihood of detecting small effects, particularly small moderating effects. In addition, the current study examined how each of the potential moderators individually interacted with alcohol establishment density. It is also possible that higher-order interactions might exist. For example, neighborhoods with few retail businesses and high numbers of condemned buildings might show differential effects of alcohol establishment density on crime. A larger sample size is needed to examine these potential effects. Finally, we primarily used secondary data sources, each with their own strengths and weaknesses. For example, the police arrest data include only offenses where police were notified and had sufficient evidence to warrant a written report.

In addition, the alcohol establishment data available from city alcohol licensing did not allow distinguishing between bars and restaurants, a distinction that others have shown to be important (Lipton & Gruenewald, 2002). Another example is that InfoUSA is a commercial business database that identifies businesses through telephone directories and new business sources (e.g., public record notices), which may result in omissions or an outdated list (Forsyth et al, 2010). However, each data source was the best available for this study.

Despite these limitations, this study advances the research literature by assessing potential moderating effects of a wide range of neighborhood attributes on the positive association between alcohol establishment density and crime. Results from this study suggest that cities should be cautious in increasing the density of alcohol establishments in any neighborhood and that city leaders should not assume that the effects of a higher density of alcohol establishments on crime will be offset by higher levels of social capital. However, further research is needed to replicate this study to see whether the observed results are consistent across other geographic areas.

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Table 1

Descriptive Statistics For All Variables (N = 83 neighborhoods)

Characteristic	*M*	Range
Crime outcomes		
Assault	21	(0-128)
Rape	4.5	(0-34)
Robbery	19	(0-97)
Vandalism	58	(7-269)
Nuisance	38	(0-676)
DWI	12	(0-155)
Public alcohol consumption	15	(0-527)
Underage possession/consumption	5.5	(0-114)
Alcohol establishments		
Number of alcohol establishments	7.5	(0-124)
Density of alcohol establishments (number per roadway mile)	0.56	(0-5.8)
Neighborhood demographics		
Socioeconomic/racial index	0.12	(13.1-10.7)
Female-headed households	8.20%	(0-20%)
Rental housing units	41%	(0-89%)
Families below poverty	12%	(0-43%)
Unemployment	5.80%	(.9-27%)
White	69%	(15-95%)
Median household income	$43,000	(12,000 - 103,000)
Median home value	$147,000	(59,000-563,000)
Population aged 15-24	817	(10 - 5,103)
Population density (pop/rdway mi)	325	(16-784)
Total population	4607	(128-15,247)
Neighborhood activism (index)	3.4	(0-8)
Neighborhood quality (index)	3.4	(1-5)

Type of business	%
Food retailers (number)	

Type of business	%
0	7
1 - 4	33
5 - 9	30
> 9	30
Non-food retailers (number)	
0 - 3	19
4 - 12	35
> 12	46
Non-healthcare services (number)	
0 - 2	24
3 - 4	25
5 - 9	23
> 9	28
Healthcare services (number)	
0	14
1 - 3	31
4 - 8	41
> 8	13
Parks (% of area in good condition)	
0	10
1 - 1.99	35
2 - 7.99	41
≥ 8	14
Elementary schools (number)	
0	31
1	39
> 1	30
Colleges (number)	
0	93
≥ 1	7
Religious institutions (number)	
0	7

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Type of business	%
1 - 3	49
> 3	43
Condemned buildings (number)	
0	52
1 - 4	33
> 4	16

Table 2

Multivariate results (Part 1): Associations between alcohol establishment density and violent crime outcomes, with potential moderating effects

	Assault	Rape	Robbery
	***B* [95% CI]**	***B* [95% CI]**	***B* [95% CI]**
Alcohol establishment density	0.40 [0.27, 0.52]*	0.24 [0.09, 0.40]*	0.28 [0.15, 0.42]*
Neighborhood demographics			
Population per roadway mi	0.40 [0.21, 0.59]*	0.39 [0.15, 0.62]*	0.52 [0.34, 0.72]*
Socioeconomic/racial index	−0.82 [−0.98, −0.66]*	−0.57 [−0.78, −0.36]*	−0.53 [−0.75, −0.32]*
Total population	0.20 [0.01, 0.39]*	−0.04 [−0.29, 0.21]	0.03 [−0.19, 0.23]
Population aged 15-24	−0.36 [−0.56, −0.15]*	−0.22 [−0.47, 0.03]	−0.33 [−0.54, −0.13]*
Potential moderators			
Non-alcohol food retailers	--	--	0.27 [0.08, 0.46]*
Healthcare services	--	0.26 [0.05, 0.48]*	--
Parks in “good” condition	--	--	−0.16 [−0.29, −0.02]*
Elementary schools	--	--	--
Colleges	0.05 [−0.10, 0.20]	--	--
Condemned buildings	--	--	0.26 [0.04, 0.48]*
Interactions			
Density × Elementary schools	--	--	--
Density × Colleges	−0.70 [−1.18, −0.22]*	--	--

Note: -- indicates variable not included in multivariate model because it was not significant in individual moderator model. All variables included in multivariate model were retained, regardless of significance

* $p < 0.05$.

Table 3

Multivariate results (Part 2): Associations between alcohol establishment density and non-violent crime outcomes, with potential moderating effects.

	Vandalism	Nuisance	Driving while intoxicated	Public Consumption	Underage Possession/Consumption
	***B* [95% CI]**	***B* [95% CI]**	***B* [95% CI]**	***B* [95% CI]**	***B* [95% CI]**
Alcohol establishment density	0.28 [0.19, 0.37]*	0.50 [0.31, 0.69]*	0.31 [−0.72, 1.16]	0.83 [0.49, 1.17]*	0.49 [0.25, 0.72]*
Neighborhood demographics					
Population per roadway mi	0.22 [0.09, 0.35]*	0.23 [−0.02, 0.48]	0.10 [−0.11, 0.31]	0.70 [0.24, 1.21]*	−0.01 [−0.39, 0.36]
Socioeconomic/racial index	−0.26 [−0.40, −0.11]*	−0.70 [−0.90, −0.49]*	−0.26 [−0.44, −0.07]*	−0.75 [−1.19, −0.31]*	−0.33 [−0.65, 0.01]
Total population	−0.10 [−0.23, 0.04]	−0.15 [−0.40, 0.11]	−0.02 [−0.23, 0.21]	−0.29 [−0.79, 0.23]	−0.55 [−0.95, −0.13]*
Population aged 15-24	0.11 [−0.02, 0.25]	0.15 [−0.10, 0.39]	0.19 [−0.03, 0.39]	0.09 [−0.42, 0.65]	0.81 [0.43, 1.16]*
Potential moderators					
Non-alcohol food retailers	--	0.32 [0.09, 0.55]*	0.21 [−0.03, 0.44]	0.26 [−0.29, 0.82]	--
Non-food retailers	--	--	--	0.27 [−0.32, 0.87]	--
Non-healthcare services	--	--	--	0.23 [−0.41, 0.79]	--
Healthcare services	--	--	−0.10 [−0.31, 0.11]	--	--
Parks in “good” condition	−0.07 [−0.16, 0.02]	--	--	--	--
Elementary schools	--	--	--	--	--
Colleges	--	0.20 [0.01, 0.39]*	−0.01 [−0.19, 0.16]	0.26 [−0.08, 0.64]	--
Neighborhood quality	--	--	−0.04 [−0.20, 0.12]	--	--
Neighborhood activism	--	--	--	0.60 [0.23, 0.99]*	0.31 [0.02, 0.60]*
Condemned buildings	0.15 [0.01, 0.30]*	--	--	--	--
Interactions					
Density × Neighborhood quality	--	--	0.15 [−0.07, 0.41]	--	--
Density × Healthcare services	--	--	−0.09 [−0.26, 0.07]	--	--
Density × Colleges	--	−0.77 [−1.38, −0.20]*	−0.52 [−1.05, 0.03]	−1.32 [−2.58, −0.07]*	--

Note: -- indicates variable not included in multivariate model because it was not significant in individual moderator model. All variables included in multivariate model were retained, regardless of significance

* $p < 0.05$.