The Association between Density of Alcohol Establishments and Violent Crime within Urban Neighborhoods

Traci L. Toomey, PhD
Darin J. Erickson, PhD
Bradley P. Carlin, PhD
Kathleen M. Lenk, MPH
Harrison S. Quick, MS
Alexis M. Jones, MPH
Eileen M. Harwood, PhD

Division of Epidemiology and Community Health, School of Public Health
University of Minnesota
1300 S. Second St. Suite 300
Minneapolis, MN 55454
USA

Division of Biostatistics, School of Public Health, University of Minnesota
A460 Mayo Building, MMC 303
420 Delaware St. S.E.
Minneapolis, MN 55455
USA

Corresponding Author:
Traci L. Toomey, PhD
1300 South Second Street, Suite 300
Minneapolis, MN 55454
Phone: (612) 626-9070
Fax: (612) 624-0315
Email: toome001@umn.edu

The study was funded by the National Institute on Alcohol Abuse and Alcoholism under grant R01AA016309-02 (Traci L. Toomey, Principal Investigator).
Abstract

Background. Numerous studies have found that areas with higher alcohol establishment density are more likely to have higher violent crime rates but most of these studies did not assess the differential effects of type of establishments or the effects on multiple categories of crime. In this study, we assess whether alcohol establishment density is associated with four categories of violent crime, and whether the strength of the associations varies by type of violent crime and by on-premise establishments (e.g., bars, restaurants) versus off-premise establishments (e.g., liquor and convenience stores).

Methods. Data come from the city of Minneapolis, Minnesota in 2009 and were aggregated and analyzed at the neighborhood level. Across the 83 neighborhoods in Minneapolis, we examined four categories of violent crime: assault, rape, robbery, and total violent crime. We used a Bayesian hierarchical inference approach to model the data, accounting for spatial autocorrelation and controlling for relevant neighborhood demographics. Models were estimated for total alcohol establishment density as well as separately for on-premise establishments and off-premise establishments.

Results. Positive, statistically significant associations were observed for total alcohol establishment density and each of the violent crime outcomes. We estimate that a 3.9% to 4.3% increase across crime categories would result from a 20% increase in neighborhood establishment density. The associations between on-premise density and each of the individual violent crime outcomes were also all positive and significant and similar in strength as for total establishment density. The relationships between off-premise density and the crime outcomes were all positive but not significant for rape or total violent crime, and the strength of the associations was weaker than those for total and on-premise density.
Conclusions. Results of this study, combined with earlier findings, provide more evidence that community leaders should be cautious about increasing the density of alcohol establishments within their neighborhoods.

Key words: Alcohol outlets, violent crime, neighborhood
Introduction

Research has found alcohol use to be associated with various types of criminal behaviors, including vandalism, rape, assault, and homicide (Greenfield, 1998, McClelland and Teplin, 2001). This relationship exists between multiple types of crime with varying degrees of severity; however, alcohol use is most strongly associated with violent criminal behavior (Greenfield, 1998). Intoxicated offenders are more likely to commit homicide, physical assault, and sexual assault than engage in other nonviolent offenses, such as burglary and theft (Felson and Staff, 2010). Victims are more likely to sustain both minor and serious injuries during a violent crime when alcohol is involved (Brecklin, 2002, Rand et al., 2010). A proven effective approach to reduce alcohol-related violent crime is to target environmental factors associated with alcohol use, such as the availability of alcohol. When these environmental issues are addressed, alcohol use and related problems decrease (Grossman et al., 1994, Popova et al., 2009, Wagenaar and Toomey, 2002). One factor shown to affect alcohol availability is the number of or density of alcohol retail establishments in an area (Voas and Fell, 2010).

Numerous studies have assessed the relationship between the density of alcohol establishments and rates of violent crime. Several older studies examined effects of alcohol establishment density in fairly large geographic areas such as states or cities but these were found to be fairly imprecise due to the variability in density of establishments within large areas (Gorman et al., 1998, Scribner et al., 1995, Stitt and Giacopassi, 1992). More recent studies have used smaller geographic units, such as the neighborhood, block or census tract level. Overall, these more recent studies have found that areas with higher alcohol establishment density are more likely to have higher violent crime rates, although some differences were found across studies as outlined below.
Most studies have examined the combined effects of all types of alcohol establishments including on-premise establishments (e.g., bars, restaurants) and off-premise establishments (e.g., liquor stores, grocery stores); these studies have consistently found a positive relationship between alcohol establishment density and violent crime (Franklin et al., 2010, Gorman et al., 2005, Gyimah-Brempong and Racine, 2006, Livingston, 2008a, Livingston, 2008b). Studies assessing effects of on-premise versus off-premise establishments separately have found inconsistent results. Approximately half of the analyses examining the relationship between density of on-premise alcohol establishments and violent crime found a positive relationship (Gruenewald et al., 2010, Livingston, 2008a, Scribner et al., 2010) and the rest found no relationship (Franklin et al., 2010, Gorman et al., 2005, Livingston, 2008b). Three studies examined effects of bar and restaurant density separately and also found mixed results (Gruenewald et al., 2006, Gruenewald et al., 2010, Lipton and Gruenewald, 2002); two of the analyses of effects of bar density on violent crime showed a positive relationship (Gruenewald et al., 2010, Lipton and Gruenewald, 2002) and two showed no relationship (Gruenewald et al., 2006, Gruenewald et al., 2010); three of the analyses of effects of restaurant density on violent crime results found no relationship (Gruenewald et al., 2006, Gruenewald et al., 2010) and one suggested a negative relationship (Lipton and Gruenewald, 2002). Similar to on-premise establishments, slightly more than half of the analyses examining the association between off-premise alcohol establishments and violent crime identified a positive association (Gorman et al., 2005, Gruenewald et al., 2006, Gruenewald et al., 2010, Livingston, 2008b, Scribner et al., 1999, Alaniz et al., 1998) and the remaining analyses found no relationship (Franklin et al., 2010, Lipton and Gruenewald, 2002, Livingston, 2008a, Scribner et al., 2010, Zhu et al., 2004).
Studies have differed on the type of violent crime outcomes assessed. Several studies used crime categories like the FBI’s Uniform Crime Report (UCR) Part I offenses, which include but are not limited to rape, assault, homicide and robbery (Franklin et al., 2010, Gyimah-Brempong and Racine, 2006, Scribner et al., 2010). Researchers who have used an aggregate of Part I offenses as a single violent or severe crime variable have found a positive relationship between alcohol establishment density and total violent/severe crime (Britt et al., 2005, Franklin et al., 2010, Gorman et al., 2001, Gorman et al., 2005, Gyimah-Brempong and Racine, 2006, Speer et al., 1998, Zhu et al., 2006, Zhu et al., 2004). Results of studies assessing the relationship between density of establishments and a single category of violent crime vary somewhat by the type of crime. Studies examining the relationship between assaults and total establishment density have found positive associations (Lipton and Gruenewald, 2002, Livingston, 2008a, Livingston, 2008b, Nielsen and Martinez, 2003, Reid et al., 2003, Franklin et al., 2010); however, mixed results are seen when effects of off- and on-premise establishments are disaggregated (Franklin et al., 2010, Gruenewald et al., 2006, Gruenewald et al., 2010, Lipton and Gruenewald, 2002, Livingston, 2008a, Livingston, 2008b). In general, robbery is positively associated with alcohol establishment density but research is limited to only three studies (Franklin et al., 2010, Nielsen and Martinez, 2003, Nielsen et al., 2005). The relationship between alcohol establishment density and homicide is not clear: three studies found a positive relationship (Gyimah-Brempong, 2001, Gyimah-Brempong and Racine, 2006, Scribner et al., 1999) and another study found no association (Franklin et al., 2010). Alcohol establishment density as related to sexual offenses has only been investigated in one study and was found to be positively associated with the total number of establishments within a census tract (Franklin et al., 2010).
Previous research on alcohol establishment density and violent crime has several limitations. Only one third of the studies assessed the differential effects of type of establishments (on-premise, off-premise, and total) (Franklin et al., 2010, Gorman et al., 2005, Lipton and Gruenewald, 2002, Livingston, 2008a, Livingston, 2008b, Scribner et al., 1999, Zhu et al., 2004) and only one included multiple categories of violent crime (Franklin et al., 2010). Additionally, many of the earlier studies did not assess or control for spatial autocorrelation, potentially resulting in a Type I error. Geographic units, such as neighborhoods, may contribute to crime occurring in nearby units; thus, these geographic units may not be independent (Banerjee, 2004, Cliff and Ord, 1981). Furthermore, most studies assessing effects of alcohol establishment density have been limited to specific geographic areas; we identified only one study conducted within Midwestern states in the U.S. (Britt et al., 2005).

The purpose of this study is to answer the following questions: (1) Is alcohol establishment density associated with different violent crime categories, including, assault, rape, robbery, and total Part I and II violent crime?; (2) Does the strength of the associations vary by type of violent crime?; (3) Does the strength of the associations vary by density of on-premise versus off-premise alcohol establishments?

**Materials and Methods**

This two-year study examined the associations between alcohol establishment density and multiple types of violent crime in neighborhoods in Minneapolis, Minnesota.

**Neighborhoods.** We used neighborhood, as designated by the city of Minneapolis, as the geographic unit of analysis. Many previous studies examining effects of alcohol establishment density used smaller geographic units of analysis such as census tracts and census blocks, which have the advantage of greater statistical power; however, these units are not based on theory.
Collective efficacy provides the theoretical basis for our selection of neighborhood as the unit of analysis. Collective efficacy is defined by Sampson and colleagues (1997) as “the linkage of cohesion and mutual trust with shared expectations for intervening in support of neighborhood social control”. Residents within a neighborhood may identify more with each other than with residents from other neighborhoods. Residents within a neighborhood also often work collectively to shape the development of the neighborhood and increase safety.

Minneapolis has 87 neighborhoods as defined by the City. We excluded three of these neighborhoods because they were industrial areas with no residents. We also excluded one neighborhood that had a 96% decline in its population between 1990 and 2000 resulting from an urban renewal project, leaving 83 neighborhoods that we used in our analyses. Population size across these 83 neighborhoods ranged from 128 to 15,247 (mean = 4,607), with the percentage of the neighborhood population that is Caucasian ranging from 15.0% to 94.9%.

Alcohol establishments. In 2009 we obtained a list of 663 licensed alcohol establishments from the Minneapolis Department of Regulatory Services. We identified and removed 40 duplicates, resulting in a final list of 623 establishments (503 on-premise establishments, 120 off-premise establishments). We geocoded addresses for the alcohol establishments using an address locator in ArcGIS and 2009 street address data from the Twin Cities Metropolitan Council; establishments were then assigned to neighborhood. Fourteen of the addresses did not have a 100% accuracy score; for these addresses we used other sources (i.e., Google Maps, Bing Maps, etc.) to confirm the accuracy of the address and assign each establishment to a neighborhood. See Figure 1 for a map of all establishments.

We developed three alcohol establishment density measures: (1) total establishment density, (2) on-premise establishment density, and (3) off-premise establishment density.
Because people move through their neighborhoods on roadway systems, we characterized alcohol establishment density based on these functional paths people take in their community—we calculated density as the number of establishments per roadway mile (Gruenewald et al., 1996, Lipton and Gruenewald, 2002). Our first step in calculating roadway miles was to remove alleys and freeway on/off ramps. Second, if a regular undivided road was on the border of two neighborhoods, we assigned the road equally to both neighborhoods. In our calculations, highways, freeways, and other divided roads were not double counted—in other words they were treated the same way as undivided roads. For roads that crossed neighborhood boundaries, we assigned the part of the road that fell within a given neighborhood to that neighborhood. We obtained information about roadway miles from the Minnesota Population Center at the University of Minnesota.

Crime. We obtained 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 (the most recent data available at the time of data collection). This dataset included the primary offense for each incident. We checked the accuracy of the address coordinates indicating the crime locations (e.g., latitude/longitude) by geocoding a subset of the crime incidents using an address locator in ArcGIS and 2009 street/address data from the Twin Cities Metropolitan Council. Because we found that the MPD address coordinates had a high level of accuracy (each coordinate was within 36 yards) we used these coordinates to assign crime incidents to the appropriate neighborhood when available. If a reported crime did not include coordinate information, we geocoded the address using the ArcGIS address locator. If an address for a crime fell outside the boundaries of Minneapolis, it was deleted from our final dataset. Ninety-nine percent of the crimes were successfully mapped and assigned to a Minneapolis neighborhood.
Crimes that fell on neighborhood boundaries were randomly distributed into neighborhoods that shared the boundary (1.04%). Figure 2 shows the raw standardized crime ratios (SCRs) for each crime outcome. SCRs are defined as 100 times the ratio of observed crime counts to the number we would have expected had the crime in question been uniformly distributed across the entire study region.

For these analyses, we include four violent crime categories that previous research/theory has shown to commonly be alcohol-related: assault (range = 0 - 128 per neighborhood, mean = 21), rape (range = 0 - 34 per neighborhood; mean = 4), robbery (range = 0 - 97 per neighborhood; mean = 19), and a combination of Part I and Part II violent crime that includes homicide, assault, rape, robbery, malicious punishment of a child, sexual molestation, and abuse of a vulnerable adult (0 to 272 per neighborhood; mean = 53). We considered assessing the association between alcohol establishment density and other specific crime categories (e.g., homicide), separately; however, the incidence was low (e.g., there were only 24 homicides in Minneapolis during that year and 75% of the neighborhoods did not have any homicides).

**Neighborhood Demographics.** We reviewed the research literature on the associations between alcohol establishment density and crime to identify neighborhood-level variables that had been found to be theoretically and empirically important in previous studies. Based on the work of previous studies (Kikuchi and Desmond, 2010, Morenoff et al., 2001), we created an index measuring economic and racial characteristics that was based on composite measures used in similar studies. 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/](http://www.ci.minneapolis.mn.us/citywork/planning/census2000/)): (1) percent female-headed
households (number households female householder with no husband present and own children < age 18 years divided by total number of households); (2) percent rental housing units (specified renter-occupied units divided by total number of housing units); (3) percent of families below poverty (number of families below poverty level divided by number of families for whom poverty status is determined); (4) percent unemployment (number unemployed in civilian labor force among those ≥ age 16 years divided by number in civilian labor force among those ≥ age 16 years); (5) median household income; (6) median home value; and (7) percent white (number of Caucasian divided by total population). These seven variables were standardized (mean=0, standard deviation = 1) and summed to create the index (range of index values: -13.14 to 10.688). The index had a high internal consistency, 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.

When using neighborhood-level Census data, an important question to answer is how much misalignment there is between the boundaries of neighborhoods and the Census block groups. 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.

Analyzes. We used a Bayesian hierarchical inference approach to model the data. Unlike in a frequentist approach where model parameters are fixed values estimated from the data, the Bayesian approach views model parameters as random variables with a distribution that reflects
prior knowledge. Inferences are based on the posterior distribution of all parameter estimates obtained by combining this prior knowledge with the information from the collected data. The Bayesian approach is particularly well-suited for the complex, hierarchical models that are needed for spatially correlated data. For an overview on Bayesian statistical methods, see Carlin & Louis (2009).

We modeled crime counts from each neighborhood using a Poisson likelihood, where the expected number of crime incidents in the $i^{th}$ neighborhood is where $E_i$ is the number of crime incidents we would see in the $i^{th}$ neighborhood if crime was uniformly distributed across the city, calculated by multiplying the number of roadway miles in the neighborhood by the city-wide crime per roadway mile rate. In addition, $\mathbf{x}_i$ denotes the vector of neighborhood-specific covariates, $\mathbf{\beta}$ is a corresponding vector of coefficients, and $\theta_i$ represents random (non-spatial) error. By contrast, $\phi_i$ are random effects that capture the spatial autocorrelation between the neighborhoods using the conditionally autoregressive (CAR) model first used in this context by Besag et al. (1991). We analyzed all models using the OpenBUGS software package, Version 3.1.1 (Lunn et al., 2009).

Because the $\mathbf{\beta}$ coefficients can be challenging to interpret, we also calculated the percent increase in model-predicted violent crime associated with a 20% increase in alcohol density in a neighborhood of average establishment density. The densities in our model were first standardized to have mean 0 and standard deviation 1 and thus, we compute this percentage as 100 times the quantity:
This is also the percent increase in crime that would be predicted to result from an increase in alcohol density in any neighborhood by 20% of the average alcohol density; i.e., all that matters is the size of the increase, not the baseline rate. We also remark that these values vary widely across the total (mean 0.577, SD 0.925), on-premise (mean 0.471, SD 0.862) and off-premise (mean 0.106, SD 0.127) cases, due to the comparative rarity of off-premise establishments in our study area.

Results

The number of reported crime incidents varies across neighborhoods (see Figure 2). Estimates and confidence intervals for establishment density and each crime outcome are shown in Table 1. Positive, statistically significant associations were observed for total alcohol establishment density and each of the violent crime outcomes. Results were similar for estimates of the percent increase in each of the crime types resulting from a 20% increase in establishment density in a neighborhood with an average density, ranging from 3.9% to 4.3%. The estimated percent increase in crime was lower for violent crime combined (3.4%), although the relationship with this outcome and total alcohol establishment density was still statistically significant.

Figure 3 maps the spatial residuals from our hierarchical CAR model fit. These residuals illustrate excess spatial variability in the fitted SCRs that are not explained by the alcohol establishment density and other covariates. As such, maps like Figure 3 are often used to generate hypotheses regarding spatially-varying covariates that may still be missing from the model. In our case, the neighborhoods with highest residual SCRs for rape are those in the downtown, near west, and near east (University of Minnesota) regions. Lower residuals are seen in a few scattered far northwest and southern neighborhoods. By contrast, elevated SCRs for robbery and assault are largely confined to the economically deprived and largely minority
northwest, with lower SCRs predominantly clustering in a vertical strip of neighborhoods in the more affluent neighborhoods of southwest.

The associations between on-premise density and each of the individual violent crime outcomes were also all positive and statistically significant (Table 1). The strength of the associations across crime outcomes was very similar to those between total establishment density and each of the crime outcomes. Estimates for the percent increase in crime for a 20% increase in on-premise establishment density were slightly lower than for total establishment density (3.3% to 3.8%). Again, the association between on-premise density and all violent crime combined was slightly lower than for the individual crime types, but still statistically significant.

The relationships between off-premise density and the individual crime outcomes were all positive, but they were not all statistically significant (Table 1). The association was not statistically significant for rape or the combined violent crime outcome. The strength of the associations for robbery and assault was weaker than the associations between these outcomes and total establishment density and on-premise density.

Discussion

We found that overall alcohol establishment density was positively associated with violent crime, indicating that neighborhoods with more alcohol establishments tend to have more assault, rape, robbery, and overall violent crime than neighborhoods with fewer alcohol establishments. This relationship was stronger and more consistent for on-premise establishments than off-premise establishments. These findings are similar to findings from several earlier studies (e.g. Franklin et al., 2010, Gorman et al., 2005, Gyimah-Brempong and Racine, 2006, Livingston, 2008a, Livingston, 2008b), although some previous studies found no association between certain violent crime outcomes and alcohol establishment density when
density was disaggregated into on-premise and off-premise density (Scribner et al., 2010, Franklin et al., 2010, Livingston, 2008a, Gorman et al., 2005, Zhu et al., 2004, Lipton and Gruenewald, 2002).

An interesting finding in this study is that the strength of the association between establishment density and crime was lower for the combined Part I and Part II violent crime outcome than for individual crime categories. Additionally, the association between off-premise density and the combined violent crime outcome was not statistically significant. The explanation for these findings is not clear. However, this combined variable included incidents of other types of violent crime, including homicides, which mostly occurred within a few geographic areas. This may have lowered the strength of the overall association.

The Task Force on Community Preventive Services (http://www.thecommunityguide.org/alcohol/outletdensity.html) has recommended “…the use of regulatory authority (e.g., through licensing and zoning) to limit alcohol outlet density on the basis of sufficient evidence of a positive association between outlet density and excessive alcohol consumption and related harms.” Given the growing research literature that suggests adding alcohol establishments—especially on-premise alcohol establishments—could increase several types of violent crime, neighborhood residents and leaders should be cognizant of proposals to add establishments within their neighborhoods.

A limitation of this study and of many of the previous studies examining the association between alcohol establishment density and crime is the cross-sectional design. Based on this study alone we cannot conclude that an increase in alcohol establishment density in a neighborhood will lead to an increase in violent crime. However, there is a growing body of research literature that has demonstrated this positive relationship across various types of violent
crime and across different geographic areas. Additionally, a few studies have assessed effects of changes in alcohol establishment density and found that adding more establishments increases the risk of violence and hospitalizations resulting from assaults (Norstrom, 1996, Gruenewald and Remer, 2006). Furthermore, a higher density of alcohol establishments means more availability of alcohol. Many studies show that as we increase availability of alcohol (e.g., through an increase in the hours that alcohol can legally be sold, a decrease in the price of alcohol, etc.), we see an increase in crime and other alcohol-related problems (Middleton et al., 2010, Elder et al., 2010, Babor et al., 2003). In addition to increasing alcohol availability, an increase in alcohol establishments, particularly on-premise establishments, may also contribute to increased violence because of an increase in the number of people gathering socially at the establishments (social aggregation of drinkers; Norstrom, 1996).

Another limitation of this study is that the police report data only include incidents of crime that were reported to police and where there was sufficient evidence to write a report. Additionally, only the primary offenses are included in the database (i.e., if a lesser crime occurred during the same event by the same person as the primary offense, the lesser offense was not included). Both of these limitations could lead to an underestimation of crime across neighborhoods; however, it is unlikely that these underestimations differ substantially across neighborhoods. Because the study was conducted in only one metropolitan area, generalizability of study findings may be limited. However, many previous studies also have been conducted in one metropolitan area (e.g., Gorman et al., 2001, Scribner et al., 1999, Speer et al., 1998) and the combined results across these different regions provide confidence that the results can be generalized to other geographic areas.
In addition to these limitations, we also identified a few methodological limitations. First, we did not control for potential edge effects of alcohol establishments located in other communities near the Minneapolis border that could influence crime in the nearby Minneapolis neighborhoods. However, this is likely not a significant limitation because most of the communities surrounding Minneapolis are suburban communities that do not have a significant number of alcohol establishments near their Minneapolis borders. In our analyses, we also explored the use of multivariate CAR models (see e.g. Banerjee, 2004, Sec. 7.4) that would allow us to account for correlation across crime outcomes as well as neighborhoods; however, the CAR models only contributed to modest additional smoothing and did not improve the fit to the data.

Despite these limitations, this study contributes to the growing research literature assessing the association between alcohol establishment density and violent crime. Similar to other studies, we observed a positive association between total establishment and on-premise density and multiple violent-crime outcomes. Results were less consistent for off-premise density. This study builds on previous studies by including several violent crime outcomes, assessing on- versus on-premise and total establishment density, controlling for geospatial autocorrelation, and using advanced Bayesian analytical methods. Results of this study, combined with earlier findings, provide more evidence that community leaders should be cautious about increasing the density of alcohol establishments within their neighborhoods.
Acknowledgments

The study was funded by the National Institute on Alcohol Abuse and Alcoholism under grant R01AA016309-02 to Traci L. Toomey, Principal Investigator. The views expressed here are solely those of the authors and do not necessarily reflect the views of the National Institute on Alcohol Abuse and Alcoholism or the University of Minnesota. We thank Drs. Linda Bosma, Paul Gruenewald, and Robert Parker for their helpful guidance in the development of this study. We also thank the city of Minneapolis with its assistance with data collection and guidance in development and implementation of the study. The study was also successful because of the valuable contributions of the Minnesota Population Center at the University of Minnesota. Finally, we thank several staff members who were critical to the success of this study: Susan Fitze for coordinating the study, William Baker for assisting with measurement development, Joe Koeller for geocoding of data, and Jake Kelberer and Alex Baker for assistance with data collection.
References


Accessed April 14, 2011.


Table 1. Associations between alcohol establishment density and violent crime (estimates and 95% confidence intervals).

<table>
<thead>
<tr>
<th>Crime outcomes</th>
<th>Alcohol Establishment Density</th>
<th>Population Density</th>
<th>SES</th>
<th>Age 15-24</th>
<th>% Increase^1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total establishments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rape</td>
<td>0.31 (0.16, 0.46)</td>
<td>0.42 (0.2, 0.65)</td>
<td>-0.54 (-0.74, -0.33)</td>
<td>-0.17 (-0.38, 0.04)</td>
<td>3.9%</td>
</tr>
<tr>
<td>Robbery</td>
<td>0.32 (0.17, 0.46)</td>
<td>0.57 (0.37, 0.77)</td>
<td>-0.7 (-0.88, -0.51)</td>
<td>-0.24 (-0.42, -0.05)</td>
<td>4.1%</td>
</tr>
<tr>
<td>Assault</td>
<td>0.34 (0.21, 0.47)</td>
<td>0.4 (0.22, 0.58)</td>
<td>-0.82 (-0.99, -0.66)</td>
<td>-0.26 (-0.42, -0.08)</td>
<td>4.3%</td>
</tr>
<tr>
<td>Combined Crime</td>
<td>0.27 (0.16, 0.38)</td>
<td>0.45 (0.29, 0.6)</td>
<td>-0.67 (-0.82, -0.52)</td>
<td>-0.2 (-0.34, -0.05)</td>
<td>3.4%</td>
</tr>
<tr>
<td>On-premise establishments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rape</td>
<td>0.31 (0.16, 0.46)</td>
<td>0.42 (0.2, 0.64)</td>
<td>-0.54 (-0.75, -0.34)</td>
<td>-0.16 (-0.37, 0.04)</td>
<td>3.4%</td>
</tr>
<tr>
<td>Robbery</td>
<td>0.3 (0.16, 0.44)</td>
<td>0.57 (0.38, 0.77)</td>
<td>-0.7 (-0.88, -0.51)</td>
<td>-0.23 (-0.42, -0.05)</td>
<td>3.3%</td>
</tr>
<tr>
<td>Assault</td>
<td>0.34 (0.22, 0.47)</td>
<td>0.41 (0.23, 0.58)</td>
<td>-0.83 (-1, -0.67)</td>
<td>-0.26 (-0.43, -0.08)</td>
<td>3.8%</td>
</tr>
<tr>
<td>Combined Crime</td>
<td>0.27 (0.16, 0.38)</td>
<td>0.46 (0.31, 0.62)</td>
<td>-0.67 (-0.81, -0.52)</td>
<td>-0.2 (-0.35, -0.06)</td>
<td>3.0%</td>
</tr>
<tr>
<td>Off-premise establishments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rape</td>
<td>0.15 (-0.04, 0.33)</td>
<td>0.4 (0.14, 0.65)</td>
<td>-0.47 (-0.71, -0.25)</td>
<td>-0.15 (-0.39, 0.08)</td>
<td>2.5%</td>
</tr>
<tr>
<td>Robbery</td>
<td>0.19 (0.04, 0.35)</td>
<td>0.54 (0.33, 0.75)</td>
<td>-0.64 (-0.83, -0.44)</td>
<td>-0.22 (-0.41, -0.03)</td>
<td>3.2%</td>
</tr>
<tr>
<td>Assault</td>
<td>0.17 (0.03, 0.31)</td>
<td>0.37 (0.17, 0.58)</td>
<td>-0.76 (-0.95, -0.57)</td>
<td>-0.24 (-0.44, -0.04)</td>
<td>2.9%</td>
</tr>
<tr>
<td>Combined Crime</td>
<td>0.11 (0, 0.23)</td>
<td>0.44 (0.27, 0.62)</td>
<td>-0.61 (-0.77, -0.46)</td>
<td>-0.18 (-0.35, -0.02)</td>
<td>1.9%</td>
</tr>
</tbody>
</table>

^1Percent increases corresponding to a 20% increase in density in a neighborhood with average density.

Note: Bold text = statistically significant at the p < 0.05 level.
Figure 1. Number of alcohol establishments (per roadway mile) in Minneapolis by neighborhood.
Figure 2. Raw standardized crime ratios (SCR) in Minneapolis by neighborhood.
Figure 3. Residuals for standardized crime ratios in Minneapolis neighborhoods.