A Geographic Analysis of DWI Offenders

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Abstract

There are almost no studies of the geographic distribution of DWI offenders. Basic information such as whether DWI offenders are randomly distributed in the population or tend to come from specific neighborhoods could have important implications for DWI prevention and interventions. If geographic clusters are identified, anti-DWI efforts can be targeted at specific areas, whereas this type of geographic targeting would not be appropriate if the DWI population is randomly distributed. The objective of this study is to determine whether the home locations of DWI offenders are spatially clustered by using appropriate spatial analytic methodology. All DWI offenders (i.e., any drinking-driving conviction) from 1990-1994 in Erie County, New York form the database for this study. Over 15,500 DWI offender home addresses were geocoded and allocated to census tracts and block groups. A spatial scan methodology based on a case-control approach was used to determine whether census tracts or block groups formed significant geographic clusters. Results based on the analysis of DWI offenders at the census tract level and block group level identified a number of statistically significant spatial clusters. The geographic analysis found that specific high and low rate areas could be identified based on official DWI conviction information. The clusters based on block groups provided a refinement of the clusters found at the tract level. The geographic distribution of DWI offenders is clustered and not random, which could be used to target intervention programs.

Keywords
Alcohol, DWI, cluster analysis, geography

Introduction

Drinking and driving offenses (DWI) occur in a number of geographic contexts, which include the road system, places where alcohol is consumed, locations of crashes, locations of arrests, and the home locations where the DWI offenders reside. Despite the various geographic links with DWI, there are relatively few studies that examine these geographic factors. Gruenewald and associates have examined the role of alcohol availability in drinking and driving (1). Wieczorek and Coyle (2) used a spatial regression technique to identify factors associated with a DWI rate in census tracts such as non-skilled occupations, high school education level, percent male population, and white ethnicity (2). In addition, simple spatial cluster analysis was used to suggest that DWI offender home locations were not randomly distributed (3); however, the technique was not able to identify specific clusters of either high or low rate locations. There is
great potential for advanced geographic cluster analysis to provide guidance for DWI prevention by identifying specific low and high DWI rate neighborhoods. DWI prevention has not usually been focused on areas that generate a disproportionate number of DWI offenders. The purpose of this study is to determine whether the home locations of DWI offenders are geographically clustered by utilizing advanced spatial cluster analysis.

Methods

The study was conducted in Erie County, New York, with a population of about 968,000 at the time of the study. The county includes a large urban area (Buffalo), suburban areas and semi-rural towns. The home address information for all persons (15,551) convicted of DWI (any drinking and driving offense) from 1990-1994 in Erie County form the database for the study. The home addresses of the DWI offenders were geocoded using TIGER line files and Erie County tax parcel information. After geocoding, the individuals were allocated to census tracts and block groups. Census population data were used to create DWI rates for the tracts and block groups. The block groups and tracts were analyzed separately to assess the impact of the geographic unit used for analysis and to determine if the cluster solutions showed convergent results.

The spatial cluster analytic techniques used was Kulldorff’s (4) SatScan algorithm. This is a spatial scan method that uses a scan window to move over the tracts and block groups to sum the number of cases (i.e., DWIs) in the overlapping scan windows to identify specific clusters. The method is a case-control approach that compares the expected number of cases in an area with the number of controls to identify the clusters. The method uses a likelihood ratio statistic that accounts for the multiple comparisons made during the spatial scan to identify statistically significant clusters. SatScan identifies clusters of any shape or size, the specific members of each cluster, and both high and low rate areas. This case-control cluster method controls for the underlying population distribution so that clusters are not merely a reflection of population density.

Results

The two main cluster analyses (one at the block group level, the other at the tract level) both found significant clusters of DWI offenders. It is important to compare the simple DWI rate maps with the cluster analysis results. Figure 1 shows the DWI rate map for DWIs at the census tract level. The mean DWI rate at the tract level is 151.96/10,000 persons. Visual inspection of this map shows that identifiable groups of tracts have similar DWI rates. Note that the natural breaks method was used to create the intervals on this map (and in Figure 3). The natural breaks method utilizes the variance of the rates to create the specified number of categories by using standard deviation units to define the intervals. This creates intervals with meaningful break points, but with a different number of tracts in each interval group, as compared to quantile interval methods that place the same number of tracts in each interval group. Despite the visual impression of the rates shown in Figure 1, there is no way to know which groups, if any, of the tracts actually form statistically significant clusters.
Figure 1: DWI conviction rate for census tracts in Erie County, New York.

Figure 2: DWI clusters at the census tract level.
The significant clusters identified at the tract level are shown in Figure 2. Cluster 1 is a low rate cluster located in the central urban area (p=.001, 1,123 DWI cases found, 1,812 cases expected). A small geographic area is typical for census tracts in highly urbanized areas, such as those in cluster 1. Cluster 2 is another high rate cluster that includes a large portion of the major suburban areas of the county (5,265 DWI cases found, 4,461 cases expected). Cluster 2 also includes some rural tracts (recognized by their large geographic areas). Cluster 3 is a high rate cluster found in a suburban-urban transition area with substantial heavy industry (p=.001, 367 DWI cases found, 246 cases expected). A visual comparison between Figures 1 and 2 show that the significant clusters overlap with the simple rate map, but are also substantially different.

Figure 3 shows the DWI rates at the block group level. The mean DWI rate at the block group level is 147.62/10,000 persons. Note that block groups are smaller geographic units than census tracts; census tracts (population range 2,500-8,000) are usually composed of fewer than ten block groups. Greater geographic variability is found at the scale of block groups as compared to tracts (see Figures 1 and 3). More nuances are present in the geographic distribution because estimates of DWI rates for smaller populations are more variable. Visualization of clusters among the block groups is much more difficult than for the tract-level map. The results of the spatial cluster analysis are shown in Figure 4. The finer-grained information from the block group-level analysis resulted in substantially more clusters in comparison to the tract-level analysis (7 clusters vs. 3 clusters). All of the block group clusters were statistically significant at the p=.001 level.

At the block group-level analysis, cluster 1 coincides well with the first cluster of the tract-level analysis. They are located in the same urban area and are low rate clusters. Cluster 1 had an expected number of 2,879 DWI cases, whereas only 2,042 were found, which indicates that this cluster includes a larger population than the same cluster at the tract level. Clusters 2 (4,995 DWI cases vs. 4,132 expected) and 5 (787 DWI cases vs. 575 expected) are high rate clusters that show a refinement of the large suburban high rate cluster at the tract-level into two distinct groups. Cluster 5 added some areas that were not included at the tract level. Cluster 2 extended to additional areas towards the urban core, whereas some rural tracts that were included in the high rate tract cluster are no longer in any cluster in the block group analysis.

In figure 4, Cluster 3 is a low rate group in a suburban area (273 DWI cases vs. 522 expected) that does not have a comparable cluster at the tract level. Cluster 4 is a low rate group that is an artifact of data reporting because it includes an Indian reservation for which reliable addresses for DWI convictions are not available. At the tract level, this artifact was not identified as a cluster with a possible explanation that the single tract was divided into multiple block groups, which then were identified as a cluster. Cluster 6 is a high rate group (471 DWI cases vs. 321 expected) that coincides with the third cluster at the tract level. Cluster 7 is a small low rate group (18 DWI cases vs. 54 expected) in the central urban area that does not have a corresponding group at the tract level.

One noteworthy difference between the two cluster analyses is that the block group clusters tend to include more cases and population than do the comparable clusters at the tract level. Even when the large high-rate suburban tract cluster was split into two clusters of block groups, the total number of cases for the two block-group clusters was greater ((5,782 vs. 5,265).
Figure 3: DWI conviction rate for block groups in Erie County.

Figure 4: DWI clusters at the block group level.
Discussion

The results at the tract and block levels of analysis provide strong evidence that the spatial distribution of DWI offenders is clustered, with some areas having significantly higher rates and other areas marked by lower rates. These clusters are not an artifact of population density because the case-control methodology used for the analysis controls for density and makes appropriate statistical tests to identify the specific cluster members. The results of the analyses at two geographic scales (tracts and block groups) resulted in convergent and complementary findings. The analysis with smaller geographic units provided a greater number of significant clusters, most of which coincided with the results at the tract level. The results suggest that a greater amount of geographic information is available from smaller geographic units, with point level data (i.e., exact home addresses) being the most preferred for spatial analysis.

DWI clusters were found in urban, suburban, and rural areas of the county, indicating that clusters are possible within any type of residential area. Although specific analysis of socioeconomic status variables such as income and poverty were not conducted for this study, the cluster results tend to reflect socioeconomic patterns. The low DWI rate urban cluster is found in the poorest areas of the city, while the suburban higher rate clusters are in working class and middle class towns. The results provide a basis to make rational decisions on targeting of resources for DWI prevention and interventions, especially if those interventions focus on areas that generate a disproportionate number of DWI offenders. Primary prevention can be focused at these areas to reduce general alcohol consumption and to provide safe-ride alternatives. Public service announcements (e.g., billboards) should also be targeted toward the high rate cluster areas. Enforcement also could be targeted to the higher rate locations.

Although the results strongly support the existence of DWI clusters, there are a number of limitations and issues that require future research. It is possible that enforcement practices may be differential and could cause DWI clusters; however, the data are from a five-year period, which minimizes the impact of short-term DWI enforcement blitzes, and many of the clusters cross police jurisdictions. Future analyses need to examine the relationships between location of the DWIs, alcohol-related crashes, and alcohol outlets with the home locations of the offenders. In additional, spatial cluster analysis that controls for ethnicity, gender, and age are necessary to provide a more complete view of the geographic distribution of DWI offenders.

References