Syringe Exchange Service Mapping and Analysis with Neighborhood Level Factors within Pittsburgh Pennsylvania

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Introduction

Drug overdose accounts for over 50,000 deaths in the United States per year, with a death rate that has been steadily rising over the last two decades (Brown and Wehby, 2016). Deaths related to opioid overdoses from prescription drug opioids have had similar rising trends (Brown and Wehby, 2016). The opioid epidemic now involves illegal opioids such as heroin and illicitly manufactured fentanyl (O'Hara, 2016).

The national trend for the opioid epidemic is displayed in Allegheny County, PA with a steady increase in overdose related deaths since 2006; an all-time high of 635 Allegheny County residents died from drug related overdoses in 2016 (Husley, 2016). The majority of these drug overdose related deaths involved opioids. It seems that this increased rate of opioid use would be correlated to an increased rate of drug injection. HCV (Hepatitis C), a blood borne infection, is most commonly transmitted through injection drug use and can survive in syringes for nearly a month after contamination. HCV poses a significant threat of outbreak, and as a result, syringe access programs, such as Prevention Point Pittsburgh (PPP) are imperative in minimizing infection and preventing outbreak (Allegheny City Council, 2008). PPP is currently the only syringe access program in Allegheny County. PPP engages in syringe exchange encounters that also include risk reduction education, referrals to additional services, and provision of sterile injection equipment. PPP collects a small amount of information from every client during a needle exchange through Exchanger Forms. This data includes number of returned needles, gender, race, neighborhood of residence, and various referrals that are filled out on paper and then electronically charted.

Risk environments shape drug use and related harms through aspects of the social and physical environment that can increase the chances of harm. Further examination into physical environments, such as the number of vacant homes, and social environments, such as the number of unsupervised youth, have led to the development of social disorganization theory. Social disorganization theory is derived from the idea in that certain structural characteristics impact a community's social cohesion and social control. A previous study explored social disorganization theory by finding the effect of social disorganization factors such as racial/ethnic heterogeneity, family disruption, and urbanization on social networks and organizational participation could lead to crime and delinquency. This implies that the neighborhood and the conditions driving it on a physical, social, and economic level may play a greater role in crime rates than the actual population itself (Shaw and McKay, 1942). Additionally, this study looked at the social determinants of health by looking at the effect of neighborhood level factors on health outcomes (Shaw and McKay, 1942).

Previous studies have additionally looked at the effects of social disorganization theory on drug use and behaviors that may influence drug related harm. A previous study in 2007 indicated that neighborhood poverty, a common indicator of social disorganization, was related

to the probability of an individual using drugs (Williams and Latkins, 2007). Similarly, another study found that neighborhood racial composition was strongly associated with harm causing drug behaviors where African-Americans were found to be less likely to share syringes (Bluthenthal, 2007).

This project attempted to address the needs of PPP through the use of the electronically charted Exchanger Forms. This dataset was entered by multiple individuals at PPP and thus there were discrepancies within the dataset. PPP sought to know basic statistics regarding syringe exchange distributor location and neighborhood of residence. This project utilizes the Exchanger Form data to determine if social disorganization related factors, such as median home value and percentage African American, in Pittsburgh neighborhoods may influence syringe exchange behaviors at PPP. Additionally, an exploratory analysis was performed to look at possible spatial clustering. A previous study utilized data from 2015 and comparisons of results between 2015 and 2017 data could allow for analysis of dynamics in the future.

Methods

A) PPP New or Exchanger Form Data

PPP volunteers and staff collect information from every patron that utilizes the services at PPP at various exchange sites. This form collected information pertaining to: number of needles returned, race, neighborhood of residence, and number of needles taken. During the 2017 year, PPP was distributing syringes at sites located in the Hill District, Oakland/East Liberty, and Perry Hilltop neighborhoods of Pittsburgh. Each patron is given a unique identifier at his or her first visit that can be utilized to track syringe data on an individual basis. At the request of PPP, this dataset was cleaned to ensure accurate spelling and numerical entries. PPP additionally requested deduplication of the data based on unique identifier, neighborhood, and syringe distribution site. This was performed with the use of Python. Descriptive statistics were calculated from the dataset with the use of SPSS.

B) Pittsburgh Department of City Planning: SNAP Raw (2010)

Pittsburgh's Department of City Planning produces a raw dataset that draws census information from various sources to provide information on all 90 neighborhoods within Pittsburgh boundaries. Neighborhood factors looked at from the dataset were percent African-American and median home value specifically. These factors were previously analyzed and found to be significant neighborhood level factors associated with HCV transmission at the neighborhood level (Heilman, 2017).

C) Pittsburgh Neighborhood Boundaries (2017)

The Western Pennsylvania Regional Datacenter generates a public Shapefile that contains a Pittsburgh map with boundaries for all neighborhoods within Pittsburgh. Neighborhood boundaries were merged based on specificity of the dataset presented by PPP. For example,

within the PPP dataset common phrasing such as 'Northside' for one of 18 possible neighborhoods within Northside resulted in merging of the 18 Northside neighborhoods into a larger spatial area by boundary. This merging behavior was performed for the Homewood (3 neighborhoods), Oakland (4 neighborhoods), Squirrel Hill (2 neighborhoods), Southside (2 neighborhoods), Point Breeze (2 neighborhoods), Hill District (3 neighborhoods), and Lawrenceville (3 neighborhoods) areas as well.

D) Analysis

QGIS version 2.18.15 was utilized to display syringe data. Contour plots displaying syringe number and syringe number/population were created through QGIS. GeoDa was utilized to conduct an exploratory spatial data analysis and to assess spatial autocorrelation. A connection matrix of Rook first order contiguity was created in GeoDa. Contiguity refers to two spatial units sharing a common border of non-zero length. Spatial correlation is a valuable parameter with use of GeoDa, as the degree of how similar an object is to one nearby can be determined.

Spatial autocorrelation for the data was found in GeoDa with the use of the univariate Moran's I tool. A Moran's I was computed for syringe number, syringe number per population, median home value, and percentage African American. Additionally, a univariate Local Indicators of Spatial Autocorrelation (LISA) and local G* cluster map were computed for syringe number per population at a Pittsburgh neighborhood level. The LISA is important as a tool in determining which regions make meaningful contributions to the global autocorrelation outcome.

Results/Discussion

Cleaning the dataset and computing simple counting statistics indicated a total of 3,259 syringe encounters engaged in by PPP. 469,262 sterile syringes were distributed across 3 sites in the East Liberty/Oakland, Hill District, and Perry Hilltop neighborhoods of Pittsburgh. Additionally, PPP served 1408 unique individuals as assessed by the number of unique codes within the dataset. There was a 92.3% increase in the number of unique individuals utilizing PPP's syringe exchange service in 2017 as PPP served 732 unique individuals in the 2016 year.

In 2017, there was a significant increase in syringes distributed per week in comparison to 2016 (Figure 1). Additionally, there was an increase in syringes distributed per week at all 3 distribution locations. The Perry Hilltop neighborhood location was recently opened in 2016; as such there is no data to show for prior years.

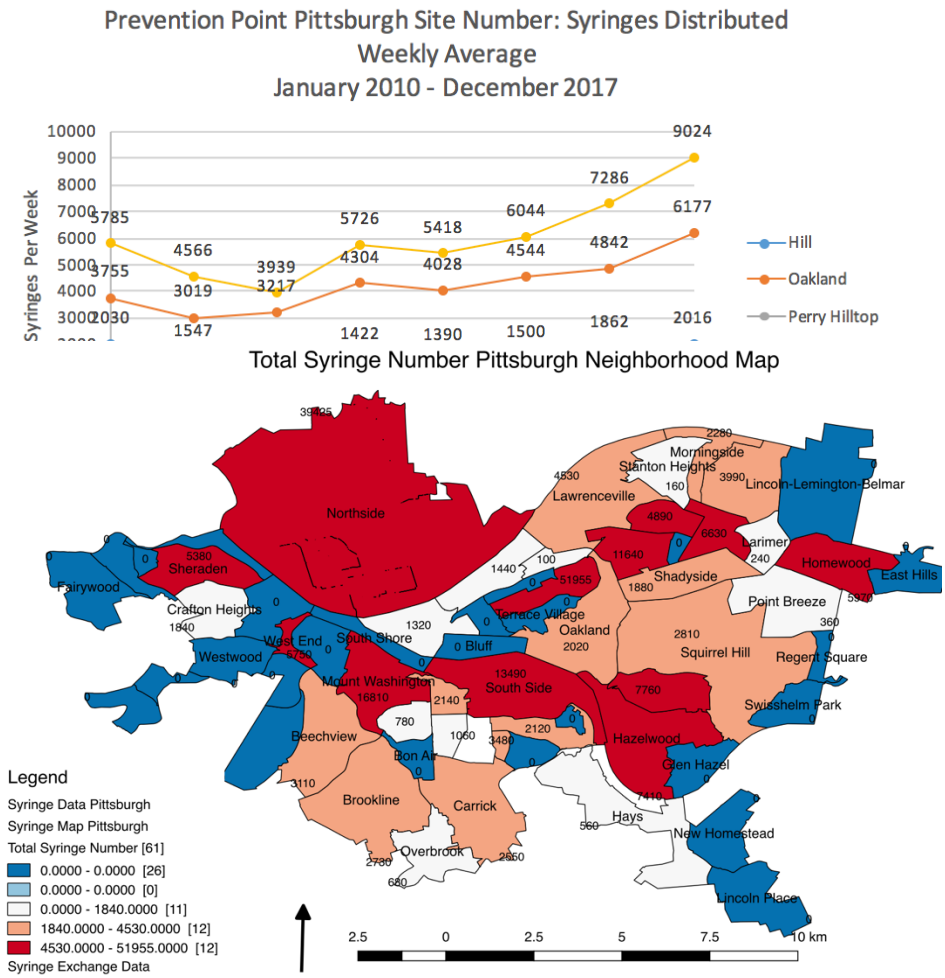

Figure 2: Displays the syringe number exploratory analysis through the use of a visual contour.

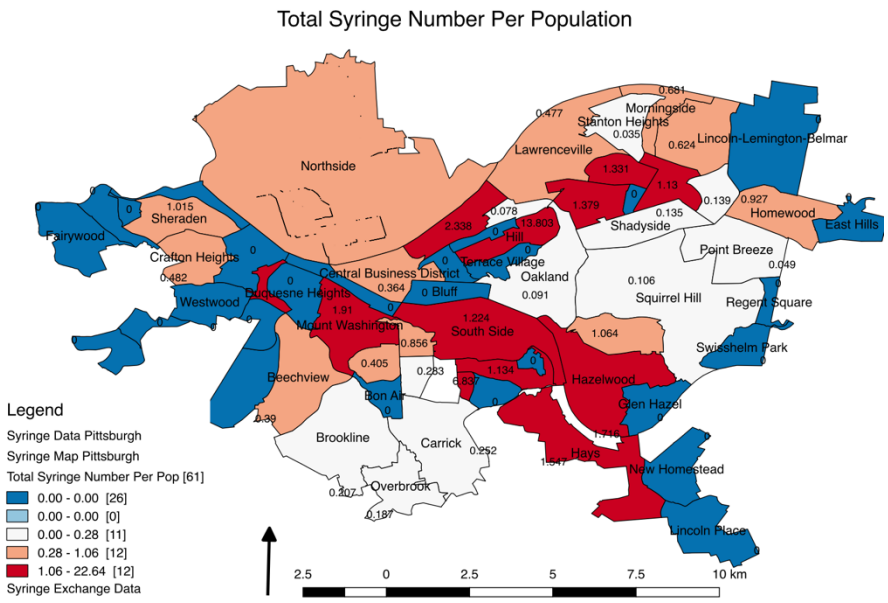

Figure 3: Displays the syringe number per population exploratory analysis through use of a visual contour.

The drastic increase in syringe number is indicative of the increasing demand from the community for the services provided by needle exchange programs, such as PPP. The increased demand should necessitate an increase in funding as PPP can serve the needs of the community.

Analysis of neighborhoods where syringes were taken back indicated large numbers of syringes taken to Northside, the Hill District, Southside, and Oakland areas of Pittsburgh (Figure 2). The Northside area is significantly greater in population than the Hill District, Southside, and Oakland areas.

When normalizing the number of syringes taken per population, a different contour distribution was obtained (Figure 3). The Northside area did not have a red contour as the Northside is significantly greater in population. When normalized per population (Figure 3), the Oakland, Squirrel Hill, and Shadyside neighborhood cluster display a decrease in gradient in comparison to the total syringe number map (Figure 2). On the other hand, the Central Business District and Strip District display an increased gradient when normalized to syringe per population.

PPP has recently obtained an outreach vehicle for mobile sites and the results of the syringe number and syringe number per population map will help PPP in concentrating outreach efforts in particular neighborhoods of Pittsburgh. Increased demands in areas such as the Northside area are important to address, as well as increased demands per population in areas such as Shadyside, Oakland, and Squirrel Hill.

Factor	Moran's I	P-Value
Syringe Number	-0.089	.1150
Syringe Number/Population	-0.089	.026
Median Home Value	.294	.010
Percent African American	.332	.003

Table 1: Effect of neighborhood level factors and PPP syringe data on Moran's I spatial autocorrelation and respective p-value.

Analysis of syringe number and syringe number/population indicated similar Moran's I values of -0.089 (Table 1). A negative Moran's I is important as this indicates a tendency towards dispersion. However, syringe number per population indicated a statistically significant p-value of less than 0.05, while syringe number did not. This indicates that normalized values of syringe number per population may be more spatially dispersed than expected if underlying special processes were random. Median home value and percent African American both displayed significant p values, indicating that clustering could possibly be non-random. Based on these results, we are unable to detect causation and correlations, however our results indicate that syringe number per population, median home value, and percent African American all display spatial clustering.

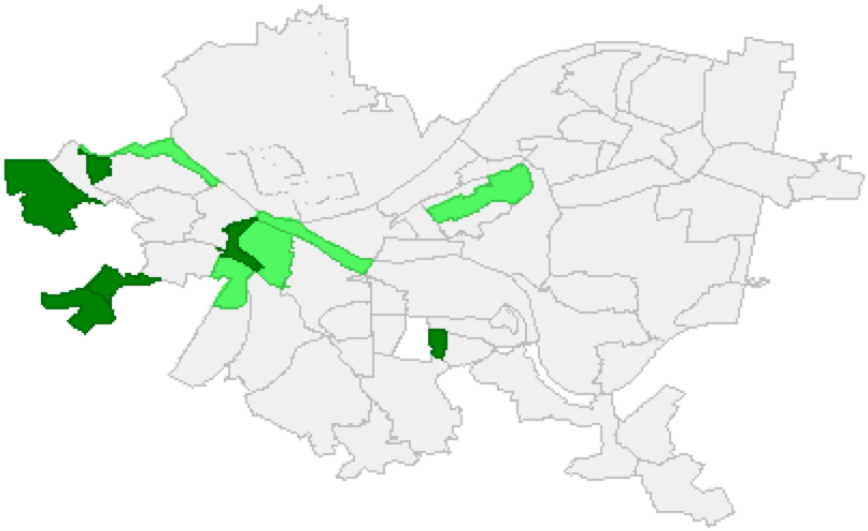

Figure 4: LISA map indicating clustering for the syringe per population value. Dark green indicates p = .0001 and light green indicates p = .05.

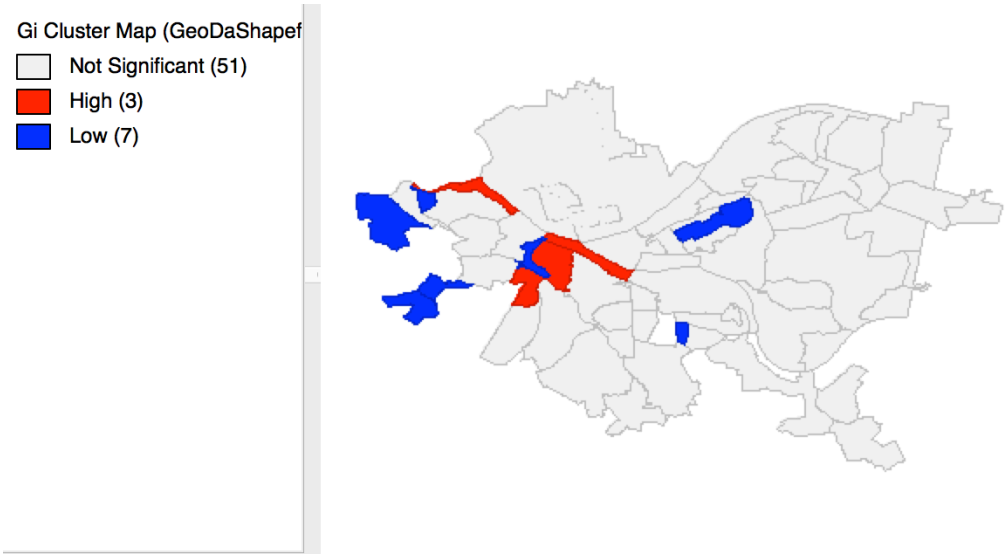

Figure 5: G*Cluster map indicating clustering for the syringe per population value. Red indicates areas of high significance, while blue indicates areas of low significance.

Analysis of the LISA indicates regions of local clusters and spatial outliers (Figure 4). Based on this map, the Hill District, South Shore, and Fairywood regions show locations of a significant statistic for syringe number per population as spatial outliers. This indicates that the syringe number per population for these areas may experience some form of clustering. The Fairywood and South Shore areas have 0 syringes per population and are proximal to areas where syringes per population are represented. Further exploratory analysis with the use of G*Cluster map indicated special clustering in similar regions (Figure 5). The South Shore, Esplen, and Duquesne Heights neighborhoods showed areas of high clustering, while the Hill District, Fairywood, East Carnegie, and West End neighborhoods showed areas of low clustering. The LISA and G*Cluster maps displayed similar regions of clustering in their analysis.

The results of this exploratory analysis will be utilized to give Prevention Point Pittsburgh a better sense of where individuals using their services predominantly reside. Additionally, the results of this study show neighborhood level differences in total syringe number and syringe number per population.

Reflection

The Community Based Research Fellowship was a unique experience that allowed me to interact with a community partner to help them address a possible need. In addition to addressing the possible need through the use of Python and SPSS statistical packages, I was additionally able to take the needle exchange dataset a step further and begin a preliminary exploratory analysis.

My relationship with Prevention Point Pittsburgh initially began as a volunteer in the bag packing role. I was particularly interested in the opioid epidemic at the time and thought that contributing as a volunteer in some form would be a valuable experience. I attended a training session and was very interested in understanding the role of the syringe exchange program in addressing the opioid epidemic. The bag packing role was eye opening because it allowed me to develop a better understanding of the people that Prevention Point Pittsburgh not only served, but its larger role in the community. Wanting to contribute to Prevention Point Pittsburgh in a more contrarian form than bag packing, I reached out to them in hopes of possibly working on a Community Based Research Fellowship.

Prevention Point Pittsburgh gave me a dataset as well as some specific needs/questions that they would have liked addressed from the dataset. The results from this study were placed in grants that Prevention Point Pittsburgh utilized for funding from the Allegheny County Health Department.

As a bioengineering student with a limited background in computer science, I learned and utilized Python to clean the data and de-duplicate the data based on entries. I additionally did a fair bit of cleaning by hand for entries that were excluded from the Python script. This process proved to be tedious, but was worthwhile in the larger scheme of the project.

I additionally learned about QGIS and mapping with the help of Dr. Christina Mair at University of Pittsburgh's School of Public Health. The process of obtaining a map that matched with the Prevention Point dataset as well as with the neighborhood level factors distributed by the Western PA Datacenter was rewarding.

Throughout this process, I continually thought about the effects of this project on Prevention Point Pittsburgh and the people that Prevention Point serves. They are currently experiencing greater demand than ever and the results of this project could help them in seeking funding. With an outreach vehicle, Prevention Point Pittsburgh can attempt to go to the neighborhood directly as opposed to having individuals travel to certain sites for services. With the data from this project, the hope is that Prevention Point Pittsburgh may be able to better target particular neighborhoods to individuals that may find the services of Prevention Point Pittsburgh useful in an effort to curb the effects of the opioid epidemic.

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