

# Combining Social Capital and Geospatial Analysis to measure the Boston's Opioid Epidemic

## Abstract

Social support is considered an important factor in the recovery of individuals who suffer from drug addiction. Traditional drug treatment interventions have mainly focused on the individual without taking into account the social and environmental conditions that may support or reduce continued drug use. By combining a social capital framework with geospatial research methodologies, we mapped opioid resilience of a community by focusing on the Boston neighborhoods. By conducting a spatial correlation analysis and a Geographically Weighted Regression (GWR) we found that in areas where social capital is low, there is a moderately high incidence of opioid deaths and sick assist calls (many hot spots and few cold spots). Our analysis shows that in neighborhoods where residents are involved in charitable organizations, where people gather around religious organizations, or where unions are more active, people help each other more and might be aware of actions to take to prevent opioid-related deaths. Individuals living in a neighborhood where there are more churches or civic organizations might be more likely to receive support when they are struggling because of the community propensity to help and be more outward focused.

## Introduction

Opioid-related deaths have increased dramatically over the past few years, and the opioid-related death rate in Massachusetts is now more than twice the national rate (Schuster & Vance, 2017). The efforts to confront the crisis in Massachusetts are just as diverse as the people impacted. These data-driven approaches help to focus attention on historically underrepresented and overlooked areas (Robinson et al., 2017; 2018). Our proposal combines geo-spatial analysis and social capital analysis for the first time to try to better understand Boston's opioid problem. Our study builds on previous work that applied spatial analyses using Geographic Information Systems (GIS) to identify significant clusters of fatal overdoses, discarded syringes (Bearnot, Pearson, & Rodriguez, 2018; Stopka et al., 2017). Recent studies have used opioid overdose and fentanyl-related fatality data between 2015 and 2018 to identify zipcodes in Boston with high densities of opioid incidents. For example, Robinson and colleagues inspected the relationship between opioid reversal drugs and fentanyl deaths and found that lifesaving opioid reversal drugs are less accessible to some residents than others (Robinson, Grippa, Lee, Avalon & Edmonds, 2018). This study builds on these contributions and suggests to combine social capital variables and geospatial analysis to identify social factors that contribute to building resilience within a community where hot-spots are identified.

In this study we correlate social capital metrics with opioid incident data (sick assists and death) for the Boston neighborhoods and apply the Kyne and Aldrich (2018) social capital (SOCA) model. We integrate variables for bonding, bridging and linking at a block level to examine community opioid resiliency through the lens of social ties. The goal is to appraise a community's resilience to the opioid crisis by its ability to adapt to this social emergency in the context of its intrinsic social makeup. Social capital is usually conceptualized as being embodied in the social ties among individuals and their positions and can be appraised by resources available to individuals via interpersonal ties and institutional connections, including family, school, and work (Coleman, 1988; Aldrich, 2012).

## Methodology

To represent bonding social capital we used seven variables that measure the thick connections among individuals looking at similarities in demographic characteristics, attitudes, and resources. Bridging social capital was represented by seven variables that measure acquaintances or loosely connected individuals

through ties that span social divisions and groups. And linking social capital was represented by six variables to measure connections of regular citizens to those in power.

	<b>Social Capital Variable</b>	<b>Study variable</b>	<b>Source</b>
<b>Bonding</b>			
1	Race similarity	Diversity Index ranges from 0 (no racial diversity) to 100 (complete racial diversity)	(ESRI 2018CA) Block Group
2	Educational equality	Absolute difference between % population with college education and % population with less than high school education	(ESRI 2018CA) Block Group
3	Race/income equality	Gini Coefficient ranges from 0 (perfect equality) to 1 (perfect inequality)	(US Census 2018AFF) Block Group
4	Employment equality	Absolute difference between % employed and % unemployed civilian labor force	(ESRI 2018CA) Block Group
5	Language competency	Calculated from the US Census Limited English Proficiency data set.	(US Census 2018AFF) Block Group
6	Communication capacity	% households with a telephone	(ESRI 2018CA) Block Group
7	Non-elder population	% population below 65 years of age	(ESRI 2018CA) Block Group
<b>Bridging</b>			
1	Religious organizations	Religious organizations per 10,000 persons	(ESRI 2018BA) Business and Facilities Search Block Group
2	Civic organizations	Civic organizations per 10,000 persons	(ESRI 2018BA) Business and Facilities Search Block Group
3	Social embeddedness-charitable ties	Member of charitable organization (%)	(ESRI 2018CA) Block Group
4	Social embeddedness-Church ties	Member of church board (%)	(ESRI 2018CA) Block Group
5	Social embeddedness-Fraternal ties	Member of fraternal order (%)	(ESRI 2018CA) Block Group
6	Social embeddedness-Religious clubs	Member of religious club (%)	(ESRI 2018CA) Block Group
7	Social embeddedness-Union ties	Member of union (%)	(ESRI 2018CA) Block Group
<b>Linking</b>			
1	Political linkage	% voting-age population who are eligible for voting	(ESRI 2018CA) Block Group
2	Local government linkage	% of local government employees working for local governments	(ESRI 2018CA) Block Group

3	State government linkage	% of state employees working for the state governments	(ESRI 2018CA) Block Group
4	Federal government linkage	% of federal employees working for the federal agencies	(ESRI 2018CA) Block Group
5	Political linkage-contribution	Contributed to political org in last 12 months (%)	(ESRI 2018CA) Block Group
6	Social linkage-social services	Contributed to social services org in last 12 months (%)	(ESRI 2018CA) Block Group
7	Religious linkage-religious contribution	Contributed to religious org in last 12 months (%)	(ESRI 2018CA) Block Group
8	Political linkage-political activities	Attended political rally/speech/organized protest (%)	(ESRI 2018CA) Block Group

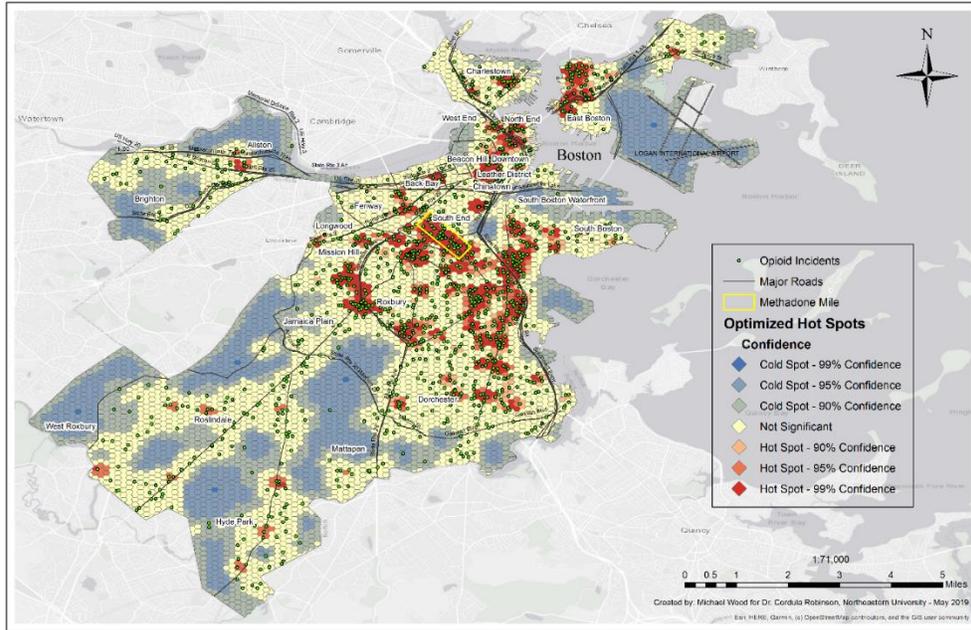
**Table 1** The social capital variables used in this study, after Kyne and Aldrich (2019).

We obtained opioid-related data from three primary sources.

1. Boston Police Department (BPD): these data are comprised of the approximate addresses of “sick assists” for the years 2015 to 2019.
2. Massachusetts Department of Public Health (DPH): these data consists of addresses of residents that died from fentanyl-related causes in 2015.
3. Environmental Systems Research Institute (ESRI) data to include pharmacies and community health centers that distribute opioid reversal drugs.
4. Social capital data, relevant to the study (Table 2), are also mostly downloaded from Esri's Community and Business Analyst sources at the block group level. The initial geodatabase includes a separate feature class for each variable: Bonding, Bridging and Linking categories.

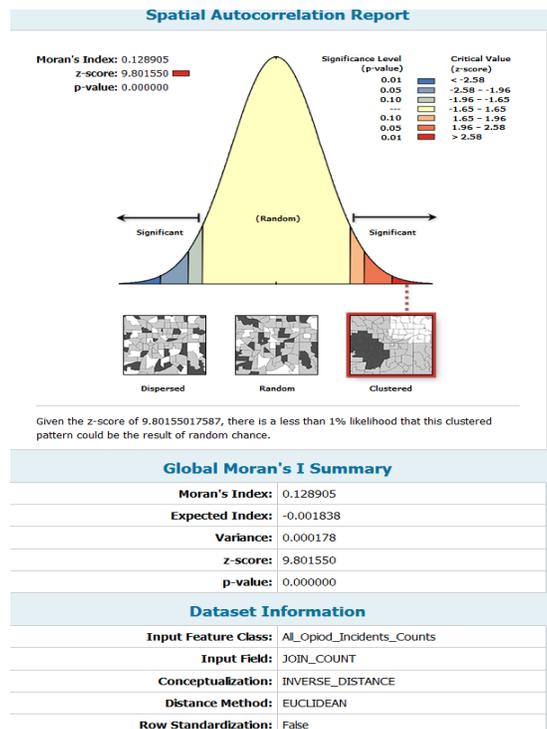
## Results

The hot spot map identifies six significant areas of heightened opioid activity throughout the city of Boston. These include East Boston, Downtown, the South End, Roxbury, Dorchester and Jamaica Plain (Figure 2). The area of highest density exists along Massachusetts Avenue, a well-known hotspot commonly referred to as the “Methadone Mile”. All areas demonstrate correspondingly high confidence levels confirming the clustered patterns are not random (Figure 2).



**Figure 2.** Getis-Ord  $G_i^*$  hotspot analysis of opioid incidents in Boston, binned per 500 feet for ease of analysis. Six prominent high-activity areas can be distinguished: Methadone Mile, Downtown, South Boston, East Boston, Dorchester and Jamaica Plain. Large areas of Brighton and areas around Jamaica Plain and Mattapan show reduced activity.

The spatial autocorrelation tool confirms clustering is significant where there is less than 1% likelihood that the clustered patterns are the result of random chance (Figure 3).

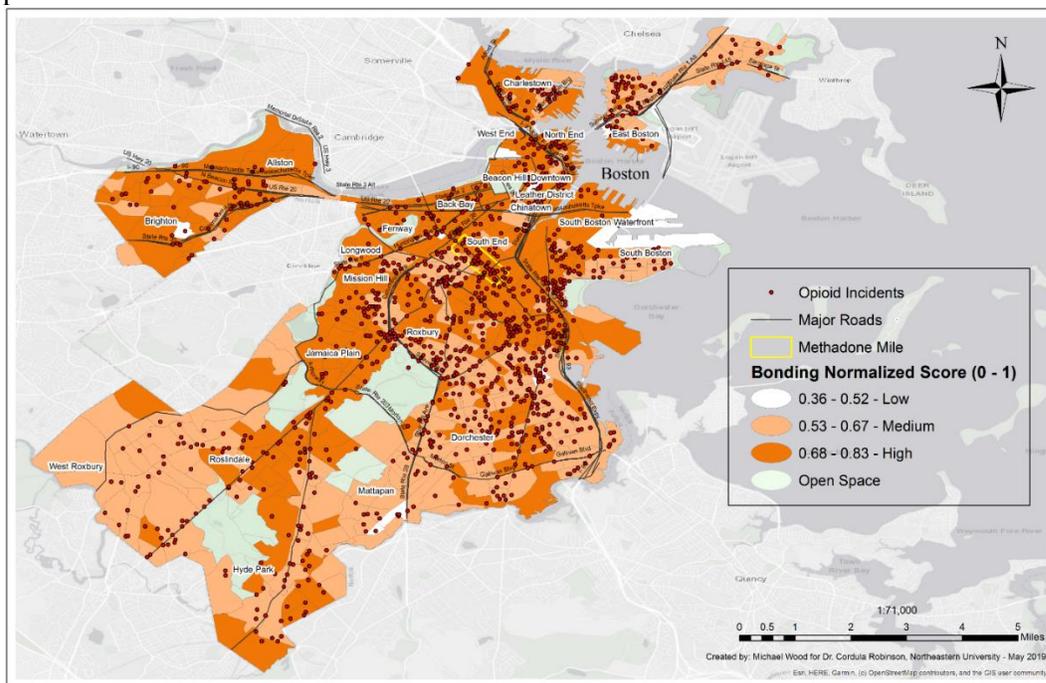


**Figure 3.** Results of inverse distance spatial autocorrelation tool confirms clustering is significant. All models indicate less than 1% likelihood that the clustered pattern is random.

***Bonding Social Capital Map by U.S. Census Bureau Block Group***

Figure 4 examines social capital bonding variables. To measure bonding, seven metrics were applied to reflect strong connections among individuals. Each of the seven variables serve as yield indicators to measure homophily and similarity. Specific bonding variables include: race similarity; educational equality; race/income equality; employment equality; percent population proficient English speakers; percent of households with a telephone; percent population below 65 years of age. At the block level racial income similarity and gender income similarity metrics were unavailable and we could not include them in the social map.

A social capital score of 0 is the lowest ranking and 1 the highest ranking. The data classification method is Equal Interval. The locations of opioid incidents including fentanyl death residence locations are plotted for context.



**Figure 4.** Bonding social capital measuring thick connections among individuals looking at similarity in demographic characteristics, attitudes, and resources. The city of Boston is comprised primarily of medium to high bonding social capital with few low social capital areas. Opioid incidents occur in or immediately adjacent to medium bonding block groups.

Boston is comprised primarily of medium to high bonding social capital with very few low bonding social capital block groups. Opioid incidents tend to occur in or immediately adjacent to the block groups with a medium bonding score.

Opioid incidents appear to be concentrated along the Massachusetts Avenue corridor (“Methadone Mile”), as well as Downtown and East Boston, where we have medium levels of bonding social capital. In the neighborhoods of Roxbury and Dorchester as well as East Boston we observe medium levels of bonding social capital and large numbers of opioid incidents.

We also observed that open Space areas have very few to no opioid incidents.

### ***Bridging Social Capital Map by U.S. Census Bureau Block Group***

Figure 5 visualizes bridging variables that reflect connections between individuals through ties that span social divisions and groups. The connections come from an individuals' involvement in various civic organizations including religious organizations, charitable organizations, churches, fraternal order, and unions. Bridging social capital variables include religious organizations (per 10,000 persons); civic organizations (per 10,000 persons); members of charitable organizations; members of church boards; members of fraternal orders; members of religious club; members of union. We were not able to collect data at the block level on the number of individuals affiliated with a religious organization per 10,000 persons, since the U.S. Census Bureau does not collect data on religious affiliation in its demographic surveys or decennial census (Public Law 94-521).

Similarly to the bonding social capital, a bridging score of 0 is the lowest ranking and 1 the highest. Equal interval classification divides the range of attribute values into equal-sized subranges with user specified intervals. Class ranges are set to 3 and enable comparative visual interpretation.

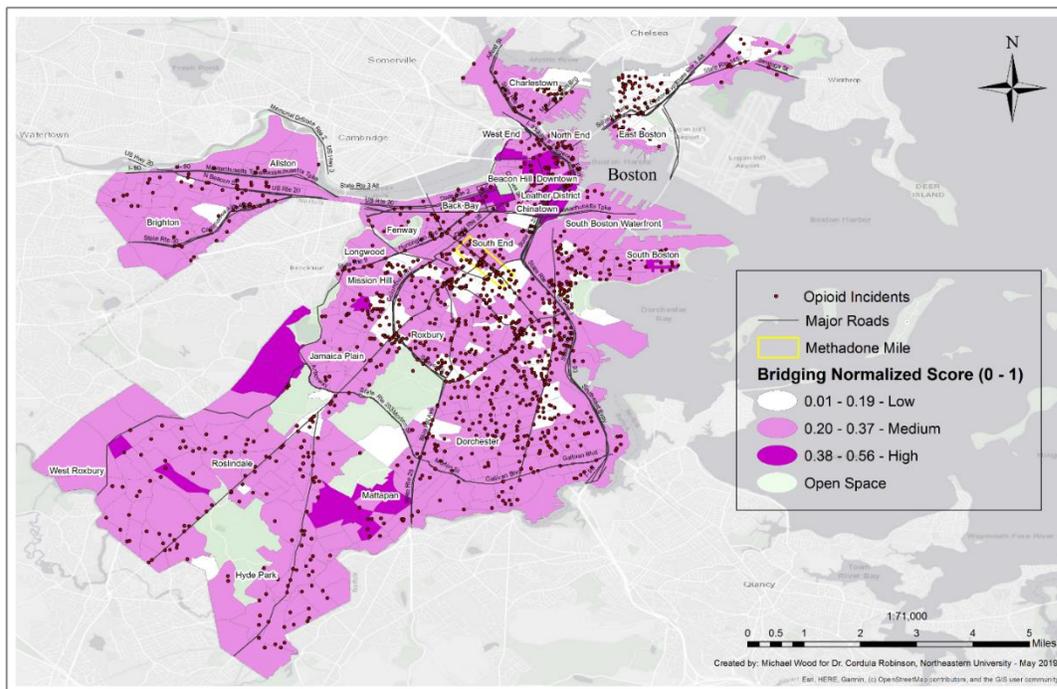


Figure 5. Bridging Variables Social Capital (SoCI) Score by Census Bureau Block Group measuring acquaintances or loosely connected individuals through ties that span social divisions and involvement in various organizations (civic, religious, charitable, fraternal orders and unions). Central locations exhibit low connections; while peripheral locations in Jamaica Plain, Mattapan, and sometimes wealthier neighborhoods (Back Bay, Beacon Hill and Downtown) show higher connections. Opioid incidents tend to occur in or immediately adjacent to the block groups with a low bridging score.

Data indicates that Roxbury and Dorchester, as well as the South End and East Boston neighborhoods have the most low bridging social capital block groups. Opioid incidents tend to occur in or immediately adjacent to the block groups with a low bridging score. Low bridging social capital appears to be concentrated along most of the Massachusetts Avenue corridor.

In neighborhoods where there is a higher concentration of people who are members of charitable organizations; members of church boards; members of fraternal orders; members of religious club; or members of union, there are fewer opioid incidents.

### *Linking Social Capital Map by U.S. Census Block Group*

Figure 6 examines the linking social capital variables measuring the connections of regular citizens to those in power. The variables include government connections, political contributions, social linkage by social services, religious linkage by contribution, and political links through openly political activities. All variables under Linking (a percentage) are normalized between 0 and 1 and equally weighted, and the data classification method is *Equal Interval*.

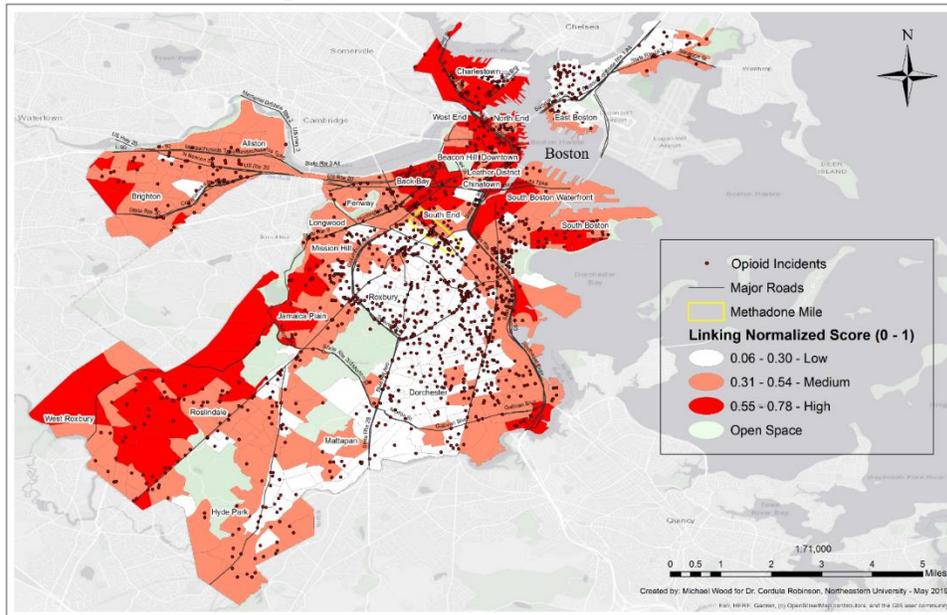


Figure 6. Map of linking social capital measuring degree of connection of regular citizens to those in power. Central locations, e.g., around methadone mile, Roxbury, Dorchester and Mattapan exhibit low connections; while peripheral locations, and mostly wealthier neighborhoods (Back Bay, Beacon Hill, Downtown and West Roslindale) show high connections. Opioid incidents correspond with a low linking social capital score.

Results show that low linking social capital is more extensive throughout the Boston neighborhoods than bonding and bridging social capital. In particular, Roxbury and Dorchester, Mattapan, the South End and East Boston include neighborhoods with low linking social capital block groups. In these block groups we observe a higher number of opioid incidents though this doesn't dominate all groups with low scores (e.g. Mattapan). Downtown, the Back Bay, Charlestown and the suburbs tend to have the highest linking social capital.

### **Discussion**

The presence of cold spots and very few hot spots in open space areas suggest relatively low opioid activity in the city parks. Overall, this study indicates that a community's resilience to the opioid crisis can be measured by its level of social capital, by differentiating between bonding, bridging and linking social capital. Recommendations include developing initiatives to reduce social stigma and provide empowerment opportunities for the addicted individual.

Charitable or religious organizations might act as catalysts for building social support, as educators, as institutions where people gather to find solutions to community and individual problems, or where people whose strong ties have deteriorated because of geographic distance, can find support and first aid. Given the importance of the bridging social capital, we would recommend the development of initiatives and incentive to build synergies among civic and religious organizations that can act as immediate social support system when strong ties (i.e. bonding social capital) become unavailable.

In areas such as "Methadone Mile", Downtown and East Boston we see a high concentration of opioid incidents, as well as medium levels of bonding social capital, and low levels of bridging social capital. In

these areas residents share fewer socio-demographics characteristics, and seem to be less involved in charitable, religious or civic organizations. As demonstrated by studies in the African American and Latino communities (McNeal & Perkins, 2007; Derose et al., 2014) church-based interventions have the potential to yield HIV stigma reduction. Fighting the opioid crisis requires a community-based approach, by developing partnerships with local institutions and organizations and investing in building opportunities to support individuals who have lost their family/friend/connections. Tailoring intervention to single race-ethnic groups may not be the best approach in diverse community settings, which are common among various Boston neighborhood.

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