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The Impact of State-Level Laws on Syringe Service Program Access and Risk Environment of People Who Inject Drugs (PWID)

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The Impact of State-Level Laws on Syringe Service Program Access and Risk Environment of People Who Inject Drugs (PWID)

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ABSTRACT

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Background: Understanding concentrated areas with high rates of opioid use disorder (OUD) improves placement of syringe services programs (SSPs). People Who Inject Drugs (PWID) have lower risk of contracting diseases the closer they are to SSPs. Tennessee prohibits SSPs within 2000ft of a school or park, impacting the placement of. Testing factors related to SSP placement within a system dynamic model can better determine the relationship between PWID risk environment and SSP access.

Methods: We identified areas of greatest need for harm reduction interventions within a non-urban Tennessee county with Emergency Medical Services (EMS) Narcan administrations data (Aim 1). We used Google Maps to theorize an ideal location for an SSP. We applied the current legal restrictions to SSP placement to find the next-closest legal location (Aim 2). We then developed a theoretical system dynamic model of SSP access and Risk Environment (Aim 3).

Results: We determined “EMS Zone 1” has a higher rate of EMS Narcan administrations than most EMS zones in the county and a higher rate compared to the whole county (Aim 1). We located a theoretical SSP location with shorter walk, drive, and public transportation times

compared to the existing location. The closest legal SPP location had an improvement in travel times but lacked other utility factors (Aim 2). Our theoretical model indicates that laws limiting SSP placement increase the distance PWID travel to SSPs. The distance of support services to SSP sites has a negative relationship with risk environment and to accessibility and utility of SSPs (Aim 3).

Conclusion: County-level geographic data is too crude to determine true “hot spots” of OUD. This new method using EMS data can provide entities a process for determining the best location for SSPs. Identifying measures of utility/accessibility for PWID can identify improved locations for SSPs but legal restrictions may lower utility/accessibility of SSPs especially for non-urban PWID. Current “Policy” or “Structural” level factors as described by the Social Ecological Model negatively impact PWID risk environment. Structural” or “Policy” and “Community” level interventions among state, city, and county governments have the highest potential to positively impact PWID risk environment.

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CHAPTER 1. INTRODUCTION

The Rural Opioid Epidemic

The United States is currently in the middle of an opioid epidemic. This has been a primarily rural epidemic, with poverty and rurality as the strongest indicators of opioid use disorder (OUD) (Ghertner & Groves, 2018). Rural People Who Inject Drugs (PWID) or rural people who have OUD have different characteristics than urban opioid users. One of the most glaring differences is in injection risk behaviors. As just one example, they are more likely to share injection equipment (97.1% vs 22-55%). This may be due to a lack of access of clean injection equipment as offered by Syringe Service Programs (SSPs) (Havens, Oser, & Leukefeld, 2011).

Disparities in SSP Access for Rural PWID

SSPs are recognized as an important part of a comprehensive care and prevention program by both the Centers for Disease Control and the U.S. Department of Health and Human Services (Centers for Disease Control and Prevention (CDC), 2012). SSPs offer one of the most readily accessible points of contact to the healthcare system for PWID and provide access to an otherwise underserved population. Through SSPs, PWID have potential access to a constellation of care to address multiple comorbidities associated with injection drug use including overdose prevention. PWID also perceive SSPs as a safe environment to get care (Barocas et al., 2014; Clarke et al., 2016; MacNeil & Pauly, 2011; Pollack, Khoshnood, Blankenship, & Altice, 2002; Zeremski et al., 2013). SSPs are the key structural component to treating PWID (Des Jarlais, 2000). Despite this, rural residents have much lower access to SSPs.

Ninety-eight percent of rural young people with Hepatitis C (HCV), an infectious disease caused primarily by injection drug equipment sharing, live more than ten miles from an SSP versus only 48% of their urban counterparts (Canary et al., 2017a). Rural areas are also seeing both an increase in admissions to substance abuse treatment services and an increase in acute HCV infections. This highlights the need of local suburban and rural jurisdictions to find ways to lower barriers and increase access to SSPs (Des Jarlais et al., 2015). While characteristics of rural and suburban areas may make it difficult to blanket at-risk rural areas with multiple SSPs, better understanding of OUD "hot spots", or concentrated areas of areas of problematic opioid use, can lead to better-targeted interventions (DiMaggio, Bucciarelli, Tardiff, Vlahov, & Galea, 2008).

There are disparities between rural and urban PWID. SSPs are an evidence-based point of intervention to improve outcomes for PWID. However, the relationship between injection drug use (IDU), opioid use disorder, risk of opioid overdose, infectious diseases, and support services like SSPs is highly complex and poorly understood (CDC, 2016; Harris & Rhodes, 2013). Better understanding of this complex system of factors may link to better outcomes for at-risk PWID. Through development of novel methodologies and utilization of a new data source, we look to identify previously hidden "hot spots" of OUD. This will allow us to target SSPs in the location of greatest need in an example county. We will then examine legal barriers to SSP placement and apply a combination of public health theories and frameworks to better understand the interplay of structural and legal barriers to SSP access and risk to PWID. Ultimately, we wish to narrow disparities between urban PWID and their rural and suburban counterparts. We believe this is best done by increasing access to SSPs through demonstration and dissemination of evidence-based approaches to SSP placement and examining the impact of policies governing their location.

The Epidemic and SSP Access in Central Appalachia as Example

The Central Appalachian region of the United States provides an example of the complexity associated with siting SSPs in rural areas to address public harm from the current opioid epidemic. There is a high prevalence of injection drug use in Central Appalachia, the area where our example county is located. This has resulted in both acute and chronic HCV and HIV infections (Zibbell et al., 2015). HCV in Appalachia has increased rapidly when compared to the rest of the United States (Suryaprasad et al., 2014; Zibbell, Hart-Malloy, Barry, Fan, & Flanigan, 2014). Four states in Central Appalachia, Tennessee, Kentucky, Virginia, and West Virginia have seen substantial increases in HCV among people aged 30 and over from 2006-2012 (Zibbell et al., 2015). Similar to rural PWID in general, Appalachian rural PWID are significantly younger at onset of opioid use and more likely to use drug dealers as their sources for prescription drugs (69% vs. 21%, $p < .001$). They are more likely to transition to injection drug use from other forms of opioid administration. They are also less likely to seek substance use treatment (Young & Havens, 2012; Young, Havens, & Leukefeld, 2012). All of these disparities make potential access to SSPs all the more important for non-urban (suburban and rural) Central Appalachians.

SSP Efforts in Central Appalachia.

Across the Central Appalachian Region, North Carolina, Kentucky, West Virginia, and Tennessee represent broad variations in SSP characteristics. SSPs are run by a variety of host organizations and require different state and local regulations and approval processes.

Regardless, there has been quick uptake in service utilization among the population served by SSPs, demonstrated by a rapid increase in the number of client visits in all three states. Kentucky saw an increase from roughly 5,000 client visits at three sites in 2015 (the first year of legal operation in Kentucky), to approximately 30,000 client visits at 24 sites in 2017. West Virginia had just under 20,000 client visits with nine operational SSPs in 2017. In North Carolina in 2018, over 18,000 client visits occurred at 29 SSPs across the state. Kentucky SSPs estimated having served roughly 8000 unique clients, North Carolina, 5300, and West Virginia, almost 4500 (Bixler et al., 2018; NC Depatment of Health and Human Services, 2019). Tennessee does not have readily available published numbers and did not report numbers to the team for this project after multiple contact attempts.

Legality of SSPs in Central Appalachia. Each of the four example states in the Central Appalachian region mentioned above have different laws governing SSPs. In Kentucky, SSPs are operated out of local public health departments (LPHDs) and require multi-level governance approval including that of "county boards of health, county fiscal courts, and city councils." In North Carolina, SSPs must register with the North Carolina Division of Public Health and report data annually to the state. There are no laws stating what type of organization is allowed to open SSPs in North Carolina. Due to this, North Carolina has a highly diverse group of agencies running SSPs including churches, LPHDs, substance use treatment centers, and a drug user union. In West Virginia there are currently no state laws governing SSPs (Bixler et al., 2018). However, local law enforcement has since placed stipulations on SSP operations in some counties. As an example, an SSP operating in a LPHD in Huntington, WV has had several restrictions implemented as ordered by the county sheriff's department (Hessler, 2018). While the laws differ in the 3 above states, they only limit the "who" and "how" of SSP management.

Tennessee is the only state in Central Appalachia and the United States as a whole that has a state law that impacts the physical location of SSPs.

Tennessee Law and Structural Barriers to SSPs

In 2017, Tennessee legalized SSPs, explicitly stating the overarching goals of the legislation in the statute. From the law, the goals are to:

> "(1) Reduce the spread of human immunodeficiency virus (HIV), acquired immunodeficiency syndrome (AIDS), viral hepatitis, and other bloodborne diseases in this state;
>
> (2) Reduce needle stick injuries to law enforcement officers and other emergency personnel; and
>
> (3) Encourage individuals who inject drugs to enroll in evidence-based treatment."
>
> (TN Code 68-1-136, 2017)

The goal of decreasing opioid overdoses in the state was implicit in the reporting requirements of the law. Required reporting of Narcan distribution and overdose education materials numbers indicates a desire to prevent opioid overdose among people with OUD (TN Code 68-1-136, 2017).

Tennessee also placed restrictions on the placement of SSPs based on proximity of structural factors. Initially, SSPs could not operate within 2000ft of any school or public park anywhere in the state. Additional legislative amendments in recent sessions have added some exceptions to this restriction. The legislature gave exceptions to specific municipalities allowing for SSPs to operate no less than 1000ft from schools or playgrounds. They expanded this exception to include all Tennessee metro areas and cities of over 165,000 residents in 2017 as outlined below in sections 2a and 2b:

> "Except as otherwise provided in subdivision (g)(2), a program established pursuant to this section shall not conduct an exchange within two thousand feet (2,000') of any school or public park.
>
> (2) A program established pursuant to this section shall not conduct an exchange within one thousand feet (1,000') of any school or public park. This subdivision (g)(2) applies only to a:
>
> (A) County having a metropolitan form of government with a population of more than five hundred thousand (500,000), according to the 2010 federal census or any subsequent federal census; and
>
> (B) Municipality with a population in excess of one hundred sixty-five thousand (165,000), according to the 2010 federal census or any subsequent federal census."
> (TN Code 68-1-136, 2017)

This work demonstrates that the law outlined above has the potential to severely limit access to SSPs for PWID, especially in non-urban counties in Tennessee. With a Tennessee county as a test case, we further demonstrate that restrictive laws on SSP placement have the potential to harm non-urban PWID especially.

A Non-Urban Tennessee County as a Test Case. Much like the rest of Central Appalachia, Tennessee has been impacted by the current opioid epidemic. Van Handel et al. (2016) reported that seven counties in East Tennessee (Carter, Greene, Hancock, Hawkins, Johnson, Sullivan, Unicoi, and Washington) were in the top 5% of counties vulnerable to an

HCV or HIV outbreak in the nation. We initially chose Washington County as the test case county for this study for convenience, availability of data, and it's rank as the 39th most likely county to have an HIV or HCV outbreak (Van Handel et al., 2016). It is the only county in TN with a non-metropolitan area SSP as defined in TN Code 68-1-136, 2017. Washington County is in East Tennessee, within the TN First Congressional District. This district had an elevated rate of drug-related death per 100,000 persons compared to the United States as a whole in 2016 (amFAR, 2016). A Tennessee-specific study, Rickles et al. (2017), used a more expansive variable list to characterize county-level risk, and indicated that Washington County is at much lower risk of an HIV or HCV outbreak. The Rickles study placed Washington County as the 89th most at risk county in Tennessee versus the 39th most at risk in the United States in the Van Handel study. The Van Handel study reflects a national-level analysis and is more widely cited. Nonetheless, we chose to move forward with Washington County as a non-urban test case for the restrictions of the Tennessee SSP law because it is the only non-urban SSP in the state.

Urban Municipal Examples of Structural Barriers to SSPs

There are no studies of structural barriers to SSP placement in suburban and rural areas. We have to look to case studies of urban cores with laws restricting SSP placement. From 2000 through 2019, within the city limits of Washington DC, an SSP could not operate within 1000ft of a school (D.C. Law 22-288, 2019; D.C. Law 48-1121, 2000). SSPs operating within the buffer zone in Washington D.C. had to comply with the new law by closing or relocating. SSP coverage dropped by 50% compared to before the buffer rule went into effect (Allen, Ruiz, & Jones, 2016b). The buffer law in Washington D.C. also impeded access "hot spots" of IDU activity identified by police data. Over different years of analysis, between roughly 52% and 88% of "hot spot" areas were ineligible for SSP services do to their proximity to schools (Allen, Ruiz, Jones, & Turner, 2016).

Denver, Colorado also had a buffer law restricting mobile SSPs (the only existing SSP method in the city). They could not be within 1000ft of a school. Harm reduction organizations quickly realized that every street address within the city limits was within 1000ft of a school. There was no legal location to operate an SSP within the city limits of Denver. After lobbying efforts by two Denver-based harm reduction organizations, the city council repealed the distance buffer law in 2013. The new ordinance allows SSPs to be anywhere in Denver except for within public parks or on the sidewalks bordering public parks (Asmar, 2013). These examples of studies identifying barriers to SSP access in metropolitan areas demonstrate the potential for barriers in suburban and rural areas.

A Theoretical Understanding of Barriers to SSP Access

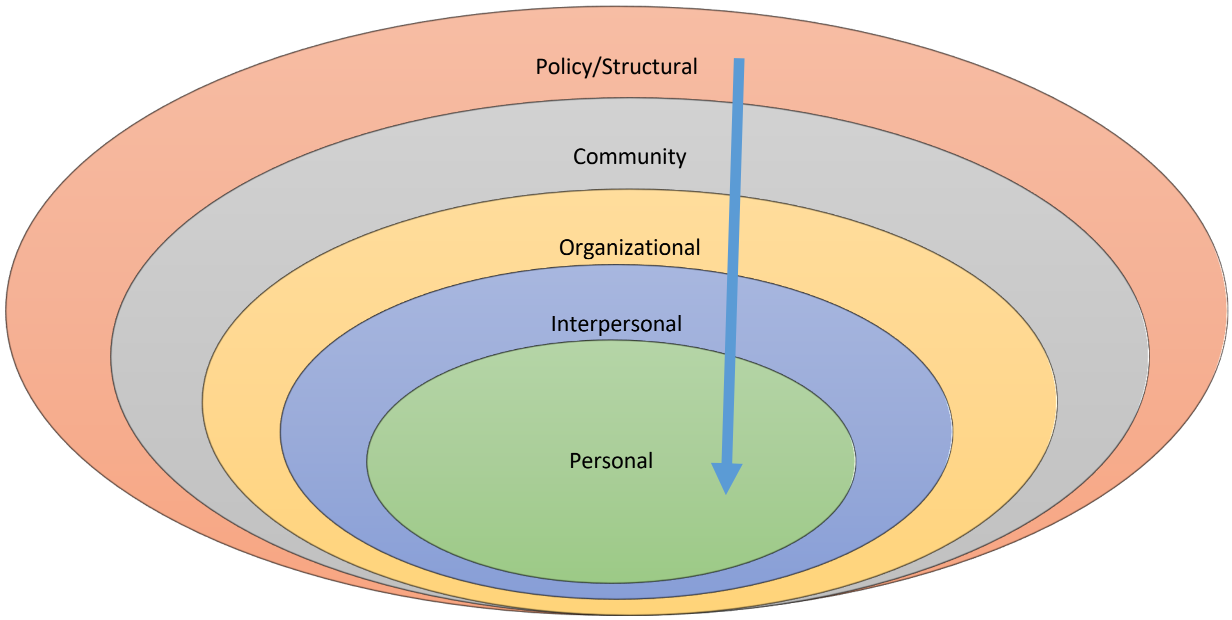
The Social Ecological Model

The Social Ecological Model is a hierarchical model describing different levels of social strata and the relative impact of interventions within each level. It examines the interplay between "Personal", "Interpersonal", "Organizational", "Community", and "Structural" or "Public Policy" factors (Bronfenbrenner, 1977) (Figure 1.1). For the purpose of this project, we are using different, commonly accepted nomenclature for the levels. Instead of "Public Policy", we refer to the top hierarchical level of the Social Ecological Theory as "Structural" or "Political". This is consistent with the work of Stokols (1996) who applied the Social Ecological Model to public health interventions. He describes the upper levels of the Social Ecological model, "Structural" or "Political", "Community", and "Organizational" levels as creating an environment for organizations or people that enables or hinders health behaviors (Stokols, 1996). As applied to TN Code Code 68-1-136, 2017, a “Structural” or “Political” level Tennessee state law potentially hinders health behaviors of PWID by limiting the placement of SSPs within a community (Stokols, 1996), which could impede access to the service based on where residents who are PWID may live.

Amending or repealing sections of TN Code 68-1-136, SSPs could facilitate more highly accessible SSP placement in a community and positively impact Social Ecological Model levels throughout the hierachy, down to the “Personal” level. Stokols argues that while difficult to fully quantify, positive change to the environment at any level can have a cumulative positive impact on the the strata below. Changes at the highest “Structural” or “Policy” levels of the Social Ecological Model have the highest potential for positive impact at the lower levels; this is true of interventions for each of the upper levels of the Social Ecological Model hierarchy. The methodology of targeting interventions at the “Structural” or “Political”, “Organizational”, or “Community” level, or any combination of the three levels is referred to as, “Environmental Change Strategies of Health Promotion” (Stokols, 1996).

At the “Community” level, placing SSPs in areas with the highest need potentially changes the environment for PWID living in the area. As PWID engage in the harm reduction as prescribed by local SSPs, more PWIDs will be exposed to “Interpersonal” level modeling of improved health behaviors. This creates potential for cultural shifts among the population to safer practices of drug use. When looking at “Structural” or “Policy” level changes, much of the same holds true.(Stokols, 1996) A legislative change in Tennessee could facilitate access to SSPs by lowering barriers to positive environmental change for PWID.

Figure 1.1
The Social Ecological Model (Modified from (Bronfenbrenner, 1977; Stokols, 1996))



Risk Environment

The theory of Risk Environment is defined as "The space, either social or physical, in which a variety of factors exogenous to the individual increase vulnerability to HIV" (Rhodes, 2009). It is the intersection of public health and geography. Geographic dimensions can be used to quantify factors of risk environment that are structural and spatial (Cooper, Bossak, Tempalski, Des Jarlais, & Friedman, 2009). The Theory of Risk Environment provides a framework and unit of measurement for addressing drug use and the associated harm (Rhodes, 2009). It has been used primarily in studies of IDU and associated co-morbidities. As an example, Cooper et al. (2009) looks at both arrest records as a measure of increasing levels of risk environment and the location of SSPs as a measure of lowering the risk environment in neighborhoods in New York City. It also demonstrates that there is a potential decay in the protection offered by an SSP moving outward, away from the SSP location (Cooper et al., 2009).

The comparison of these elements and their effect on the risk environment of PWID can help determine ideal locations for support services for PWID based on surrounding structural factors.

Similar work has been published demonstrating the increased risk environment associated with restrictive and aggressive law enforcement techniques targeting PWID. In the early 2000s, scientists studying spatial environments and neighborhoods inhabited by PWID found that areas were negatively impacted by increased police presence and police "crack down" techniques including frequent personal searches and increases in overt surveillance. These techniques most affected people's ability or desire to carry clean injection equipment and forced them to access more hidden and less safe locations to inject drugs, away from potential surveillance efforts. This had the greatest impact on homeless PWID (Cooper, Moore, Gruskin, & Krieger, 2005). Our research builds upon the existing literature on risk environment to examine the influence of Social Ecological Model "Structural" or "Political" level laws limiting the placement of SSPs on the risk environment of PWID. Ultimately, we combine aspects of the Social Ecological Model and the theory of Risk Environment framework to inform a dynamic system model of risk environment. This will help us better understand the multiple factors that influence SSP placement and access for PWID.

Construction of a System Dynamic Model

A system dynamic model is a model where outputs (or outcomes) depend on both past and present values of the inputs into the model (Bahill & Szidarovszky, 2008). Luke and Stamatakis further define a system dynamic model as one made of heterogeneous elements with the elements interacting with each other. The interactions produce an emergent anticipated effect that is different from the impact of individual elements on an outcome variable. The effect persists over time and adapts as inputs change (Luke & Stamatakis, 2012). Another way to think of a dynamic system model is a theoretical model set in motion in a population. The constructs and variables used in static models are still present in a dynamic system model. Some constructs in a dynamic system model are given more specific terms and values than in a static model. The most common of these is called a stock. A stock is a variable that has a set value that is either diminished or replenished due to interactions between the constructs. Interactions are further specified and given a set symbols to better explain the interaction. The most common interactions are positive interactions or negative interactions (identical to theoretical model construction). There are also flows, or rates of occurrence of a construct or variable, and feedback loops, or interactions that reinforce or balance themselves due to the type of interaction with related elements (Luke & Stamatakis, 2012). There has been limited application of system dynamic modeling to OUD or any associated co-morbidities including opioid overdose. Specifically, modeling has not been used on the prevention side looking at factors associated with successful interventions in the prevention of injection-related infectious diseases or opioid overdose. The Committee on Pain Management and Regulatory Strategies to Address Prescription Opioid Abuse has called for models to address potential interventions targeting PWID, stating, “Creating such models would have important advantages: it would guide and strengthen surveillance and foster a common policy vocabulary” (National Academies of Sciences Engineering and Medicine, 2017). Through the development of a system dynamic model, we believe we can better understand and illustrate the factors associated with individual risk of opioid overdose as well as “Structural” or “Political” barriers within the Social Ecological Model to improve access to SSPs by PWID.

The Social Ecological Model and Data Sources

Current understanding of fatal and non-fatal overdose associated with opioid use in non-urban areas is typically limited to county-level data, which is highly influenced by local policy decisions, but acts as a base unit for analysis. However, when working to understand the "Structural" or "Political", "Community", "Interpersonal", and "Personal" factors within the Social Ecological Model that can determine the risk environment of PWID and risk behaviors associated with overdose, more specific data is required. We believe this to be the case when taking into consideration the current "Structural" or "Political" level state law, TN Code 68-1-136, 2017. As stated earlier, this law that limits SSP placement in Tennessee uses feet as a unit of measure for enforcement. In order to properly analyze the impact to the risk environment of PWID, we need a data source that will give us like or similar units of measure for comparison and analysis.

"Organizational" Level EMS Data

EMS Narcan administration data offers an under-utilized, low-cost, validated tool for surveillance of opioid overdose at the "Organizational" level of the Social Ecological Model. In a retrospective validation study, it was determined that pre-hospital Narcan administration acts as a surrogate marker for community opioid overdose rates that are typically calculated by extrapolation of emergency room Narcan administrations (Lindstrom et al., 2015). EMS data also offers multiple advantages over other data sources. EMS data is not considered health information when de-identified by the EMS provider and provided in aggregate. Using this data offers privacy protection to PWID while still containing geographical information that can be used to establish units of analysis at smaller geographic areas than the county. This

"Organizational" level data provides "Community" level insight within the Social Ecological Model framework and offers the potential to understand otherwise hidden "hot spots" of opioid use that cannot be identified with "Structural" or "Political" level data. "Hot spot" data can lead to targeted interventions like the placement of SSPs (DiMaggio et al., 2008). Identifying new needed locations for SSPs can also determine if the existing "Structural" or "Political" level law that limits the placement of SSPs hinders potential access for PWID. At the "Community" level, placement of SSPs in areas as informed by "Organizational" level EMS data may change the environment into an "enabler of health behavior" due to increased proximity to the PWID population (Stokols, 1996). As PWID engage in harm reduction behaviors as prescribed by local SSPs, more PWIDs will be exposed to "Interpersonal" level modeling of improved health behaviors. This creates potential for cultural shifts among the population to safer practices of drug use.

To address these issues, and to serve the overarching goal of reducing potential harm caused by the law requiring a strict physical distance from schools and parks, this study had the following aims:

Aim 1

Develop a novel methodology using EMS Narcan administration data to identify areas of highest risk environment for opioid overdose for comparison to the location of existing support services for PWID using Washington County Tennessee as a proof-of-concept county.

Aim 2

Determine the barriers to SSP access by PWID in suburban and rural environments created by preemptive buffer laws at the state level. As a proof of concept, the constraints of current Tennessee law, TN Code 68-1-136, will be apllied to a theoretically ideal placement of an SSP in the “hot spots” identified in Aim 1 to compare changes in potential utility to PWID based on these constraints. The constraints will be modified to determine if changes to or repeal of TN Code 68-1-136 would improve the potential utility of SSPs in Washington County, TN.

Aim 3

Develop a theoretical dynamic system model using both Social Ecological Model and the theory of Risk Environment framework to inform potential evidence-based policy recommendations based on the findings of Aim 1 and Aim 2. Detail existing political barriers of SSP placement and the potential increased utility of SSPs to PWID created by hypothetical amendments to current laws.

CHAPTER 2. DETERMINING THE AREA OF HIGHEST RISK ENVIRONMENT FOR OPIOID OVERDOSE IN WASHINGTON COUNTY, TN. A NOVEL METHODOLOGY AS A PROOF OF CONCEPT

By: Pettyjohn S, Mamudu H, Hillhouse J, Pack R

ABSTRACT

Background: Understanding potential "hot spots" of opioid use disorder in urban areas has become a mainstay in harm reduction efforts. Understanding concentrated areas of use allows for interventions including improved placement of Narcan access points, traditional syringe services programs (SSPs), mobile SSPs, and supervised injection sites (SISs). Less is known about "hot spotting" methods in rural and suburban areas, compounding the disparities among urban and non-urban people who inject drugs (PWID).

Methods: We identified areas of greatest need for harm reduction interventions within a non-urban Tennessee county using 2016-2018 Emergency medical services (EMS) Narcan administration data paired with U.S. Census tract data. Merging two data sources and using graphic art software, we were able to determine the "EMS zone", a geographic area used to dispatch ambulances and emergency services, with the highest rate of EMS Narcan administration.

Results: "EMS Zone 1" had a statistically significant higher rate of EMS Narcan administrations per 10,000 than four of the other seven EMS zones (16.7 95% C.I. 12.4, 22.4), (18.2 95% C.I. 13.7, 24.2) in 2016 and 2018 respectively, and a statistically significant higher rate compared to

the whole county, 9.9 (95% C.I. 11.78, 8.3), and 10.8 (C.I. 9.2, 12.8) per 10,000 in 2016 and 2018 respectively.

Conclusion: This proof of concept can provide local public health departments and harm reduction non-profit agencies a process for determining the best location to increase harm reduction efforts and target SSP locations using readily available data and software.

Introduction

There is a high prevalence of injection drug use in Central Appalachia contributing to significant increases in acute, chronic, infection of Hepatitis C (HCV) and Human Immunodeficiency Virus (HIV) (Zibbell et al., 2015). There are major differences in rural and metropolitan opioid use and associated co-morbidities in Appalachia (Young et al., 2012). Of the current opioid crisis, one of the most striking contrasts between rural and urban people who inject drugs is access to harm reduction related services like syringe services programs (SSPs). Ninety eight percent of young people living in rural environments with a diagnosis of HCV (a co-morbid condition of injection drug use) have no access to syringe service programs within 10 miles of their location while just under half (48%) in urban areas do (Canary et al., 2017b). SSPs are one of the most readily accessible points of contact to the healthcare system for people who inject drugs (PWID) (Clarke et al., 2016). While the above-mentioned study represents one of the more extreme examples in differences in distance and access to health services, it demonstrates a large gap between rural and urban that has often been the theme in the current opioid epidemic.

Studies in urban areas have identified where to place services like SSPs to improve access to at-risk populations (DiMaggio et al., 2008). As early as 1997, researchers were able to determine there was a single geographic cluster of heroin overdoses in San Francisco using basic geospatial analysis and follow the cluster over time (Davidson et al., 2003). This work later went on to spur a geospatial “hot spotting” technique that lead to a rapid response satellite SSPs launching in both San Francisco and Los Angeles (Davidson, Scholar, & Howe, 2011). An additional study in San Francisco determined that that the mean distance of activity space a person that injects drugs regularly traverses is 1.4 miles (Martinez, Lorvick, & Kral, 2014). This means that PWID will typically walk to support services that are in about a 1.4-mile radius from where they currently sleep. This information as well as general knowledge of existing “hot spots” of drug use influenced the location of interventions and services. In Washington D.C. it has been determined that people that must walk less than 10 minutes to an SSP are the most likely to consistently use the services provided. (Allen, Ruiz, & Jones, 2016a; Allen, Ruiz, Roess, & Jones, 2015).

Application of Public Health Theory to SSP Placement

Current understanding of fatal and non-fatal overdose associated with opioid use, especially in rural areas, is typically limited to county level data. This limits data-driven policy decisions and analysis to the county and regional levels at best. Understanding the geographic relationship between accessibility of services and location of PWID at the local level is essential for effective use of public resources.

County level data is “Structural” of “Political” level data within the Social Ecological Model. The Social Ecological Model is a hierarchical model consisting of different levels of social strata. It examines interactions between “Personal”, “Interpersonal”, “Organizational”, “Community”, and “Structural” or “Public Policy” factors (Bronfenbrenner, 1977). Instead of “Public Policy”, we refer to the top hierarchical level of the Social Ecological Theory as

"Structural" or "Political" matching Stokols (1996). Stokols applies the Social Ecological Model to public health interventions. The upper levels of the Social Ecological Model, "Structural" or "Political", "Community", and "Organizational" levels create an environment for organizations or people that enables or hinders health behaviors (Stokols, 1996). The Social Ecological Model can also help to better understand the theory of Risk Environment.

Risk environment is defined as "The space, either social or physical, in which a variety of factors exogenous to the individual increase vulnerability to HIV". Geographic dimensions can be used to quantify factors of risk environment that are structural and spatial (Cooper et al., 2009; Rhodes, 2009). The theory of Risk Environment provides a framework and unit of measurement for the environment surrounding PWID. Environmental factors can be associated with harm. Built environment can also be associated with comorbidities of Injection Drug Use (IDU) (Rhodes, 2009). In 1988, Wallace & Wallace determined that built environment decay was correlated to an increase in drug use (Wallace & Wallace, 1988). In 2005, Hembree et al. discovered a significant link between neighborhood built environment and overdose mortality (Hembree et al., 2005). This work put drug use in a category with a number of chronic diseases, risk behaviors, and co-morbidities associated with the built environment including STDs, cancer, diabetes, homicide, suicide, obesity, asthma, and a variety of psychological conditions including depression, addictive behaviors and increased injection-risk practice (Cohen et al., 2003, 2000; Cummins & Jackson, 2001; Perdue, Hagan, Thiede, & Valleroy, 2003; Weich et al., 2002). Understanding the relationship between environment and IDU has the potential to impact health outcomes of PWID, who are some of the most vulnerable and stigmatized people (Martinez et al., 2014). To understand the interplay of "Structural", "Community", "Interpersonal", and "Personal" factors within the Social Ecological Model that can determine the risk environment and risk behaviors in non-urban environments, more-localized data is required. This is especially true when taking into consideration state and local policies acting as a barrier to SSP access.

In Tennessee, TN Code 68-1-136 limits the location of SSPs explicitly in rural and suburban areas: […] a program established pursuant to this section shall not conduct an exchange within two thousand feet (2,000') of any school or public park (TN Code 68-1-136, 2017). There is the potential of this law to severely limit access to and utility of SSPs in non-urban counties. The potential impact has not been examined at any level. When placing this legal intervention within the Social Ecological Model, we understand that "Policy" or "Structural" level changes have the potential to have the greatest impact on risk and behaviors at the "Personal" and "Interpersonal" level. This is the opposite effect of what Stokols calls an "Environmental Change Strategy of Health Promotion". In this case, a change made at the highest level of the environment has the potential to increase injurious conditions at a lower level (Stokols, 1996).

Two urban municipalities have previously passed ordinances that limit the placement of SSPs within their community. In 2000, Washington D.C. started restricting the placement SSPs within the city. SSPs cannot operate within 1000ft of a school. This restriction has negatively affected the coverage SSPs provide of the region, lowering it by 50% compared to before the law took effect (Allen, Ruiz, Jones, et al., 2016). In reference to targeting SSP coverage at known "hot spots" of drug activity, over the years of study, between 52% and 88% of known opioid use hot spots fell outside of the coverage area of SSPs due to the ordinance restriction (Allen, Ruiz, Jones, et al., 2016). The law was repealed in 2019 (D.C. Law 22-288, 2019). In Denver, Colorado, mobile SSPs, the only method currently in the city, were not allowed to operate within 1000ft of a school. This essentially created a buffer zone that encompassed the entire city limits of Denver. After protest from two harm reduction groups, the city replaced the law with an ordinance that allowed SSPs to operate anywhere in the city except within parks or on sidewalks that border parks (Asmar, 2013).

Washington County, TN, our test-case non-urban county, is a prime location to examine potential "hot spotting" of areas of opioid use in non-urban areas. It is home to the only SSP program in the predominantly rural Northeast Region of TN. The SSP is located within an infectious disease clinic located in close proximity to a large hospital complex and a cluster of outpatient clinics.

While convenient to other medical services, its geographic location and its reach into the most at-risk populations for opioid overdose may be severely curtailed by preemptive state-level policy. Due to the sensitive nature of the SSP's work, they, like most SSPs use an unidentifiable identifier system, a codified system that uses specific patient attributes such as client's birth order, middle initial of their mother that cannot be easily understood without a master key. They keep no records of patient addresses, historical use of Narcan or any otherwise potentially patient-identifying information. Free distribution of Naloxone, or Narcan, opioid overdose reversal drugs, and associated training in overdose reversal are key components of this SSP's services and best practices for SSPs (Bluthenthal, Kral, Sherman, & Tolbert, 2009).

For the purposes of this study, aggregate EMS data are a unique resource for analysis at both a "Community" and "Organizational" level within the Social Ecological Model framework. When de-identified by the EMS provider, EMS Narcan administration data is not considered health information. This offers protections to PWID, a highly stigmatized group.

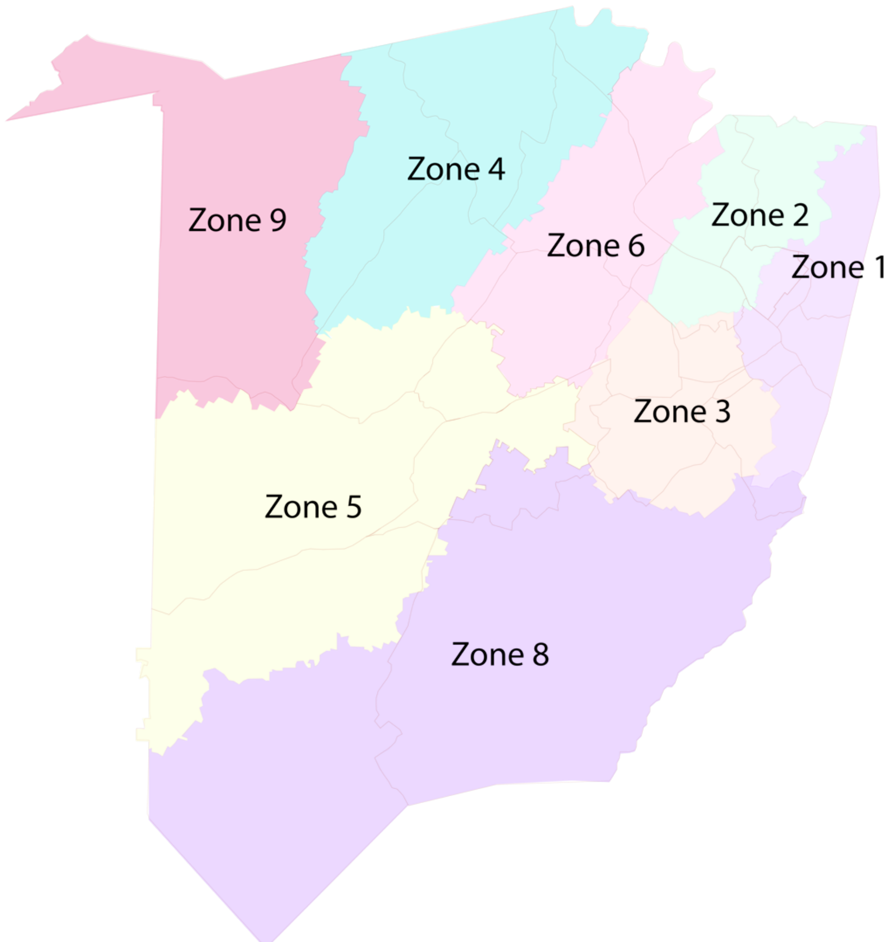
EMS units operate in pre-defined and bounded areas within a county. This creates smaller, discrete geographic areas within a county. EMS administration of Narcan among people diagnosed with opioid overdose has been validated as a tool for use in public health surveillance of opioid overdose. In a retrospective validation study, it was determined that pre-hospital Narcan administration acts a surrogate marker for community opioid overdose rates that are typically calculated by extrapolation of emergency room Narcan administration (Lindstrom et al., 2015). We believe that EMS data provides a distinct advantage in rural and suburban settings as well. Hospitals are geographically fixed entities and the reach of rural hospitals may also expand beyond county lines. EMS data offers researchers an opportunity to estimate the geographic location of patients that cannot be captured in hospital data. However, use of this readily available source of data has not been previously used as a tool for determining potential areas of high-risk environment.

Methods

The research team used EMS Narcan administration data to determine potential hot spots of opioid use at the community or sub-community, level in Washington County, TN. Local EMS uses a system of “zones” that divide the county into 8 discreet geographic areas that encompass the entire county. (Figure 2.1) These boundaries are determined by existing road infrastructure, county lines, and some city limit lines within the county. EMS Emergency Medical Technicians (EMTs) are dispatched on calls from stations and sub-stations within these “zones”. This EMS data was provided by Washington County EMS.

Figure 2.1

EMS Zones, Washington County, TN



Narcan administration by EMS is standard protocol any time the responding EMT suspects an opioid overdose or if bystanders report potential opioid use by the patient in question. Opioid administration is tracked using the electronic medical record or "ticket" associated with each EMS call. De-identified EMS Narcan administration data for 2016-2018 from Washington County EMS was imported to a Microsoft Excel spreadsheet generated by the department chief. The data was recoded with assistance from Washington County EMS to meet our needs. After recoding, there were 11 total missing EMS zone records from an N of 388.

Using this data, the research team generated an initial raw count of EMS Narcan administrations for 2016-2018.

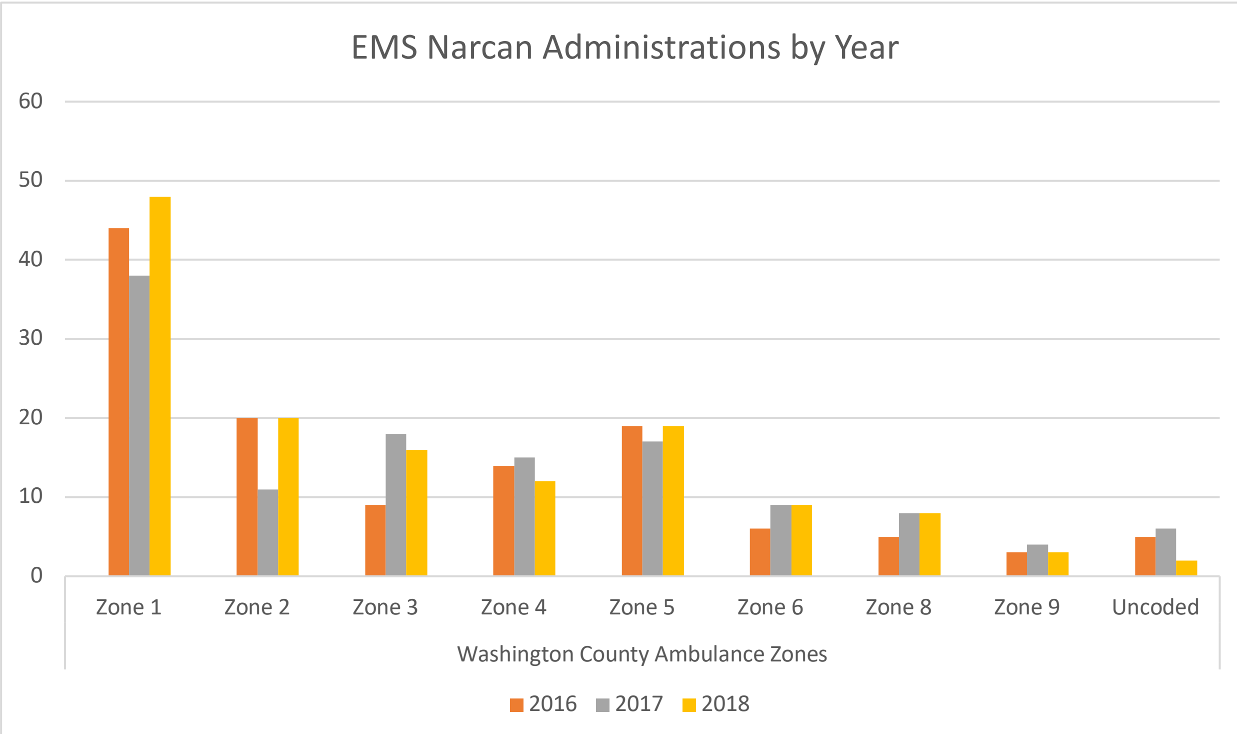
We then deployed a novel method using Adobe Illustrator 2020, a graphic design tool familiar to members of the research team. Using a digital .pdf map of EMS zones provided by Washington County EMS, we traced each EMS zone using the "pen" tool in Adobe Illustrator to create a new, editable 2-D shape as a layer in a new digital map. We created each EMS zone as a labeled layer in the digital map. Next, we created a new layer using the same method incorporating US Census tracts from a digital .pdf map from the factfinder.census.gov website. We collected the population estimates from 2017 within Washington County, TN by census tract from the table, "Population, Housing Units, Area, and Density: 2010 - County -- Census Tract 2010 Census Summary File", available through the census.gov website. Then, we used a free script created by the contributor, Bryan Buchanan, from the code sharing site github.com, that calculates the area of shapes in Illustrator (Buchanan, 2015). We were able to determine the number of square centimeters (sq. cm.) of each U.S. Census tract at scale on the newly created map using the script. We calculated the number of people per sq. cm. by dividing the number of estimated people in each census tract by the number of sq. cm. of each tract. By combining the above-mentioned map layers of EMS zones and U.S. Census tracts and then running the script again, we determined the area of each census tract located in each EMS zone. We estimated the number of people living in each EMS zone using the known area of each tract in each zone. As validity check, we added the total population of the eight zones together and compared it to the total census count estimate for 2017. Our method estimated the population of Washington County, TN at 126851.45 people while simple addition of all U.S. Census tracts in Washington County, TN for 2017 was 126437, a difference of .3%. With the estimates of the population of each EMS zone, we were then able to use the raw number count of Naloxone administration by zone by year to calculate the prevalence rate of EMS Narcan administrations per 10,000 people by EMS zone. Using Microsoft Excel for Mac v. 16.34 to calculate the census rates, we were also able to generate 95% confidence intervals for each rate to determine significant differences between EMS zones. Significant differences between rates were determined by comparing rate confidence intervals for overlap among zones (alpha≤.05).

Results

The initial raw count of numbers indicated that over the three-year period in question, “Zone 1”, an area encompassing much of the downtown Johnson City area, had the highest number of Narcan administrations each year with the most occurring in 2018 with 48 total. This area also has the highest estimated population of any EMS zone, at approx. 26,350 people. Zones 2, 3, 4 and 5 have similar numbers of EMS Narcan administrations but vary in population from 13,729 people in “Zone 2”, the least populous of the three zones in question, to “Zone 3”, with approximately 18225 people. Zones 6, 8 and 9 vary in estimated population from approximately 15959 people in Zone 6 to as few as approximately 7060 in Zone 9, but all share the characteristic of low instances of EMS Naloxone administration across all three years (Figure 2.2).

Figure 2.2

Raw Count of EMS Narcan Administrations Stratified by EMS Zone, 2016-2018, Washington County, TN



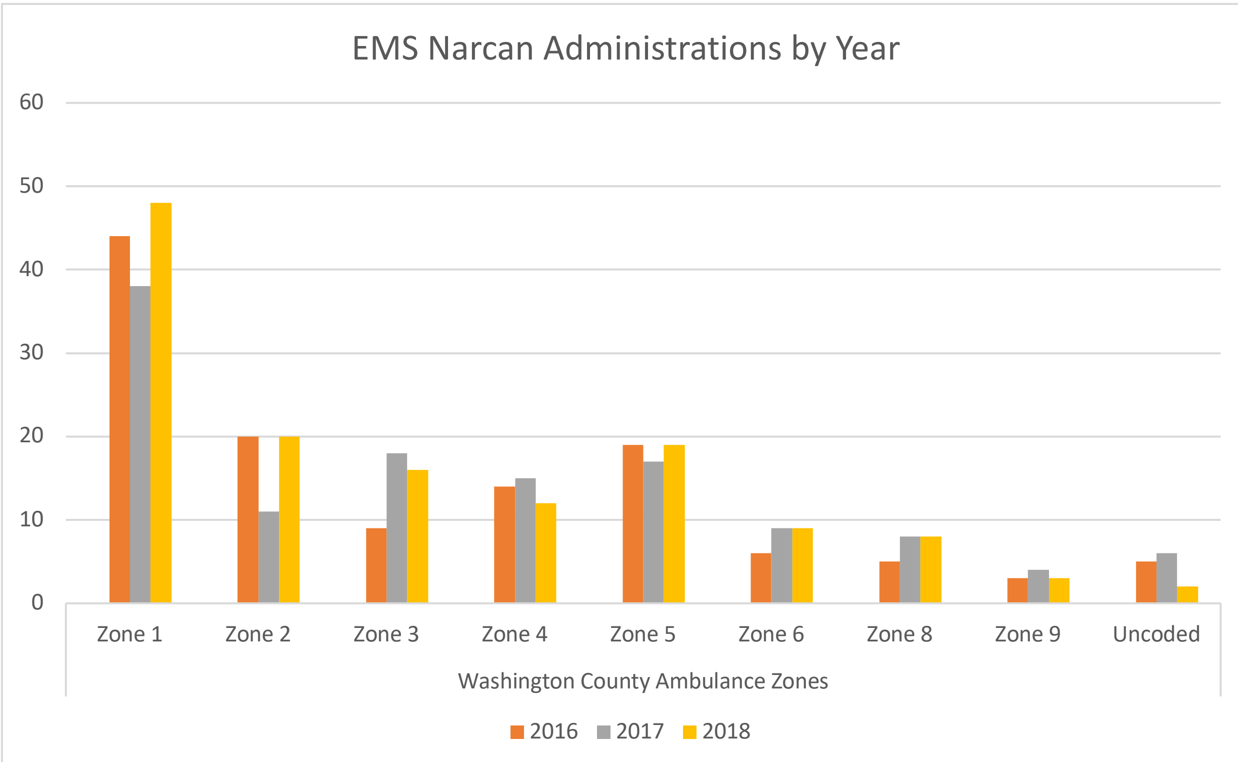
When calculating rates based on the estimated population of each zone, similar Narcan administration characteristics emerge. “Zone 1” sees the highest rates of EMS Narcan administration over the three-year period with 16.70 (95% C.I. 12.43, 22.3) administrations per 10,000 people in 2016, 14.42 (95% C.I. 10.50, 19.89) in 2017 and the highest rate occurring in 2018 with approximately 18.22 (95% C.I. 13.73, 24.17) administrations. Only the rates for 2016 and 2018 were statistically significant in comparison to other EMS zones. In 2016, “Zone 2” also had a statistically significantly higher rate of administrations with 14.57 (C.I. 9.40, 22.57) per 10,000 people. The same year, “Zone 5” showed an elevated rate (approaching significance) compared to the other EMS zones with approximately 12.56 (95% C.I. 8.02, 19.69) (Table 2.1, Figure 2.3).

Table 2.1.
Rate of EMS Narcan Administrations Stratified by EMS Zone per 10,000 People, 2016-2018, Washington County, TN

	2016		2017		2018	
	Rate per 10,000	95% CI	Rate per 10,000	95% CI	Rate per 10,000	95% CI
Zone 1	16.70*	12.43, 22.43	14.42	10.50, 19.89	18.22*	13.73, 24.17
Zone 2	14.57*	9.40, 22.57	8.01	4.44, 14.46	14.57	9.40, 22.57
Zone 3	4.94	2.57, 9.49	9.88	6.22, 15.67	8.78	7.08, 17.01
Zone 4	8.37	4.96, 14.12	8.97	5.41, 14.87	7.17	4.08, 12.63
Zone 5	12.56**	8.02,19.69	11.24	6.99, 18.08	12.56	8.02, 19.69
Zone 6	3.77	1.69, 8.38	5.65	2.94, 10.86	5.56	2.94, 10.86
Zone 8	3.65	1.52, 8.76	5.84	2.92, 11.67	5.84	2.92, 11.67
Zone 9	4.25	1.32,13.17	5.67	2.13, 15.09	4.25	1.371, 13.17

Denotes statistically significant difference to other EMS Zones*
Approaching statistically significant difference**

Figure 2.3
Rate of EMS Narcan Administrations Stratified by EMS Zone per 10,000 people, 2016-2018, Washington County, TN



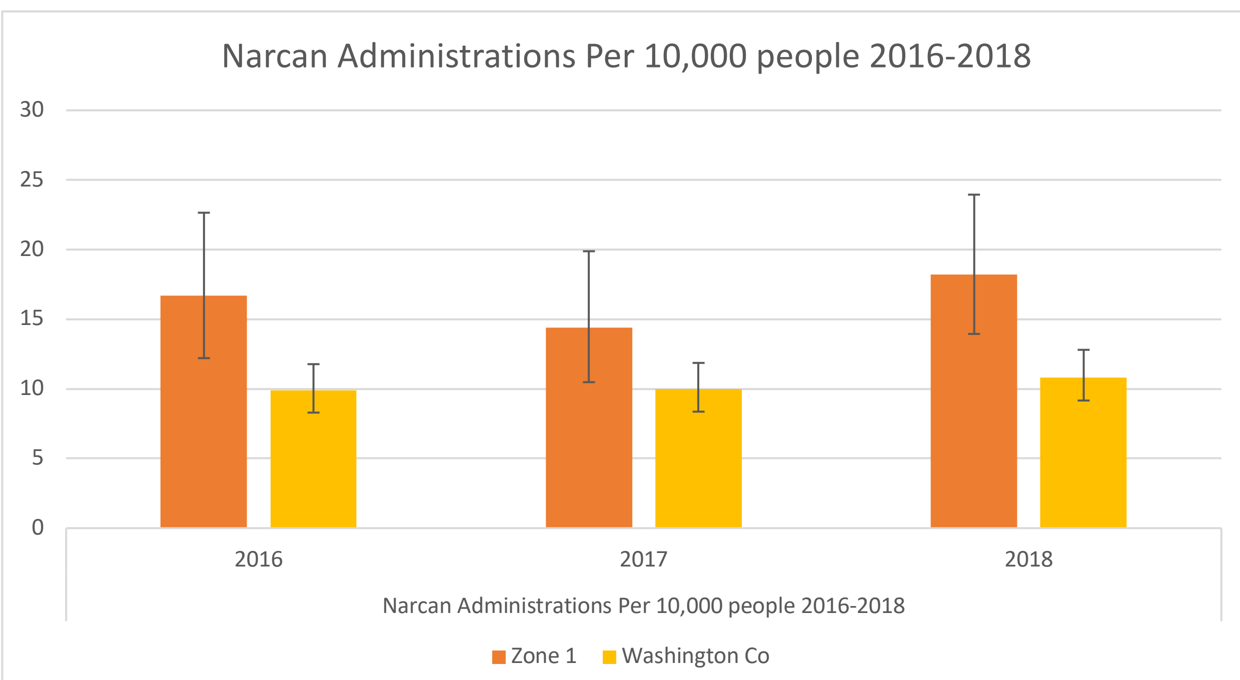
When comparing zones 1, 2, and 5, the zones with the three highest rates of EMS Narcan administration, all three are higher in comparison to the average rate of administration in the county for the same year although only "Zone 1" shows a statistically significant higher incidence rate of EMS Narcan administrations in both 2016 and 2018 with 16.70 (95% C.I. 12.43, 22.43) compared to 9.89 (95% C.I. 8.30, 11.78) and 18.22 (95% C.I. 13.73, 24.17) per 10,000 versus the county level incidence rate of 10.84 (95% C.I. 9.17, 12.81). Table 2, and Figure 3 contain details. Additional Tables and Figures used to derive results are in Appendix 1.

Table 2.2
Prevalence rates of EMS Narcan Administration Stratified by EMS ALS Zone in Comparison to County Rate, 2016-2018, Washington County, TN

	2016		2017		2018	
	Rate per 10,000	95% CI	Rate per 10,000	95% CI	Rate per 10,000	95% CI
Washington County	9.89	8.30, 11.78	9.97	8.37, 11.87	10.84	9.17, 12.81
Zone 1	16.70*	12.43, 22.43	14.42	10.50, 19.89	18.22*	13.73, 24.17
Zone 2	14.57	9.40, 22.57	8.01	4.44, 14.46	14.57	9.40, 22.57
Zone 5	12.56	8.02,19.69	11.24	6.99, 18.08	12.56	8.02, 19.69

Denotes statistically significant difference to County Rate*

Figure 2.4
Prevalence Rate of EMS Narcan Administrations in EMS Zone 1 in Comparison to County Rate, 2016-2018, Washington County, TN



Discussion

Most opioid use-related data are at the county level. We argue that this data at the "Policy" or "Structural" level of the Social Ecological Model is not accurate enough to inform policy that impacts every corresponding level downward through the hierarchy of the model. This proof-of-concept method demonstrates the potential to determine "Community" level intra-county differences of risk environment that are not visible at the "Structural" or "Political" level county data. This analysis, using readily available, non-HIPAA data and fairly accessible software (Microsoft Excel, and Adobe InDesign) demonstrates the potential to for smaller "Organizational" and "Community" level entities including non-profits and local public health departments to better identify "hot spots" of opioid use in non-urban communities and counties. Examining the EMS Narcan administration rates at the county level does not capture potential opioid overdose problems occurring in a smaller, more densely populated areas of the county and offers no insight into the ideal placement of services to maximize the impact of harm reduction efforts.

Per our data, "EMS Zone 1" represents approximately 21% of the population of Washington County yet accounts for approximately 34% of all EMS Narcan administrations over the three-year period of study. We hypothesize that other counties in the region or with similar geographic characteristics/demographics may have similar, as-of-yet unidentified hot spots of opioid use that could be better understood and targeted using this methodology.

This developed method is not without limitations. Determining prevalence rates within EMS zones by overlaying census tract maps operates under the false assumption that populations are distributed equally within census tracts. This limitation should be balanced with the potential safety this data provides to PWID. While providing some level of geographic information, it does not risk exposing potentially identifiable locations of PWID. This method yields a more precise measure than county data with a simple methodology that could target interventions without the risk of exposure to the population.

Conclusion

This new methodology represents a streamlined approach to improved surveillance of OUD for targeting of harm reduction services. Using EMS Narcan administrations as a proxy for problematic opioid use, it can be assumed that there is at least one community of concentrated opioid users in Washington County located in “EMS Zone 1”. The significantly higher prevalence rate of EMS Narcan administration in “EMS Zone 1” likely represents an environment of increased risk for overdose that may be underserved by the existing SSP in Washington County. More research is needed to determine if targeting “EMS Zone 1” might be hindered due to the potential limitation of state (“Structural” or “Political”) level policies in Tennessee. An environmental scan of geographic characteristics of “EMS Zone 1” shows an area that includes a large cluster of schools and public parks associated with the most densely populated area of Washington County, Johnson City, TN. Further geographic analysis should be conducted comparing the location of the existing SSP and other support services associated with opioid use to determine if there is a true mismatch between the location of services and the location of the population at highest risk of opioid use. Examination of additional factors associated with the risk environment of “EMS Zone 1” in Washington County, TN may also garner insight into an eventual model identifying factors associated with “hot spots” of opioid use.

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CHAPTER 3. LEGAL AND GEOGRAPHIC BARRIERS TO IMPROVED ACCESS TO SYRINGE SERVICE PROGRAMS IN WASHINGTON COUNTY, TN AS DEMONSTRATION OF LOCAL CONSEQUENCES OF STATE POLICY

By: Pettyjohn S, Mamudu H, Hillhouse J, Pack R

ABSTRACT

Background: Syringe services programs (SSPs) are considered key structural elements in lowering risk among People Who Inject Drugs (PWID). PWID are at lower risk of contracting diseases the closer they are to SSPs. Tennessee law prohibits SSPs within 2000ft of a school or park, potentially impacting the placement of SSPs in rural/suburban areas.

Method: Using EMS data, U.S. Census tracts, and related support services locations, we used Google Maps to calculate travel times walking, driving, and on public transit as utility and accessibility measures. With these, we proposed a location for an SSP. We applied current legal restrictions to find the next-closest legal location and compared accessibility/utility of the two proposed sites to the existing SSP location.

Results: From the 24 related services locations, the current SSP location has a mean travel time of 8.3 (95% C.I. 7.5,9.2), 52.6 (95% C.I. 44.6, 60.6) and 31.5 (95% C.I. 26.9, 36.0) minutes driving, walking, and using public transportation respectively. From the proposed SSP location, mean travel time is 4.7 (95% C.I. 2.1, 7.3), 15.3, (95% C.I. 8.3, 22.3), and 10.0 (95% C.I. 6.6, 13.4) minutes driving, walking and using public transportation respectively. From the closest

legal SSP location, mean travel time is 4.5 (95% C.I. 3.6, 5.2), 25.8 (95% C.I. 19.4, 32.2) and 17.2 (95% C.I. 13.2, 21.2) minutes driving, walking and using public transportation respectively.

Conclusion: Findings indicate that identifying measures of utility/accessibility for PWID can identify improved locations for SSPs. Legal restrictions may lower utility/accessibility of SSPs for rural/suburban PWID.

Introduction

The Theory of Risk Environment defines risk environment as a geographic measure of a person's risk for negative health outcomes based on where they live (Cooper et al., 2009). Rhodes further refines the Theory of Risk Environment by breaking environmental conditions into 4 categories, physical, social, economic, and policy. These 4 categories can be divided into micro- and macro-level factors. Micro-level factors are measured in the direct vicinity of an individual while macro-level factors are measured at higher levels like the community up to the country where the person resides (Rhodes, 2002; Rhodes & Simic, 2005). A person's location can be defined from spatial factors like distance to medical services and access to other built infrastructure. Other factors, including measures like crime levels and policing practices, that are not necessarily structural components can also determine the total level of risk associated with a disease or condition (Cooper et al., 2009). The theory of Risk Environment is consistent with and can be understood within the Social Ecological Model framework as well. It is our premise that macro-level factors fit neatly into the upper levels of the Social Ecological Model framework, “Organizational”, “Community”, and “Structural” or “Political”, while micro levels partially describe “Personal” and “Interpersonal” factors.

Structural environment is known to play a role in drug use risk behaviors. For example, overall built-environment decay in the Bronx borough of NYC in the 1980’s was correlated with an increase in drug abuse in the community (Wallace & Wallace, 1988). Known co-morbidities associated with injection drug use (IDU) and People Who Inject Drugs (PWID) including sexually transmitted diseases (STDs), homicide, suicide, depression, and increased injection-risk practice all have structural environment correlations (Cohen et al., 2003, 2000; Cummins & Jackson, 2001; Perdue et al., 2003; Weich et al., 2002). Deaths mapped to the New York City Housing and Vacancy Survey showed that dilapidated built environment, lack of social resources, increased level of psychosocial stressors, and rate of reported opioid overdose were all significant factors in neighborhood-level opioid overdose mortality (Hembree et al., 2005).

Syringe Services Programs (SSPs) are widely regarded as a primary point of risk prevention among a highly vulnerable population. SSPs and secondarily, pharmacies that supply clean injection equipment, are considered the key structural element in lowering risk environment among PWID in relation to Human Immunodeficiency Virus (HIV), Acquired Immunodeficiency Syndrome (AIDS), and Hepatitis C, (HCV) (Des Jarlais, 2000). PWID are at lower risk of contracting an infectious disease the closer they live to an SSP. There is also a potential decay in the protection offered by an SSP in the surrounding area the farther a person must travel to access services (Cooper et al., 2009). Geographic locations of SSPs also play a role in perceived access, acceptability, and utilization among PWID. PWID list distance to SSPs and barriers to travel as concerns among other stigma-associated factors including fear of police, and fear of being identified an injection drug user as reasons for poor SSP utilization (Bruneau, Daniel, Kestens, Zang, & Généreux, 2008; Cooper et al., 2009; Rich, Strong, Towe, & McKenzie, 1999).

There are specific behaviors among PWID associated with travel and risk avoidance based distances from syringe service programs (SSPs) (Cooper et al., 2009; Mitra et al., 2017). In San Francisco, the mean distance of activity space a person that injects drugs regularly traverses is 1.4 miles (Martinez et al., 2014). Studies in Washington D.C. determined that people that walk less than 10 minutes to an SSP are the most likely to consistently use the services provided. Seasonality can also play a factor, with PWID willing to walk less in winter months due to weather conditions (Allen, Ruiz, & Jones, 2016a; Allen et al., 2015). These conclusions also hold true in potential locations of safe injecting sites (SISs), a new service that provides a safe place to inject drugs under the watch of trained medical professionals. Studies of SISs are relatively new and limited but may give additional insight into PWID preference and ability to access services. In a study in Ottawa, Canada, a majority of PWID interviewed were not willing to walk more than 20 minutes to a SIS, with people being even less likely to do so in winter months. Over half of participants (53%) were willing to ride a bus in summer and just under half (46%) were willing to ride a bus in winter (Mitra et al., 2017).

The Comer Foundation funded a report outlining best practices for establishment of SSPs in rural areas that takes into account access to services and how to best meet the needs of PWID. These "Organizational" level factors can influence "Interpersonal" and "Personal" level factors within the Social Ecological Model. The Comer Foundation recommends that the location of SSPs must be central to the population they serve and must maintain hours of operation that meet the need of a maximum number of PWID. There should be low transportation barriers including easy points of access via public transportation. SSPs should take into account the central mode of transportation among PWID in the area and identify locations near known locations where PWID congregate. Additionally, the report's authors recommend finding existing support services tied to co-morbidities of IDU to co-locate with, or to establish SSPs close to existing services. This eases the burden of travel for referrals between services for PWID (La Belle, 2017).

SSP location may also be influenced by "Structural" or "Political" level factors within the Social Ecological Model framework like laws and zoning ordinances. These laws create barriers to the "Community" level placement of SSPs based on the proximity of an SSP to a school or a public park. There are two urban examples we can look at to better understand the potential impact of "Structural" of "Political" level laws on a non-urban community. Two cities have previously passed ordinances that limit the placement of SSPs. In 2000, Washington D.C. started restricting the placement SSPs within the district. SSPs cannot operate within 1000ft of a school. This restriction led to a 50% drop in coverage of the city compared to previous measures (Allen, Ruiz, & Jones, 2016b). SSPs in Washington D.C. were also less able to set up in known "hot spots" of drug activity. It is estimated that between 52% and 88% of known opioid use hot spots within Washington D.C. have become unreachable by SSPs due to these restrictions (Allen, Ruiz, Jones, et al., 2016). This law has since been repealed (D.C. Law 22-288, 2019).

In Denver, Colorado, mobile SSPs, the only method currently in the city, could not operate within 1000ft of a school. This essentially restricted access to SSPs within the entire city of Denver. Through local advocacy efforts, the city refined the ordinance to allow SSPs to operate in the city except within city parks or on sidewalks that border city parks (Asmar, 2013). In Tennessee, TN Code 68-1-136 limits the location of Syringe Service Programs in rural and suburban areas: "[…] a program established pursuant to this section shall not conduct an exchange within two thousand feet (2,000') of any school or public park" (TN Code 68-1-136, 2017).

Through an examination of one suburban county in Tennessee, the research team aims to create a methodology to identify areas of highest risk of overdose, hot spots of opioid use, and strategies to target harm reduction interventions in the local areas they are most needed. Previously, the research team used EMS data from Washington County, TN to identify "EMS zones" with statistically significantly higher rates of administration of Narcan by EMTs. Use of Narcan administration data to measure "Community" level overdose measures is a validated technique. Pre-hospital Narcan administration acts a surrogate marker for community opioid overdose rates that are typically calculated by extrapolation of emergency room Narcan administration (Lindstrom et al., 2015). In non-urban counties, hospitals are often regional entities, especially in rural areas. Using the Social Ecological Model, we maintain that use of hospital data represents more of a "Structural" or "Political" level of understanding of opioid overdose in non-urban areas. Using EMS Narcan administration data with as a proxy for problematic opioid use, the research team was able to identify an "EMS zone" within Washington County, TN most at need for an SSP. We consider this data source to be more in line with a true "Community" measure due to the inclusion of geographic data and the ability to target areas of high EMS Narcan administration.

Currently, in Washington County, an SSP operates out of an infectious disease clinic in close proximity to a large hospital complex and a cluster of outpatient clinics. The research team will apply the theory of Risk Environment framework by Rhodes, known travel and risk avoidance behaviors from previous studies, and the Comer Foundation report on best practices for rural SSP, to determine an ideal area within "EMS Zone 1" in Washington County, TN for the placement of an SSP (Allen, Ruiz, & Jones, 2016a, 2016b; Allen, Ruiz, Jones, et al., 2016; La Belle, 2017; Rhodes, 2002, 2009; Rhodes & Simic, 2005). After the research team determines this ideal theoretical location based on the above analysis, we will apply the restrictions outlined by TN Code 68-1-136 to the proposed location to determine if the state law hinders the potential placement.

Methods

The research team located the current SSP location in Washington County, TN using Google Maps (maps.google.com). By cross referencing the map, AmbulanceZoneMap.pdf, provided by Washington County EMS, we found that the current SSP is located in “EMS Zone 3”. (Figure 3.3). We used the “measure distance” function in Google Maps, a technique described by Allison Sanders, an epidemiologist for the Tennessee Department of Health overseeing harm reduction programming, to determine distances from the current SSPs to opioid use-related landmarks within Washington County, TN (Sanders, 2019). We identified U.S. Census tracts from a digital .pdf map from the factfinder.census.gov website and applied population estimates from 2017 within Washington County, TN to the tracts from the table, “Population, Housing Units, Area, and Density: 2010 - County -- Census Tract 2010 Census Summary File”, available through the census.gov website to find the point of highest population density (Figure 3.2).

We used an informational booklet from a homeless day center and clinic, the Johnson City Downtown Day Center. The booklet, “Homeless Services, Johnson City, TN was used to identify the geographic location of services associated with support of people that are homeless as a proxy for problem opioid use. Homelessness, substance use disorder (SUD) and OUD are all linked. Eighty four percent of homeless men and 58% of homeless women have substance use disorder (North, Eyrich, Pollio, & Spitznagel, 2004). While alcohol is the most commonly used substance among people that are homeless, opioids are the second most common. Opioid use accounts for 22% of people that are homeless that are admitted to treatment (U.S. Department of Health and Human Services, 2011). And, Doran et al. (2018) demonstrated a positive correlation between homelessness and heroin use, illicit prescription opioid use, and lifetime opioid overdose among hospital emergency department patients (Doran et al., 2018).

For our model, we added several additional services to our list known to be associated with opioid use in the region including behavioral health services in Johnson City, Office-Based Opioid Treatment (OBOT; buprenorphine prescriber) clinical locations, Johnson City Housing Authority Housing, and two general population privately owned subsidized housing locations within Johnson City. The names of these locations are not included to protect the residents' privacy. We used the Johnson City Transit website (johnsoncitytransit.org) to identify bus routes and highway exits. The research team only included highway exits in the model for drive time. The research team deemed the location of highway exits irrelevant to people walking or traveling via public transportation. We intentionally left out homeless encampments known to the research team to protect their occupants from potential exposure. We entered all geographic datapoints into Google Maps (maps.google.com) and created a map called, "Opioid Support Services, Washington County, TN" The datapoints are in Table 3.1 and the map is in Figure 3.1, below.

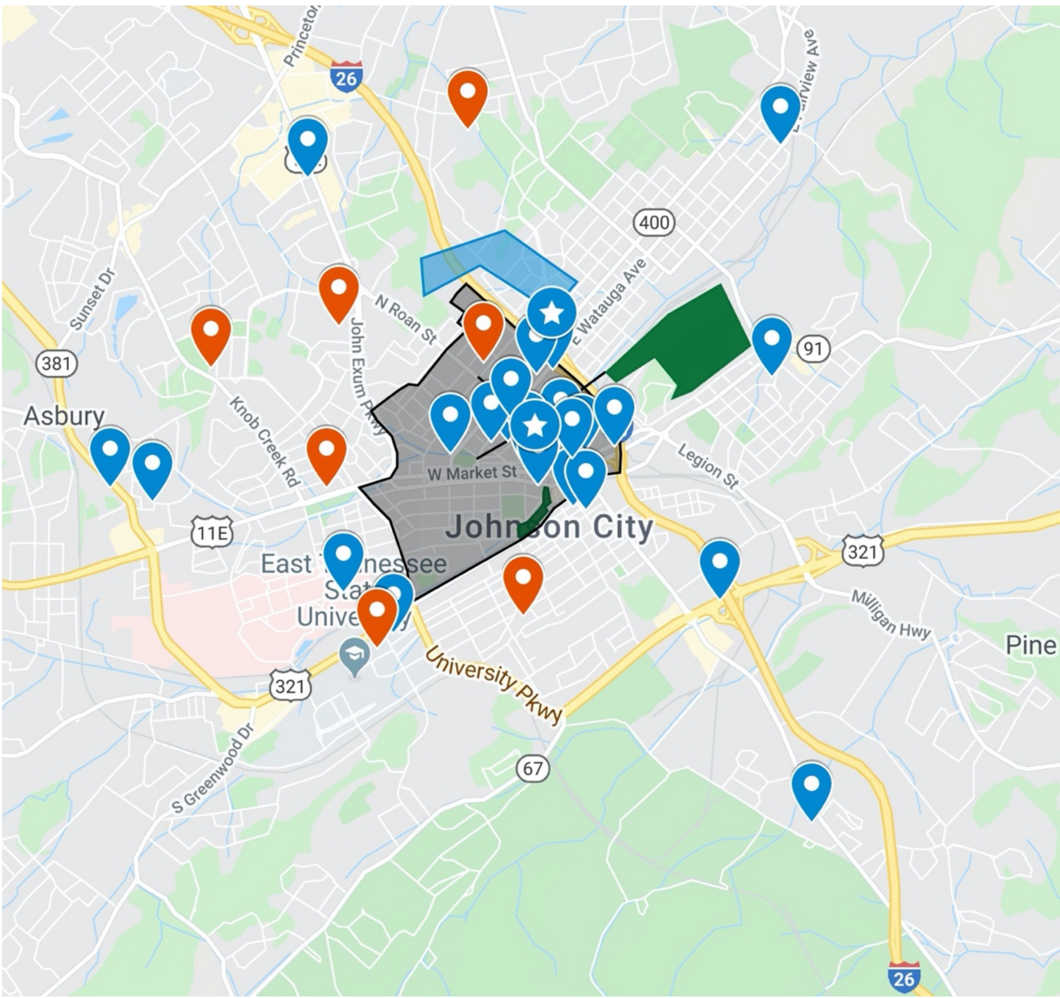
Table 3.1
Travel Time from Support Services sites to SSP Locations

	Driving Time			Walking Time			Public Transportation		
	Current Location	Closest Legal Location	Proposed Location	Current Location	Closest Legal Location	Proposed Location	Current Location	Closest Legal Location	Proposed Location
Johnson City Downtown Day Center	8	3	1	47	16	3	28	12	3
Appalachian Regional Coalition on Homelessness (ARCH)	13	8	9	94	62	48	36	27	16
James H. Quillen VA Medical Center	7	9	8	34	40	31	28	35	24.5
Good Samaritan Ministries Inc.	8	3	1	52	17	3	30	8.6	3
United Way of Washington County	8	7	6	54	37	31	47	24	12
Haven of Mercy Rescue Mission	8	3	2	49	18	4	26	11	4
Johnson City Transit Center	8	5	3	48	20	7	21	6	2
Munsey Memorial United Methodist Church	9	4	1	54	18	6	30	12	6

Salvation Army Services	9	5	3	54	26	13	32	14	10
Turning Point Clinic	8	2	2	53	7	6	35	7	6
The River	8	4	2	48	22	8	25	12	5
Family Promise of Greater Johnson City	7	3	2	46	17	6	27	13	6
Manna House	9	5	3	54	26	12	30	17	10
Watauga Behavioral Health	9	2	1	58	12	3	39	6	3
ETSU Family Medicine Associates	7	7	6	45	40	29	36	21	12.5
Johnson City Public Library	8	3	1	51	17	2	27	7	2
Johnson City Housing Authority 1	12	4	6	87	32	39	58	17	14.5
Johnson City Housing Authority 2	11	5	5	75	36	29	40	28	18
Johnson City Housing Authority 3	7	5	5	41	25	10	28	27	15
Private Subsidized Apartment 1	7	4	2	53	19	5	32	11	7
Private Subsidized Apartment 2	2	9	8	7	49	40	7	35	26.5
I-26 Exit 22	8	2	1						
I-26 Exit 23	9	3	2						
I-26 Exit 24	10	4	6						

Figure 3.1
Support Services Map

(available online at:
https://drive.google.com/open?id=14XUCk_T9ZmYHfirlleInQcZOKTbr-44_&usp=sharing)



Using the U.S. Census data, we found that U.S. Census tracts 608, 601, are the two most densely populated within "EMS Zone 1", the zone previously determined to be an opioid "hot spot". While U.S. Census tract 608 has the highest population density, it is primarily single-family residential and is not zoned for businesses. It also does not house any support services identified using the methodology described above. U.S. Census tract 601, the second most densely populated, houses over 50% of all support service locations and is zoned for mixed use. Due to this factor and the high population density we selected U.S. Census tract 601 as the tract most in need of an SSP within the previously identified opioid "hot spot", EMS Zone 1. (Figure 3.2, Figure 3.3)

Figure 3.2
Washington County Census Tracts by Population Density

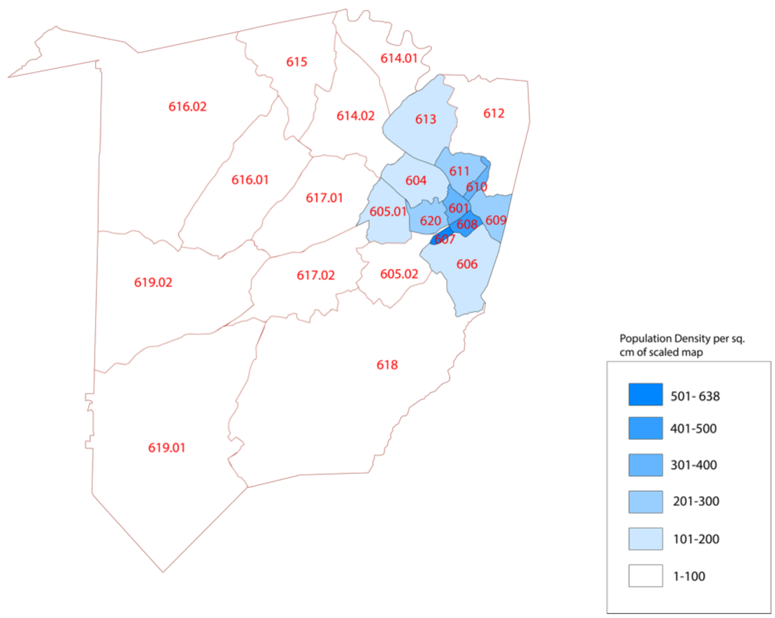
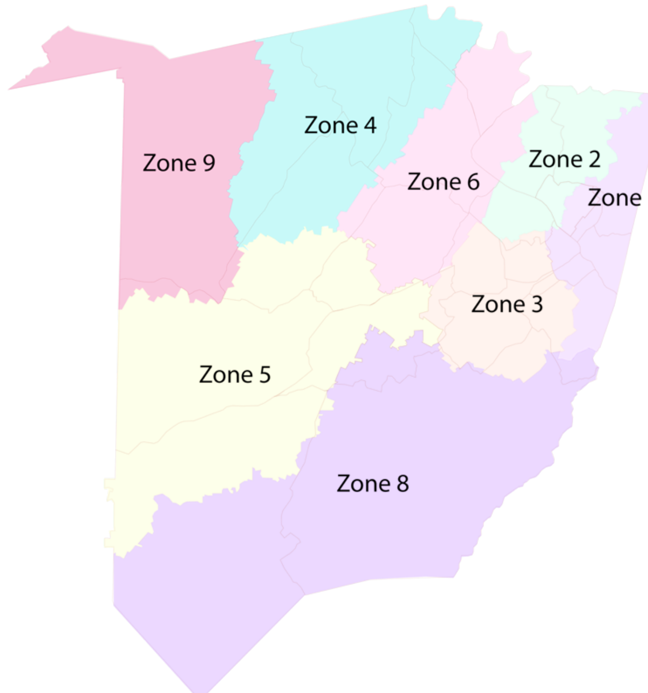


Figure 3.3
Washington County EMS Zones



In order to find a location with a high level of utility, we looked to previous studies of SSP placement and geographic public health studies. Quinn and colleagues demonstrated a similar technique in a project identifying distances and drive time to hospitals capable of stroke care in rural areas of Tennessee. Their primary measure of utility was mean travel time (Quinn, 2020). This measure is easily measurable using Google Maps, the preferred tool used by the Tennessee Department of Health to determine SSP distance from protected locations (Sanders, 2019). Previously conducted studies of SSPs in urban environments also used mean walking time and public transportation time as key measures for understanding both the risk environment of PWID and the potential utility of SSPs (Allen, Ruiz, Jones, et al., 2016; Janulis, 2016). In order to gain a more accurate picture of public transportation times, which can vary greatly over the course of a day, we calculated mean public transportation time for sites by taking the mean travel time of all available public transportation routes from a support service location to the different SSP locations. We collected this data between 12:00pm and 1:00pm on weekdays. We chose this time based on previous work and observations with PWID and other vulnerable people in Washington County. We also looked to our understanding of the Social Ecological Model for guidance. Personal use of transit would be considered as “Personal” and “Interpersonal” level factors as we have observed at risk populations typically traveling in small friendship groups or partnership dyads. Their decision to use transit at a regular time daily is influenced by the level above, or “Organizational” level decisions. The noon hour is a high transit and transition time between support services among people with IDU co-morbidities as most are traveling to or from locations offering free lunch or traveling in between services and shelters with different amenities and hours. In some cases, when we measured public transportation time between support services and the SSP sites, the public transportation directions instructed users to walk due to very close proximity between locations. In these cases, we used the walk time again as the public transit time. Due to the rural nature of the area surrounding the census tract most in need, and from anecdotal stories of rural PWID driving from rural areas across the region to access SSPs, we also included mean drive time in our model.

We calculated mean travel time across driving time, walking time, and public transportation time from support services for several intersections within the census tract that had the shortest straight-line linear distances from the support services included in the model. We found that of the hypothesized intersections, 500 N. Roan St. Johnson City, TN., had the lowest mean travel time across all three travel methods. We calculated all times using the “Directions” tool in Google Maps. After we decided on our proposed SSP location intersection within Washington County, TN, we calculated the travel times between the model of support services and the current location of the SSP in Washington County, 615 N State of Franklin Rd, Johnson City, TN for comparison. After we calculated and compared the mean travel times between the current SSP and support services versus the proposed location, we identified protected sites within U.S. Census tract 601 as mandated by TN Code 68-1-136. We identified four parks (one currently under construction), and one school within the tract. Using the "Measure Distance" tool in Google Maps, we measured outward .379 miles, the equivalent of 2000ft, from the borders of each protected site. We found that the proposed SSP location, 500 N. Roan St. was within 2000ft of all four of the protected sites within the census tract. On further examination, we found that the entire census tract is within 2000ft of a park or school. We then changed the criteria to 1000ft and found that the entire census tract would still be legally off-limits to an SSP if the law were amended. Moving outward from U.S. Census tract 601, we determined that the closest location that meets the restrictions of TN Code 68-1-136 is a small residential area to the north. We then identified the closest intersection within the selected area to support services as the corner of Hillrise Blvd., and East Holston Ave, Johnson City, TN. (Figure 3.1) We then calculated the mean travel time to this location from support services locations using the same method as described above for comparison to the existing SSP location and proposed ideal SSP location.

Results

The location of the currently operating SSP in Washington County, TN has a mean driving time of 8.3 minutes, mean walking time of 52.5 minutes, and mean public transportation time of 31.5 minutes. This is compared to a mean of 4.7 minutes driving time, 15.3 minutes walking time, and 10.0 minutes public transportation time at the proposed location. The closest legal location to the proposed location under the restrictions of TN Code 68-1-136 had mean travel times of 4.5 minutes driving, 25.8 minutes walking, and 17.2 minutes via public transportation (Table 2, Figure 1).

The range difference between organizations that currently serve the homeless and lower-income populations and the current location of the SSP varied widely. Travel time to the current SSP location from the closest support service site, a privately-owned subsidized housing complex, was 2, 7, and 7 minutes away by car, walking, and public transportation respectively. In this case, Google Maps instructed public transportation users to walk, making the public transportation travel times and walking times are identical.

At the proposed site, 500 N. Roan St., Both Watauga Mental Health Services and The Johnson City Downtown Day Center were the closest travel times with 1, 3, and 3 minutes driving, walking, and public transportation respectively (another instance of walking directions generated in place of public transportation due to proximity). The Appalachian Regional Commission on Homelessness (ARCH), was also the farthest point from the proposed SSP site at 9, 48, and 16 minutes driving, walking, and public transportation respectively. The privately-owned subsidized apartment complex that is closest to the current SSP location was the second most-distant location from the proposed site at 8, 40, and 26.5 minutes driving, walking, and public transportation, respectively.

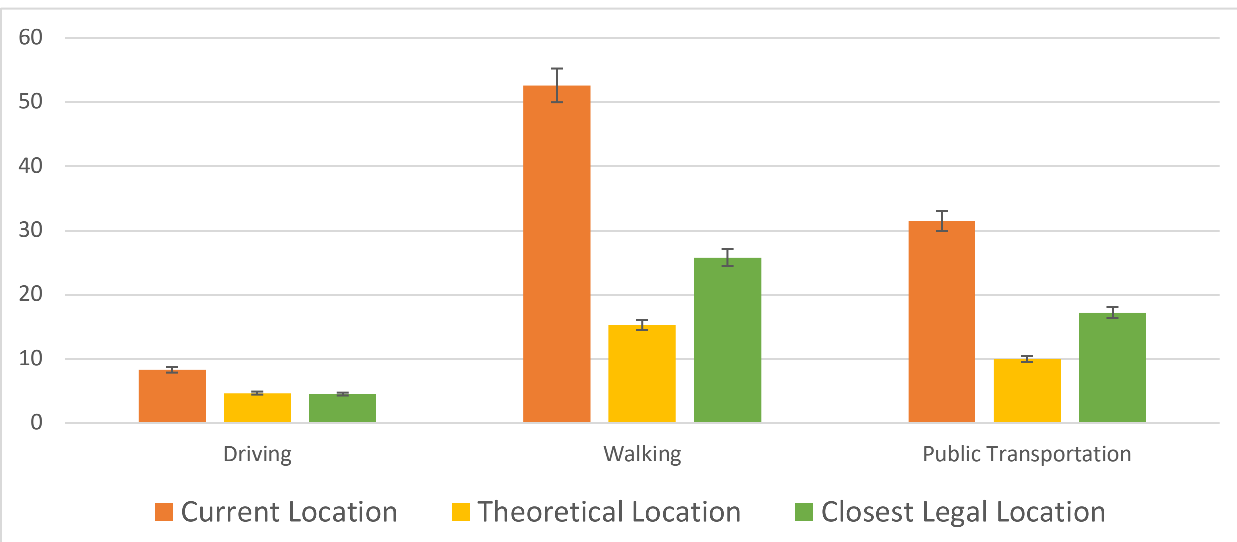
The closest legal location to the proposed site, the intersection of Hillrise Blvd. and E. Holston, was Turning Point Clinic with 2, 7, and 7 minutes travel time via driving, walking, and public transportation respectively. The Johnson City Public Library and Johnson City Downtown Day Center were the second closest locations with similar numbers. The farthest location in terms of travel time from Hillside and E. Holston was less clear with a privately-owned subsidized apartment complex, James H. Quillen VA Hospital campus, and Appalachian

Regional Commission on Homelessness (ARCH) the greatest distance away depending on mode of transport. (Table 3.2, Figure 3.4) (Additional Tables and Figures used derive results in Appendix 2)

Table 3.2.
Mean Travel Times to SSP from Support Services (in Minutes)

	Current Location	95% C.I.	Proposed Location	95% C.I.	Closest Legal Location	95% C.I.
Driving	8.3	7.5, 9.2	4.7	2.1,7.3	4.5	3.6,5.2
Walking	52.6	44.6, 60.6	15.3	8.3, 22.3	25.8	19.4, 32.2
Public Transportation	31.5	26.9, 36.0	10.0	6.6, 13.4	17.2	13.2, 21.2

Figure 3.4
Mean Travel Times to SSPs from Support Services (in Minutes)



Discussion

In comparing the current SSP location in Washington County to the proposed location, there is a practical tremendous improvement to the potential utility of the SSP for PWID. Every support service site is closer to the proposed location in comparison to the current location save for one privately owned subsidized apartment complex, located almost immediately across the street from the current SSP location. There is a substantial change in drive time between the current site and the two proposed sites. Both the proposed site and the closest legal location to the proposed site are roughly half the time to other support services in comparison to the current location. Due to the relatively small size and suburban nature of Johnson City, these time differences are not as dramatic as other forms of transit measured. The most substantial improvement in access and utility in comparison of the current location, proposed location, and the closest legal location to the proposed location is the decreased walking time. Previously cited urban studies use walking time as a basis for determining the utility of SSPs in urban environments. While there are differences between an urban and non-urban population of PWID, the closer the proximity to SSPs to the population in need, the easier it is to access services and potentially lower the risk associated with IDU.

The average ride time on public transportation was also substantially lower at both new locations compared to the current SSP location. This also demonstrates an improvement in SSP utility for PWID. However, there is a difference in walking travel time between the proposed site and the closest legal site by several minutes. The research team believes that this is due to the closest legal site being on the other side of a four-lane highway from most other support services. Highways seem to serve as a choke point, forcing people that are walking to take specific routes to cross under, adding distance and travel time to and from the potential SSP location.

Washington County, TN has less substantial public transportation infrastructure than an urban environment but still has a centralized bus system that can be utilized by PWID and optimized by service providers by choosing locations convenient to bus routes. The proposed SSP location is within 50ft or less of bus stops associated with four bus routes. The closest legal location to the proposed site has less public transportation access with one bus route in its proximity and the closest stop over 2 blocks away at major roads. The research team believes this factor is a key driver in the increased mean public transportation time due to increased walking time between the bus stop and the actual location of the closest legal location SSP.

As observed by the study staff, the limitations of placing an SSP caused by TN Code 68-1-136 may have unintended consequences. Using our empirical decision strategy for placing the SSP to the closest possible point to the proposed location yet stay within the bounds of the state law, we determined that the only places that met the criteria were primarily residential. The law seems to be intended to keep syringes from being discarded near schools or parks. This assumes that PWID discard syringes near SSPs, which is an assumption not based in evidence; SSPs offer syringe disposal services. If discarded syringes were a problem at the closest legal SSP site to the proposed site, PWID would be discarding syringes in residential neighborhoods. We believe that the legally operating SSP and its clients would suffer "Community" level stigma and "Organizational" level challenges within the Social Ecological Model if this were to happen. These challenges may make operation of an SSP more difficult at the closest legal location than if syringes were improperly disposed of at an SSP at the proposed site, near other support services in a commercially zoned section of the county.

Conclusion

As proof of concept, our study team identified a number of geographic factors, the location of Narcan administrations by EMS, the population density by census tract within the larger area of the EMS zone, and the location and density of support services within and around the most densely populated US Census tracts within Washington County, TN, to determine an ideal proposed site for an SSP. After determining the best proposed site in comparison to the existing SSP, we applied the restrictions put on SSP locations by a "Structural" or "Political" level pre-emptive state law to determine the next best location within the law's constraints. Then, we compared the utility of the three sites by calculating mean travel times via different modes of transport to identify the potential impact to utility of, and access to the SSP locations by PWID.

We argue that while it is possible to find a site that meets the restrictions of the law within the county in question, the restrictions placed on SSP location in Tennessee negatively impact the potential utility and access of sites. Walking and public transportation access were most impacted by the restrictions of the law. Further, while it appears that the framers of the law intended to prevent improper disposal of syringes in unsafe locations, the location that was closest to the proposed location and met the requirements of the law was in a primarily residential area. If PWID disposed of syringes near the legal site, it could have more negative consequences than if the SSP were at the proposed site. Arguably, the potential "Organizational" level risks to the SSP, and the "Personal" and "Interpersonal" level risks to PWID within the Social Ecological Framework may be greater at the closest legal location compared to the proposed location. It should also be noted that while improper disposal of syringes around SSP sites may be a perceived problem, there is little data to indicate that this is true. Additional research is needed to determine what factors associated with SSP placement can be modeled beyond placement in a theoretical Risk Environment framework and Social Ecological Model.

Understanding the interplay of factors associated with access and utility of SSPs will better inform ideal “Community” level placement of SSPs and the potential consequences of “Structural” or “Political” level laws limiting their locations.

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CHAPTER 4. USING RISK ENVIRONMENT, THE SOCIAL ECOLOGICAL MODEL, AND A DYNAMIC SYSTEM APPROACH TO INFORM STATE-LEVEL OPIOID POLICIES

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ABSTRACT

Background: Risk environment is a geographic measure of a person's risk of harm. Previous studies determined that risk environment to People Who Inject Drugs (PWID) is based on geographic factors. Factors at all levels of the Social Ecological Model interplay to determine personal risks and behaviors. Variables that can be applied and tested in a system dynamic model nested in the Social Ecological Model can better determine the relationship between PWID risk environment and Syringe Services Program (SSP) access and utility.

Method: In a Tennessee suburban county, we collected EMS Narcan administration data, US Census Tract data, injection drug use (IDU) support services locations, and state law restrictions to SSP placement to develop a theoretical system dynamic model nested within the Social Ecological Model theorizing factor interactions of how SSP access and utility impact the level of PWID risk environment.

Results: Our theoretical model indicates that laws limiting SSP placement increase the distance from the space where PWID travel regularly to SSPs. This increases mean travel time to SSPs. This negatively impacts SSP access and utility among PWID. The distance of support services to SSP sites has a direct negative relationship with risk environment and a direct negative relationship to the accessibilty and utility of an SSP. We also believe structural and community

stigma both directly impact fear of law enforcement among PWID, increasing PWID risk environment.

Conclusion: We theorize that "Policy" or "Structural" factors in the SEM framework negatively impact PWID risk environment. Application of our theoretical system dynamic model to non-urban (rural and suburban) areas indicates the potential to increase disparities between non-urban and urban PWID. Further research should focus on potentially decreasing stigma at the structural and community level and the potential impact on SSP placement policy, as well as the impact of policy changes to SSP placement on measures of utility and access to SSPs by PWID.

Introduction

Risk environment is a geographic measure of a person's risk of a potential health outcome. Work has been done previously to determine risk environment associated with opioid use disorder (OUD) and People Who Inject Drugs' (PWID) geographic location. A person's location can be defined from spatial factors like distance to medical services and access to other built infrastructure. Other factors, including local, state and federal laws, and policing practices associated with law enforcement can also determine the total level of risk associated with a disease or condition (Cooper et al., 2009). Factors of risk environment can be placed in a framework of four categories, physical, social, economic, and policy and each of these categories can be either micro or macro in nature. Micro factors occur within smaller physical areas such as a home, a single block, or neighborhood. Macro factors are at the city, county, or country of residence (Rhodes, 2002; Rhodes & Simic, 2005).

In the environment where PWID live, multiple factors at all levels of the Social Ecological Model, “Personal”, “Interpersonal”, “Organizational”, “Community”, and “System” (sometimes referred to as “Policy” or “Structural”) interplay to determine daily personal risks and behaviors. “Organizational” up to “Structural” or “Policy” level factors can all be malleable to “Environmental Change Strategies of Health Promotion”. Changes in the environment at any of the upper levels of Social Ecological Model can also reduce (or increase) injurious conditions (Stokols, 1996).

The application of the Social Ecological Model framework can be further refined to determine other variables to be tested in relation to SSP access and utility to PWID. By placing factors from levels of the Social Ecological Model in a system dynamic model, we can start to understand the complex interaction of factors that ultimately influence PWID risk environment. A system dynamic model is a model where outputs (or outcomes) depend on both past and present values of the inputs into the model (Bahill & Szidarovszky, 2008). It is made of heterogeneous elements that interact with each other. The interactions produce an emergent effect that is different from the individual elements. The resulting effect is dynamic over time and changes as inputs change (Luke & Stamatakis, 2012). Another way to think of a dynamic system model is a theoretical model set in motion in a population.

There has been limited application of system dynamic modeling to OUD or any of the associated co-morbidities including opioid overdose. System dynamic modeling has not been used on the prevention side looking at factors associated with successful interventions preventing infectious diseases or opioid overdose. The only known opioid OUD model is by Wakeland et al. (2015) and demonstrates the complexity of opioid misuse and the precipitous decline in recreational use of prescription opioids to the transition and addiction to heroin (Wakeland, Nielsen, & Geissert, 2015).

The Committee on Pain Management and Regulatory Strategies to Address Prescription Opioid Abuse highlighted the Wakeland et al. model as a strong innovation in recognizing the complexity of opioid misuse, but called for additional models to address potential interventions targeting PWID, stating, “Creating such models would have important advantages: it would guide and strengthen surveillance and research, foster a common policy vocabulary” (National Academies of Sciences Engineering and Medicine, 2017).

Application of Social Ecological Model to Proposed SSP Site Location

Syringe services programs (SSPs) are considered the primary point of risk prevention among PWID. They are considered the key structural element in lowering risk environment among PWID in relation to Human Immunodeficiency Virus (HIV), Acquired Immunodeficiency Syndrome (AIDS), and Hepatitis C (HCV) (Des Jarlais, 2000). As a proposed environmental change strategy, our research team developed an evidence-based method to inform where an SSP should be placed in the built environment to provide the greatest point of accessibility and utility to PWID in a suburban Tennessee county.

We used Emergency Medical Services (EMS) Narcan administration data to determine the areas of highest risk of opioid overdose in a suburban Tennessee county. First, we identified the “EMS zone”, a predefined area within the greater county area, with the highest rate of EMS Narcan administration as a proxy for high levels of opioid use. After determining the area, we applied U.S. Census tract data information and the geographic location of known support services associated with opioid use disorder co-morbid conditions within the county. This identified the census tract most appropriate for SSP placement. We then calculated mean travel times driving, walking, and using public transportation as a measure of accessibility and utility to PWID to determine the ideal placement of a proposed SSP within the county of study.

We propose that focusing on the area most at-need through identification of the area of highest risk environment creates the potential for change at the “Community” level within the Social Ecological Model framework (Bronfenbrenner, 1977). Each subsequent level under “Community” can be impacted positively in relation to OUD and opioid overdose. As Stokols argues, any positive change to the environment at any level can have a cumulative positive impact on the strata below (Stokols, 1996) The effect is stronger the the higher the level of change. By making changes at the “Community” level, the positive impact can potentially impact the “Individual”, “Interpersonal”, and “Organizational” levels below. By placing SSPs in areas with the highest risk, the environment surrounding PWID can be an “enabler of health behavior” versus an area of increasing risk due to improved proximity of services. Additionally, as PWID engage in the harm reduction practices taught and employed by more-accessible SSPs, more PWIDs could be exposed to interpersonal modeling of health behaviors, leading to shifts in risk culture (Stokols, 1996).

Application of Social Ecological Model to Barriers to SSP Placement

The Social Ecological Model framework can also be applied when addressing barriers to SSP placement. SSPs have history as a controversial public health intervention. There have always been arguments that SSPs facilitate if not outright promote drug use. While there has been a ban on federal dollars being used for the purchase of sterile syringes for illicit drug use since 1988, the federal government has since endorsed SSPs as “an effective part of a comprehensive strategy to reduce in incidence of HIV transmission and do not encourage the use of illegal drugs" (Shalala, 1998). Regardless of years of evidence demonstrating the value of SSPs in combating the spread of disease and improving the health of PWID, laws have been written in some jurisdictions that limit the placement of SSPs essentially to deter PWID engaging in injection drug use (IDU) and related behaviors in and around certain locations.

The primary concern about SSPs regarding safety has been the placement of SSPs near schools and parks. In Washington D.C., a local ordinance started restricting the placement SSPs within the city in 2000. SSPs cannot operate within 1000ft of a school. Studies have indicated that this restriction negatively impacted SSP coverage. It has been estimated that there was a 50% drop in SSP coverage since the law went into effect (Allen, Ruiz, Jones, et al., 2016). Additionally. SSPs were less able to target "hot spots" of opioid use in D.C. Between 52% and 88% of known opioid use hot spots between 2015 and 2018 within Washington D.C. could not be reached because of the current law (Allen, Ruiz, Jones, et al., 2016). This law was repealed in 2019 (D.C. Law 22-288, 2019). The city council in Denver, Colorado limited mobile SSPs, the only method legal in the city at the time, from operating within 1000ft of a school. This eliminated SSP access within the city limits of Denver. Due to a demonstration of the complete lack of access by agencies trying to offer mobile SSP, the city council modified the law, allowing mobile SSPs to operate in the city except within city parks or on sidewalks that border city parks (Asmar, 2013). Finally, in the case of our above-mentioned project in Tennessee, TN Code 68-1-136 restricts placement of SSPs in rural and suburban areas to not "within two thousand feet (2,000') of any school or public park" in non-metro areas. Metro areas are defined in this law as areas with more than 165,000 people and are granted 1000ft buffer from schools or parks (TN Code 68-1-136, 2017).

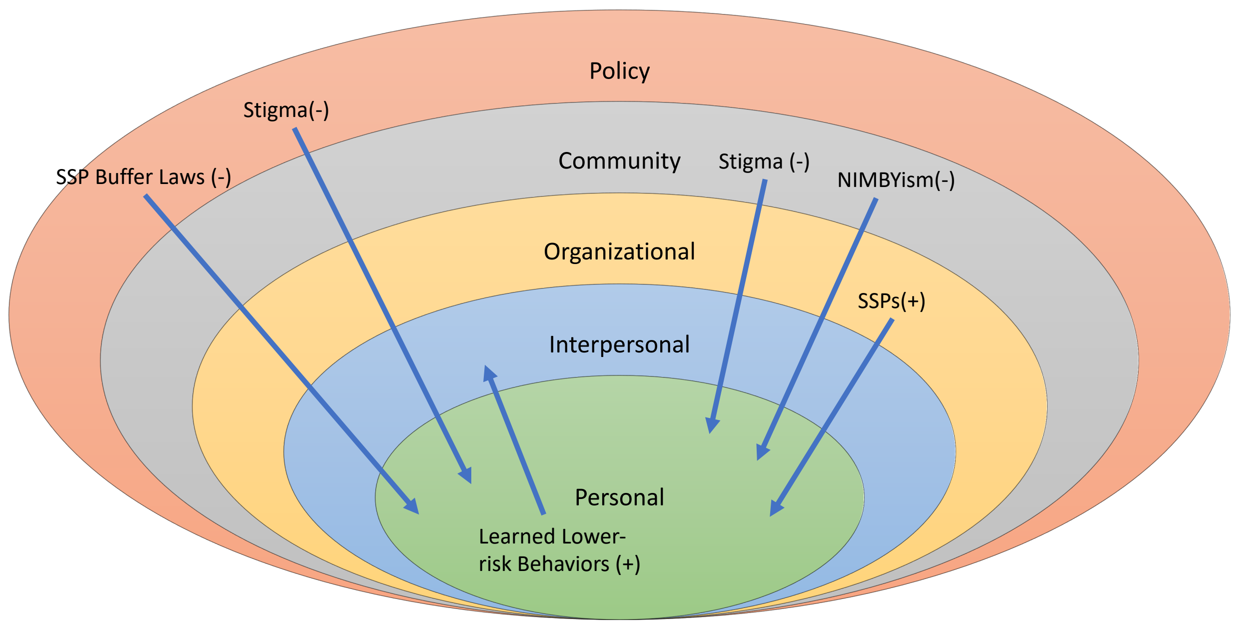
When applying the restrictions of TN Code 68-1-136 to the U.S. Census tract for the area we found to be the highest risk environment for opioid use and co-morbidities, the entire tract was restricted from SSP placement. This was due to three existing and one planned park, and one public school. Additionally, there are some grey areas in the law that are not explicitly addressed, the most pertinent being the standing of private schools, pre-schools and daycare programs. If these programs are included in geographic restrictions, there are at least two more protected sites within the U.S. Census tract in question. Essentially, in order to comply with current Tennessee law, any SSP targeting the community of PWID in this suburban Tennessee county cannot be located in the area the evidence suggests it is most needed.

The research team identified the closest legal location to the originally proposed location. The closest legal location to the proposed location was in a residential area to the north of the proposed site, outside of the census tract most at need for an SSP. It had less public transportation access with one bus route in its proximity versus four at the originally proposed site. It also had a mean walking time ten minutes longer, and public transportation time over seven minutes longer than the originally proposed site. While these differences are explicit, measurable differences in access and utility for PWID, the research team believes there are implicit factors to consider in association with restricting placement of SSPs. In the case of the county of study, the closest legal area to the original site where the SSP could be placed is an irregularly shaped 1.9 sq. mile area that is entirely residential and intersects a raised four lane highway. The irregular shape of the area is due to other parks and schools that surround it. There is a long history of SSP placement and Not In My Back Yard (NIMBYism) activism among communities (Strike, Myers, & Millson, 2004). This history leads the research team to believe that SSP placement literally in the front yard of a previously residential property on a residential street would be more controversial at the “Community” level within the Social Ecological Model than placement within 2000ft of a school or park in an area with multiple pre-existing opioid use support service locations. It is unknown to the research team if the intent of the law was to make SSP placement difficult in rural or suburban areas, but in the case of our work in one Tennessee suburban county, TN Code 68-1-136 increases the difficulty of placement while also lowering the potential utility and access to SSPs in the area they are needed most.

When placing TN Code 68-1-136 in the Social Ecological Model framework, the law is at the “Structural” or “Political” level, negatively impacting each corresponding level below it. Only by amending or repealing sections of TN Code 68-1-136, can SSPs can be placed in the most adventagious locations at the “Community” level and positively impact the subsequent levels of the Social Ecological Model. Positive change, or in this case removel of a barrier to change in the environment, can have a cumulative positive impact on all levels. By making changes at the highest level of Social Ecological Model, “Structural or “Policy”, the positive impact on the layers below are potentially the highest (Stokols, 1996) (Figure 4.1).

Figure 4.1

Social Ecological Model and Syringe Services Program Placement



SSP Utility and Access in a Dynamic System Model

The first step in developing a system dynamic model is to define the conceptual definitions of the constructs that will make up the proposed model. Definition of concepts is necessary to understand more complex and specific definitions and measurements. Not all definitions are included in the model. Some definitions are needed to build understanding and context of other more complex definitions. This also allows a basis for measurement of change in variables as models go from theoretical to practical application (Jaccard & Jacoby, 2010). We also assign placement on the Social Ecological Model hierarchy within our definitions to understand the potential impact of each definition and to aid in placement within the theoretical system dynamic model.

Definitions

IDU is a method of illicit drug use. The drug of choice is injected directly into the body, either into a vein, muscle or under the skin with a needle and syringe. Types of drugs that are typically injected are opioids including heroin, cocaine, and methamphetamines (U.S. Department of Health and Human Services, 2018). **Social Ecological Model Level: Personal**

People Who Inject Drugs (PWID) are defined as people who had injected an illicit substance in the past 12 months. This is the standard definition in many inclusion criteria in meta-analyses focusing on injection drug use (Degenhardt et al., 2017). **Social Ecological Model Level: Personal**

Syringe Services Programs (SSP) are defined as programs that provide access to sterile needles and syringes free of cost and provide disposal services of used needles. Ideally, SSPs work to provide additional services and care as outlined in the CDC summary guidance for integrated prevention services (Centers for Disease Control and Prevention (CDC), 2012). **Social Ecological Model Level: Organizational**

Social stigma is defined as social phenomena when large groups of the population endorse negative stereotypes and act against a stigmatized group (Livingston, Milne, Fang, & Amari, 2012). For the purposes of this model, this definition is further refined to **Community Stigma of PWID.** We define this as stigma held by community members directed at PWID.

Structural stigma of PWID is defined as rules, policies and procedures of institutions that restrict the rights and opportunities for stigmatized groups (Livingston et al., 2012). In the case of our model, this definition is structural stigma held by political entities directed at

PWID including barriers to access to SSPs. **Social Ecological Model Level: Community, Structural**

Mean Travel Time to SSP is defined at the average time it takes to travel to an SSP from a constellation of IDU-related support services. Mean travel time driving, walking, and using public transportation is a metric used previously by the research team. **Social Ecological Model Level: Structural/Community**

Distance from PWID Activity Space is defined as the distance from a PWID's area they navigate regularly to complete tasks. It has been used as a measure in determine distances related to risk environment among PWID (Martinez et al., 2014). **Social Ecological Model Level: Personal**

Distance of Support Services is defined as the geographic distance between IDU support services and the location of an SSP. It has been used as a measure of access and utility to SSPs by PWID by the research team previously. **Social Ecological Model Level: Interpersonal**

Legal Buffer Zone Between SSP and protected space is defined as the geographic distance between a park or school and the location of a SSP. It has been used as a measure of barriers to SSPs placement by the research team and in previous studies of political barriers to SSP placement. This distance will change depending on state and local laws (Allen, Ruiz, Jones, et al., 2016; Allen et al., 2015; Asmar, 2013). **Social Ecological Model Level: Structural**

SSP Access/Utility is defined as a measure of ease of access and maximization of utility to PWID an SSP provides due to location and other factors. **Social Ecological Model Level: Organizational**

Fear of Law Enforcement is defined as fear felt by PWID of dealing with police due to stigma and potential arrest for possession of IDU paraphernalia (Cooper et al., 2009, 2005). **Social Ecological Model Level: Interpersonal / Organizational**

PWID High Risk Environment is defined as physical, social, economic, and policy factors at the micro level of risk environment that as a whole create an environment of higher risk to PWID (Rhodes, 2009). **Social Ecological Model Level: Interpersonal/Personal**

PWID Low Risk Environment is defined as physical, social, economic, and policy factors at the micro level of risk environment that as a whole create an environment of lower risk to PWID (Rhodes, 2009). **Social Ecological Model Level: Community**

Theoretical Model Description

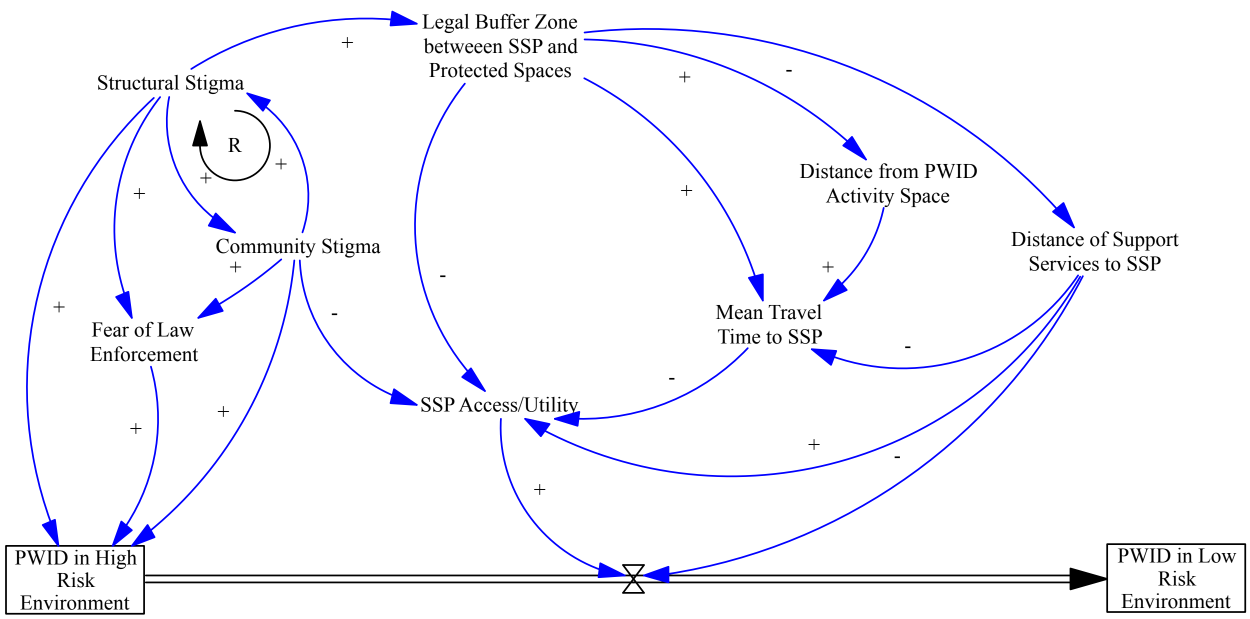
We used Vensim PLE for Macintosh Version 8.0.1 to develop our theoretical system dynamic model. In this theoretical system dynamic model, we chose our measurable stock to be factors of PWID micro risk environment. We theorize a change of micro risk environment from a combination of factors creating higher risk to a combination of factors creating a low risk, or even protective micro risk environment. With this measurable stock of the number of PWID within a community, we theorize that the relationship between the other defined factors is related to improving the risk environment of PWID.

In our theoretical dynamic system model, we theorize that the size of a legal buffer zone between the proposed site of an SSP and protected spaces like parks and schools has a positive impact on the distance from PWID activity spaces. This means that as the legal buffer space size increases, the distance from the space where PWID travel regularly will increase. This leads to an increase in mean travel time to SSPs for PWID which negatively impacts SSP access and utility among PWID. We theorize that "SSP Access/Utility" is the primary factor in potentially lowering the micro risk environment among PWID. In this theoretical model, the legal buffer zone between SSPs and protected spaces directly negatively impacts both the distance of the support services and mean travel time to a proposed SSP site. Our previously discussed primary data supports this theory. We also believe that the distance of support services to SSP sites has a direct negative relationship to the accessibilty and utility of an SSP to PWID.

In our model, we posit that the key factor that impacts the size of the legal buffer zone between and SSP site and the protected spaces is structural stigma. We further theorize that structural stigma and community stigma are linked in a positive feedback loop in that laws that limit the placement of SSPs increase stigma in communities and increased stigma in communities leads to increased stigma of PWID at the structural level which leads to additional laws that limit the placement of SSPs in communities. Both structural and community stigma directly impact fear of law enforcement among PWID which increases the risk of PWID micro environment. Both structural and community stigma also have a positive relationship with the number of PWID functioning in a higher risk micro environment as increased stigma leads to less-safe practices among PWID. We also posit that community stigma directly negatively impacts SSP access and utility. An illustration of our proposed model is in Figure 4.2 below.

Figure 4.2

A Theoretical System Dynamic of PWID Risk Environment and SSP Access and Utility



Conclusion

Applying the Social Ecological Model, and system dynamic modeling to current limitations on SSP placement policy like city ordinances in Washington DC and Denver, CO and Tennessee law, TN Code 68-1-136 shows us the potential impact of state laws on individuals. These laws have a greater impact on the risk environment of PWID as they occur at the "Structural" or "Political" level of the Social Ecological Model and therefore have the potential to negatively impact each corresponding level below. This potentially impacts suburban and rural PWID in Tennessee due to the different legal distances from parks and schools depending on an area's population as prescribed by TN Code 68-1-136. This has the potential to further increase disparities between non-urban and urban PWID. We believe that these restrictive policies are primarily structural and community stigma driven. We have identified potential sources of data for variables outside the scope of this project to include in model measures in future iterations. These data sources are found below, in Table 4.1.

Table 4.1
Social Ecological Model Levels of Theoretical System Dynamic Model

Variable	SEM Level	Data Source
Structural Stigma	Structural/Political	Policy Analysis as described in (Hatzenbuehler, Keyes, & Hasin, 2009)
Community Stigma	Community	Exploratory Factor Analysis as described in (Sorhaindo, Karver, Karver, & Garcia, 2016)
Fear of Law Enforcement	Interpersonal / Organizational	Policy Analysis as described in (Crofts & Patterson, 2016)
Legal Buffer Zone between SSP and Protected Spaces	Structural/Political	Analysis of State Law/Local Ordinance
SSP Access and Utility	Personal	Additional Measures to Collected Primary Data
Mean Travel Time to SSP	Organizational	Collected Primary Data
Distance from PWID Activity Space to SSP	Personal	Qualitative Interview as described in (Martinez et al., 2014)
Distance from Support Services to SSP	Community	Collected Primary Data
PWID Risk Environment	Personal	Scale to be determined from Model All Measures

Further research should focus on the potential of decreasing stigma at the structural and community level and the impact on SSP placement policy. More research of buffer-zone policy changes on measures of utility and access to SSPs by PWID is also needed. We believe that the proposed model could be improved and expanded on two fronts, first the addition of primary data measures to add weight and powers to variables, and the inclusion of additional factors like measures of rurality, access to primary care medical services, co-morbidities including mental health status, HIV/AIDS or HEPC status, and housing security.

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CHAPTER 5. CONCLUSION

The results of this work further demonstrate a need to expand research to the risk environment level to adequately address the opioid epidemic in rural and suburban areas. Surveillance data at the “Structural” or “Political” level of the Social Ecological Model is sub-optimal in suburban and rural settings given their relatively small area compared to larger urban areas. County statistics do not highlight the areas in most need of intervention at the “Community” level as demonstrated in Aim 1. The areas of higher risk that are smaller than a county at the “Community” level and the PWID that occupy them risk being overlooked, comparatively under-served, and further marginalized. As an example, there was a significantly higher incidence rate of “Organizational” level EMS Narcan administration in “EMS zone 1” versus the county administration rate and the administration rates in other EMS zones. This zone likely represents an environment of increased risk for overdose that is not otherwise visible with “Structural” or “Political” level county data.

Use of novel data sources, like “Organizational” level EMS Narcan administration provides better “Community” level insight because it includes geographic information. It offers a more complete understanding of OUD and potential opioid overdose at the “Community” and sub-community level. We believe that other data sources like hospital Narcan administration data may appear to be “Community” level but are actually more in line with “Structural” or “Political” level data in the Social Ecological Model due to hospitals being at a fixed location. This may be especially true in suburban and rural areas as hospitals in these areas provide regional emergency department coverage versus in urban centers with multiple hospitals and emergency departments operating within smaller geographic areas.

This new methodology also demonstrates a streamlined approach using easily accessible and understandable data. Using EMS Narcan administrations as a proxy for problematic opioid use also offers opportunity for collaboration, information sharing, and coalition building between public health, harm reduction, and emergency medical entities. Such surveillance partnerships may position coalitions to identify and react quickly to emergening hotspots of OUD, opiod overdose, or infectious disease clusters previously seen in rural areas.

In determining the geographic factors linked to SSP placement in communities, collection and analysis of "Community" level local data is key to understanding the impact of any SSP site location on PWID living within an area. "Structural" and "Political" level county data does not provide an accurate depiction of factors that best determine SSP placement as demonstrated in Aim 2. Understanding of local population distribution, existing locations of services related to OUD, as well as knowledge of EMS Narcan administration locations and public transportation provides a more-complete assessment of SSP placement, access, and utility.

In the case of Tennessee, with "Structural" or "Political" level pre-emptive state restrictions on SSP placement, "Community" and sub-community level data further addresses the constraints of legally mandated buffer-zones around schools and parks. Without "Community" and "Organizational" level local understanding, placement of an SSP within the constraints of the law that also meets a basic level of utility to the greatest number of potential clients would be exceedingly difficult. Looking to the Social Ecological Model, "Community" level local civic engagement around SSP placement and advocacy for repeal or modification of pre-emptive state laws may also offer a path for increased access to and improved geographic placement of SSPs.

Lack of understanding of "Community" and "Organizational" level local factors associated with PWID and SSP placement may be a driving factor for the unintended consequence of poor "ideal" location for SSPs as demonstrated in Aim 2. In our example county, one of the only places to legally operate an SSP in proximity to the area of greatest need was a residential neighborhood. And while the framers of the Tennessee law and similar municipal laws in urban centers like Denver, CO and Washington D. C. appear to be attempting to prevent improper disposal of syringes in unsafe locations, the potential legal SSP location in the suburban county highlighted in Aim 2 could cause community backlash and increase "Community" level stigma towards PWID and SSPs.

The power of localized data relative to PWID and SSP placement in suburban and rural areas also demonstrates the greatest limitation to this study. Many aspects of this project including recoding "Organizational" level EMS Dispatch data determining "hot spots", identification of the U.S. Census tract most at need for an SSP, and evaluation of access and utility of SSPs to PWID all rely heavily on "Community" and "Organizational" level local knowledge, relationships, and field experience. Replication of this work may be difficult in other suburban or rural regions without strong "Community" and "Organizational" level relationships with similar entities used in data collection and model building in this project. The use of Google Maps is imperfect for highlighting protected areas without first-hand "Community" and "Organizational" level knowledge of in-process or slated projects that will add additional limitations to future SSP placement.

Application of the theory of Risk Environment framework, Social Ecological Model, and system dynamic modeling to the findings of Aim 1 and 2 shows us that the micro level of PWID risk environment is negatively impacted by the "Structural" or "Political" level factors of the pre-emptive Tennessee law. Within the proposed theoretical system, the "Structural" or "Political" level law is a key driver determining the impact of multiple other factors of utility and access to

SSPs by PWID. State and federal laws have a greater impact on the risk environment of PWID as they occur at the “Structural” or “Political” level of the Social Ecological Model and negatively impact each corresponding level below. This has the potential to increase already-present “Personal” and “Interpersonal” level disparities among suburban and rural PWID. TN Code 68-1-136 prescribes a smaller buffer zone around parks and schools for defined urban areas, potentially creating greater disparities.

Pressure to change “Structural” or “Political” level factors within the Social Ecological Model by “Organizational” and “Community” level entities is entirely possible. “Community” level advocacy among city and county governments paired with evidence-based information and education on SSP access and utility by “Organizational” level entities has the potential to positively impact the micro risk environment of PWID. “Community” and “Structural” level educational interventions may have an effect stopping or slowing stigma moving downward through the levels of the Social Ecological Model. This could directly improve “Interpersonal” and “Personal” level factors of PWID and create an indirect effect moving upward to impact “Community” level policy which has the best chance of impacting “Structural” or “Political” level policy.

Currently, “Structural” or “Political” level county data cannot determine “hot spots” of OUD. This proof of concept method using “Organizational” level EMS data can provide a tool for “Community” and “Organizational” level entities to find the best location for SSPs to impact the “Personal” and “Interpersonal” level micro risk environment of PWID. Identifying measures of “Personal” and “Interpersonal” level utility/accessibility for PWID can identify improved locations for “Organizational” level SSPs but, “Structural” or “Political” level legal restrictions may lower utility/accessibility of SSPs especially for rural/suburban PWID. Current “Structural” or “Political” level factors in the Social Ecological Model framework negatively impact PWID risk environment. “Structural” or “Political” and “Community” level interventions among state, city, and county governments have the highest potential to positively impact PWID risk environment. We believe that our system dynamic model should continue to be improved and expanded upon with the inclusion of additional primary and secondary data to create a testable model. This would allow for the creation of “Community” and “Organizational” level interventions for modification of “Personal” and “Interpersonal” level variables to PWID micro risk environment. Through future model improvement, we can better impact SSP access and utility for the most at-risk suburban and rural PWID and inform policy at the local, state, and federal level.

At the conclusion of this project, we developed a targeted policy brief for Tennessee state lawmakers highlighting potential barriers to SSP placement caused by TN Code 68-1-136, 2017. The brief is included as an appendix in this document. Our intention was to draw attention to disparities between urban and non-urban PWID in Tennessee that not otherwise be understood by state lawmakers. We also wanted to explain the problems previously caused by buffer laws in example urban areas that may be present and possibly exaserbated in non-urban areas in Tennessee. Ultimately, we hope to both inform state lawmakers and propose collaborative efforts to further examine and potentially amend the current law based on the findings from this project.

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APPENDICES

APPENDIX A: ADDITIONAL TABLES AND FIGURES USED TO DERIVE AIM 1 RESULTS

Table 1.
Raw Counts of EMS Narcan Administrations by EMS Dispatch Zone by Year

Year	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 8	Zone 9	Uncoded	Total
2016	44	20	9	14	19	6	5	3	5	125
2017	38	11	18	15	17	9	8	4	6	126
2018	48	20	16	12	19	9	8	3	2	137
Total	130	51	43	41	55	24	21	10	13	388

Figure 1.
Raw Counts of EMS Narcan Administrations by EMS Dispatch Zone by Year

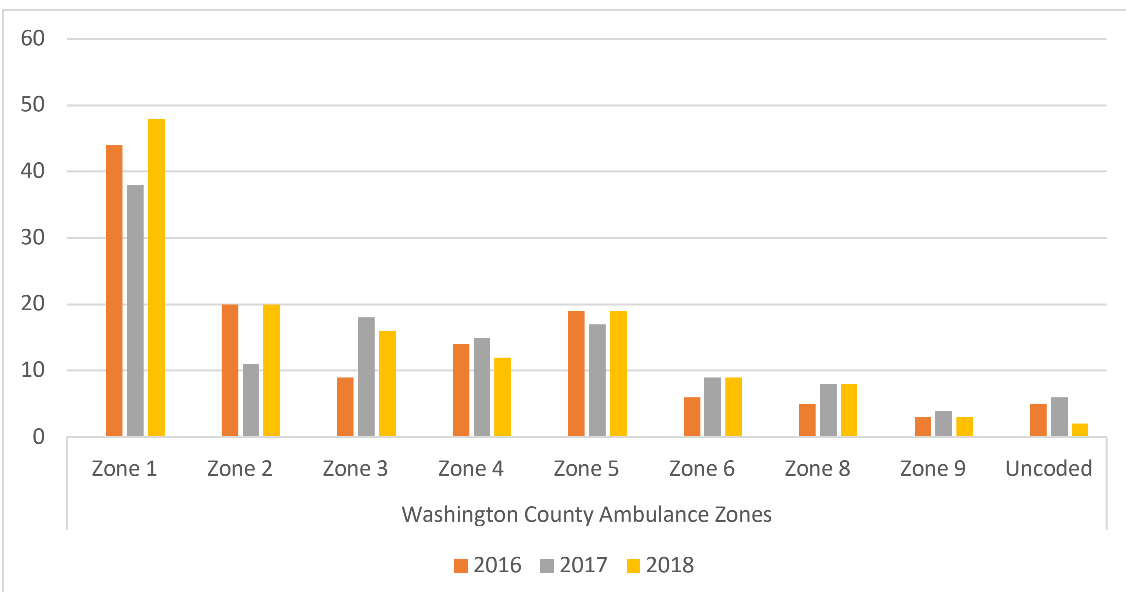


Table 2.
Estimated Population per Area of Census Tract at Scale. Washington, Co. TN. 2016

Census Tract #	Estimated Pop (2016)	Error +/-	Total mapped sq. cm	Est. Pop per sq. cm
601	3424	406	9.28	369.12
604	6175	445	34.74	177.75
605.01	5075	445	35.17	144.29
605.02	5440	718	56.19	96.82
606	7548	570	61.66	122.41
607	1933	265	3.03	637.11
608	3186	412	7.25	439.39
609	5900	621	19.68	299.84
610	2301	413	5.77	398.72
611	4453	360	20.70	215.09
612	3598	453	105.87	33.98
613	8343	573	62.14	134.25
614.01	5686	469	67.43	84.33
614.02	6868	490	109.82	62.54
615	8032	569	106.87	75.16
616.01	4160	268	150.69	27.61
616.02	8809	554	428.50	20.56
617.01	6613	459	115.55	57.23
617.02	7216	532	110.22	65.47
618	6590	358	485.03	13.59
619.01	6678	462	431.96	15.46
619.02	4909	392	239.54	20.49
620	3500	421	16.89	207.25
Total	126437			

Table 4.

Rate of EMS Narcan Administrations by EMS Dispatch Zone. Washington Co. TN 2016

	Rate per 10,000	95% C.I.
Zone 1	16.70	12.43, 22.43
Zone 2	14.57	9.40, 22.57
Zone 3	4.94	2.57, 9.49
Zone 4	8.37	4.96, 14.12
Zone 5	12.56	8.02, 19.69
Zone 6	3.77	1.69, 8.38
Zone 8	3.65	1.52, 8.76
Zone 9	4.25	1.32, 13.17

Figure 2.

Rate of EMS Narcan Administrations by EMS Dispatch Zone. Washington Co. TN 2016

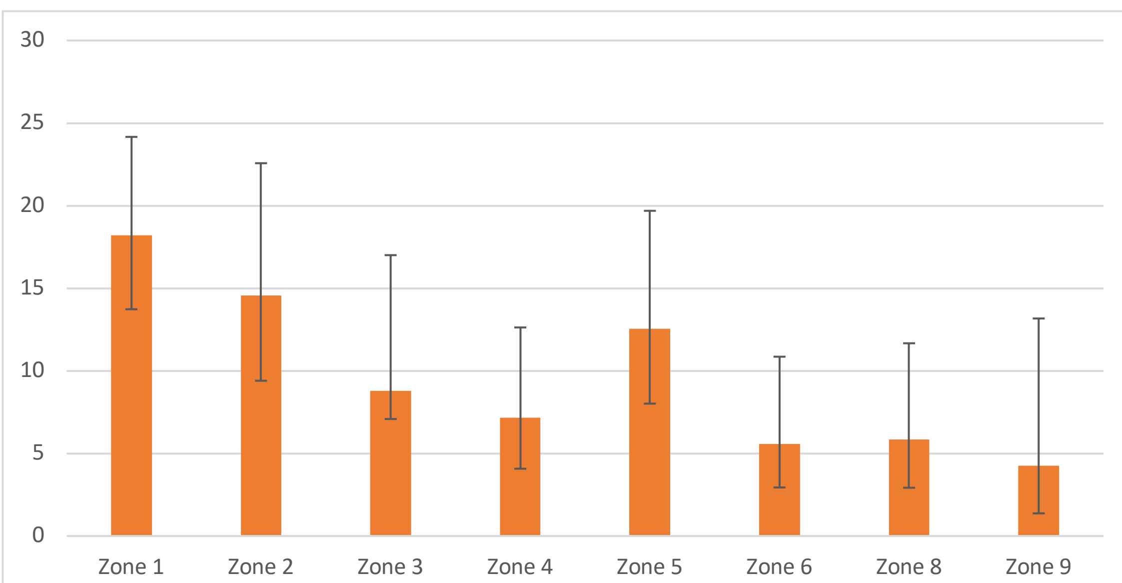


Table 5.
Rate of EMS Narcan Administrations by EMS Dispatch Zone. Washington Co. TN 2017

	Rate per 10,000	95% C.I.
Zone 1	14.42	10.50, 19.89
Zone 2	8.01	4.44, 14.46
Zone 3	9.88	6.22, 15.67
Zone 4	8.97	5.41, 14.87
Zone 5	11.24	6.99, 18.08
Zone 6	5.65	2.94, 10.86
Zone 8	5.84	2.92, 11.67
Zone 9	5.67	2.13, 15.09

Figure 3.
Rate of EMS Narcan Administrations by EMS Dispatch Zone. Washington Co. TN 2017

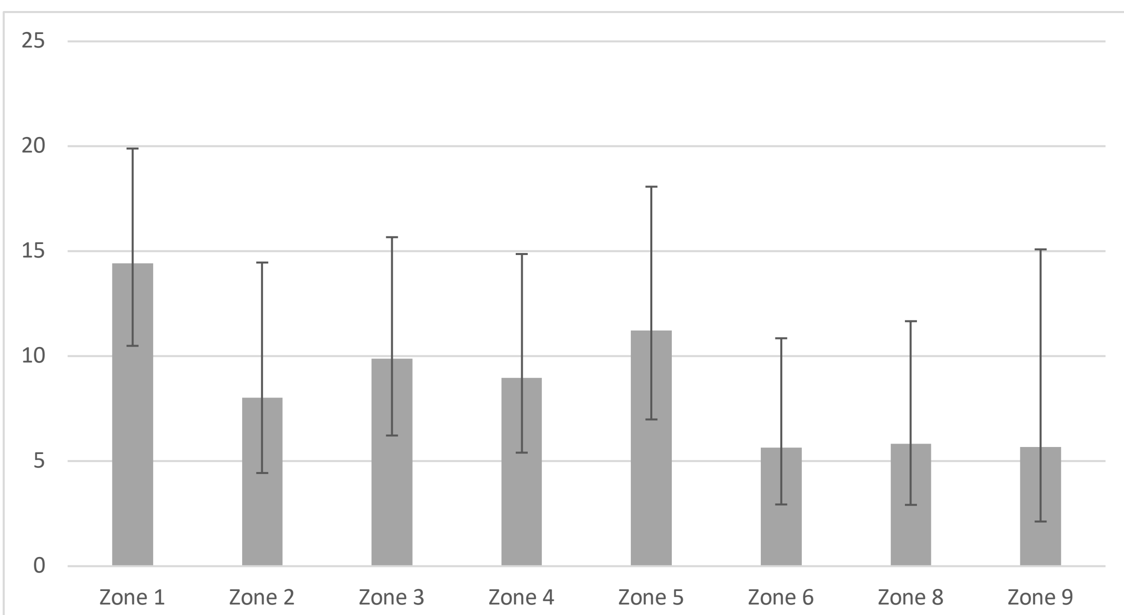


Table 6.
Rate of EMS Narcan Administrations by EMS Dispatch Zone. Washington Co. TN 2018

	Rate per 10,000	95% C.I.
Zone 1	18.22	13.73, 24.17
Zone 2	14.57	9.40, 22.57
Zone 3	8.78	7.08, 17.01
Zone 4	7.17	4.08, 12.63
Zone 5	12.56	8.02, 19.69
Zone 6	5.56	2.94, 10.86
Zone 8	5.84	2.92, 11.67
Zone 9	4.25	1.37, 13.17

Figure 4.
Rate of EMS Narcan Administrations by EMS Dispatch Zone. Washington Co. TN 2018

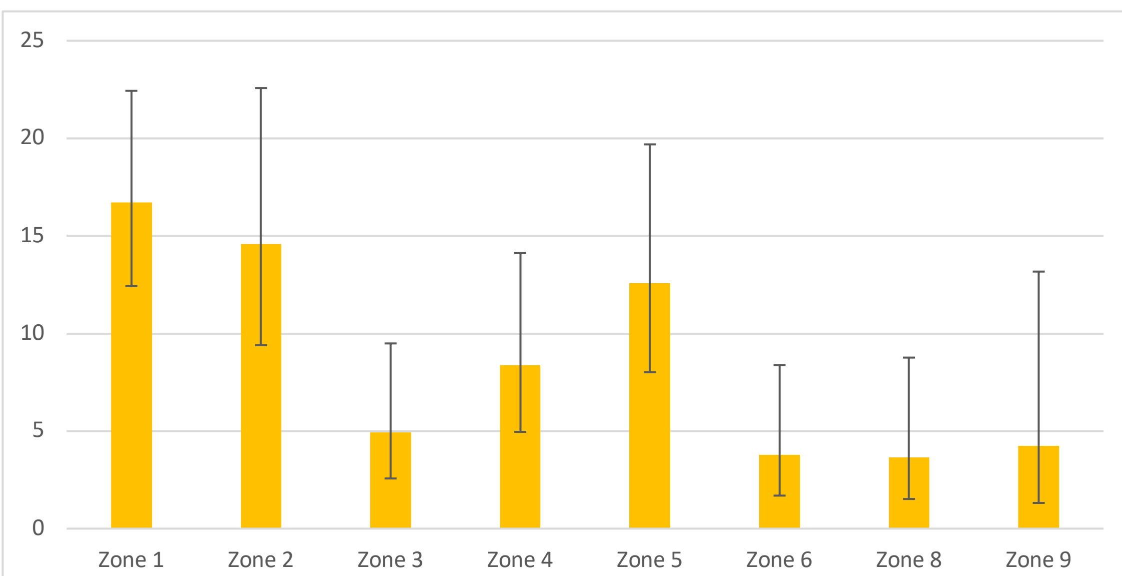
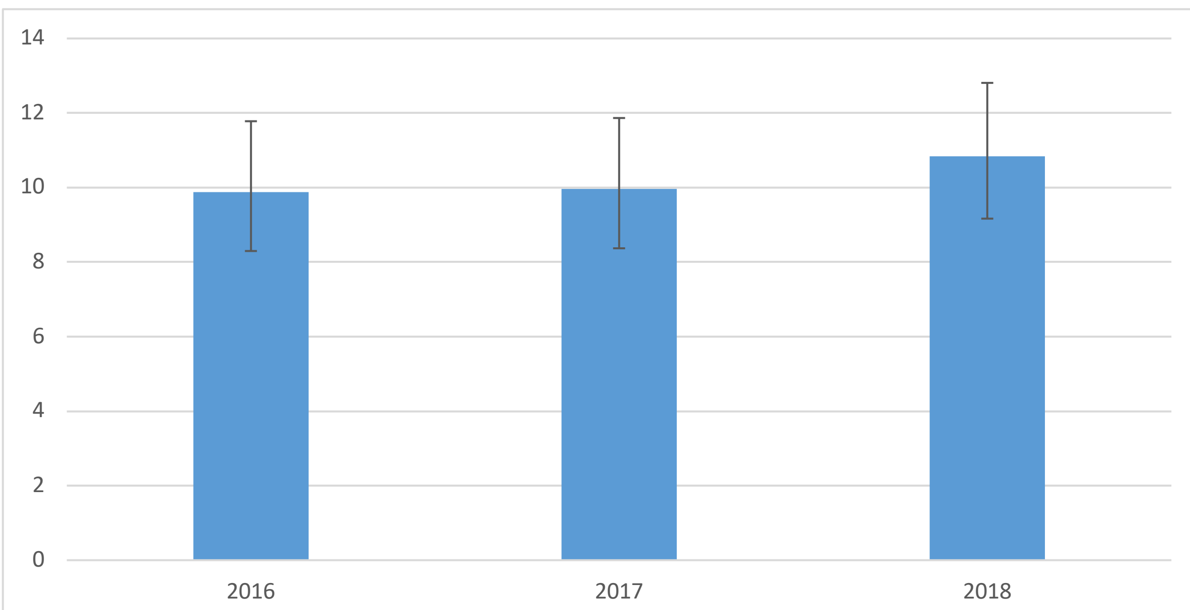


Table 7.
Rate of EMS Narcan Administrations. Washington Co. TN 2016-2018

	Rate per 10,000	95% C.I.
2016	9.89	8.30, 11.78
2017	9.97	8.37, 11.87
2018	10.84	10.84, 12.81

Figure 5.
Rate of EMS Narcan Administrations. Washington Co. TN 2016-2018



APPENDIX B: ADDITIONAL TABLES AND FIGURES
USED TO DERIVE AIM 2 RESULTS

Table 1.
Mean Public Transit, Drive Time, Walk Time from Current SSP Location

Mean Public Transit		*Drive Time*		*Walk Time*	
Mean	31.46714286	Mean	8.33333333	Mean	52.5714286
Standard Error	2.181690383	Standard Error	0.41991488	Standard Error	3.83813659
Median	30	Median	8	Median	52
Mode	28	Mode	8	Mode	54
Standard Deviation	9.997761321	Standard Deviation	2.05715436	Standard Deviation	17.5885515
Sample Variance	99.95523143	Sample Variance	4.23188406	Sample Variance	309.357143
Kurtosis	2.867918404	Kurtosis	3.93998167	Kurtosis	2.8867131
Skewness	0.395272647	Skewness	-0.4915567	Skewness	0.19949006
Range	51	Range	11	Range	87
Minimum	7	Minimum	2	Minimum	7
Maximum	58	Maximum	13	Maximum	94
Sum	660.81	Sum	200	Sum	1104
Count	21	Count	24	Count	21
Confidence Level (95.0%)	4.550926391	Confidence Level (95.0%)	0.8686601	Confidence Level (95.0%)	8.00621264
Lower Bound	26.91621647	Lower Bound	7.46467323	Lower Bound	44.5652159
Upper Bound	36.01806925	Upper Bound	9.20199344	Upper Bound	60.5776412

Table 2.

Mean Public Transit, Drive Time, Walk Time from Proposed Ideal SSP Location

Mean Public Transportation		*Drive Time*		*Walk Time*	
Mean	10	Mean	4.695652174	Mean	15.3
Standard Error	1.634336	Standard Error	1.229471403	Standard Error	3.329374843
Median	8.5	Median	3	Median	7.5
Mode	3	Mode	1	Mode	3
Standard Deviation	7.308971	Standard Deviation	5.896337712	Standard Deviation	14.88941694
Sample Variance	53.42105	Sample Variance	34.76679842	Sample Variance	221.6947368
Kurtosis	0.073409	Kurtosis	13.88718329	Kurtosis	-0.384534795
Skewness	0.892576	Skewness	3.424678083	Skewness	1.056178069
Range	24.5	Range	28	Range	46
Minimum	2	Minimum	1	Minimum	2
Maximum	26.5	Maximum	29	Maximum	48
Sum	200	Sum	108	Sum	306
Count	20	Count	23	Count	20
Confidence Level (95.0%)	3.420704	Confidence Level (95.0%)	2.549767631	Confidence Level (95.0%)	6.968461632
Lower Bound	6.579296	Lower Bound	2.145884543	Lower Bound	8.331538368
Upper Bound	13.4207	Upper Bound	7.245419805	Upper Bound	22.26846163

Table 3.

Mean Public Transit, Drive Time, Walk Time from Closest Legal SSP Location

Drive Time		*Walk Time*		*Mean Public Transportation*	
Mean	4.541666667	Mean	25.8095238	Mean	17.22571
Standard Error	0.425539584	Standard Error	3.07340284	Standard Error	1.934245
Median	4	Median	22	Median	14
Mode	3	Mode	17	Mode	11
Standard Deviation	2.08470969	Standard Deviation	14.0841011	Standard Deviation	8.863825
Sample Variance	4.346014493	Sample Variance	198.361905	Sample Variance	78.5674
Kurtosis	0.050695755	Kurtosis	0.72499772	Kurtosis	-0.55298
Skewness	0.925319945	Skewness	0.92779109	Skewness	0.700531
Range	7	Range	56	Range	29
Minimum	2	Minimum	6	Minimum	6
Maximum	9	Maximum	62	Maximum	35
Sum	109	Sum	542	Sum	361.74
Count	24	Count	21	Count	21
Confidence Level (95.0%)	0.880295698	Confidence Level (95.0%)	6.41100597	Confidence Level (95.0%)	4.034765
Lower Bound	3.661370969	Lower Bound	19.3985178	Lower Bound	13.19095
Upper Bound	5.421962365	Upper Bound	32.2205298	Upper Bound	21.26048

Figure 1.
Drive Time from Support Locations to SSP Locations

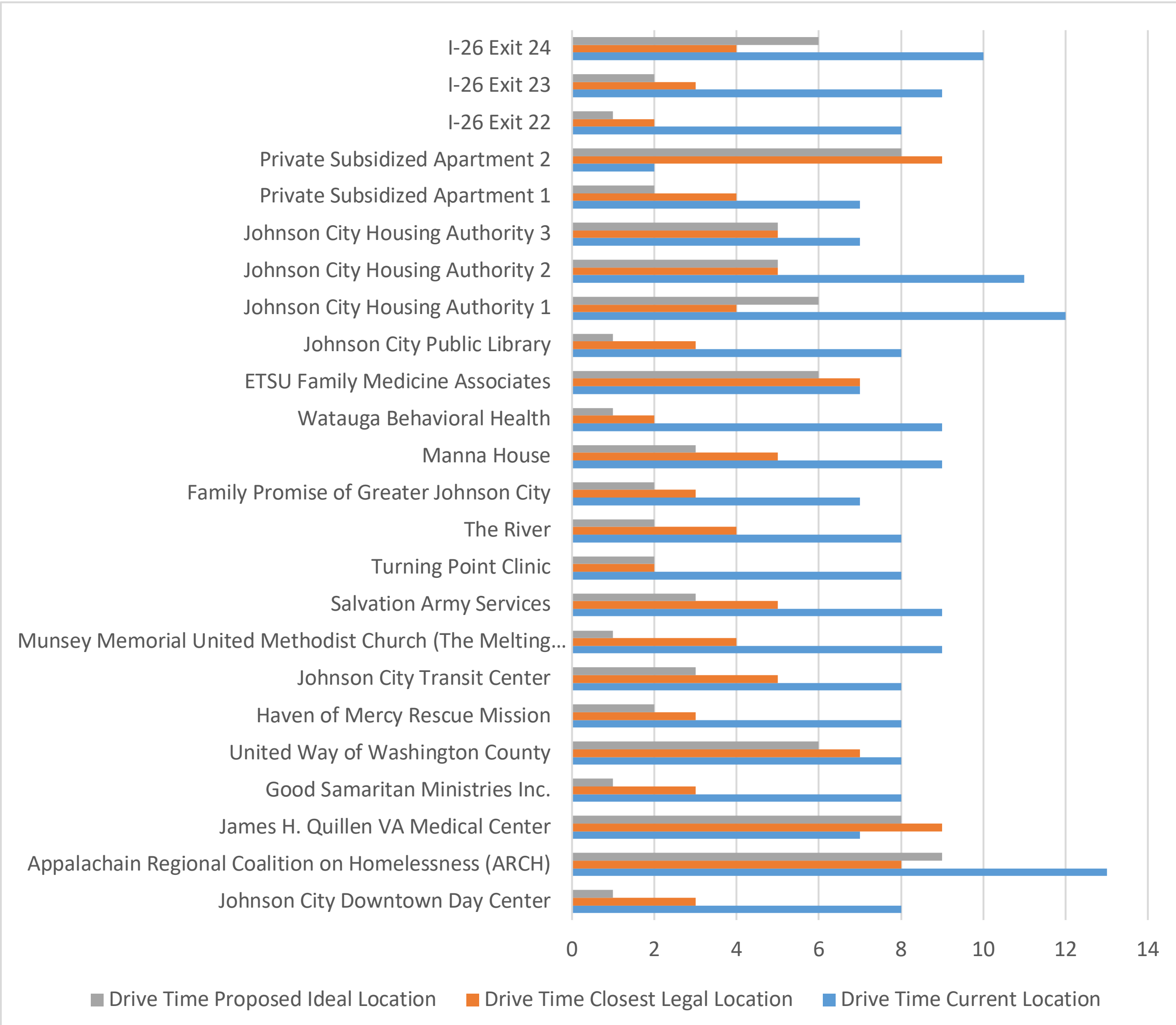


Figure 2.

Walk Time from Support Locations to SSP Locations

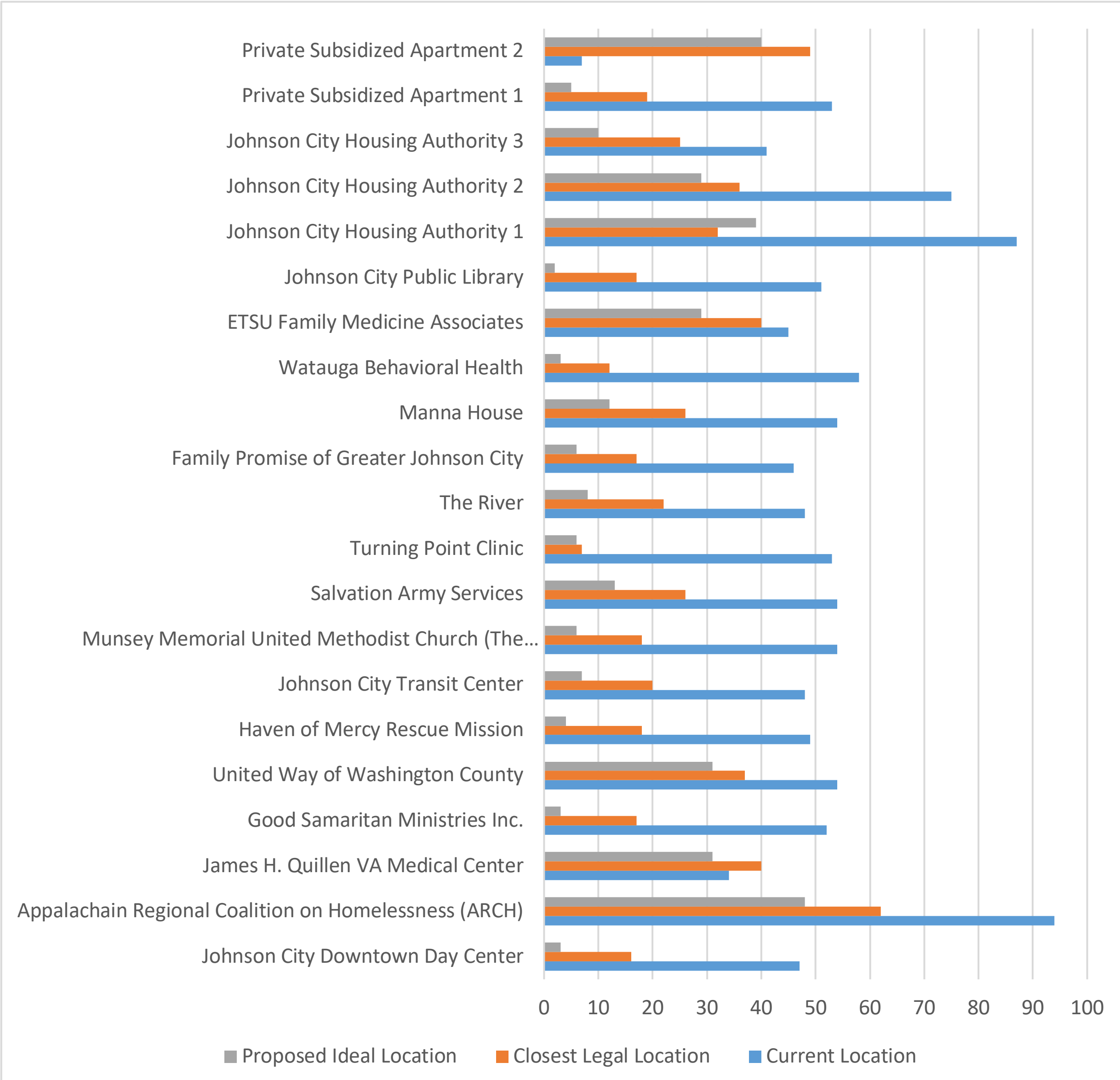
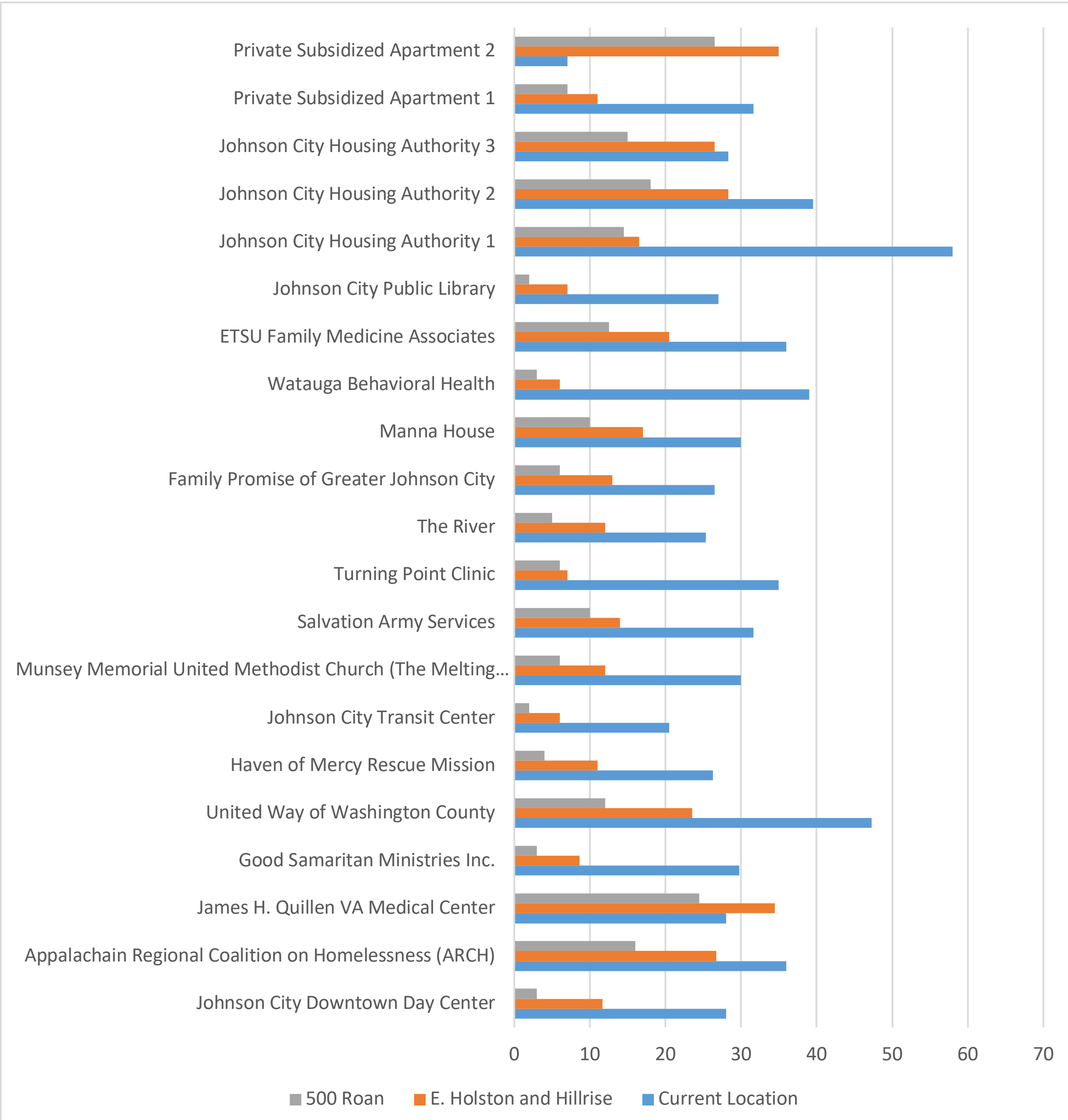


Figure 3.

Public Transportation Travel Time from Support Locations to SSP Locations



APPENDIX C: POLICY BRIEF FOR STATE LAWMAKERS

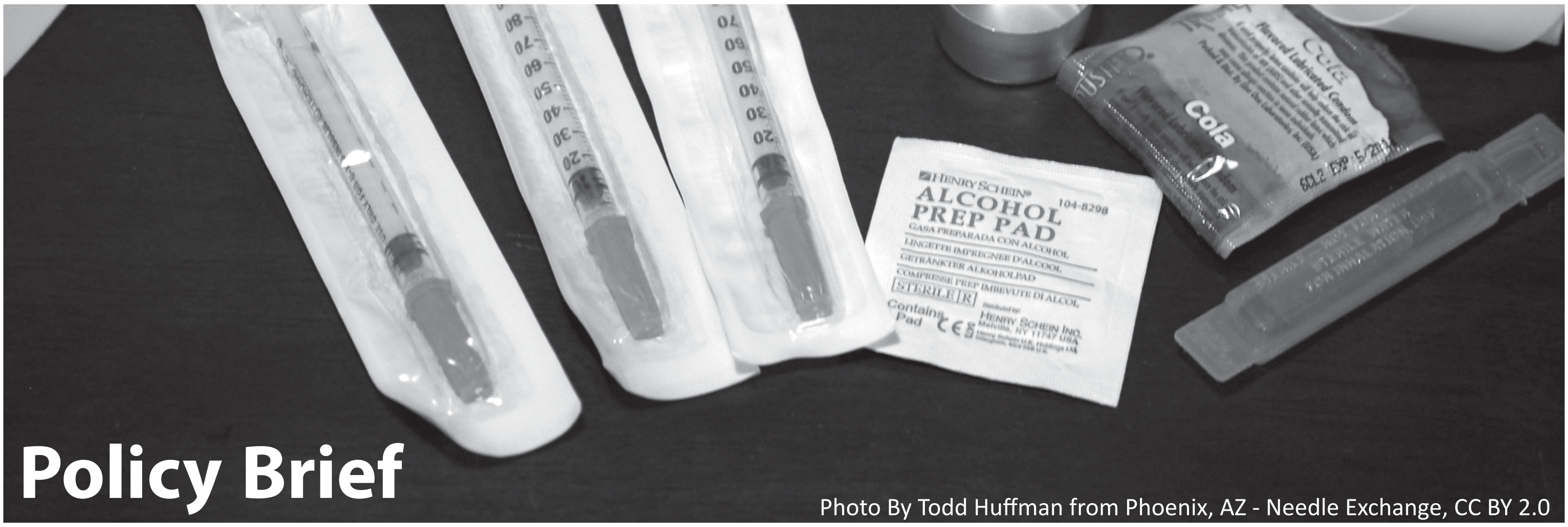


Photo By Todd Huffman from Phoenix, AZ - Needle Exchange, CC BY 2.0

Current Tennessee law makes it hard for people to get clean syringes

What is a Syringe Service Program?

Syringe service programs or SSPs are a source of health care for people that use drugs. They are also a powerful prevention program to stop HIV and Hepatitis C (HCV)[1]. SSPs are also a source for free Naloxone, an overdose reversal drug, and training.[2,3,4] County officials in Clark County, IN, think free Naloxone from SSPs lowered their overdose rate by 30% between 2016-2017.[5]

People that use SSPs report a 48% drop in needle sharing.[6] People that can go to an SSP regularly do risky things less, like sharing, borrowing, or lending needles.[7] People that inject drugs are also one of the most under served types of people for primary care, mental health services and chronic disease care. SSPs can fill that role.[8,9,10,11]

SSPs are the key element in lowering risk of HIV, AIDS, and HCV among people that inject drugs.[12] The closer a person is to an SSP the lower there risk of getting an infectious disease.[13]

People that Inject Drugs in Tennessee

Opioid use disorder, sometimes called OUD, and injection drug use has increased in suburban and rural areas.[14] There is a high prevalence of injection drug use in the Central Appalachian region that includes Tennessee.[15] This has been paired with a rapid increase in HCV in Appalachia.[16,17]

There are also major differences between rural and metropolitan counties within Appalachia. Rural people who use drugs are younger when they start using. They are likely start injecting opioids and are less likely to seek treatment.[18,19] 97% of rural people that inject drugs report sharing injection equipment while somewhere between 22% and 55% of urban drug users do. This may be because rural people that inject drugs do not have easy access to clean injection equipment.[20] There is a strong need to increase the number of SSPs in rural and suburban areas.[21]

SSPs in Tennessee

TN Code 68-1-136, 2017 Limits where SSPs can be in the state. In defined rural and urban areas SSPs cannot be within 2000ft of a school or park. This restriction makes it difficult to place SSPs in the areas they are needed most.

As an example, in Washington CO, TN, US Census Tract 601 is one of the most densely populated tracts in the county. It is in a commercial area of Johnson City, TN. It is home to 80% of support services associated with injection drug use in the area. It also is in the area with the highest rates of Emergency Medical Services responses to opioid overdose. Under the current law, the entire census tract and much of the surrounding area is off limits to an SSP.[22]

Over ->

A History of Laws Limiting SSPs

Washington D.C. did not let SSPs be within 1000ft of a school from 2000 until the law was repealed in 2019.[23] Many SSPs that were already in the city had to close or move. This led to a 50% drop in SSP coverage in the city.[24] SSPs were also not able to set up in areas that had high drug use, called "hot spots". Over the years the law was in place, police data showed that between 52% and 88% of "hot spot" areas could not be served by SSPs because they were within 1000ft of a school.[25]

Denver, Colorado also did not let SSPs be within 1000ft of a school or park. This law was part of the original law that made SSPs legal in Denver in 2008 but it accidentally made it impossible for SSPs to be within the city of Denver. Every street within Denver was within 1000ft of a school or park. When the city council was shown this, it allowed SSPs to be anywhere in Denver except for within public parks or on the sidewalks bordering public parks.[26]

What Can Tennessee Do?

TN Code TN Code 68-1-136, 2017 does not let SSPs in defined urban areas operate within 1000ft of schools or parks compared to 2000ft in suburban and rural areas. Amending current law to make the rule 1000ft for all areas of Tennessee still limits SSP access in the "hot spot" areas where it is needed most in our example suburban county, Washington CO, TN.

Consider the following policy options:

1. Amend TN Code 68-1-136 to match the current law in Denver, CO. This would let SSPs operate anywhere except in parks or on the sidewalks bordering parks.[19]

2. Consider funding a feasibility study through TN Department of Health to look at having SSPs at local public health departments like our neighboring states have done. These states are: Kentucky, West Virginia, Virginia, and North Carolina.[27]

3. Consider allowing county and municipal level governments decide what restrictions, if any should limit where SSPs can be in their community.

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