Neighborhoods and Opioids: A Look at Community-Level Factors

by

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ABSTRACT

The opioid crisis has become one of the most persistent public health crises in America, killing over 100 people a day. The opioid crisis emerged in the late 1990s and 2000s when opioid overdoses began to dramatically increase due to prescription painkillers. Heroin subsequently became a popular drug that was obtained through illicit markets in 2010. More recently, fentanyl, a potent and illicitly manufactured synthetic opioid, has driven a notable increase in the number of opioid overdose deaths. The opioid crisis has impacted many communities across the country. However, some communities are more susceptible to higher rates of opioid use. In order to determine which neighborhoods in Tempe, Arizona are more vulnerable to opioid use the author uses Tempe Emergency Medical Services (EMS) calls for service data and American Community Survey data to address two research questions: 1) What sociodemographic factors at the census-tract level are associated with calls for service to opioid related incidents and 2) are aspects of the physical environment associated with calls for service to opioid related incidents (e.g. vacant units, lack of complete plumbing, multiple unit housing structures)? Understanding community-level risk and protective-factors is essential for furthering the discussion on interventions that aim to address problematic opioid use in vulnerable communities. The current study finds that communities that are economically disadvantaged, and have a higher percentage of units that are vacant have more EMS calls for service to opioid related incidents. However, counter to the proposed hypothesis of social disorganization theory, residential instability was associated with fewer calls for service to opioid related incidents (i.e. higher levels of residential transience). Additionally, racially and ethnically diverse communities had fewer calls for

service to opioid related incidents albeit statistically non-significant. These findings have implications for future research and for possible policy implications directed at reducing opioid overdoses.

KEYWORDS emergency medical services, opioids, social disorganization theory

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INTRODUCTION

The opioid crisis in America has been persistent since the 1990s and has both evolved and worsened. This public health crisis can be broken down into three major waves of opioid overdoses (Center for Disease Control and Prevention [CDC], 2020). Prescription opioids drove the first wave, as the late 1990s and 2000s saw a large increase in the number of overdose deaths. The second wave began 2010 and was due to the rise in heroin use. The third wave, which began in 2013, was driven by the introduction of synthetic opioids, most notably fentanyl. Fentanyl's presence in the illicit drug market has drastically increased the number of opioid overdoses due to its high potency and its ability to be combined with other illicit substances such as heroin, cocaine, Percocet, and methamphetamine.

As a whole, the opioid crisis has taken the lives of many. According to the Centers for Disease Control and Prevention (2020), between 1999 and 2018, roughly 450,000 people overdosed and died as a result of opioid use. Rudd et al. (2016) explained that in 2014, drug overdoses involving an opioid accounted for 28,647 deaths; which represented 61% of all drug overdoses in 2014. Additionally, since 2000, the rate of drug overdose deaths has increased by 137%, with a 200% increase in drug overdose deaths that include opioids (Rudd et al., 2016). More recently, opioid-related drug overdose deaths decreased from 2017 to 2018, however, there was an increase in the number of synthetic opioid overdose deaths (Wilson et al., 2020). The opioid crisis is a public health issue that continues to affect many lives. In 2018 alone, there were 46,802 drug overdose deaths involving an opioid, representing 69.5% of all the drug overdose deaths that occurred that year (Wilson et al., 2020). Although preliminary, current research shows

that the opioid crisis worsened in 2020 during the COVID-19 pandemic (American Medical Association, 2020). The lethality and the prevalence of the opioid crisis are clear. As the mortality rate reached unprecedented levels – killing more than 100 people a day – the Department of Health and Human Services declared a public health emergency in regards to the opioid crisis (Johnson and Wagner, 2017).

In an attempt to better understand patterns of drug use and overdoses, researchers have focused on the environment and the prevalence of drug use and overdoses. Both social and physical characteristics have been analyzed to see if either are associated with higher rates of problematic drug use. Hembree et al. (2005) looked at the built environment, specifically, the exterior and interior of neighborhood housing and the likelihood of fatal drug overdoses. Chichester et al. (2020) looked at environmental factors that increase the risk of opioid overdose in Jefferson County, Alabama using Risk Terrain Modeling. Additionally, studies have examined the overlap between crime and opioid overdose deaths through the theoretical framework of the law of crime concentration (Carter et al., 2019). The relationship between the physical environment and opioid use may be explained by opportunity theories (Cohen and Felson, 1979) and broken windows theory through neighborhood decline (Wilson and Kelling, 1982). The relationship between social characteristics of the neighborhood and the opioid crisis has also been analyzed (Ford et al., 2017; Galea et al., 2003; Marzuk et al., 1997; Rowe et al., 2016). The literature assessing the relationship between the opioid crisis and the environment is one that can have direct policy implications. Specifically, policies that promote targeted interventions through a collaborative effort between various organizations including service providers, public health experts, first responders, and

local government can provide adequate resources and support for communities vulnerable to higher levels of opioid use.

However, much of the literature on drug use and the environment has not looked directly at opioid use and overdoses. Moreover, the available research has been mixed in terms of the relationship. For example, previous research has shown that opioid overdoses do cluster and form hot spots (Carter et al., 2019; Davidson et al., 2003; Rowe et al., 2016). The literature has found that there are characteristics of the built environment that increase the likelihood of an overdose taking place or are associated with higher rates of opioid overdoses (Chichester et al., 2020 and Hembree et al., 2005). Further, social factors in a neighborhood such as higher levels of social capital have been linked to lower prescription drug use rates and opioid use (Ford et al., 2017). Census-tracts that exhibited higher income inequality, more drug arrests, and had a lower percentage of Black residents were associated with higher rates of opioid overdoses and naloxone reversal events (Rowe et al., 2016). Overall, while there is a significant amount of literature looking at community structures and drug use broadly, the body of literature assessing the relationship between community structures and opioid use is limited. Even fewer studies that address opioid use incorporate both social and physical characteristics into their analyses.

Furthermore, emergency medical service (EMS) data will be used in this thesis. Studies often use official police data (i.e. calls for service to drug related incidents or narcotics arrests) when assessing crime and drug related problems. Other sources of data are often underutilized, such as EMS data. Given the persistence and lethality of the opioid crisis, the use of EMS data is needed to provide a more robust understanding of

where opioid-related incidents may be most prevalent. The limited use of EMS data and the lack of research assessing both the social and physical environment warrants immediate attention. To address this gap in the literature, the current study examines EMS calls for service to opioid related incidents and assesses their relationship with various sociodemographic factors and the physical environment in Tempe, Arizona.

Given the prior research on drug use and the social and physical environment, communities that are disadvantaged may be at risk for higher levels of opioid use and overdoses. Disadvantaged communities lack social cohesion among the residents. This lack of social cohesion creates a void where positive social ties and supervision among family, friends, and neighbors would otherwise be. Further, disadvantaged communities harbor social and physical disorder where vacant units may be more widespread. Vacant buildings, for instance, can provide an opportunity for residents to engage in illicit behaviors due to its isolation and lack of guardianship (Cohen and Felson, 1979). A lack of social ties and supervision in combination with social and physical disorder creates a community where opioid use can persist and ultimately, where opioid use may be more likely to result in an overdose. The analyses in this thesis will address an area of the literature that is sparse by showing which sociodemographic characteristics are associated with calls for service to opioid related incidents, furthering the discussion in regards to the social environment and its relationship with opioid related incidents. Additionally, and more importantly, the analyses will allow for a better understanding of how the social and physical environment impact levels of opioid related incidents within the same statistical models. For example, if the social environment is significantly associated with opioid related incidents, yet when physical characteristics are added to the model the

effect of the social environment is rendered insignificant, this would have implications not only for future research but for policy aimed at reducing opioid use.

I intend to add to the literature by assessing the relationship between opioid use and the environment using a social disorganization theory lens. This thesis will provide insights regarding opioid use and its relationship with poverty, residential instability, ethnic heterogeneity, and the physical environment, furthering the discussion about targeted interventions in vulnerable communities. Specifically, I plan to look at the levels of disadvantage, residential instability, and ethnic heterogeneity at the census-tract level to assess their relationship with opioid related calls for service by employing a negative binomial regression. First, I will present a literature review regarding social disorganization theory and how it has been used to explain crime, disorder, and drug use. The methods section will follow the literature review. I will then present the results of the analyses which will then be followed by a discussion and conclusion section that considers directions for future research and the policy implications of my findings.

RESEARCH QUESTIONS AND VARIABLES OF INTEREST

1. What sociodemographic factors at the census-tract level are associated with calls for service to opioid related incidents?
2. When controlling for sociodemographic factors, are aspects of the physical environment associated with calls for service to opioid related incidents?

Dependent Variable

The dependent variable for the analyses will be a count of EMS calls for services to opioid related incidents in Tempe, Arizona from 2017 to 2020 at the census-tract level.

Independent Variables

Independent variables of interest will include measures of concentrated disadvantage, residential mobility, and ethnic heterogeneity. Other variables that will be included in the models are: the percent of vacant units, the percent housing units lacking complete plumbing, the percent of housing structures with multiple units, percent of the population aged 18-24 and 25-44, and the % of the population that is non-Hispanic Black and Hispanic. For models assessing the relationship between the physical environment and calls for service to opioid related incidents, the variables of interest that will be included in the models are the percent of vacant units, the percent of housing units without complete plumbing, and the percent of housing structures with multiple units while controlling for the sociodemographic factors.

LITERATURE REVIEW

Social Disorganization Theory

Shaw and McKay (1942) posited communities that experience low socioeconomic status (SES), have higher levels of racial heterogeneity, and experience residential instability are socially disorganized and are vulnerable to crime and delinquency. This thesis became known as social disorganization theory. After studying juvenile arrest records, Shaw and McKay (1942) noted the arrests were not randomly distributed across the city. The arrests were concentrated in certain areas of the city. This led the researchers to theorize beyond the traditional theoretical model of focusing on the individual. Shaw and McKay (1942) hypothesized that community structures impacted the level of crime and delinquency neighborhoods experienced. The traditional model that was outlined by Shaw and McKay (1942) proposed that communities of low SES,

ethnic heterogeneity, and residential instability would lack social cohesion among members of the community (see Figure 1.). The lack of cohesion among the residents is due to a few factors: a community that is racially and ethnically diverse will have a wide range of cultural norms that may not be agreed upon; in communities experiencing low SES, there is a lack of economic resources to effectively combat criminal activity (Shaw and Mckay, 1972); and residential instability creates a neighborhood where individuals are frequently moving in and out which impedes the community's ability to establish social ties. These characteristics can lead to a social distancing among community members that inhibits social cohesion. This lack of cohesion, in return, erodes the community's willingness to engage in informal social control processes (Sampson et al., 1997). When community members abstain from intervening in deviant or delinquent behavior informally, the unwanted behavior persists. Furthermore, communities that have common values, and are more united, are more effective at informally intervening with neighborhood issues (Shaw and McKay, 1969 and Thrasher, 1963). Social organization can be defined as "the regulatory capacity of a neighborhood that is imbedded in the structure of that community's affiliational, interactional, and communication ties among the residents" (Bursik, 1999:86). A socially disorganized community does not have regulatory capacity. Socially disorganized communities are unable to reach a consensus in regards to values and norms, in addition to the failure to resolve community disputes (Bursik 1984, Kornhauser, 1978).

Social mechanisms

Within socially disorganized communities, low SES, ethnic heterogeneity, residential transience may be present. However, these characteristics of the community

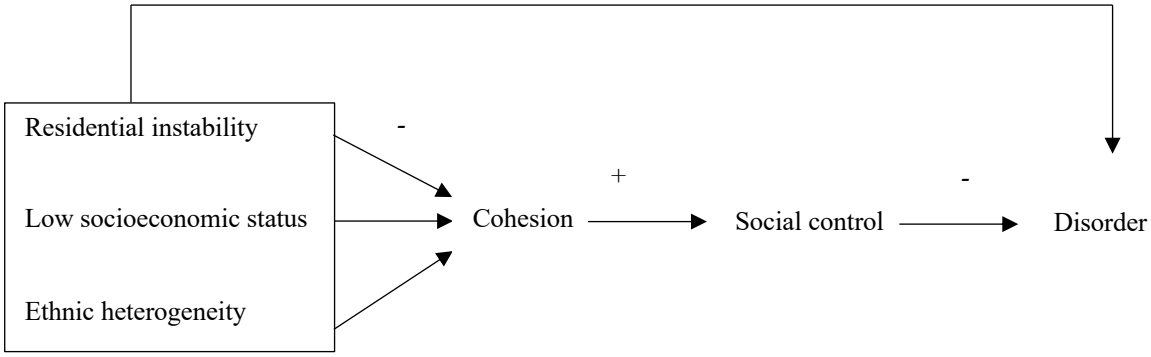
are not directly related to crime. There are social mechanisms that mediate the relationship between a socially disorganized community and crime. In the social disorganization literature, various social mechanisms have been shown to mediate the effect between community structures (i.e. disadvantage, residential instability, racial heterogeneity) and crime. Most notably, collective efficacy, coined by Sampson et al. (1997), refers to the willingness of residents to intervene on behalf of their neighbor. Collective efficacy has two crucial dimensions, social cohesion and mutual support among the neighborhood residents. A community that has high levels of collective efficacy will experience low levels of crime. Sampson et al. (1997) found that low levels of collective efficacy were associated with higher crime rates and self-reported violence.

Social capital is another social mechanism that can explain the relationship between community structures and crime rates. Social capital can be defined as "the investment in social relations with expected returns" (Lin, 1999). Mainly, pro-social engagement in social and civic organizations provides a benefit to the larger community by improving informal social controls (Kubrin and Wo, 2016). Social capital has been operationalized in various ways in the literature including the number of neighborhood organizations present, trust among the residents of the community, and participation in organizations. These measures have also been combined to create a social capital scale (Kubrin and Wo, 2016).

Lastly, social ties among residents has been used to measure the level of cohesion within the community. Social ties can be measured in a couple of different ways, such as the frequency of social ties (Bellair, 1997) and the density of social ties (Morenoff et al., 2001; Veysey and Messner, 1999). The former presents an issue when considering the

quality of the ties. The sheer quantity of social ties does not mean that informal social controls will be present in a community. The quality of those ties matter (Sampson, 2006). Pro-social ties help facilitate the emergence of informal social controls in a community. The density of social ties, on the other hand, measures the "strength" or the quality of the ties. When social ties are strong, they are critical for enacting informal social controls (Kubrin and Wo, 2016).

Figure 1. Traditional social disorganization theory flow chart (see Steenbeek and Hipp, 2011)



Social Disorganization Theory and Crime

Much of the literature on social disorganization theory shows that it can explain the prevalence of crime, disorder, drug use, and delinquency at the neighborhood level (Browning, 2009; Ford et al., 2017; Mazerolle, Wickes, and McBroom, 2010; Pratt and Cullen, 2005; Sampson and Groves, 1989; Sampson, Raudenbush, and Earls, 1997; Sampson and Raudenbush, 1999). As mentioned above, researchers have employed various measures to capture levels of cohesion and willingness to engage in informal social control at the neighborhood level: namely, collective efficacy, social capital, and social ties. This section will categorize the literature into these three sections (e.g.

collective efficacy, social capital, social ties) and review the literature regarding the social mechanisms used in the studies as they relate to crime and disorder.

Collective efficacy

Research exploring the concept of collective efficacy as part of the social disorganization framework accelerated in the 1990s and has provided empirical support for the theory's ability to explain varying levels of crime between neighborhoods (Pratt and Cullen, 2005; Sampson, Raudenbush, and Earls, 1997; Sampson and Raudenbush, 1999). For example, Browning (2002) looked at collective efficacy's impact on partner violence and found that higher levels of collective efficacy were associated with lower levels of domestic violence when controlling for variables at the individual level. Moreover, Maimon and Browning (2010) employed multilevel modeling to assess the effect of collective efficacy on violence in Chicago. They found that collective efficacy does have a negative relationship with levels of violence (Maimon and Browning, 2010). Brody et al. (2001) assessed the impact of collective socialization on children's affiliation with deviant peer groups. They found that there is an inverse relationship between collective socialization and children's self-reported affiliation with deviant peers. Interestingly, this effect became more pronounced as the level of disadvantage increased in the community cluster (Brody et al., 2001).

Furthermore, both Morenoff et al. (2001) and Sampson and Raudenbush (1999) find similar results. Sampson and Raudenbush (1999) found that higher levels of collective efficacy were related to lower levels of observed disorder as well as lower rates of homicide, burglary, robbery, and victimization. Similarly, Morenoff et al. (2001) showed collective efficacy was inversely related to levels of homicide at the

neighborhood level. In a meta-analysis, Pratt and Cullen (2005) note that the literature on social disorganization theory shows support for its ability to explain crime at the macro-level. They also find that collective efficacy has the largest effect size among the key social disorganization theory variables (e.g. racial heterogeneity, residential mobility, socioeconomic status, urbanism, unsupervised peer groups) (Pratt and Cullen, 2005). Additionally, they note that out of all 23 macro-level variables included in their meta-analysis (i.e. police size, police expenditures, incarceration, religion, education, etc.), collective efficacy had the fourth-highest effect size (Kubrin and Wo, 2016 and Pratt and Cullen, 2005). The research on collective efficacy shows support for its relationship to crime and disorder, indicating that this characteristic may be a robust indicator. Moreover, research shows that residents living in a community with low collective efficacy and high levels of physical and social disorder are more likely to engage in unhealthy and delinquent behaviors (Cohen et al., 2000). Collective efficacy is often associated with reduced crime and delinquency because a more cohesive community is more likely able to enact informal social control mechanisms (Sampson et al., 1997).

Research should continue to assess the relationship between collective efficacy and various outcomes with longitudinal datasets to understand the temporal sequence between the two variables. Does crime impact collective efficacy? Traditional models assume collective efficacy impacts crime. Recent models have indicated that there is a feedback loop showing that this relationship should be researched further (Steenbeek and Hipp, 2011).

Social Capital

Engagement in neighborhood organizations can enhance social cohesion through shared values and norms, which then increases the prevalence of informal social controls (Peterson et al., 2000 and Wilson, 1987). Lee (2008) constructed an index to measure civic engagement that captured the level of social capital in rural counties in the US. Lee (2008) found there were lower crime rates when the county had a higher level of civic engagement. Peterson et al. (2000) conducted a study in Columbus, Ohio to assess the impact of recreation centers and libraries on the level of crime at the census tract level. They found that recreation centers are associated with lower levels of violent crime and this relationship is stronger in more disadvantaged areas. Libraries, however, did not have an impact on crime. Similarly, using the British Crime Survey, Veysey and Messner (1999) found that when residents participated in neighborhood organizations such as committee or club meetings, it reduced the level of victimization. According to Kubrin and Wo (2016), Putnam's (1995, 2000) work on social capital is considered the "standard" for operationalizing the concept of social capital. Putnam discusses the importance of community trust and participation in civic and social organizations. These two crucial aspects of social capital are negatively related with crime (Putnam, 2000). Moreover, in Pratt and Cullen's (2005) meta-analysis of macro-level theories, they include "noneconomic institutions" as a variable in the analysis. Noneconomic institutions were a proxy measure for social capital. Out of the 23 macro-level variables, noneconomic institutions were first on the list, with the largest weighted effect size (Pratt and Cullen, 2005). Consistent with much of the literature on social disorganization theory, communities with higher levels of civic engagement and organizational

participation are better equipped to informally and formally deal with deviant and criminal behavior. Communities with high levels of participation in neighborhood organizations increase their level of social cohesion among residents in the community.

Social ties

The literature regarding social ties and their influence on crime and delinquency at the neighborhood level has long suggested that neighborhoods with little social interaction and few social ties will have a limited capacity to engage in informal social control (Park and Burgess, 1925; Sampson et al., 2006; Shaw and Mckay, 1942). Bellair (1997) found that higher levels of social interaction at the neighborhood level is associated with lower rates of crime. Specifically, motor vehicle theft, burglary, and robbery rates declined as the level of social interaction increased. The lack of social ties in a community creates distance between residents, not physically but socially. This social distance makes it difficult to enact informal social control mechanisms. Warner and Rountree (1997) found that engaging in neighborly activities was related to lower rates of assault; however, these findings were complicated due to a finding that showed that social ties were positively associated with burglary rates. The research covering social ties and their relationship to neighborhood crime rates is largely mixed. While the presence of social ties in a community is important, the quality of those ties is more important. As discussed above, the difference between the quantity and quality of social ties present in a community could determine whether informal social control mechanisms are enacted or not. Sampson and Groves (1989) found that social ties are crucial for reducing crime, however, Pattillo (1998) found that social ties can enhance the level of crime. This disparate finding could be explained by the fact that not all social ties are the

same. As Sampson et al. (2006) state, “not all networks are created equal.” Following this statement, Pattillo (1998) noted that neighborhood ties can facilitate informal social control, however, the integration and presence of deviant individuals in those networks can backfire and thwart a neighborhood’s ability to enact informal social controls. Additionally, Browning, Feinberg, and Dietz (2004) noted that social ties can serve as a facilitator for deviant behavior. Their findings showed that collective efficacy has crime reduction benefits, however social ties can limit the neighborhood’s capacity to use informal social controls due to the quality of the ties (Browning, Feinberg, Dietz, 2004).

Social Disorganization Theory and Drug Use

Researchers have primarily used social disorganization theory to examine crime rates, disorder, and delinquency at the neighborhood level. Social disorganization has been used to assess other outcome variables at the neighborhood level as well. In regards to drug use, community structures that are characteristics of a socially disorganized neighborhood have been found to be associated with drug use, specifically, dilapidated housing, residential instability, unemployment, lack of investment in institutional resources, and low socioeconomic status (Cerda et al., 2013; Hayes-Smith and Whaley, 2009; Hill and Angel, 2005; Kawachi and Kennedy, 1999; Marzuk et al., 1997; Winstanley et al., 2008,). The conditions of a socially disorganized community allow for drug use to persist due to the structural issues of lacking social cohesion, mutual support, and weak informal social controls. These social characteristics coupled with the physical disorder such as vacant units, dilapidated housing, and vacant lots gives an opportunity for drug use to go unchecked by residents. Disadvantaged neighborhoods could see an increase in the prevalence and availability of drugs in the community due to the poor

regulation of behavior by residents and the opportunities provided by the physical environment (e.g. vacant buildings). More specifically, physical and social disorder in the community can lead to a withdrawal of the residents which impedes social control mechanisms. Subsequently, vacant units and abandoned buildings may provide an area where drug use can take place and go un addressed due to a lack of guardianship. Additionally, the disadvantage hinders and erodes social cohesion, which can lead to higher levels of drug and alcohol use (Duncan, Duncan, and Stryker, 2002). Hannon and Cuddy (2006) found support for the relationship between social disorganization and drug dependence mortality in New York City. Specifically, they found that increased poverty and a higher proportion of Black and Hispanic residents were positively associated with drug mortality at the neighborhood level. This link between poverty, race, and drug deaths may be explained by the increased likelihood of minorities residing in poor communities (Krivo and Peterson, 1998). These disadvantaged communities are more likely to lack social cohesion, mutual support, pro-social ties, and the ability to enact informal social controls. Communities with these characteristics are unable to thwart deviant and unwanted behavior. Additionally, residents may be resorting to opioid use as a coping mechanism due to the strain of poverty and disorder in the community (Agnew, 1992). They also found that homeownership had a negative association with drug mortality rates while boarded-up housing had a positive association (Hannon and Cuddy, 2006).

However, the literature assessing the relationship between neighborhood-level characteristics and opioid use and overdoses is limited. A handful of researchers have linked narcotics arrests (Rowe et al., 2016), income inequality (Galea et al., 2003; Rowe

et al., 2016; Visconti et al., 2015), social capital (Ford et al., 2017), and the physical environment (Hembree et al., 2005) with opioid use and overdoses rates. Similar to Hannon and Cuddy's (2006) finding that boarded-up housing was associated with higher drug dependence mortality, Hembree et al. (2005) found that multiple external physical environmental characteristics were associated with drug overdose deaths when controlling for drug use, household income, and demographics. Those characteristics were dilapidated conditions, deteriorating conditions, window issues, stairway problems, and cleanliness of the street. Further, Hembree et al. (2005) found that there were characteristics of the internal environment that were associated with drug overdose deaths. They noted that housing units that experienced toilet issues, needed additional heating, and had peeling paint or plaster were associated with drug overdose deaths. These findings support the notion that the physical environment is associated with various outcomes, such as crime, poor health, and drug use (Cohen et al., 2000, 2003; Cummins and Jackson, 2001; Wallace and Wallace, 1988). These aspects of the physical environment and their association with higher rates of opioid use and overdoses can be explained by the spiraling decay of the neighborhood. When disorder is prevalent within a neighborhood, it causes residents to withdrawal from the community which negatively impacts social controls (Wilson and Kelling, 1982; Skogan, 1992). Additionally, with the presence of vacant units and abandoned buildings, there is an opportunity to engage in opioid use with a lack of guardianship in the community (Cohen and Felson, 1979).

Concerning the social environment, Rowe et al. (2016) found that population size, a higher percentage of Black residents, the number of narcotics arrests, and lower levels of income were all associated with opioid overdose deaths at the census tract level.

Looking at age-adjusted drug overdose mortality rates, Marzuk et al. (1997) found that living below the poverty line accounted for 69% of the variance in deaths resulting from cocaine and opiate overdoses. Specifically looking at disorganization and social mechanisms, Ford et al. (2017) created three scales, one to measure the level of social disorganization, one for social capital, and one for social participation. They found that social disorganization, social capital, and social participation were all associated with prescription drug misuse and opioid misuse. While the social capital measure had a negative association with prescription drug misuse and opioid misuse (also see Curran, 2007, Reynoso-Vellejo, 2011), social disorganization, however, had a positive association with prescription and opioid misuse (Ford et al. 2017). Social participation was not statistically significant in their multivariate models. Hayes-Smith and Whaley (2009) found that community structures were associated with opioid use. Specifically, they found that low socioeconomic status, residential transience, and ethnic heterogeneity were significantly associated with methamphetamine use. While low socioeconomic status and residential instability were positively associated with methamphetamine use, racial and ethnic diversity was associated with lower rates of methamphetamine use (Hayes-Smith and Whaley, 2009).

Broken Windows Theory

Wilson and Kelling (1982) stated that when disorder in the community goes unaddressed, serious crime will increase. Disorder being present in a community weakens the neighborhood's willingness to enact informal social controls. When the willingness to engage in informal social controls is reduced, crime and disorder persists. This thesis became known as broken windows theory (BWT). Disorder can be categorized as

physical or social. Physical disorder refers to litter, graffiti, abandoned buildings, and literal broken windows. Social disorder refers to panhandling, public drunkenness, drug dealing, and rambunctious teenagers out past curfew. While these aren't exhaustive lists, they provide a picture of the distinction between the two categories of disorder.

The research looking at BWT mainly assesses the relationship between disorder and fear (Brunton-Smith and Sturgis, 2011; Markowitz et al., 2001; Robinson et al., 2003), as well as disorder and crime (Boggess and Maskaly, 2014; Branas et al., 2011; Skogan, 1990). However, the disorder-crime nexus is more complicated than simply stating that disorder causes crime. While some research has found an effect for disorder impacting crime (Bogges and Maskaly, 2014; Roundtree, Land, and Miethe, 1994; Skogan, 1990; Brunton-Smith, 2011), others have found that the disorder-crime relationship is mediated by other aspects of the neighborhood such as fear and cohesion (Markowitz et al., 2001). Also, the temporal sequencing of this implied relationship between disorder and crime has been studied. Researchers have posited that there is a feedback loop in which crime is associated with increased levels of disorder (Bogges and Maskaly, 2014: Markowitz et al., 2001). Related, Steenbeck and Hipp (2011) found a cyclical relationship between disorder and community stability.

Other studies have examined the relationship between disorder and various health related outcomes such as sexually transmitted diseases and alcohol and drug use (Cohen et al. 2000; Browning, Soller, and Jackson, 2015). More specifically, Cohen et al. (2000) posited that disorder would promote higher levels of risky sexual activity, therefore increasing the rate of sexually transmitted diseases. A meta-analysis that was conducted in 2019 looked at various health related outcomes such as risky behavior, mental health,

and physical health found that disorder predicted higher levels of risky behavior which included substance use (see O'Brien, Farrell, and Welsh, 2019). Both Hembree et al. (2005) and Hannon and Cuddy (2006) found that dilapidated housing and abandoned buildings (e.g. physical disorder) were associated with higher overdose mortality. This relationship between physical disorder and higher overdose mortality can be explained by the BWT framework. Neighborhood disorder goes unaddressed which results in the neighborhood experiencing urban decay. The presence of disorder and decay forces residents to be fearful and withdrawal from the neighborhood both physically and psychologically (Skogan, 1986). Community controls are then weakened leading to more disorder and deviant behavior. Because the disorder and deviant behavior are not addressed, to onlookers, it appears to be accepted by residents in the community. This leads individuals to engage in disorderly acts, crime, or risky behavior like opioid use.

Also, thinking about the individual within this framework of a declining neighborhood, there is strain on residents due to poverty. Opioid use may be a coping mechanism to deal with the strain that they are experiencing (Agnew, 1992). Considering this aspect, a neighborhood experiencing urban decay may experience higher levels of opioid use as a form of coping. However, due to the declining nature of the neighborhood, residents are withdrawing from the community and this may result in a lower likelihood that residents will call for help or intervene into an overdose situation.

Routine Activities Theory

Cohen and Felson (1979) posited that the variation in crime rates were largely a product of citizens' activities in their day-to-day lives. They noted that crime took place across space and time when there was a convergence of 3 critical characteristics; a

motivated offender, a suitable target, and a lack of guardianship. Routine activities theory (RAT) has been used to explain various types of crime (see Fisher et al., 1998; Mustaine and Tewksbury, 1999; Sampson, 1987; Wilcox et al., 2007) across time (Cohen and Felson, 1979) and geography (Messner and Blau, 1987). Within the routine activities framework, the presence of capable guardians can prevent or deter criminal activity. Specifically related to opioid use, the presence of guardians within a neighborhood may prevent or reduce opioid use from occurring. Conversely, when there is a lack of guardianship, opioid use will occur and persist. However, RAT has not been used to test neighborhood variation in regards to opioid use.

While RAT implies that all offenders are motivated to commit crime, the key to understanding where crime might occur is to either assess the presence of suitable targets or the absence of guardians in a given area (Morenoff et al., 2001). Related to this idea, Hannon and Cuddy (2006) found support for the deviant opportunity perspective. Deviant opportunity perspective posits that there are aspects of the physical environment that allow for unhealthy behaviors or criminal activity to occur. They found that abandoned buildings were associated with higher levels of drug dependence mortality, highlighting the role that abandoned buildings play in providing an opportunity to engage in drug use. This finding may also be highlighting the role that the absence of guardianship plays in drug use. Additionally, Chamberlain and Hipp (2015) showed that the percent of occupied units at the census-tract was associated negatively with property crime and violent crime. Related to opioid use, high vacancy rates indicate an absence of capable guardians and this characteristic of a neighborhood may facilitate opioid use. Much of the literature looking at opioid use and the environment focuses on the social environment

(Ford et al., 2017; Galea et al., 2003; Marzuk et al., 1997; Rowe et al., 2016; Wagner et al., 2018) while others have looked at the physical environment (Chichester et al., 2020; Hembree et al., 2005). Few studies have looked at both social and physical characteristics together (Li et al., 2019; Visconti et al., 2015). The present study seeks to address this limited area in the literature by analyzing community structures, both social and physical, and their relationship with calls for service to opioid related incidents. To better understand the opioid crisis and how it varies between communities, analyses involving both physical and social characteristics are needed. This thesis will be able to investigate which sociodemographic characteristics are associated with calls for service to opioid related incidents as well as whether or not physical aspects of the environment matter in regards to the prevalence of those calls.

METHODS

Opioid Crisis in Arizona

From 2016 to 2017 there was a 20% increase in opioid overdose deaths in Arizona (Arizona Department of Health Services [AZDHS], 2020), leading the Governor of Arizona to then issued a State of Emergency. Despite this declaration, opioid overdose deaths increased approximately 45% from 2017 to 2018 (AZDHS, 2020). According to the Arizona Department of Health Services, there have been 62,806 suspected opioid overdoses and 8,666 suspected opioid overdose deaths since June 15, 2017 (Through March 1, 2021).[1] Maricopa County represents over 50% of the statewide confirmed

[1] https://www.azdhs.gov/prevention/womens-childrens-health/injury-prevention/opioid-prevention/index.php

opioid overdoses. Tempe, Arizona, the location of the current study, is located in Maricopa County.

Data

The current study uses two datasets: EMS calls for service to opioid related incidents obtained from Tempe Fire and Medical Rescue (TFMR) for the years 2017 to 2020; and the American Community Survey (ACS) data for Tempe, Arizona.[2] The EMS calls for service data include the location of the incident at the 100 block level, which was then aggregated up to the census-tract for the analyses. The ACS data contains the 5 year average (2012-2016) of various housing, operational, socio-economic, and demographic statistics of the residents in Tempe, Arizona. The ACS is a survey that is conducted by the United States Census Bureau. The Census Bureau uses monthly survey samples to then generate annual estimates of the various characteristics listed above at the census-tract and block-group level. The two datasets were merged together on a census tract-level indicator (e.g. FIPS code). The raw data includes 2,080 EMS calls for service. After cleaning the data and dealing with missing data there were 1,932 calls for service. Additionally, the EMS calls for service data includes two variables that describe whether the call for service was opioid related or not. From the beginning of 2017 until around June, 2018, EMS first-responders reported whether or not opioid abuse was probable. In 2018, the statewide reporting system changed from indicating whether opioid abuse was probable to whether or not the incident was opioid related. The criteria that determines if the incident was opioid related did not change. Therefore, from 2018 to 2020 incidents

[2] The ACS dataset is publicly available https://data.tempe.gov/datasets/select-demographics-acs-2012-2016-census-2010-tempe-tracts

involving opioids are labeled as opioid related instead of opioid abuse probable. Due to this change in reporting, the dataset has been cleaned in order to include only "opioid related" and "opioid abuse probable" incidents. The final sample contains 1,559 calls for service to opioid related incidents.

Measures

The concentrated disadvantage measure is a scale of the percent of persons below the poverty line, percent of persons who are unemployed, percent of female-headed households, median household income, and median house value (see Chamberlain and Hipp, 2015; Krivo and Peterson, 1998; Sampson et al., 2008 for measures of concentrated disadvantage). I constructed this measure by using a confirmatory factor analysis. Median household income and median house value were loaded negatively while persons below the poverty line, unemployed, and female-headed households were loaded positively (eigenvalue of 2.43). Residential instability was captured by one variable – the percent of individuals who lived in a different house the year prior. Studies have also used the percent of individuals who lived in a different house in the previous five years (see Hayes-Smith and Whaley, 2009). This variable is dichotomized at one standard deviation above the mean due to collinearity issues. Specifically, this measure shows census-tracts with high residential instability (1 = census-tracts one standard deviation above the mean and higher). Ethnic heterogeneity was calculated by using the Herfindahl Index (Gibbs and Martin, 1962). This index is measured by 1 minus the sum of the squared proportions for each racial/ethnic group, then logged. The index includes six different racial/ethnic groups (non-Hispanic White, non-Hispanic Black, Hispanic, Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander). The percent of multiple unit

housing structures captures the density of the population at the census-tract. This variable is a combination of two variables; percent of housing structures with 2 to 9 housing units and the percent of housing structures with 10 or more housing units.

The remaining independent variables were included directly in the ACS dataset. The percent of vacant units was calculated by dividing the number of vacant units by the total number of housing units. The percent of units that lack complete plumbing was calculated by dividing the number of units without complete plumbing by the total number of housing units. This variable captures poor housing conditions at the census-tract. The percent of the population that was aged 18-24 and 25-44 was calculated by their respective proportion out of the total population. Both age-groups are included for two reasons: 1) Tempe is home to one of the largest state universities in the country and has an undergraduate population of over 53,000 in Tempe alone (Enrollment Figures, 2020); 2) According to the Arizona Department of Health Services, those aged 25 to 44 represent approximately 45% of all opioid overdoses. Also included in the analyses are the percent of the population that is non-Hispanic Black and Hispanic.

Analytical Plan

First, to assess the distribution of variables in the dataset, I will present the descriptive statistics. Then, because the outcome variable is in count form, the author employed a negative binomial regression (see Hayes-Smith and Whaley, 2009). Additionally, throughout the negative binomial regression models, an exposure variable is used to adjust for the risk of a call for service to an opioid related incident occurring within the census-tract. The exposure variable is the total population at the census-tract level and has a coefficient of 1 to account for the variation among the population (see

Osgood, 2000). This is critical because a census-tract with a larger population has a higher risk of having a call for service to an opioid related incident when compared to a census-tract that has a smaller population (i.e. more people means more opportunities for an opioid related incident). To account for that difference in risk, the exposure variable is used. My Moran's I test was statistically significant, therefore I incorporate a spatially lagged variable on my measure of concentrated disadvantage to account for the effect of nearby neighborhoods (Chamberlain and Hipp, 2015). This spatially lagged variable has an inverse distance decay of 2 miles from the focal neighborhood (i.e. neighborhoods outside of the 2 mile range have no effect on the focal neighborhood). Multicollinearity was not an issue in any of the models. All mean VIF scores were below 5 and individually, no VIF scores were above 10 (Kennedy, 2003). The first two models look at the social and physical characteristics of the census-tract independently. The third model looks at both social and physical characteristics. The fourth and final model incorporates additional control variables such as those aged 18-24, 25-44, percent non-Hispanic Black, and Hispanic.

These analyses will address my research questions by showing which characteristics are associated with a higher prevalence of calls for service to an opioid related incident. Also, these analyses will show how social and physical characteristics are associated with calls for service to opioid related incidents within the same models. This will allow for a better understanding of how both physical and social factors influence calls for service to opioid related incidents.

RESULTS

Table 1 presents the descriptive statistics of the variables included in the models. All 36 census-tracts included in the analyses experienced at least one call for service to an opioid related incident with the mean number of opioid related calls for service at the census-tract being approximately 42. Concentrated disadvantage is standardized with a mean of zero. Ethnic heterogeneity has a mean value of approximately .55. Residential instability is dichotomized as census-tracts with high levels of instability having a value of 1 and census-tracts with instability levels below one standard deviation above the mean having a value of 0. The mean percent of vacant units at the census-tract is about 11%.

In Table 2, there are 4 negative binomial regression models shown in stepwise fashion. The first model of the negative binomial regression shows the main independent variables (e.g. concentrated disadvantage, ethnic heterogeneity, residential instability) and their relationship with calls for service to opioid related incidents. Also included in this model is a measure of multiple unit housing structures indicating the level of population density at the census-tract. This model shows no statistically significant predictors for the amount of calls for service to an opioid related incident.

Table 1. Descriptive Statistics of Calls for Service and Neighborhood Characteristics in Tempe, Arizona (N = 36)

Variable	Mean	SD	Min	Max
Opioid related calls for service	42.306	28.19	4	122
Concentrated disadvantage	-0.00	0.906	-1.525	2.490
Percent below poverty	20.512	15.13	1.380	63.06
Percent unemployed residents	5.918	2.533	2.500	13.35
Percent female-headed household	10.569	4.586	2.010	21.96
Median household income	$58,652	$27,016	$20,799	$134,943
Median household value	$217,500	$98,878	$43,400	$458,200
Ethnic heterogeneity	0.546	0.111	0.254	0.754
Residential instability	0.139	0.351	0	1
Percent vacant housing units	10.594	6.517	0.540	28.26
Percent units lacking complete plumbing	1.153	0.712	0.490	3.740
Percent multiple unit housing structures	19.118	11.594	0.680	48.36
Percent aged 18-24	22.246	18.737	5.710	81.59
Percent aged 25-44	30.395	8.435	9.580	48.71
Percent Hispanic	21.551	9.326	4.280	48.52
Percent Black	5.550	3.924	0.240	14.63
Spatially lagged disadvantage	0.814	4.535	-6.047	8.990

Model 2 removes the social disorganization variables and includes only the characteristics of the physical environment. The percent of vacant units at the census-tract level is associated with a statistically significant increase in the number of calls for service to an opioid related incident; specifically, a 1% increase in the amount of vacant units results in a 7% increase in the rate of calls for service to opioid related incidents (b = 0.067, IRR = 1.070). The percent of housing units that lacked complete plumbing was statistically non-significant in this model. Model 3 presents both the social and physical characteristics of the census-tract together and shows their relationship with calls for

service to opioid related incidents. This model indicates that a standard deviation increase in concentrated disadvantage is positively and significantly associated calls for services to opioid related incidents (b = .584, IRR = 1.794). More specifically, a standard deviation increase in the concentrated disadvantage measure is associated with a 79% increase in the rate of calls for service to an opioid related incident. Similar to model 2, the percent of vacant units is positively and significantly associated with opioid related incidents (b = 0.073, IRR = 1.076). Also, residential instability is significantly associated with fewer opioid related incidents: namely, census-tracts that are one standard deviation above the mean for instability are associated with a 69% decrease in the rate of calls for service to opioid related incidents and this is statistically significant (b = -1.184, IRR = .306).

Model 4 includes the percent of the population that is aged 18-24 and 25-44 as well as the percent of the population that is non-Hispanic Black and Hispanic. Additionally, a squared term for concentrated disadvantage is included. The squared concentrated disadvantage variable was incorporated to see if there was a curvilinear relationship between disadvantage and calls for service to opioid related incidents. This model shows three statistically significant findings. A standard deviation increase in concentrated disadvantage is associated with a 126% increase in the rate of calls for service to opioid related incidents (b = 0.813, IRR = 2.255). Also, a 1% increase in vacant units is associated with a 7% increase in the rate of calls for service to opioid related incidents (b = 0.071, IRR = 1.074). Residential instability is statistically significant in this model as well, indicating that census-tracts with higher levels of residential instability are associated with lower levels of calls for service to opioid related

incidents (b = -1.106, IRR = .331). Figures 2 and 3 highlight the relationship between concentrated disadvantage and opioid related incidents and vacant units and opioid related incidents.

Lastly, the spatially lagged concentrated disadvantage measure was non-significant throughout all five models. This indicates that nearby neighborhoods that are experiencing disadvantage are not associated with calls for service to opioid related incidents. This will be further discussed in the following section.

DISCUSSION

Prior research has employed various methodologies and analyzed various units of analysis (e.g. census-tract, county, block-group) to study social and physical characteristics of the environment and their relationship with drug use, however, little research has addressed opioid use specifically. Additionally, most studies look at social and physical characteristics independent of each other. To better understand the relationship between opioid use and the physical and social environment, both must be used in the same statistical models. The effect of the social environment might be rendered insignificant when including aspects of the physical environment or vice versa.

The present study assessed the relationship between social and physical characteristics independently in Models 1 and 2. However, Models 3 and 4 look at both social and physical characteristics. I find that both social and physical characteristics of the census-tract are associated with opioid related calls for service. Concentrated disadvantage was associated positively and significantly with a higher number of calls for service to opioid related incidents. This finding is consistent with prior literature (Hayes-

Smith and Whaley, 2009; Marzuk et al., 1997; Rowe et al, 2016), indicating that communities that are disadvantaged are at a greater risk for higher rates of opioid use.

Additionally, a higher percentage of vacant units was associated with higher levels of opioid related calls for service. This is consistent with prior literature indicating that the physical environment matters (Chichester et al., 2020; Hannon and Cuddy, 2006; Hembree et al., 2005). From a Routine Activities framework, aspects of the physical environment (i.e. vacant units) provide the opportunity to engage in opioid use given the lack of guardianship. This highlights the importance of opportunity theories as well as disorder in the neighborhood. Vacant units provide an opportunity where deviant behavior, more specifically, opioid use, can persist and go unnoticed.

Table 2. Negative Binomial Regression of Opioid Related Incidents on Independent Variables

	(Model 1)		**(Model 2)**		**(Model 3)**		**(Model 4)**	
Variables	*b*	IRR	*b*	IRR	*b*	IRR	*b*	IRR
Concentrated disadvantage	0.590	1.804			0.584*	1.794	0.644*	1.904
	(0.355)				(0.245)		(0.301)	
Ethnic heterogeneity	0.003	1.003			-0.007	.993	-0.007	.993
	(0.014)				(0.010)		(0.017)	
Residential instability	-0.795	.452			-1.184**	.306	-1.333**	.263
	(0.548)				(0.417)		(0.514)	
% multiple unit housing structures	-0.015	.985			-0.013	.987	-0.011	.989
	(0.013)				(0.010)		(0.012)	
% units lacking complete plumbing			0.028	1.028	0.089	1.093	0.074	1.076
			(0.102)		(0.104)		(0.113)	
% vacant units			0.067**	1.069	0.073**	1.076	0.077**	1.080
			(0.015)		(0.014)		(0.015)	
% aged 18-24							-0.002	.998
							(0.010)	
% aged 25-44							-0.005	.995
							(0.018)	
% Black							-0.009	1.009
							(0.033)	
% Hispanic							-0.007	.993
							(0.013)	
Spatially lagged variable	0.047	1.049	0.032	1.032	0.008	1.008	0.007	1.008
	(0.041)		(0.022)		(0.032)		(0.033)	
Constant	-4.531**		-5.538**		-4.879**		-4.605**	
	(0.731)		(0.201)		(0.544)		(0.033)	
Observations	36		36		36		36	

Note: standard errors in parentheses
+p < .1, *p < .05, **p < .01

Figure 2. Scatterplot Between Concentrated Disadvantage and Opioid Related Incidents

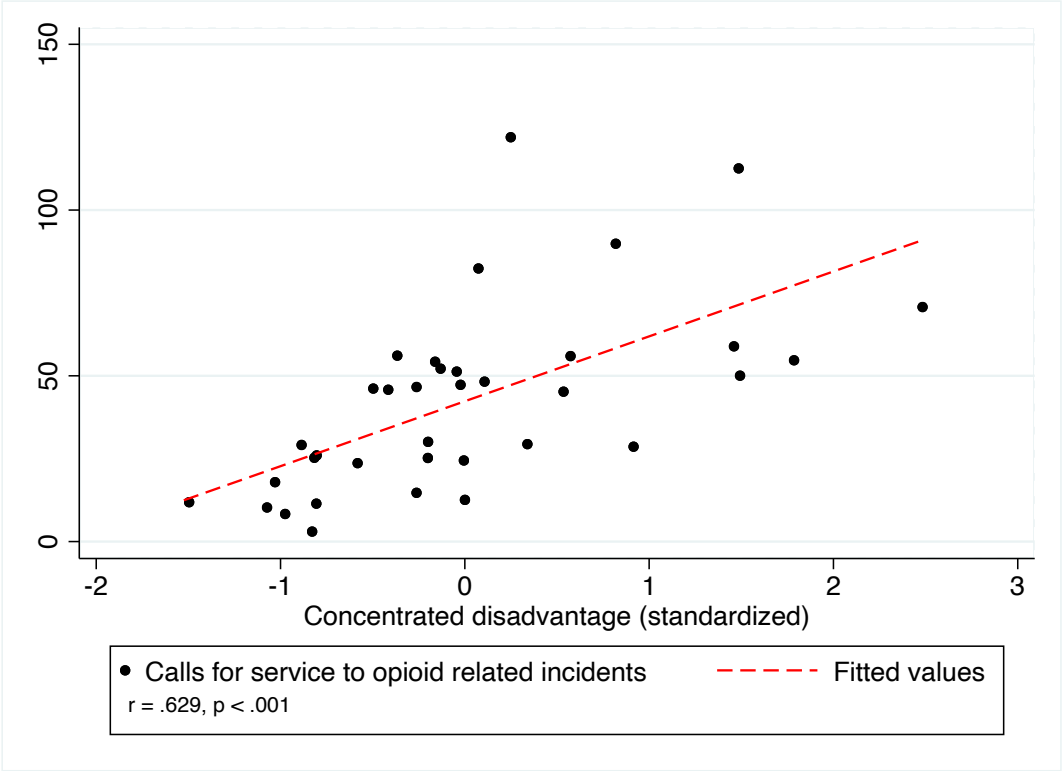
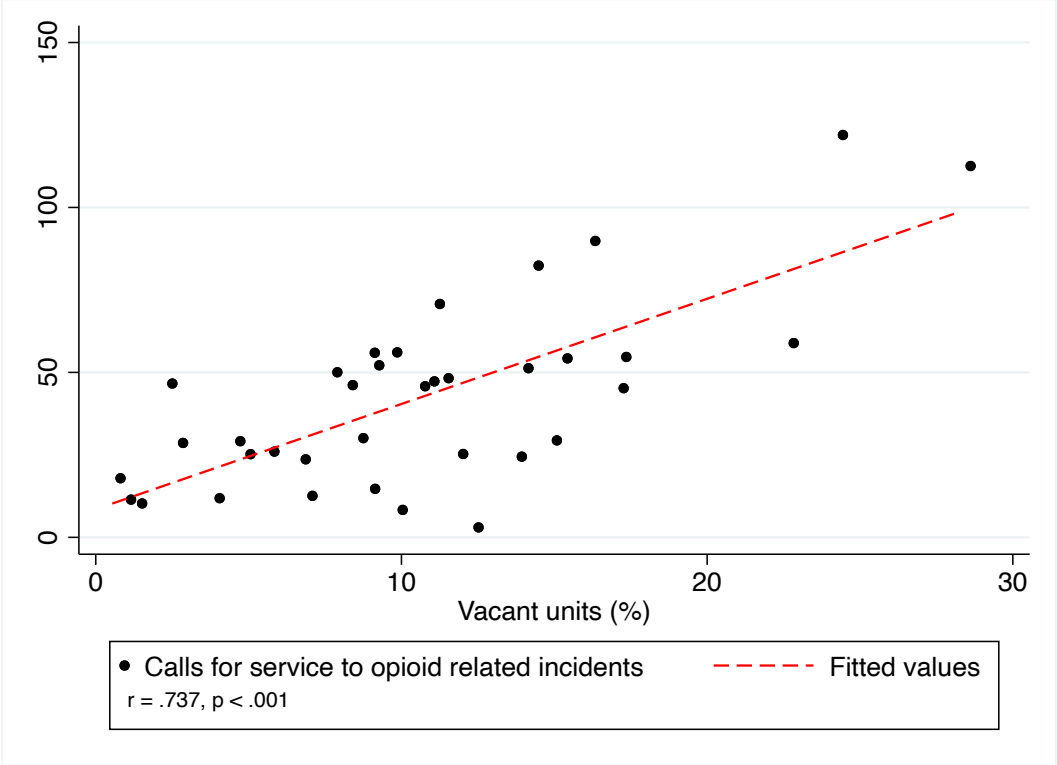


Figure 3. Scatterplot Between Vacant Units and Opioid Related Incidents



Furthermore, residential instability was associated with fewer calls for service to opioid related incidents. This finding is at odds with previous research that shows residential transience is often related to deviant behavior due to the coming and going of residents which perpetuates a socially distant community, weakening control mechanisms (see Sampson, 1997). In regards to drug use, residential instability has been shown to be positively and significantly associated with methamphetamine use (see Hayes-Smith and Whaley, 2009). However, drug markets are often comprised of dense networks. In areas with high residential turnover, ties to these networks could be weak resulting in drug markets having a transient presence and therefore limiting the flow of drugs in the market in that particular area. This relationship between high levels of residential transience and lower levels of opioid related incidents could be mediated by the lack of social ties, for example. Weak ties to deviant individuals, or in the case of illicit opioids, weak ties to the drug market, could result in less drug use. Another possible explanation for this finding is that in census-tracts where residential instability is high, social cohesion among residents is weak resulting in weak informal social control mechanisms. Fewer calls for service to an opioid related incident, by proxy, is a sign of weak informal social control mechanisms. Providing some support for this possible explanation, van Holm and Monaghan (2020) found that an increase in the number of evictions – a form of forced instability – at the block-group level was associated with fewer 311 calls. The association between residential instability and calls for service to opioid related incidents warrants further investigation.

Nearby neighborhood disadvantage was not associated with opioid related calls for service in any of the models. These results emphasize the effect of concentrated

disadvantage, residential instability, and vacant units within the focal neighborhood. However, within the social disorganization literature, adjacent neighborhoods can produce a reinforcing effect within the focal neighborhoods, specifically in regards to violent crime (Chamberlain and Hipp, 2015). It is possible that with opioid use, nearby neighborhoods do not have that reinforcing effect that may be exerted with violent crime. This relationship should be assessed in future studies to better understand how adjacent neighborhoods and focal neighborhoods interact with regards to opioid use.

Limitations

The current study does have a few limitations that warrant discussion. The generalizability of this particular study is lacking given that it is a study of one city and because the sample size is rather small. While the number of opioid related incidents within the dataset was sufficient, Tempe, Arizona has just 37 census-tracts and for the main analyses there were 36 census-tract included due to listwise deletion of a missing value within the census-tract.

Additionally, census-tracts are not homogenous. Within census-tracts there is heterogeneity among social and physical characteristics. While assessing variation at the census-tract is important, looking at a micro-level unit of analysis, such as the block-group, is essential for addressing the heterogeneity within the census-tract. The block-group and block-level units of analysis provide a clearer understanding of the geographical location where opioid use may be the most problematic, however even at these more micro-level units of analysis, there is still heterogeneity. Empirical findings suggest that structural characteristics exert different effects at different units of analysis (Hipp, 2007). This may be an explanation for my residential instability finding, it is

possible that at a micro-level unit of analysis, the relationship between instability and calls for service to opioid related incidents changes. This could be true for my other findings as well.

Further, due to data limitations I was unable to include measures of social mechanisms linking the structural characteristics to the opioid related calls for service. Measures of collective efficacy, social ties, and social capital were not feasible. The datasets that were available did not include these measures. The analyses in this study are largely a test of the traditional social disorganization theory hypothesis outlined by Shaw and Mckay (1942). While I can conclude that low socioeconomic status was associated with higher levels of opioid related calls for service, I am unable to explain any mediating factors that may be guiding this relationship. Further research should incorporate the social mechanisms described above to extend the research beyond the link between structural characteristics and opioid related incidents. Including these measures would allow for a better understanding of how structural characteristics, such as concentrated disadvantage, are associated with a higher number of calls for service to opioid related incidents.

Also, although I provided two possible explanations for census-tracts with higher levels of residential instability being associated with fewer calls for service, this finding could be unique to the city of Tempe. As mentioned previously, Tempe is home to a public university that has a large undergraduate population. This population is quite transient moving from one address to the next throughout their years in college. To the extent that this population is affecting this finding is unknown. The main reason residential instability is dichotomized is due to its collinearity with the population aged

18-24. However, once it was dichotomized, that collinearity was reduced to a sufficient level that did not warrant concern.

The ACS data that was used for this thesis contained information about residents in Tempe, Arizona from 2012 to 2016. However, the EMS calls for service data that was obtained from Tempe Fire and Medical Rescue is from 2017 to 2020. This is another limitation to point out. The 2012-2016 data on residents in Tempe may not be accurately reflecting the census-tract makeup from 2017-2020.

Lastly, my models are missing a measure of crime as a control variable. Including a measure of crime would improve the validity and robustness of my regression models. Considering that tenets of social disorganization theory and aspects of the physical environment have been found to be associated with various types of crime, it's possible my coefficients and incident rate ratios are inflated due to their correlation with crime.

Future research

Future studies should continue to use EMS data to assess the location of problematic opioid use. It has long been understood that police data is incomplete (Mosher et al., 2011; Schwartz and Vega, 2017). To gain a clearer picture of crime, and specifically for the opioid crisis, where opioid use is most prevalent or problematic, researchers should use various datasets. EMS data is often overlooked and underutilized in criminal justice research and it has been found to be complimentary to police data (Ariel et al., 2015; Telep and Hibdon, 2017). Using EMS data may provide further insight into the opioid crisis that official police data may not reveal. Seim (2020) found that 20% of EMS calls for service also included the presence of the police. Seim's (2020) findings indicate the need to compliment police data with EMS data to provide a more complete

picture into where police and EMS resources should being allocated. This approach is essential for understanding not only where the police and EMS are most frequently responding to opioid overdoses but it can also help inform better policy by providing a better understanding of the "where, why, and how" of the opioid crisis in a given city.

Another avenue to help inform research and policy is to look at the opioid crisis at a micro-level unit of analysis. As mentioned in the limitations, census-tracts are macro-level units of analysis with heterogeneity within them. Additionally, when looking at micro-level units of analysis, researchers can incorporate place-based and spatiotemporal analyses (see Chichester et al., 2020; Li et al., 2019). These types of analyses will allow for a precise understanding of where calls for service or opioid overdoses are occurring in relation to certain types of establishments (i.e. parks, hotels, vacant lots) and when they are occurring (i.e. day of the week, time of day, seasonal variation). Also, the micro-level analyses should include various measures of social and physical disorder which would add to the literature by showing how broken windows theory and urban decay might explain variation in opioid use.

Lastly, incorporating multi-level designs to assess opioid use would be beneficial to understanding the variation between individual and ecological effects at different levels of aggregation (i.e. individual, street segment, block-group, census-tract).

CONCLUSION

The opioid crisis has taken the lives of many and it is crucial to understand the trends in opioid use and opioid overdoses in order to devise a comprehensive plan that will help address problematic use. In regards to geographical trends, assessing macro-level, meso-level, and micro-level distributions is essential for identifying communities

that are susceptible to higher rates of opioid overdoses. Interventions can then be targeted to the residents of those communities. The present study sought to understand which social and physical characteristics at the census-tract level were associated with more calls for service to opioid related incidents. The findings from this study suggest that socioeconomic status, vacant units, and residential instability are significantly associated with opioid related EMS calls for service. While concentrated disadvantage and percent vacant units were significantly and positively associated with more calls for service to opioid related incidents, higher levels of residential instability were associated with lower levels of opioid related calls for service.

The findings from this study have implications for policy and future research. First, given that the percentage of vacant units at the census tract level was associated with higher levels of opioid related incidents, policies aimed at increasing the availability of affordable housing may prove to be an effective way to reduce the number of calls for service to opioid related incidents. Also, increasing homeownership within disadvantaged communities could work to limit the opportunities for drug use to persist. If the percentage of vacant units is reduced, opioid users will have fewer isolated and unsupervised locations to engage in drug use. Additionally, higher rates of homeownership is often associated with higher levels of social cohesion. Increasing homeownership may also improve cohesion among residents, strengthening their informal social control mechanisms. Further, if a portion of these vacant units are abandoned buildings, a good policy would be to repurpose them. Eliminating abandoned buildings would reduce the number of areas where there is isolation and a lack of guardianship in return reducing the opportunities for opioid use to persist.

Second, disadvantaged neighborhoods often lack resources that address a variety of issues. Increasing the amount of resources and improving the quality of resources in these communities may be a beneficial pathway towards reducing problematic opioid use. For example, increasing the prevalence of employment centers within disadvantaged neighborhoods would provide better access to employment opportunities. Reducing the number of individuals that are below the poverty line and unemployed with the deployment of employment centers may help address financial strain and improve the community's level of social disorganization by increasing the employment rate. Incorporating adequate mental health services and community organizations within these communities will not only get some individuals the help they need but it can also improve social ties within the community.

Lastly, harm reduction policies and initiatives should be aimed at provided resources to communities that are vulnerable to higher rates of opioid use. This could mean implementing lay naloxone distribution sites for citizens in order to reduce the number of opioid overdose deaths. Targeted community education campaigns to educate residents on opioid use and naloxone can be helpful for communities that are vulnerable to higher rates of opioid use. Additionally, outreach organizations providing resources to help individuals in the community gain access to employment opportunities, education, rehabilitation, and therapy should also note the geographical trends to provide resources to those in need. Further, first-responders carrying naloxone could direct their attention to locations that are showing higher levels of opioid overdoses in order to reduce the number of deaths as a result of opioid use. Also, in line with targeted harm reduction policies and initiatives, a multi-disciplinary approach should be employed to combat the

opioid crisis. A collaborative effort among various agencies in order to provide adequate services to those in need to prevent problematic opioid use and opioid overdoses is essential (CDC, 2020).

In line with the goals of harm reduction strategies, the Tempe Opioid Recovery Project, which began in January of 2020, aims to reduce opioid overdoses and overdose deaths by training and outfitting Tempe police officers with Narcan while an outreach organization (EMPACT) offers services to those who experience and survive an overdose. The project works as follows. Tempe Police Department (TPD) and Tempe Fire Department (TFD) respond to a 911 call. Upon arrival, TPD or TFD (whoever arrives first) determines whether the individual is experiencing an opioid overdose, and if so, administers Narcan. If the individual recovers and agrees, they are transported to the hospital. If a Tempe police officer is at the incident, they contact *The Tempe First-Responder ORP* hotline which is staffed 24/7 by counselors from EMPACT. A peer support navigator is given pertinent information from the responding officer, the peer support navigator then meets with the person who overdosed at the hospital or the survivor's address/location. The person is then given the opportunity to engage with a variety of services that are offered by EMPACT.

TPD has administered Narcan 109 times as of March 1, 2021. Of those 109 administrations, 89 were successful, meaning that the individual was unresponsive upon arrival, TPD administered Narcan and the overdose victim regained consciousness and started breathing. Prior to the project, TPD did not have Narcan and had to wait for TFD to respond to the incident. Additionally, the project has experienced a high level of engagement among overdose survivors and services offered by EMPACT. Prior research

shows that engagement is typically around 30% (Dahlem et al., 2017; Wagner et al., 2016). The Tempe Opioid Recovery Project has had an engagement rate of approximately 54%. Although these results are preliminary, they show the positive impact of a multi-faceted approach to combat the opioid crisis. Outfitting Tempe police officers with Narcan has and will continue to save lives. Also, engagement with services is rather high compared to prior studies and may prove to reduce the prevalence of opioid overdoses in Tempe. Nonetheless, the need to use data is critical for understanding why there is community variation in regards to opioid use. Similar to the Tempe Opioid Recovery Project's approach, a data-driven approach could be the driving factor of a successful prevention or intervention program.

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