

Community Health Senior Honors Thesis

Examining the Relationship between Drug Overdose Rates
and Homeless Population Size in Individual Counties in the United States in 2016

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RESEARCH AIMS

This thesis will explore the association between overdose deaths and size of homeless population in United States counties. The overarching aim is to identify potential factors that relate to the disproportionate rates of substance misuse and overdose fatalities in the United States' homeless population. By exploring the mechanism of the potential relationships between overdose deaths and homeless population size, this thesis will provide evidence to inform substance use disorder interventions among homeless populations. Specifically, this thesis will examine potential policy effects (e.g. Emergency Department availability and the existence of Substance Abuse Treatment Centers) to explore the necessity of expanding access to emergency overdose reversal as well as examining the impact of various sociodemographic factors and their implications.

BACKGROUND

Epidemiology

Substance use and substance use disorders (SUDs) disproportionately impact homeless populations across the United States leading to increased morbidity and mortality (Baggett et al., 2013; Bamrah et al., 2013; Bharel et al., 2013; Centers for Disease Control and Prevention, 1987, 1991; Coady et al., 2007; Fischer & Breakey, 1991; Kerker et al., 2011; Linton, Celentano, Kirk, & Mehta, 2013; J. O'Connell, 2005; O'Toole et al., 2007; Stanley, Jansson, Akinyemi, & Mitchell, 2016). The 2016 Point in Time (PIT) estimate of homelessness conducted by the United States Department of Housing and Urban Development gave a national estimate of 549,928 individuals experiencing homelessness on a night in January 2016 with 202,297, about 37%, of those individuals also experiencing a mental health or substance use disorder or both (Substance Abuse and Mental Health Services Administration [SAMHSA], 2017; The United

States Department of Housing and Urban Development [USDHUD], 2016). Other epidemiological reports from previous years found similar high numbers of SUDs within the United States homeless population; a report by the Substance Abuse and Mental Health Services Administration (SAMHSA) found that, in 2003, about 38% of homeless individuals were dependent on alcohol and 26% misused other drugs; and in 2007, the United States Conference of Mayors reported that about 26% of America's homeless population was experiencing some kind of substance use disorder (National Coalition for the Homeless, 2009e; The United States Conference of Mayors, 2008). While it is hard to obtain accurate and up to date information around homeless populations due to the cyclic nature of homelessness, the mobility of the population and the constantly developing research methods, many reports have shown a much higher rate of SUDs in the homeless population than the 2016 national SUD prevalence of 20.1 million, representing only 7.5% of the national population age 12 and up (Center for Behavioral Health Statistics and Quality, 2015; SAMHSA, 2017a). SUDs in homeless populations are important to explore and address because substance use can be both a result and a cause of homelessness, has many health implications and can present a significant obstacle to overcoming homelessness (NCH, 2009).

Different Types of Homelessness

People across the United States experience different types of homelessness. The 2016 PIT estimate recorded 68% of the homeless population in sheltered locations and 32% in unsheltered locations (USDHUD, 2016). Furthermore, 7% of the homeless population were veterans and 22% were individuals experiencing chronic homelessness (USDHUD, 2016). While there is overlap across these different subcategories of homelessness there are important

implications of each situation. The states that reported the highest numbers of homeless individuals in 2016 were California with 22% or 118,142 individuals, New York with 16% or 86,352 individuals and Florida with 6% or 33,559 individuals (USDHUD, 2016).

Sheltered Individuals

In 2016, 373,571 individuals (68%) experiencing homelessness were in some form of shelter such as transitional housing, safe havens or emergency shelters (USDHUD, 2016). Rhode Island had the highest sheltered rate of 1,123 sheltered individuals or 96.8% of their homeless population sheltered (The United States Department of Housing and Urban Development, 2016).

A second count of sheltered homelessness is done by the decennial Census and recorded as a part of Group Quarters population under Other Noninstitutional Facilities called the Emergency and Transitional Sheltered Population (United States Census Bureau, 2012). The most recent count was conducted in 2010 that found a total of 209,324 homeless individuals (United States Census Bureau, 2012).

Unsheltered Individuals

The other 32% of individuals experiencing homelessness in the 2016 PIT estimate were in unsheltered locations such as the streets, outdoors or abandoned buildings and cars (USDHUD, 2016). California had the highest unsheltered rate of 78,390 unsheltered homeless individuals or 66.4% of the total homeless population in California (USDHUD, 2016). A study conducted in 2016 from a sample of 25,489 homeless people found that individuals living in unsheltered situation such as streets, parks, cars and abandoned buildings often show poorer

health, are more frequently veterans than nonveterans, have a history of incarceration, had lower levels of education, have significant histories of substance abuse and are more frequently experiencing chronic homelessness (Montgomery, Szymkowiak, Marcus, Howard, & Culhane, 2016). Furthermore, the same study found that unsheltered status was a risk factor for mortality among homeless individuals (Montgomery et al., 2016). A Boston study conducted in the early 2000s found that unsheltered homeless populations suffer a significantly higher risk of death than the general United States population and sheltered homeless populations (J. O'Connell, 2005). An additional study found that unsheltered women were 3 times more likely to have poor health than sheltered women and were 12 times more likely to have poor mental health (Nyamathi, Leake, & Gelberg, 2000). Unsheltered women were also more likely to have reported the use of alcohol or non-injection drugs and reported less usage of health services including drug treatment (Nyamathi et al., 2000).

Chronic Homelessness

In 2016, 22% or 77,486 individuals were experiencing patterns of chronic homelessness. Chronic homelessness refers to individuals who have a disability and have been homeless for 1 year or experiences at least four different episodes of homelessness in the past three years (SAMHSA, 2017b; USDHUD, 2016). Chronically homeless individuals also have a higher overall rate of living in unsheltered locations with 68% or 52,890 individuals living under bridges or in abandoned buildings in comparison to the overall unsheltered rate of 44% (The United States Department of Housing and Urban Development, 2016). According to SAMHSA, while the chronic homeless population makes up 22% of the overall United States homeless population, they utilize and consume about half of the services (SAMHSA, 2017b). Additionally,

about two thirds of people experiencing chronic homelessness have a primary SUD or other chronic health condition (SAMHSA, 2017b).

Veterans Experiencing Homelessness

Of the total 2016 PIT estimate, 39,471 homeless individuals or 7.2% were veterans (USDHUD, 2015). A veteran refers to any person that served in active duty in the armed forces in the United States (USDHUD, 2015). In 2011, 69% of veterans involved in the Department of Housing and Urban Development and Department of Veterans Affairs Supportive Housing (HUD-VASH) Program were either chronically homeless, experiencing co-occurring mental illness and SUD or was hospitalized on multiple occasions in the last 12 months (United States Interagency Council on Homelessness, 2012). In 2015, it was reported that 73.8% sheltered homeless veterans were found in major urban areas whereas 72.4% of the total United States veteran population lived in suburban and rural areas, and 66.5% of U.S. veterans were living in poverty (USDHUD, 2015). In 2015, veterans experiencing homelessness living in a shelter were 53.1% White, Non-Hispanic, 91.9% male, 43.3% 51-61 years old, 53.1% with a disability, 73.8% in a city and before entering the shelter, 46.6% were already homeless (The United States Department of Housing and Urban Development, 2015).

Rural Homelessness

Another important focus of homelessness is among rural populations. The definition of homelessness in rural populations requires more adjustment due to the lack of shelters in rural areas as well as the different living situations that can be considered a form of homelessness; such definitions can include literal homelessness on streets or in shelters, as well as

overcrowding with relatives, or living in cars or campers (National Coalition for the Homeless, 2007; SAMHSA, 2014). Like urban homelessness, rural homelessness is caused by a lack of affordable housing and living in poverty. Those experiencing rural homelessness are found to more likely be white, female, married and employed (M. G. Fisher, 2005; SAMHSA, 2014). Additionally, Native Americans experience disproportionate rates of rural homelessness; the National Survey of Homeless Assistance Providers and Clients found in 1996 that individuals experiencing rural homelessness were 41% Native American (Post, 2002; United States Census Bureau, 1996). Although research is limited, there is growing evidence that suggests there are many behavior health problems among rural homeless populations. In Montana, 15% of the rural homeless population admitted to an alcohol and drug use disorder and 26% reported that chronic drug or alcohol use was the cause of their homelessness (Montana Department of Public Health & Human Services, 2014; SAMHSA, 2014).

Social and Demographic Characteristics of U.S. Homeless Population

In 2016, of the total number of homeless individuals, 22% were under 18, 9.1% were between 18 and 24 years of age and 68.9% were above the age of 24 (USDHUD, 2016). Across all age groups, 39.5 % of homeless individuals were reported female, 60.2% were reported male and 0.3% were transgendered (USDHUD, 2016). Researchers believe that the higher rate of homeless men versus women could be related to the presence of support and resources for homeless families that are more frequently headed by women (Folsom et al., 2003). In 2016, 48.3% of homeless individuals were White, 39.1% were African American, 2.8% were Native American, 1.6% were Pacific Islander, 1.0% were Asian, and 7.2% were multiple races (USDHUD, 2016). In reported ethnicity, 77.9% of homeless individuals were non-Hispanic and

22.1% were Hispanic (USDHUD, 2016). All racial and ethnic groups except for non-Hispanic White and Asian were overrepresented in the reported homeless population compared to the general population¹.

Substance Use as a Cause and Result

Cause

Substance use has been reported as both a cause and result of homelessness and can result in a cycle of homelessness that is difficult to break (Fischer & Breakey, 1991; Glasser & Zywiak, 2003; National Coalition for the Homeless, 2009e). Addiction can result in consequences such as loss of social and economic resources including jobs, family and friends. As economic resources deplete, bills become harder to pay and can result in the loss of housing (Johnson, Freels, Parsons, & Vangeest, 1997; National Coalition for the Homeless, 2009e). In 2008, 25 cities gave their top three causes of homelessness and 68% reported that the single largest cause of homelessness for individuals was SUD (The United States Conference of Mayors, 2008). Additionally, a study conducted by Didenko and Pankratz reported that two thirds of homeless individuals stated that drugs and/or alcohol were the biggest reason for their homeless status (Pankratz & Didenko, 2007).

Result

Despite instances of substance use as a cause, there have been many instances of homelessness resulting in SUDs (Johnson et al., 1997; National Coalition for the Homeless,

¹The 2016 United States Census found of the total United States population 76.9% were White, 13.3% were Black or African American, 1.3% were American Indian and Alaska Native, 5.7% were Asian, 0.2% were Native Hawaiian and Other Pacific Islander, 2.6% were Two or More Races, 17.8% were Hispanic or Latino and 61.3% were non-Hispanic White

2009e). Many individuals use drugs and alcohol as a coping mechanism for living conditions and as a way to self-medicate as a temporary relief of their situation (Johnson et al., 1997; National Coalition for the Homeless, 2009e). In reality, SUDs can make it extremely hard to find and sustain a job or return to a stable place (National Coalition for the Homeless, 2009e). Many individuals with SUDs cannot even access shelters as many shelters require sobriety (United States Interagency Council on Homelessness, 2012). More importantly, the conditions of homelessness may create low motivation to seek help for SUD and without a support system help does not get prioritized over food and shelter (National Coalition for the Homeless, 2009e). Even if sobriety is achieved among homeless individuals, it can be difficult to sustain in the conditions and around other users (G. L. Fisher & Roget, 2009; National Coalition for the Homeless, 2009e).

Mental Health

Mental illness disproportionately affects homeless individuals (National Coalition for the Homeless, 2009d; National Institute of Mental Health, 2016; SAMHSA, 2017b). Between one fourth and one third of homeless individuals have a serious mental illness including schizophrenia, bipolar disorder and major depression, compared to 4.2% of the general population (Fischer & Breakey, 1991; Sullivan, Burnam, Koegel, & Hollenberg, 2000). More than two-thirds of 6,494 homeless individuals included in a study from Boston Health Care for the Homeless had some form of mental illness, most frequently depression (Bharel et al., 2013). Mental illness can cause a disruption in an individual's daily life such as in carrying out essential tasks of self-care and household management (National Institute of Mental Health, 2016). Mental illness can cause disruptions in relationships, often causing negative reactions that can sever an

individual's access to social support (National Institute of Mental Health, 2016). Consequently, people experiencing mental illness are more likely than the general population to become homeless (Folsom et al., 2003; National Coalition for the Homeless, 2009d). Furthermore, one study has shown variations in psychiatric conditions and their related risk for homelessness such that patients with schizophrenia were 2.4 times more likely to be homeless and patients with bipolar disorder were 1.6 times more likely to be homeless than those with depression (Folsom et al., 2003). When mental illness is combined with homeless conditions, hygiene can play a part in the development of respiratory infections, skin diseases or exposure to communicable diseases (National Coalition for the Homeless, 2009d). Mental illness can also lead to suicidal ideation, suicide attempts and suicide; these consequences disproportionately affect homeless individuals at a higher rate than the general populations (Coohey Carol, Easton Scott D., Kong Jooyoung, & Bockenstedt Julie K. W., 2014; Lee et al., 2017; Patterson Allisha A. & Holden Ronald R., 2012).

Mental Health and Substance Abuse Co-Morbidity

SAMHSA has reported the prevalence of mental health and substance abuse comorbidity in 3.4% of adults in the U.S. general population. Someone experiencing a SUD is two times as likely to be diagnosed with an anxiety or mood disorder (NIDA, 2011). One direction of this relationship frequently studied is the potential for a mental illness to lead to drug abuse as a means of self-medication (NIDA, 2011). Individuals suffering from anxiety and depression may depend on alcohol and other drugs to ease symptoms (NIDA, 2011). Frequencies of co-morbidity can be related to a common contributing factor between a SUD and a mental illness, such as stress (Volkow, 2001). For example, an individual experiencing posttraumatic stress disorder

(PTSD) can be triggered into drug abuse to temporarily relieve symptoms, not realizing, however, that drug abuse activates stress in the brain, thus completing the cycle (Volkow, 2001). While there is no proven cause and effect relationship between SUDs and mental disorders, studies have also shown that drug abuse can bring about mental illness. The National Institute on Drug Abuse explains that substance use can lead to changes in the brain similar to changes produced by mental disorders serving to start the development of a mental illness (National Institute on Drug Abuse [NIDA], 2018). One example of this pathway is from a case study that found the use of three substances, alcohol, PCP and stimulants, likely induced subacute and chronic psychotic symptoms within the individual (Ross & Peselow, 2012).

Mental illness and substance abuse comorbidity is frequently found at disproportionate rates in homeless populations complicating both illnesses. A study conducted by Torchalla et al., found that in a sample of 489 homeless individuals, 73% reported having experienced a traumatic event, 20.5% met the criteria for being diagnosed with PTSD, 82.6% had a current SUD and 18.8% had both PTSD and a SUD; of the subset of individuals with a SUD, 22.8% had PTSD and among the subset of individuals with PTSD, 92% had a SUD (Torchalla et al., 2014). Further studies have demonstrated the same co-morbidities among homeless populations at even higher rates. A study conducted in 2007 in the Emergency Department (ED) of a Baltimore hospital, found that high-frequency utilizers of the ED for substance use were significantly more likely to be homeless and have either a chronic mental health condition, a chronic medical condition or both (O'Toole et al., 2007). In a second study conducted at Boston Health Care for the Homeless, 48% of 6494 patients had a co-occurring mental illness and SUD (Bharel et al., 2013).

Physical Health Consequences of SUD

In addition to affecting day-to-day life, SUDs can have significant short-term and long-term impacts on physical health (NIDA, 2011). Various drug and alcohol use can cause changes in heart rate, wakefulness and blood pressure as well as more significant effects such as heart attacks, strokes, psychosis and overdose (NIDA, 2011). In the long term, use of substances including alcohol can result in heart or lung disease, cancer, sexually transmitted diseases and mental illness (NIDA, 2011; Schulte & Hser, 2014). Among homeless substance users, there is a higher risk of Human Immunodeficiency Virus (HIV) and Tuberculosis (TB) (Bamrah et al., 2013; Centers for Disease Control and Prevention, 2018; Deiss, Rodwell, & Garfein, 2009).

Substance use has also been examined as a risk factor for suicide in different populations. One study found that injection drug users were 2.4 times more likely to have suicidal ideation than non-injection drug users (Havens, Sherman, Sapun, & Strathdee, 2006). A second study found that heroin users have a 13 times higher death rate than the general population with an estimated 3% to 35% deaths by suicide (Darke Shane & Ross Joanne, 2002). Specifically among homeless populations, Lee et al. also found that drug abuse caused homeless individuals to be 1.24 times more likely to experience suicidal ideation than homeless individuals without drug use (Lee et al., 2017).

Health Consequences of Substance Use Disorder and Mental Health Disorder Co-morbidity

Studies exploring the relationship between SUDs and mental health disorders have found both significant and insignificant results related to suicidal ideation, suicidal attempts and

suicide. The relationship between suicidal behavior in dually diagnosed homeless individuals for a SUD and mental health issue was explored in a study of over 7,000 homeless individuals and found 37.5% of individuals reported past 30-day suicidal ideation and 7.9% of individuals reported past 30-day suicidal attempt (Prigerson, Desai, Liu-Mares, & Rosenheck, 2003). Although there were no risks of suicidal ideation or attempts found that were significantly increased with a co-morbid diagnosis, an interaction between age and co-morbidity was discovered; among older clients, aged 30 to 39 years old, individuals comorbid with substance use were at a significantly greater risk for suicidal ideation than those without substance use and, in general, older clients experiencing co-morbidity had significantly increased risks of suicide (Prigerson et al., 2003). In 2012, Walsh found that homeless participants who reported co-morbidity of a SUD and mental health disorder demonstrated higher rates of suicide attempt than those with just a mental health disorder or just a SUD (Folsom et al., 2003).

Homeless individuals with co-occurring mental illnesses and SUDs had high health care utilization with more than a third having 6 or more ED visits and more than 20% having 3 or more hospitalizations (Bharel et al., 2013). In addition, access to substance use treatment is harder for homeless individuals dually diagnosed with a mental health disorder (Folsom et al., 2003).

SUDs and Risky Behavior

In addition to the adverse health conditions caused by drug and alcohol abuse, there is a link between homelessness and risky drug behaviors which can lead to the spread of communicable diseases in homeless populations (Coady et al., 2007; Linton et al., 2013). A

longitudinal study conducted in Baltimore, Maryland from 2005 to 2009 found that homeless individuals failed to cook or filter drugs and practiced unsafe drug paraphernalia disposal due to the fear of confiscation and arrest by the police (Linton et al., 2013). Another finding was the risky behavior of paraphernalia sharing as a result of both the confiscation of sterile syringes by police and the lack of income among the homeless population to afford sterile syringes, which causes transmission of blood borne diseases such as HIV and hepatitis C (Linton et al., 2013). In 2006, The National Coalition for the Homeless reported that HIV prevalence in homeless populations was estimated at 3.4% compared to the 0.4% prevalence in the general population, a rate 8.5 times higher than the general population (National Coalition for the Homeless, 2009c). A study conducted in 2013 in Boston found that 23% of the 6,494 homeless individuals had HCV and 6% had HIV (Bhareel et al., 2013).

Blood borne diseases can then lead to many dangerous health conditions. HIV progresses in stages up to the development of AIDS, which compromises the immune system and can lead to death after about 3 years (Centers for Disease Control and Prevention [CDC], 2015). Hepatitis C in a majority of untreated cases leads to a long-term infection, which then leads to liver cancer and cirrhosis, scarring of the liver (CDC, 2015). The CDC found that 13% of all HIV cases in the United States is attributable to risky behaviors from SUDs (Badiaga et al., 2008). Furthermore, many homeless shelters are same-sex and offer limited privacy, which can prevent the formation of stable sexual relationships (National Coalition for the Homeless, 2009c; University of California Center for AIDS Prevention Studies, 2005). It is important to note, however, that many of the risky behaviors among homeless populations are due to their environment and not a

lack of judgment, meaning that as long as homeless individuals remain on the streets, the risky behavior will not stop and dangerous health conditions will continue to occur.

Life Expectancy

Due to the high burden of disease among homeless populations, the average life expectancy of a homeless individuals is only 41 to 47 years compared to the United States national average of 78 years (Centers for Disease Control and Prevention, 1987, 1991; Hanzlick & Parrish, 1993; National Center for Health Statistics, 2017; J. O’Connell, 2005). Various studies across Boston, San Francisco and Atlanta have suggested significantly lower rates of average life expectancy for homeless individuals due to natural causes and external causes including drug and alcohol poisoning, accidents, suicide, acute and chronic illnesses (Centers for Disease Control and Prevention, 1987, 1991; Hanzlick & Parrish, 1993; J. O’Connell, 2005). Early mortality has also been documented finding a homeless mortality rate that is 3.5-4 times higher than the general population in Philadelphia and New York (Barrow, Herman, Cordova, & Struening, 1999; Hibbs et al., 1994). In individuals experiencing chronic homelessness, the mortality rate has been found to be four to nine times higher (SAMHSA, 2014).

In terms of racial and ethnic homeless mortality differences, non-Hispanic White homeless individuals face a higher rate of death than other racial groups, different from the pattern observed in the general population (Baggett et al., 2013; C. S. North & Smith, 1994; Rosenheck, Bassuk, & Salomon, 1998). One study found that over 15 years from a total of 1,302 deaths in the homeless population, 68% of drug overdose deaths, 68% of substance use disorders and 89% of suicide occurred in non-Hispanic White homeless individuals (Baggett et al., 2013).

One possible explanation is the underlying routes to homelessness that individuals of difference racial backgrounds experience. Research suggests that African American individuals are at risk of becoming homeless from structural factors such as poverty and discrimination, whereas White individuals are more likely to be homeless due to personal factors such as trauma, familial disruptions, mental illness and substance abuse; factors that have a higher risk of death (Baggett et al., 2013; C. S. North & Smith, 1994; Rosenheck et al., 1998). Furthermore, in recent years there have been notable increases in death among the middle-aged non-Hispanic White general population attributable to suicide, drug and alcohol poisonings and liver diseases (Case & Deaton, 2015).

Healthcare Access and Treatment Access

Homeless individuals often do not have health insurance or a means of accessing proper care and treatment especially for SUDs and the related health risk factors (Baggett, O'Connell, Singer, & Rigotti, 2010). In the case of both HIV and Hepatitis C, treatment options are time consuming and costly and, as a result, many homeless individuals cannot afford the treatments even with insurance because primary care services available to homeless populations generally do not have the resources (United States Interagency Council on Homelessness [USICH], 2015). There are few federal funding sources specifically targeting substance abuse treatment and prevention in homeless populations (National Coalition for the Homeless, 2009b). Addiction treatment services accessible specifically for homeless individuals are sparse and many focus on abstinence only instead of harm-reduction strategies that are more effective (National Coalition for the Homeless, 2009b). Even when treatment programs exist there are many barriers that still persist such as long wait lists, lack of transportation and lack of documentation (National

Coalition for the Homeless, 2009b). A study conducted in Los Angeles among 1,000 homeless women excluding those living directly on the streets found that 37% still had unmet medical needs higher than the national average reported at 21% (Lewis, Andersen, & Gelberg, 2003). In 2003, an additional survey conducted across different Health Care for the Homeless locations found that of 966 respondents, 73% reported one unmet health need, which included 32% unable to get necessary medical or surgical care, 36% unable to get prescription medication, 21% unable to get mental health care, 41% unable to get eyeglasses and 41% unable to get dental care (Baggett et al., 2010).

While the Medicaid expansion via the Affordable Care Act (ACA), implemented in participating states in 2014, expanded health care services for poor and homeless individuals with incomes up to 138% of the federal poverty level, there remain reported barriers to enrollment for homeless individuals preventing access to health care (Fryling, Mazanec, & Rodriguez, 2015). A study conducted across a cohort of 134 homeless and 516 non-homeless individuals in San Francisco, CA found that homeless individuals were more likely to have never heard of the ACA than their non-homeless counterparts (Fryling et al., 2015). Furthermore, not being aware of qualification accounted for the most common reported barrier to enrollment at 70% and the most significant barrier to enrolment at 30% for homeless individuals (Fryling et al., 2015). Of the total homeless individuals that did not know their personal eligibility, 91% had an income less than 138% of the federal poverty level, which would likely qualify them for Medicaid coverage (Fryling et al., 2015). Lastly, only 74% of the homeless participants compared to the 99% of the non-homeless participants reported having access to a phone or the internet for enrollment purposes (Fryling et al., 2015).

Emergency Department Visits

Homeless individuals must prioritize their needs such as food, safety and shelter over their own health in order to survive and, therefore, go without seeking medical care until conditions and illnesses become serious or cause permanent damage (Bharel et al., 2013). Thus, homeless individuals are more likely than their housed counterparts to access emergency services such as inpatient services and crisis residential services than outpatient services (Folsom et al., 2003). A study conducted in Baltimore looked at the top 20 ED users in the city among three different EDs and found that, in total, all 20 of them accounted for 2,079 visits, 18 of the 20 were homeless and 13 of the 20 had a form of public insurance (DiPietro, Kindermann, & Schenkel, 2012). The most frequent chronic conditions were hypertension, HIV infection, diabetes, substance abuse and alcohol abuse with homelessness being the most common factor between them (DiPietro et al., 2012). A Boston study that followed 115 chronic homeless individuals that had lived on the streets for at least six consecutive months found that from 1999 to 2003 the group had a total of 18,384 ED visits, and from 2000 to 2004 more than 25% of the cohort had died (J. J. O'Connell et al., 2004). From the frequent ED visits, it was found in Boston that homeless individuals had total healthcare expenditures 3.8 times that of an average individual with Medicaid (Bharel et al., 2013).

Overdose Deaths

The most severe consequence of SUD is overdose and overdose deaths. Coinciding with the disproportionate rate of SUDs among the homeless population is the disproportionate overdose rates and fatalities. In the U.S. in 2015 there were a reported 52,404 overdose deaths in

the general population accounting for about 2% of total deaths (Centers for Disease Control and Prevention, 2016b; NIDA, 2017). A study conducted in Boston in 2013, however, found that overdose accounted for about 17% of deaths of homeless individuals in a cohort of 28,000 from 2003 to 2008 (Baggett et al., 2013). The study also compared overdose mortality rates, controlled for age and sex, and found that mortality due to drug overdose was 16 to 24 times higher for homeless individuals than the general population (Baggett et al., 2013). From 2003-2011, 279 violent deaths among homeless individuals in Maryland were characterized and analyzed to uncover more information around homeless mortality in Maryland (Stanley et al., 2016). The study uncovered that from 182 undetermined deaths of homeless individuals, 74.4% of the homeless individuals had substance use problems and 43.9% had alcohol problems (Stanley et al., 2016). In addition, from all 279 deaths, 14.3% of homeless individuals had mental health problems and 35.3% of the 38 suicide victims had a depressed mood at the time of their death (Stanley et al., 2016). Lastly, toxicology found that more than half of the individuals had a raised blood alcohol content (BAC) with 30.5% of BACs higher than the standard of intoxication, 31.3% of individuals with cocaine in their system, 54.8% with opiates in their system and 45.2% with other drugs in their system (Stanley et al., 2016). In 2003, Kerker et al. found that substance abuse death rates in homeless adults were 5 times that of the general population (Kerker et al., 2011).

Emergency Rooms and Access

Due to lack of health insurance and access to specific treatment resources for homeless individuals, many individuals end up utilizing emergency departments (ED) for treatment and life-saving intervention in the case of overdose (NHC, 2009). A study conducted in 2002 showed

that 40.4% of homeless respondents had one or more visits to the ED in the previous year, 7.9% reported high rates of 3 or more visits to the ED in the past year and accounted for 54.5% of all the ED visits (Kushel, Perry, Bangsberg, Clark, & Moss, 2002). Factors that were associated with high use of EDs were unstable housing, arrests, physical and mental illness and substance abuse (Kushel et al., 2002). Homeless individuals with SUDs are more likely to get medical care through the ED than non-homeless individuals; in a study conducted among Boston Healthcare for the Homeless outpatient services, a patient with a history of drug use, mental health and having hepatitis C were strong predictors of frequent ER visits (Machlin & Chowdhury, 2008; Thakarar, Morgan, Gaeta, Hohl, & Drainoni, 2015). In the event of drug overdose immediate emergent medical attention is required to prevent death and accessible emergency medical responders and EDs are necessary.

Naloxone

In the specific case of opioid overdose, Naloxone, a FDA approved drug, has been developed to reverse the effects of opioids by blocking opioid receptors (NIDA, 2016). Naloxone can be administered via injection, auto-injection devices and nasal spray (NIDA, 2016). The latter two forms of Naloxone have been approved for distribution among trained bystanders to increase the prevalence of Naloxone to prevent more avoidable deaths (NIDA, 2016). While Naloxone is a prescription drug, it does not have abuse potential, thus safe to increase access to bystanders (Davis, Chang, Carr, & Hernandez-Delgado, 2017).

Laws

In addition to life-saving drugs, laws enacted in different states can make a difference in the way that overdose, drug use and drug use amongst homeless individuals is handled. In July of 2017, all 50 states and the District of Columbia had enacted legislation to increase the access of Naloxone for laypeople (Davis et al., 2017). Many times overdose occurs when around family and friends, thus, increasing access to surrounding people can save lives (Davis et al., 2017). Before these laws, there were state practice laws around naloxone that prohibited the prescription of a medication to an individual that is meant for a different individual, also known as a third-party prescription. In addition, laws also prevented naloxone from being a standing order drug, which meant that an individual had to meet with a doctor each time to get a prescription. Now, legislation has changed so that approved individuals are able to distribute pre-written doctor prescriptions of naloxone to people who qualify for the prescription such as at an organization or clinic (Davis et al., 2017). While all 50 states have enacted laws increasing naloxone access, the laws in each 50 states differ on various aspects of immunity granted. Outlined in each law across the country is whether the law provides civil, criminal or disciplinary immunity for medical professionals prescribing or dispensing naloxone. The law also specifies whether laypeople are allowed to possess naloxone without a prescription, whether prescriptions are able to be provided to third parties not at risk of overdose and, lastly, if naloxone can be prescribed by a standing order (Davis et al., 2017). The Bureau of Economic Research found that the implementation of naloxone access laws is associated with a 9 to 11 percent decrease in opioid-related deaths in a state (Rees, Sabia, Argys, Latshaw, & Dave, 2017). A study conducted by Walley et al. found that upon training approximately 2,900 bystanders with naloxone administration in

Massachusetts, opioid overdose death rates were reduced in communities that provided the training (Walley et al., 2013).

A second law enacted by 40 of the 50 states in the United States in July 2017 that has important implications when dealing with overdose in America is the Good Samaritan law. In 2012 in New Mexico, emergency medical services were called for 72% of the fatal overdoses directly witnessed (Levy et al., 2016). A second study conducted in Baltimore, Maryland reported that of 397 overdoses witnessed, emergency medical services were called for only 23% of them (Tobin, Davey, & Latkin, 2005). Additional studies display the failure to call 911 in the event of witnessing an overdose, reflecting a fear of arrest and a desire to avoid law enforcement (Centers for Disease Control and Prevention (CDC), 2000; P. J. Davidson et al., 2003; MD & MD, 2007; Pollini et al., 2006). The Good Samaritan law can address these issues by providing different types of protection from prosecution or arrest of individuals who report an overdose. Across the different states the law outlines whether individuals are protected from arrest, charge or prosecution for possessing a substance or possession of paraphernalia. In addition, the law can provide protection from violating protective and restraining orders, probation or parole. Lastly, the Good Samaritan law can provide mitigation for reporting an overdose in a sentence for a crime not granted immunity. After passing the Good Samaritan law in Washington state, 88% of opiate users indicated after being aware of the law that they were more likely to call emergency medical services for future overdoses (Banta-Green, Kuszler, Coffin, & Schoeppe, 2011). Furthermore, an overdose witness with correct information about the Good Samaritan law was 3 times more likely to call 911 than an overdose witness with incorrect or no knowledge of the Good Samaritan law (Jakubowski, Kunins, Huxley-Reicher, & Siegler, 2017). Not only is the

implementation of certain laws important to the reduction and prevention of overdose fatalities but the dissemination of correct knowledge about the laws themselves is additionally important to the impact of the laws (Zadoretzky et al., 2017).

IMPLICATIONS

SUDs disproportionately impact homeless populations across the United States leading to increased morbidity, mortality and barriers to ending homelessness. While other studies have demonstrated the high prevalence of SUDs and overdose mortality rates in homeless populations, many of these studies are conducted in smaller cohorts in specific and individual locations of the United States. This thesis will contribute to the literature by exploring the association between overdose mortality and homeless population on the county level as well as identify potential factors that relate to the disproportionate rates of SUDs and overdose mortality among homeless populations.

RESEARCH QUESTION

- 1) Is there an association between overdose mortality and homeless population by United States county in 2016?

Hypothesis 1: Overdose mortality and homeless population will be positively associated.

- a. How do sociodemographic characteristics of counties and the homeless population influence the relationship between overdose mortality and homeless population by county?

- i. Hypothesis 2: non-Hispanic White homeless population will be positively associated with overdose mortality
 - ii. Hypothesis 3: Percent of uninsured and unemployment will be positively associated with overdose mortality and with homeless population. Rurality will be positively associated with overdose mortality and negatively associated with homeless population.
- b. How do treatment providers (e.g. Substance Use Treatment Centers and Emergency Departments) influence the relationship between overdose mortality and homeless population by county?
 - i. Hypothesis 4: Both types of treatment providers (e.g. Substance Use Treatment Centers and Emergency Departments) will be negatively associated with overdose mortality and have no association with homeless population per county.

METHODS

This analysis draws on five publically available data resources including The Center for Disease Control's (CDC) Wide-ranging Online Data for Epidemiologic Research Database (WONDER) providing data on overdose mortality for 2016; The Census Bureau's Group Quarters decennial count for the sheltered homeless population in 2010; The Centers for Medicaid Services' (CMS) Provider of Services (POS) file for 2016 count of emergency departments; The Substance Abuse and Mental Health Service Administration's (SAMHSA) Behavioral Health Treatment Services Locator for 2018 substance abuse treatment center count;

and The County Health Ranking National Data for 2015 rural percent, 2015 non-Hispanic White population percent, 2014 unemployment percent and 2015 adult uninsured percent .

Dependent Variable

The outcome variable in this analysis is Overdose Mortality. Overdose Mortality uses data from 2016, is measured on the county level and population adjusted to Overdose Mortality number per 10,000 people. This dataset was provided by the CDC's WONDER. WONDER produces the Underlying Cause of Death database which collects mortality and population counts of all U.S. counties. The data is based on death certificates for United States residents, which state a single underlying cause of death and demographic information. The variable includes ICD-10 codes X40-X44, X60-X64, X85, Y10-Y14, X45, X65 and Y15. The deaths include accidental, intentional and undetermined poisoning by drug and alcohol substances from 2016 (Centers for Disease Control and Prevention, 2016b).

Key Explanatory Variable

The key explanatory variable in this study is Sheltered Homeless Population. Sheltered Homeless Population uses data from 2010, is measured on the county level and population adjusted to the Sheltered Homeless Population per 10,000 people. The data was provided by The United States Census Bureau's 2010 Census Decennia Group Quarters Population.

The Census breaks up the living quarters into housing units and the group quarters population. Within the group quarters population there is an 'other noninstitutionalized facilities' category, which separates 'sheltered and transitional shelters (with sleeping facilities) for people

experiencing homelessness population' per county from other non-institutional facilities such as adult group homes and religious group quarters. The 2010 Census Service-Based Enumeration (SBE) operation was conducted at service locations and targeted non-sheltered outdoor locations in order to enumerate homelessness. The various locations included emergency and transitional shelters, soup kitchens and mobile food vans. The Census Bureau took a total of three days starting on March 29, 2010 to conduct the SBE operation.

Despite the inability of the SBE operation to provide a total count of the United States homeless population due to the exclusion of unsheltered individuals and the complexity of the population, the decennial Census was chosen to be the proxy measure of homeless population as it provides the most widespread count of homeless populations at the county level compared to other databases. Furthermore, the dataset included racial and ethnic data of homeless individuals, enabling the exploration of homeless race and ethnicity within this study.

Covariates

Treatment Provider Variables

Two co-variates were grouped into treatment provider variables including Emergency Departments and Substance Abuse Treatment Centers in order to consider their potential impact on overdose mortality. These two covariates are important to consider in order to explore the impact of treatment access on predicting explained variability in overdose mortality and improve the accuracy of the relationship between Sheltered Homeless population and Overdose Mortality. Emergency Department data was collected from the CMS's POS file from 2016. Emergency Departments are measured on the county level as number per 10,000 people. Substance Abuse

Treatment Center data was collected from SAMHSA's Behavioral Health Treatment Services Locator. Substance Abuse Treatment Centers are also measured on the county level as number per 10,000 people.

The CMS's POS file contains data on the characteristics of hospitals and healthcare facilities providing information on certain services provided. Each individual record for every Medicare-approved provider is collected and updated on a quarterly basis. Only the hospitals that reported emergency services were used in the study (Centers for Medicare, 2016).

The Behavioral Health Treatment Services Locator is a public online tool for finding information on treatment facilities for substance use disorders and mental illness problems. The tool was created from SAMHSA's Center for Behavioral Health Statistics and Quality via two annual surveys called the National Survey of Substance Abuse Treatment Services and the National Mental Health Services Survey. Eligible substance addiction treatment facilities consist of centers either licensed by the state substance abuse agency (SSA) or a national accredited organization, staff with credentials to provide substance addiction treatment services or a facility authorized to bill third party payers for treatment services using an alcohol or drug diagnosis. The excluded facilities from the tool include facilities that provide either mental health or substance addiction services strictly to incarcerated individuals, facilities who focus providing services to persons with Mental Retardation, Developmental Disability, or Traumatic Brain Injuries, and mental health professionals in private practices or small group practices that are not certified or licensed as a mental health clinic or community center (Substance Abuse and Mental Health Services Administration, 2017).

Sociodemographic Variables

Four additional co-variates, Rural percent, non-Hispanic White population percent, Unemployment percent and Uninsured percent, were grouped under sociodemographic variables to be used in the study due to their potential influence on the relationship between Overdose Mortality and Sheltered Homeless Population. Because these covariates are speculated to have effects on the outcome and explanatory variable, it is important to consider them in the model in order to improve the accuracy of the effects of the primary explanatory variable. The Uninsured, non-Hispanic White and Rural variables were collected from 2015 data and the Unemployment variable was collected from 2014 data. All four variables are measured as a percentage of each county's population and came from the County Health Ranking National Data.

The County Health Rankings is a collaboration between the Robert Wood Jonson Foundation and the University of Wisconsin Population Health Institute. The Rankings compile county-level measures from various public national and state data sources and standardize them using scientifically-informed weights. The data sources and years used for the specific variables chosen are the Census Population Estimates (2015), The Census Bureau's Small Area Health Insurance Estimates (SAHIE) (2014) and the Bureau of Labor Statistics (2015) (County Health Rankings and Roadmaps, 2017).

The United States Census Bureau population estimates provided data on population number, race and ethnic data per county and rural percentage per county. Due to national racial and ethnic inequalities, racial and ethnic minorities experience increased rates of unemployment, uninsured

rates and poverty (Adjeiwaa-Manu, 2017; Macartney, Bishaw, & Fontenot, 2013; Sohn, 2017). Thus, non-Hispanic White percentage per county is used to measure the difference in counties between majority non-Hispanic White counties and majority-minority counties. Measuring minority make-up of counties can help take into account these systematic inequalities that discriminate against minorities, contribute to pathways into homelessness and lead to conditions of increased drug use and overdose.

Each year the Census estimates the resident population from the most recent decennial census report in 2010 by measuring population change. The census uses the population base from the 2010 decennial census, adds births and net migration and subtracts deaths. In order to get a more reliable estimate, a “top-down” approach is used by beginning with estimating monthly population at the national level by age, sex, race and Hispanic origin. Annual county populations are then estimated and summed up to the state level. The national characteristics and state and county totals are then used to estimate state and county characteristics. The estimates are ensured to be consistent across all geographic and demographic characteristics. Because consistency does not occur automatically a process called raking is used to generate controlled estimates in order to help a column sum to one total. In order to control population estimates for characteristics, a two-way raking process is used. (United States Census Bureau, 2017).

The Census Bureau’s SAHIE program develops model-based estimates of county-level adult health insurance. SAHIE is the only single-year health insurance coverage source that adjusts estimates to ensure county estimates sum their respective state totals. The data is collected through a combination of sources including from the American Community Survey,

demographic population estimates, federal tax returns, the Supplemental Nutrition Assistance Program, Medicaid, Children's Health Insurance Program and the 2010 Census (United States Census Bureau, 2016).

The Bureau of Labor Statistics' Current Population Survey (CPS) is a monthly survey of 60,000 households from the noninstitutionalized population age 16 and older run by the Bureau of Census for the Bureau of Labor Statistics. The survey consists of both telephone and in-person interviews with respondents. The survey collects demographic characteristics and determines employment status of respondents (United States Department of Labor, 2017a).

DATA ANALYSIS

This thesis conducts secondary data analysis using data from multiple sources to examine the relationship between the outcome variable, Overdose Mortality and the primary explanatory variable, Sheltered Homeless Population, adjusting for the covariates. More specifically, this thesis will aim to develop a best fit linear regression model in order to provide insight on explained variations in Overdose Mortality by the primary explanatory variable, improving accuracy with the inclusion of covariates to consider their independent effects. Different racial and ethnic groups that make up the Sheltered Homeless Population will be considered in order to determine any differences in associations with Overdose Mortality across racial and ethnic Sheltered Homeless Population groups as suggested by previous literature. The co-variables being explored in the analysis include treatment provider variables and sociodemographic variables.

Descriptive Statistics

The first phase of the analysis included univariate exploratory data analysis calculating descriptive statistics for each variable including number of observations, highest and lowest value, mean and standard deviation. Normality tests were also conducted including Shapiro-Wilk test, skewness, kurtosis, histograms and Normal Q-Q plots. After describing the data, bivariate exploratory data analysis was conducted using Pearson correlation tests and scatterplots to ensure validity of the r-values.

Regression Analysis

The second phase of analysis was the development of the linear regression model. After conducting normality tests, Sheltered Homeless Population was log-transformed in order to normalize the left-skewed distribution to better fit the model. A directed acyclic graph (DAG) shown in Figure 1 was then developed in order to conceptually address the research question by logically mapping the potential relationships between the outcome variable, explanatory variable and co-variates (Elwert, 2013). Pearson Correlations were run and analyzed to ensure the elimination of co-linearity and non-significance in order to create the best model for Overdose Mortality.

RESULTS

Descriptive Statistics

There was a total of 3,147 counties in the United States from which data was collected by secondary sources and used for the study. Table 1 depicts the mean, minimum, maximum and

standard deviation for the outcome variable, key explanatory variable, sheltered homeless race and ethnicity variables, county sociodemographic variables and treatment provider variables.

Variable	Sub-Categories	N	Mean	Min	Max	S.D.
Overdose Mortality		848	3.85	0.82	16.09	1.78
Sheltered Homeless Population	Total	1,159	6.19	0.13	64.91	6.39
	Non-Hispanic White	1,159	3.49	0.0	38.44	3.53
	African-American	1,159	1.57	0.0	36.33	3.18
	Asian	1,159	0.06	0.0	4.87	0.22
	Native Hawaiian	1,159	0.04	0.0	11.79	0.48
	American Indian	1,159	0.31	0.0	35.44	1.54
	Hispanic	1,159	0.63	0.0	31.71	1.49
	Two or More Races	1,159	0.22	0.0	7.30	0.46
	Other	1,159	0.16	0.0	12.64	0.57
Sociodemographic	Unemployment	3,139	6.27	1.19	23.67	2.30
	Uninsured	3,140	21.05	3.66	51.26	6.58
	Rural	3,141	58.62	0	100	31.51
	White Non-Hispanic	3,140	77.09	3.14	98.61	19.90
Treatment Providers	Substance Abuse Treatment Centers	3,136	0.41	0	16.18	0.69
	Emergency Departments	3,140	1.00	0	21.39	1.71

Table 1: Summary Statistics of Outcome Variable, Exploratory Variable and Covariates

Across 848 counties, the average overdose mortality rate was 3.85 deaths per 10,000 population. The lowest reported overdose death rate was 0.82 deaths per 10,000 and the highest was 16.09 deaths per 10,000. Sheltered Homeless Population was counted by 1,159 counties in the United States, found an average of 6.19 sheltered homeless individuals per 10,000, a minimum of 0.13 sheltered homeless individuals per 10,000 and a maximum of 64.91 sheltered homeless individuals per 10,000. The highest homeless group across race and ethnicity was

sheltered non-Hispanic White homeless individuals with an average of 3.49 per 10,000 population.

Sociodemographic variables were reported across most of the counties with an average Unemployment rate of 6.27%, an average Uninsured rate of 21.05%, an average Rural rate of 58.62% and an average White non-Hispanic county population of 77.09%. Unemployment ranged from 1.19% to 23.67%, while Uninsured ranged from 3.66% to 51.26%. Looking at treatment provider variables, the mean number of Substance Abuse Treatment (SAT) Centers across 3,136 counties is 0.41 centers per 10,000 and the mean number of Emergency Departments (ED) is 1.00 per 10,000 population. The minimum for both SAT Centers and EDs was 0 and the maximum was 16.18 SAT Centers and 21.39 EDs per 10,000 population.

Directed Acyclic Graph

A Directed Acyclic Graph was created to help conceptualize the relationships to be tested in the statistical model. The directions of the relationships shown are based on evidence from the literature (Hollingsworth, Ruhm, & Simon, 2017; National Alliance to End Homelessness, 2018; National Coalition for the Homeless, 2009a; National Law Center on Homelessness & Poverty, 2015). The DAG (Figure 1) informed the inclusion of sociodemographic and provider treatment variables in the final linear regression model. Because the Non-Hispanic White county population impacted both Unemployment and Uninsured percent, as well as its relationship with Rurality, in order to create a parsimonious regression model, it was left out to prevent confounding and co-linearity effects. All other covariates including Unemployment, Uninsured,

Rurality, Substance Abuse Treatment Centers and Emergency Departments were considered for the final linear regression model.

Pearson Correlations

A Pearson correlation analysis was conducted to assess any associations between Overdose Mortality, Sheltered Homeless Population, socioeconomic variables and treatment provider variables in order to anticipate confounding effects and collinearity in the covariates (Table 2). Results from Table 2 found that Sheltered Homeless Population and Overdose Morality had a small positive correlation ($r=0.11, p<.01$).

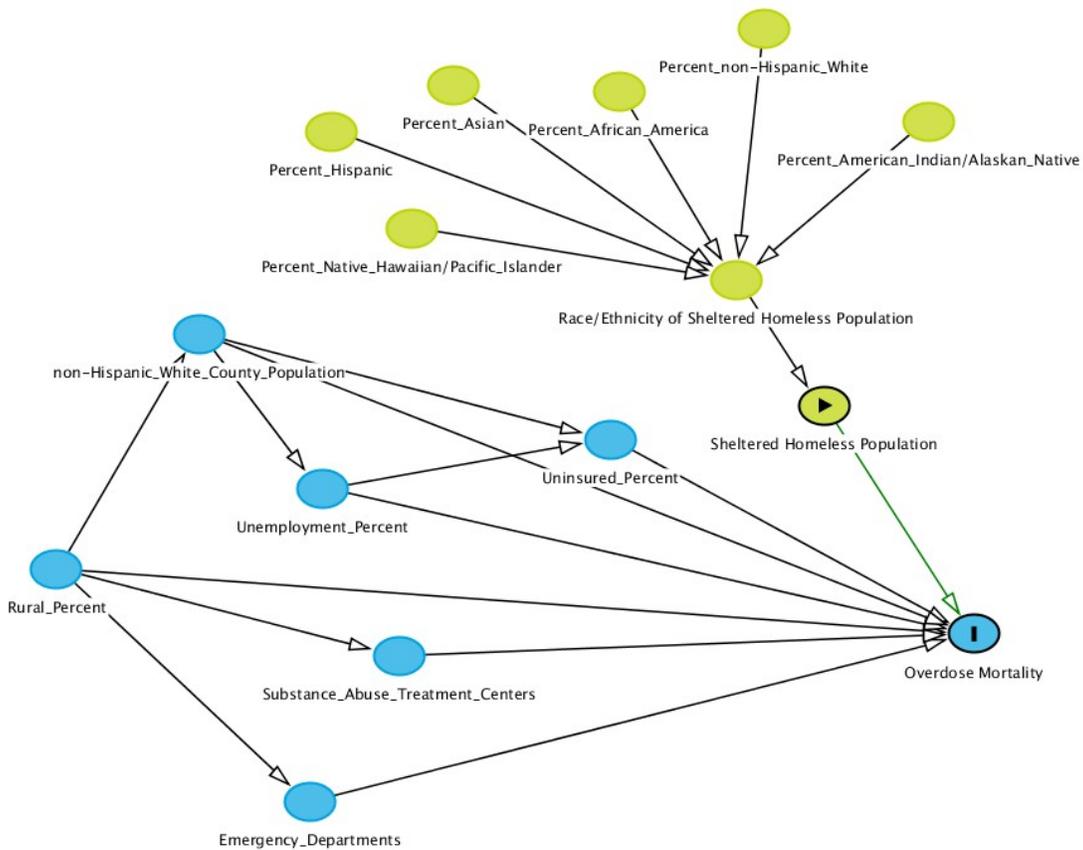


Figure 1: Directed Acyclic Graph of Outcome Variable, Explanatory Variable and Covariates

Dependent	Explanatory				Sociodemographic				Treatment Providers	
	Overdose Mortality	Total Homeless Population ⁺	Non-Hispanic White Homeless Population ⁺	Non-Hispanic White County	Rural	Uninsured	Unemployment	Emergency Departments	Substance Abuse Treatment Centers	
1. Overdose Mortality	1.00									
2. Total Homeless Population ⁺	0.11**	1.00								
3. Non-Hispanic White Homeless Population ⁺	0.24**	0.84**	1.00							
4. Non-Hispanic White County	0.23**	-0.20**	0.18**	1.00						
5. Rural	0.36**	-0.22**	0.01	0.30**	1.00					
6. Uninsured	0.03	0.05	-0.05	-0.52**	0.15**	1.00				
7. Unemployment	0.25**	0.03	-0.05	-0.32**	0.06**	0.27**	1.00			
8. Emergency Departments	0.35**	0.045	0.14**	0.09**	0.31**	0.08**	-0.22**	1.00		
9. Substance Abuse Treatment Centers	0.33**	0.10**	0.18**	0.07**	0.06**	-0.06**	0.04*	0.08**	1.00	

*p<.05, **p<.01, ⁺ log transformed variables

Table 2: Pearson Correlation Matrix of Outcome Variable, Explanatory Variable and Covariates

Exploration of different racial and ethnic sheltered homeless groups found that Overdose Mortality had a small positive correlation with sheltered homeless individuals who identified as White non-Hispanic ($r=0.24$, $p<.01$), American Indian ($r=0.24$, $p<.01$) and Two or More Races ($r=0.09$, $p<.01$). Because of the higher r-value discovered between Overdose Mortality and non-Hispanic White and American Indian Sheltered Homeless Population over total Sheltered Homeless Population, further exploration of these two racial group were pursued; with the support of existing literature suggesting higher rates of overdose mortality in non-Hispanic White homeless populations, a second set of linear regression models were simultaneously conducted using non-Hispanic White sheltered homeless population as the primary explanatory variable and Overdose Mortality as the outcome variable (Table 4). Additional linear regression models were conducted with the American Indian Sheltered Homeless Population as the primary explanatory variable due to the high r-value (Table 5).

Results from sociodemographic variables in Table 2 showed that Overdose Mortality had a small positive correlation with every sociodemographic county characteristic (except for Uninsured) including non-Hispanic White ($r=0.23$, $p<.01$) and Unemployment ($r=0.25$, $p<.01$) and a moderate positive correlation with Rural ($r=0.36$, $p<.01$). Sheltered Homeless Population had a small positive correlation with Rural ($r=0.22$, $p<.01$), a small negative correlation with non-Hispanic White ($r=-0.20$, $p<.01$) and was not correlated with either Uninsured or Unemployment. The Pearson correlations eliminated Uninsured percent from the linear regression model due to the lack of significance with both the explanatory and outcome variable.

Non-Hispanic White county population, defined as non-Hispanic White percentage versus minority percentage in counties, was the only race/ethnicity variable considered in the analysis to further create a parsimonious model.²

Finally, results from treatment provider variables showed that Overdose Mortality was moderately positively correlated with both types of treatment provider including Emergency Departments ($r=0.35$, $p<.01$) and Substance Use Treatment Centers ($r=0.33$, $p<.01$).

Overall, the results from the Pearson correlations further informed the inclusion of Unemployment, Rurality, Substance Abuse Treatment Centers and Emergency Department covariates in the final linear regression model. Uninsured was excluded from the final model because of its insignificance with both the outcome and primary explanatory variable. Furthermore, three separate linear regression models using Overdose Mortality as the outcome variable were run using total Sheltered Homeless Population as the primary explanatory variable in the first set of models (Table 3), non-Hispanic White Sheltered Homeless Population as the primary explanatory variable in the second set of models (Table 4), and American Indian Homeless Population as the primary explanatory variable in the last set of models (Table 5). The purpose of running the three sets of models was to explore which model was better fit to predict the explained variation in Overdose Mortality and which explanatory variable had a stronger correlation and thus, ability to predict Overdose Mortality.

² Overdose Mortality was found to have a small negative correlation with Hispanic ($r=-0.17$, $p<.01$), African American ($r=-0.20$, $p<.01$) and Native Hawaiian or Pacific Islander ($r=-0.10$, $p<.01$); and a moderately negative correlation with Asian ($r=-0.31$, $p<.01$). Homeless Population had a small positive correlation with African American ($r=0.14$, $p<.01$), Asian ($r=0.17$, $p<.01$), Native Hawaiian ($r=0.09$, $p<.01$) and American Indian ($r=0.08$, $p<.01$).

Research Question: Predicting Overdose Mortality with Sheltered Homeless Population

After controlling against any collinear or confounding effects, a set of linear regression models were run in order to quantify the relationship between Sheltered Homeless Population and Overdose Mortality, adjusting for the sociodemographic and treatment provider covariates (Table 3).

Bivariate Analysis

The unadjusted bivariate linear regression established that the log transformation of Sheltered Homeless Population significantly predicted Overdose Mortality per county (coeff.=0.189, $p<.01$). For a 1% increase in the total Sheltered Homeless Population per 10,000 we can expect to see a .00012 increase in Overdose Mortality number per 10,000. Sheltered Homeless Population accounted for 1.20% of the explained variability in Overdose Mortality on the county level.

Model: Rural, Unemployment, Substance Abuse Treatment Centers, Emergency Departments

The final model adjusted for Rural, Unemployment, Substance Abuse Treatment Centers and Emergency Departments (Table 3). The final linear regression model, Model 4a, included the log transformation of the Sheltered Homeless Population (coeff.=0.204, $p<.01$), Rurality (coeff.=0.014, $p<.01$), Unemployment (coeff.=0.142, $p<.01$), Substance Abuse Treatment Centers (coeff.=1.090, $p<.01$) and Emergency Departments (coeff.=1.235, $p<.01$). In total, the explanatory variable and the four co-variates accounted for 19.4% of the explained variability in Overdose Mortality on a county-level. These results can be interpreted such that when all

variables remain constant, for a 1% increase in Sheltered Homeless Population we can expect to see a 0.002 increase in Overdose Mortality number per 10,000 per county; for a 10% increase in Rurality we can expect to see a 0.14 increase in Overdose Mortality number per 10,000 population while all other variables remain the same; for a 1% increase in Unemployment we can expect to see a 0.142 increase in Overdose Mortality number per 10,000 population; for a 1 unit increase in Substance Abuse Treatment Centers we would expect to see 1.090 increase in Overdose Mortality number per 10,000 population; and lastly, for a 1 unit increase in Emergency Departments we can expect to find a 1.235 increase in Overdose Mortality number per 10,000 population.

Model: Comparisons by Race/Ethnicity of Homeless Population

Univariate Analysis

In order to assess the homeless racial and ethnic differences further from the Pearson correlations, the second and third linear models were simultaneously run to observe the differences between Total Sheltered Homeless Population and the strongest associated sheltered homeless racial groups, the non-Hispanic White Sheltered Homeless Population and the American Indian Sheltered Homeless Population. The second unadjusted bivariate linear regression found that the log transformation of the non-Hispanic White Sheltered Homeless Population significantly predicted Overdose Mortality (coeff.=0.397, $p<.01$) and accounted for 5.62% of the explained variability in Overdose Mortality. This means, for a 1% increase in the non-Hispanic White Homeless Population rate per 10,000 we can expect to see a 0.004 increase in the Overdose Mortality per 10,000. The third unadjusted bivariate linear regression found that the log transformation of the American Indian Sheltered Homeless Population significantly

predicted Overdose Mortality (coeff.=0.344, $p<.01$) and accounted for 5.5% of the explained variability in Overdose Mortality. This means, for a 1% increase in the American Indian Sheltered Homeless Population rate per 10,000 we can expect to see a 0.003 increase in the Overdose Mortality per 10,000.

Model: Rural, Unemployment, Substance Abuse Treatment Centers, Emergency Departments

Upon interpreting the three final linear regression models between the use of Total Sheltered Homeless Population, Sheltered non-Hispanic White Homeless Population and Sheltered American Indian Homeless Population as the explanatory variable, the results found in Model 4a, for a 1% increase in the total Homeless Population rate per 10,000 we can expect to see a 0.0020 increase in the Overdose Mortality per 10,000. In Model 4b, for a 1% increase in the non-Hispanic White Homeless Population rate per 10,000 we can expect to see a 0.0030 increase in the Overdose Mortality per 10,000. And, in Model 3c, for a 1% increase in the total Homeless Population rate per 10,000 we can expect to see a 0.0018 increase in the Overdose Mortality per 10,000. Furthermore, Models 4a, 4b and 3c account for almost the same percent, 19.4%, 19.2% and 19.1% respectively, of explained variability in Overdose Mortality.

Variables	Bivariate			Model 1a			Model 2a			Model 3a			Model 4a			
	N	R ²	Coef.	P-value	Confidence Interval	Coef.	P-value	Confidence Interval	Coef.	P-value	Confidence Interval	Coef.	P-value	Confidence Interval		
Log of Sheltered Homeless Population ⁺	722	0.012	0.189	0.002	0.068 0.311	0.345	0.000	0.225 0.464	0.313	0.000	0.195 0.431	0.230	0.000	0.111 0.349		
Rural Percent Unemployment	848	0.126	0.030	0.000	0.024 0.035	0.028	0.000	0.022 0.034	0.026	0.000	0.020 0.032	0.018	0.000	0.012 0.025		
Substance Abuse Treatment Centers ⁺	848	0.059	0.239	0.000	0.175 0.303				0.148	0.000	0.088 0.208	0.0153	0.000	0.094 0.0211		
Emergency Departments ⁺	848	0.124	3.143	0.00	2.581 3.704							1.241	0.000	0.828 1.654		
Model Statistics						N = 722	R ² = 0.115		N = 722	R ² = 0.142		N = 722	R ² = 0.181		N = 722	R ² = 0.194

*p<.05, **p<.01, + variables population adjusted to 10,000

Table 3: Summary of Linear Regression Models for Predicting Overdose Mortality by Sheltered Homeless

Population Mediated by Sociodemographic and Treatment Provider Variables

Variables	Bivariate			Model 1b			Model 2b			Model 3b			Model 4b			
	N	R ²	Coef.	P-value	Confidence Interval	Coef.	P-value	Confidence Interval	Coef.	P-value	Confidence Interval	Coef.	P-value	Confidence Interval		
Log of Non-Hispanic White Sheltered Homeless Population ⁺	716	0.056	0.397	0.000	0.279 0.515	0.395	0.000	0.281 0.508	0.398	0.000	0.287 0.510	0.330	0.000	0.216 0.444		
Rural Percent Unemployment	848	0.126	0.030	0.000	0.024 0.035	0.022	0.000	0.016 0.028	0.020	0.000	0.014 0.026	0.015	0.000	0.009 0.021		
Substance Abuse Treatment Centers ⁺	848	0.059	0.239	0.000	0.175 0.303				0.162	0.000	0.104 0.221	0.163	0.000	0.106 0.221		
Emergency Departments ⁺	848	0.107	1.993	0.000	1.607 2.380							1.001	0.000	0.573 1.429		
Model Statistics						N = 716	R ² = 0.124		N = 716	R ² = 0.159		N = 716	R ² = 0.182		N = 716	R ² = 0.192

*p<.05, **p<.01, + variables population adjusted to 10,000

Table 4: Summary of Linear Regression Models for Predicting Overdose Mortality by non-Hispanic White Sheltered Homeless Population Mediated by

Sociodemographic and Treatment Provider Variables

Variables	Bivariate			Model 1c			Model 2c			Model 3c			Model 4c				
	N	R ²	Coef.	P-value	Confidence Interval	Coef.	P-value	Confidence Interval	Coef.	P-value	Confidence Interval	Coef.	P-value	Confidence Interval	Coef.	P-value	Confidence Interval
Log of American Indian Sheltered Homeless Population*	429	0.055	0.344	0.000	0.21 1	0.230	0.001	0.095 0.365	0.231	0.001	0.100 0.363	0.181	0.007	0.050 0.313	0.118	0.076	-0.012 -0.249
Rural Percent	848	0.126	0.030	0.000	0.02 4	0.026	0.000	0.017 0.035	0.022	0.000	0.013 0.032	0.013	0.008	0.003 0.023	0.005	0.388	-0.006 0.015
Unemployment Percent	848	0.059	0.239	0.000	0.17 5			0.17 0.303	0.184	0.000	0.107 0.261	0.189	0.000	0.113 0.265	0.180	0.00	0.105 0.254
Substance Abuse Treatment Centers*	848	0.107	1.993	0.000	1.60 7			2.380				1.224	0.000	0.655 1.794	1.056	0.00	0.495 1.617
Emergency Departments*	848	0.124	3.143	0.000	2.58 1			3.704							2.348	0.00	1.358 3.339
Model Statistics						N = 429	R ² = 0.118		N = 429	R ² = 0.159		N = 429	R ² = 0.191		N = 429	R ² = 0.229	

*p<.05, **p<.01, + variables population adjusted to 10,000

Table 5: Summary of Linear Regression Models for Predicting Overdose Mortality by American Indian Sheltered Homeless Population Mediated by

Sociodemographic and Treatment Provider Variables

DISCUSSION

The goal of this study was to explore the association between overdose mortality and homeless population size on a county level in order to understand the breadth and gravity of substance use disorders in homeless populations and form evidence to understanding the necessity and importance of interventions. The main research question set out to find whether any association between Homeless Population and Overdose Mortality existed, additionally exploring sociodemographic and treatment provider variables to understand how they would contribute and affect the potential association, or have valuable associations of their own.

Major Findings

In total, there were four major findings of this study. (1) Total Homeless Population is significantly positively associated with Overdose Mortality. (2) Across all homeless population race and ethnicities, non-Hispanic White Homeless Population rates was the strongest predictor of Overdose Mortality, even stronger than total Homeless Population. (3) When considering the effects of other socioeconomic factors, Unemployment percentage was positively associated with Overdose Mortality and not associated with Homeless Population; Rurality was positively associated with Overdose Mortality and negatively associated with Homeless Population; and there was no association of Uninsured percentage with Overdose Mortality or Homeless Population. (4) All treatment provider variables were positively associated with Overdose Morality.

Implications of Finding Number 1: Increasing Overdose Prevention

The first hypothesis stated that Homeless Population and Overdose Mortality would be positively associated on a significant level across counties. The results from the study confirmed this hypothesis and found that Homeless Population was significantly positively associated with Overdose Mortality per county. While this thesis was one of the first to conduct nationwide research related to homelessness and overdose mortality at the county level, the positive association between homeless population and overdose mortality across 722 counties is supported by previous findings of both higher rates of substance use disorders and the higher risk of overdose deaths among homeless individuals (Baggett et al., 2013; Bamrah et al., 2013; Bharel et al., 2013; Centers for Disease Control and Prevention, 1987, 1991; Coady et al., 2007; Fischer & Breakey, 1991; Kerker et al., 2011; Linton et al., 2013; National Coalition for the Homeless, 2009e; J. O’Connell, 2005; O’Toole et al., 2007; SAMHSA, 2017b; Stanley et al., 2016; USDHUD, 2015).

A study conducted in Boston that followed about 28,000 individuals for 3 years discovered not only that drug overdose accounted for about 17% of all deaths but that 81% of these deaths were due to opioid involvement, 37% were contributed by cocaine, 43% involved multiple substances and 32% involved alcohol as a co-occurring substance (Baggett et al., 2013). A report from The Commonwealth of Massachusetts found that risk of opioid-related overdose death for a person who has experienced homelessness is 30 times higher than someone who has not (Baker, Polito, Sudders, & Bharel, 2017). While there have been multiple substances attributable to the high overdose rate among homeless populations, opioid overdose has been responsible for the most deaths (Baggett et al., 2013). Because intranasal naloxone is safe and

effective for opioid overdose reversal, one way to prevent and lower overdose mortality among homeless populations is to implement opioid overdose protocols with increased access to naloxone at locations commonly utilized by homeless individuals such as homeless shelters, behavioral health centers, homeless clinics and food banks (Dahlem, Horstman, & Williams, 2016).

Studies have shown efficacy in overdose mortality prevention through the development of safety protocols around overdose, increasing awareness of overdose symptoms and naloxone trainings in drug users, providers and staff (Behar, Santos, Wheeler, Rowe, & Coffin, 2015; Dahlem et al., 2016; Kirane et al., 2016; Wagner et al., 2010). Increasing education around overdose and naloxone administration has been shown to increase knowledge, confidence, accuracy and likelihood to intervene in drug users, bystanders, staff and providers (Behar et al., 2015; Doe-Simkins, Walley, Epstein, & Moyer, 2009; Gaston, Best, Manning, & Day, 2009; J. D. Jones, Roux, Stancliff, Matthews, & Comer, 2014). Furthermore, implemented naloxone programs have shown to increase the use of naloxone in the event of an overdose (Gaston et al., 2009; Tobin, Sherman, Beilenson, Welsh, & Latkin, 2009). Boston Healthcare for the Homeless has implemented a program called Supportive Place for Observation and Treatment (SPOT), which offers engagement, support and medical monitoring in a safe place for individuals that might otherwise be alone on street corners, in alleys or public restrooms (Boston Healthcare for the Homeless, 2016). While expanding prevention measures cannot address the root cause of substance use disorders in homeless populations, it is a good start in preventing overdose mortality as well as initiating conversations about treatment.

Implications of Finding Number 2: Considering Different Racial Pathways to Homelessness

The results from the study confirmed the second hypothesis of a stronger association between non-Hispanic White and American Indian Homeless Population groups than other racial and ethnic groups. Data on other homeless racial and ethnic groups provided additional findings of Overdose Mortality a lower association with Two or More Races Homeless Population rates and no association with Hispanic, African American, Asian, Native Hawaiian and Other Race Homeless Population rates. While homelessness disproportionately affects African American, Hispanic, Native Hawaiian and Other Pacific Islander and multiple race groups and is deleterious for all race/ethnicities, the stronger association found between non-Hispanic White Homeless Population and American Indian Homeless Population Rates and Overdose Mortality supports previous studies indicating higher risks and disproportionate rates of overdose within these two homeless population groups (Baggett et al., 2013; Hibbs et al., 1994; Kasproh & Rosenheck, 1998; Metraux, Eng, Bainbridge, & Culhane, 2011; NCAI Policy Research Center, 2012; Schinka et al., 2017; Westerfelt & Bird, 1999).

While homelessness disproportionately affects African American, Hispanic, American Indian and Alaskan Native, Native Hawaiian and Other Pacific Islander and multiple race groups and is deleterious for all race/ethnicities, the stronger association found between non-Hispanic White Homeless Population Rates and Overdose Mortality supports previous studies identifying significantly higher overdose mortality in non-Hispanic White homeless adults than Black or Hispanic homeless adults (Baggett et al., 2013; Hibbs et al., 1994; Metraux, Eng, Bainbridge, & Culhane, 2011; Schinka et al., 2017). As discussed in the background, the increased rate of mortality in non-Hispanic White individuals over other racial and ethnic groups does not parallel

overall patterns of mortality in the United States. One explanation is the presence of different racial pathways to homelessness. Evidence proposes that African Americans are more likely to become homeless due to structural factors such as through discrimination and poverty (Kaspro & Rosenheck, 2000). Kaspro and Rosenheck hypothesized that due to the greater prevalence of poverty among minorities, there is less impact of homelessness on cumulative vulnerability due to already high levels of existing vulnerabilities (Kaspro & Rosenheck, 2000). Alternatively, White individuals often end up homeless due to personal and familial factors such as mental illness, substance abuse, trauma, family dysfunction and family histories of substance use, which increases risk of death, especially by suicide and drug overdose (Baggett et al., 2013; Hibbs et al., 1994; Metraux et al., 2011; Carol S. North, Smith, & Spitznagel, 1994). Lastly, there have been both higher overall mortality rates and higher overdose mortality rates reported in the non-Hispanic White general population that exceed other racial and ethnic groups and are continuing to rise attributable to suicide, drug and alcohol poisonings and liver diseases (Case & Deaton, 2015; The Kaiser Family Foundation, 2018).

The finding of a strong association between American Indian and Alaskan Native Homeless Population rates and Overdose Mortality agrees with a similar pattern found in previous studies showing higher rates of alcoholism in American Indian and Alaskan Native homeless populations (Kaspro & Rosenheck, 1998; NCAI Policy Research Center, 2012; Westerfelt & Bird, 1999). Higher alcoholism death rates have also been noted in the general American Indian and Alaskan Native population (NCAI Policy Research Center, 2012; Zerger, 2004). Factors that contribute to American Indian and Alaskan Native pathways to homelessness

include alcoholism, urbanization, poverty and discrimination (Westerfelt & Bird, 1999; Zerger, 2004).

The racial and ethnic differences found within the United States homeless population concerning substance use disorders are important to consider when developing proper interventions, improving effective treatment, retention and access for all racial and ethnic groups (SAMHSA, 2017b). While this study was limited in resources to explore in further depth the racial and ethnic homeless relationships to overdose mortality, further research could provide more insight to these pathways and relationships noted in previous studies.

Implications of Finding Number 3: Sociodemographic Relationships with Overdose and Homelessness

As hypothesized, non-Hispanic White county population was positively associated with Overdose Mortality and negatively associated with Homeless Population. Both of these findings follow patterns in the literature that have described high overdose mortality rates in non-Hispanic White populations as well as higher economic advantage in non-Hispanic White populations (Case & Deaton, 2015; Proctor, Semega, & Kollar, 2015). Studies can explain the negative association between non-Hispanic White county population and homeless population as non-Hispanic White populations experience lower rates of poverty and unemployment than most racial and ethnic minorities; this in combination with residential segregation perpetuates patterns of poverty and discrimination by isolating racial and ethnic minorities in neighborhoods that lack employment opportunities, receive lower incomes and face higher rates of poverty; three reported causes of homelessness (American Psychological Association, 2016; Macartney et al.,

2013; National Alliance to End Homelessness, 2018; National Law Center on Homelessness & Poverty, 2015; United States Department of Labor, 2017b).

Rurality was found to be positively associated with Overdose Mortality and negatively associated with Homeless Population, confirming another part of the third hypothesis. Once again, these findings are supported by previous studies. The CDC reported in 2015 that the rural overdose death rate of 17 per 100,000 surpassed the 16.2 overdose death rate in metropolitan areas (Centers for Disease Control and Prevention, 2016a). Reports of higher overdose mortality in rural areas explain the positive association found between Rurality and Overdose Mortality. When exploring the negative association between Overdose Mortality and Homeless Population, the National Alliance to End Homelessness found in 2010 that only 7% of the homeless population was located in rural areas (National Alliance to End Homelessness, 2010). Additionally, in 2013, the USDHUD found 14% of the homeless population living in a Balance of State Continuum of Care, which often include many rural areas (USDHUD, 2013). Both of these reported percentages found less than one fifth of the homeless population living in rural areas, supporting the negative association between Rurality and Homeless Population.

As hypothesized, Unemployment percentage was positively associated with Overdose Mortality. This finding agrees with previous literature found a positive association between unemployment and both overdose mortality and ED hospital visits (Hollingsworth et al., 2017). Unemployment was not, however, associated with Homeless Population, a finding that disagrees with the hypothesis and sources citing unemployment as a cause of homelessness (National

Alliance to End Homelessness, 2018; National Coalition for the Homeless, 2009a; National Law Center on Homelessness & Poverty, 2015).

The last part of the third hypothesis that was rejected was the finding of no association of Uninsured percentage with either Overdose Mortality or Homeless Population. The first finding contradicts studies that have found increased substance use among those without insurance; with increased substance use we would expect to find increase risk of overdose mortalities (C. M. Jones, Logan, Gladden, & Bohm, 2015). Another study conducted found that all of the 254 individuals that died from overdose were uninsured (Lanier, Johnson, Rolfs, Friedrichs, & Grey, 2012). Thus, we would have expected to find a positive association between uninsured percentage and overdose mortality. The second finding contradicts the National Health Care for the Homeless that discovered 38% of homeless individuals were uninsured in 2015 compared to the United States rate of 8.8% (National Health Care for the Homeless Council, 2017). Due to this high disproportionate rate of homeless individuals uninsured, we would have expected to find a positively associated relationship between uninsured and homeless population.

Implications of Finding Number 4: Improving Substance Abuse Treatment Access, Engagement and Retention

The finding of a significant positive association between Overdose Mortality and Emergency Departments (ED) as well as Substance Use Treatment Centers rejected the final hypothesis. This finding goes against the idea that a higher presence of EDs and special treatment facilities would have a protective factor, increasing access and thus, lowering mortality due to drug overdoses. It is important to note that the positive association does not indicate that

the presence of EDs or Substance Use Treatment Centers increases the rates of overdose mortality in counties. One possible explanation for the positive association is the increasing ED visits for opioid overdoses (CDC, 2018b). From July 2016 to September 2017, ED visits for opioid overdose increased by 30% across most areas in the United States and overdose mortality increased by 22% from 2015 to 2016 (CDC, 2018a, 2018b). Because overdose and overdose mortality rates have continued to increase sharply, it is clear that more preventative and effective treatment actions need to be taken. The greater presence of EDs and treatment centers have not stopped the increasing mortality rates in the general population and especially, among homeless individuals facing more access and retention issues. Another possible explanation could be the distance of each ED within each county; there may be a high number of EDs per capita in certain counties but all concentrated in one area making them less accessible from different parts of the county, increasing the risk of overdose mortality. Lastly, while all treatment centers were included in the study from a recently updated source, there was no guarantee that the centers had availability or that they were specifically accessible for homeless individuals.

Because homeless individuals more frequently report using the ED as their primary source of care as well as use the EDs more often than non-homeless patients, EDs can serve as an important source of intervention. EDs can be a source of naloxone distribution and connect patients to appropriate and accessible treatment sources (CDC, 2018b; Houry, Haegerich, & Vivolo-Kantor, 2018). EDs do not have one specific protocol for dealing with overdose after the individual is stable and the event is over (Houry et al., 2018). Thus, creating guidelines that promote overdose education and collaborations with public health agencies, community services, treatment centers and other homeless center care services could provide a system to better help

homeless individuals suffering from SUDs (Houry et al., 2018). Another service EDs could provide is staffing trained therapists to engage in motivational interviewing with homeless patients, which has been shown to reduce levels of overdose risk behaviors in the general population (Bohnert et al., 2016). EDs can also be a point of reference and initiation of medication-assisted treatment (MAT) or opioid agonist therapy (OAT), an effective medication treatment for opioid addiction and other substance use disorders usually involving methadone (D’Onofrio et al., 2017). EDs can work to identify patients experiencing homelessness as a “vital sign” to improve data and knowledge about homelessness populations in order to better inform treatment needs (Wilkins, 2016). Lastly, EDs can implement presumptive eligibility programs that immediately enroll homeless patients without insurance in states’ Medicaid to connect them to services such as SAMHSA’s Supplemental Security Income and Social Security Disability Insurance Outreach, Access, and Recovery (SOAR) (Wilkins, 2016).

States and cities can assist with increasing access to MAT and OAT for homeless individuals by creating publically funded programs to reduce waiting lists and cover treatment fees or provide health insurance for treatment (Hall et al., 2014; Peterson et al., 2010; United States Interagency Council on Homelessness, 2017). For example, the New Jersey Division of Mental Health and Addiction Services took legislative action to direct funding to establish the New Jersey Medication Assisted Treatment Initiative (NJ-MATI) in six cities (National Council on Alcoholism and Drug Dependence [NCADD], 2014). The NJ-MATI provides outreach through a mobile van that is fully staffed and supplied with opioid medication in order to provide services for hard-to-reach groups including homeless individuals (NCADD, 2014). MATI also linked individuals to offices and centers that could provide the proper services based on each

patient's needs (NCADD, 2014). After one year of implementing MATI, there was a 69% decrease in heroin use, 78% decrease in injection drug use and a 20% decrease in the proportion of clients visiting EDs (Hall et al., 2014; NCADD, 2014).

Substance use treatment centers are a very important resource for addiction recovery. The best way to prevent overdose and overdose mortality within the homeless population is to treat the substance use disorder. However, there are many barriers that prevent successful treatment among homeless individuals including access, social isolation, distrust of authorities and providers, geographic instability and lack of multiple needs (Zerger, 2002). In 2014, one fifth of cities reported additional substance abuse and mental health services were necessary to combat homelessness (The U.S. Conference of Mayors, 2014). Retention issues in substance abuse treatment are also a big issue among homeless populations as about two-thirds of homeless individuals drop out of treatment (Orwin, Garrison-Mogren, Jacobs, & Sonnefeld, 1999; Zerger, 2002). In order to improve substance use treatment in homeless populations, improvements in access, engagement and retention must be made.

A couple ways to improve access and engagement among homeless individuals is through outreach, case-management and providing resources in non-threatening environments. Outreach can improve expansion of resources to homeless individuals and initiate contact with substance use treatment, proving to be an effective intervention (Rowe, Fisk, Frey, & Davidson, 2002). Local communities can develop outreach teams to serve as a point of entry into systems of treatment and increase the number of homeless individuals who access treatment (Fisk, Rakfeldt, & McCormack, 2006). Standard case management has shown evidence for reducing substance use among homeless individuals, connecting these individuals to services based on

specific personal health needs (Conrad et al., 1998, 1998; de Vet et al., 2013). Furthermore, to address issues of distrust, communities can initiate engagement in safe and non-threatening environments such as sobering up stations, purpose-built drug consumption rooms like SPOT, needle exchange programs, shelters and through housing assistance (Bonham, 1993; Boston Healthcare for the Homeless, 2016; Rhodes et al., 2006; Zerger, 2002).

Another important part of improving engagement and retention is by providing housing assistance. Because substance use is both a cause and result of homelessness it is important to treatment both of the issues together (National Coalition for the Homeless, 2009e; The National Center on Addiction and Substance Abuse at Columbia University & Corporation for Supportive Housing, 2009; Zerger, 2012). The Housing First model provides housing for the homeless while emphasizing client-centered approaches to services without requiring sobriety or treatment participation (C. Davidson et al., 2014; Padgett, Stanhope, Henwood, & Stefancic, 2011). Housing First has been shown to significantly increase retention over abstinence-based programs as well as significantly reduce the reported use of stimulants and opiates at follow-up (C. Davidson et al., 2014). Connecting homeless service providers with health care providers and housing providers could improve connections to effective treatment and assist with access to MAT (United States Interagency Council on Homelessness, 2017).

Study Limitations

There are several study limitations to be noted. This study was conducted using the Emergency and Transitional Shelters Population; while United States 2010 Census count of the Emergency and Transitional Shelters Population provides data on homeless populations, it does not provide a total count of the homeless population in the United States due to the dynamic and

complex nature of homeless population. Some homeless individuals' survival relies on their ability to hide, some individuals do not wish to disclose their housing status, some individuals mistake enumerators for police officers or authority figures and do not wish to speak with them and, characteristically, the populations is constantly on the move to find adequate shelter (National Coalition for the Homeless, 2010; United States Census Bureau, 2012). While the count is, instead, aimed to provide information on homeless individuals accessing Emergency and Transitional Shelter at one point in time, many individuals could have been missed; this is evident due to the comparison between the HUD Exchange's total sheltered homeless population count in 2010 that found a total of approximately 403,500 and the Census' count of approximately 209,300, or about half of the HUD Exchange's total (United States Census Bureau, 2012; United States Department of Housing and Urban Development, 2017). Another limitation is the lack of data on the types of homelessness being experienced by the individuals enumerated; results have found significant differences between transitionally, episodically and chronically homeless populations (Kuhn & Culhane, 1998). More specifically, one study found that transitionally homeless populations make up about 80% of shelter users and are less likely to experience substance abuse, whereas, episodically homeless and chronically homeless populations made up 10% each of shelter use and were more likely to experience higher levels of substance abuse. Because the study was focused on sheltered homeless population, the findings may not be generalizable to homeless individuals who avoid use of food and shelter services.

Potential Future Research

Future research should aim to include the different types of homelessness in both data collection and data analysis in order to assess different characteristics of the three groups and

better understand differential health impacts within them. Expanding this research to incorporate unsheltered homeless population would increase the generalizability of this study and potentially find stronger results due to reported increases in SUDs in homeless populations that do not access shelter (Ann Elizabeth Montgomery, Dorota Szymkowiak, Jessica Marcus, Paul Howard, & Dennis P. Culhane, 2016). In addition, exploration of homeless racial and ethnic data could provide more insight to important pathway and access differences. Future studies could improve accuracy of certain co-variables such as by looking at the distance to each ED in each county and ensuring each treatment center is specifically available for homeless individuals to access, as well as their waitlist times and availability. Lastly, finding a more direct and widespread measurement of overdose specific to homeless populations, perhaps by the inclusion of a subcategory of homelessness in CDC's WONDER database could provide more concrete conclusions.

CONCLUSION

This study has important implications for policymakers, providers, public health personnel and organizations involved in serving homeless populations with substance use disorders. Many studies conducted within homeless populations have found disproportionate rates of substance use disorders and overdose mortality within homeless populations compared to the general population. However, many of these studies are performed on a smaller scale in specific cohorts of homeless populations in one location. The significant associations between overdose mortality and homeless populations living in emergency and transitional shelters across 722 counties in the United States demonstrates the serious impact of substance use disorders within this population. This study suggests that substance use issues exist on a much higher scale

and are not yet being addressed by the number of treatment providers that exist. These findings suggest the importance of expanding more preventative measures such as naloxone trainings and Medicaid enrollment, improving substance abuse treatment for homeless populations by increasing access, engagement and retention and expansion of MAT and housing.

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