An Accessibility Analysis of the Homeless Populations' Potential Access to Healthcare Facilities in the Los Angeles Continuum of Care

by

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List of Abbreviations

AHAR	Annual Homeless Assessment Report
CA	California
CD	Council District
CoC	Continuums of Care
CONUS	Continental United States
DHHS	Department of Health and Human Services
HMIS	Homeless Management Information System
HUD	Department of Housing and Urban Development
LA	Los Angeles
LAHSA	Los Angeles Homeless Services Authority
PIT	Point-in -Time
USC	University of Southern California
USICH	US Interagency Council on Homelessness
VA	U.S. Department of Veteran Affairs
2SFCA	Two-step floating catchment area

Abstract

Los Angeles has a homelessness crisis. The city has long struggled to meet the needs of the growing homeless population, and the problem continues to amplify as the most recent 2019 Point-In-Time (PIT) Count shows an increase in homelessness. The Department of Housing and Urban Development (HUD) Continuum of Care (CoC) federal grant program establishes regional or local planning bodies to coordinate housing and services funding for homeless people in an effort to promote an integrated system of care. As a local planning body, CoCs address the issues their local communities and have the potential to affect positive change. Access to healthcare is one such issue facing homeless populations that the LA CoC could better address using spatial analysis, namely where homeless populations reside in the CoC boundaries relative to established hospitals and medical facilities.

This project used a geographic information system (GIS) to assess the state of homelessness in the Los Angeles CoC as of June 2019. A population distribution and density analysis was conducted, indicating that homeless populations tended to be larger and more concentrated in the census tracts comprising downtown Los Angeles and Santa Monica. To determine the degree to which homeless individuals can access hospitals and medical facilities, an accessibility analysis was conducted using a modified two-step floating catchment area (2SFCA) methodology. The 2SFCA accessibility index indicated that census tracts within the downtown area had homeless populations within a 1-mile distance of at least one hospital as opposed to more rural tracts that tended to lack any access. However, access to medical facilities within a walkable distance varied in the downtown census tracts. Recommendations for funding allocation, the establishment of transportation initiatives, and additional medical facilities to improve access were made.

Chapter 1 Introduction

Homelessness is a national issue that requires both federal and local government attention. Federal spending on homelessness is distributed via programs and grants through a number of agencies including HUD, the Department of Veteran Affairs (VA), Department of Education, and Department of Health and Human Services (DHHS). One of the longest standing federal programs addressing the issue of homelessness is the HUD CoC grant program which uses funding to coordinate homelessness planning and response at the local level (Tinoco 2019). The HUD CoC federal grant program establishes and funds local and regional level administrative services that provide housing and essential services, including healthcare. This program is a prime example of an effort that has had and can continue to have a positive impact in reducing homelessness and improving the lives of those who have fallen into homelessness.

Within the state of California, homelessness is particularly prevalent in several cities and counties, one of which being Los Angeles. The LA CoC is the local planning body tasked with coordinating housing and service funding for homeless people in Los Angeles. The CoC can have a significant impact on the state of homelessness in LA if equipped with the proper data. A Greater Los Angeles PIT Count was conducted in January 2019, providing data on where homeless populations are residing at the census tract level. Accounting for the census tracts within the LA CoC administrative boundaries, an accessibility analysis of medical facilities was conducted to provide LA CoC administrators and those concerned about homeless individuals' access to medical care facilities a spatial study of accessibility.

1.1 Definitions

1.1.1 Homelessness definitions

The definitions of key terms throughout this study were based on definitions provided by HUD (Henry et al. 2018). Individuals considered "homeless" were defined those who lacked a fixed, regular, and adequate nighttime residence. An "individual" refers to a person who is not part of a family with children during an episode of homeless, such as single adults or unaccompanied youth. Homeless families and children are accounted for as individuals in the total population counts of the PIT. Homeless individuals were considered "sheltered" if they were staying in emergency shelters, transitional housing programs, or safe havens. "Unsheltered" homelessness referred to people whose primary nighttime location was a public or private place not designated for or ordinarily used as a regular sleeping accommodation. Examples of such locations given were streets, vehicles, and parks (Henry et al. 2018).

1.1.2 CoC and PIT definitions

HUD defines a Continuum of Care as a regional or local planning body responsible for coordinating the full range of homelessness services in a geographic area. The area may cover a city, county, metropolitan area, or an entire state. The jurisdictions vary from state to state and based on funding allocation. CoCs are generally composed of nonprofit service providers and local government agencies, including health and human services, public housing agencies, and other stakeholders (Center for Evidence-Based Solutions to Homelessness 2017). As part of their commitment to the region they service and in order to meet funding requirements, CoCs are tasked with conducting counts and surveys of the homeless population in their territory. Biannual

PIT counts of the homeless population is one such effort that CoCs conduct (National Alliance 2010).

Point-in-Time Counts are used in HUD homeless counts. HUD outlines a PIT as an unduplicated one-night estimate of both sheltered and unsheltered homeless populations. One-night counts are conducted by CoCs nationwide and occur during the last week in January of each year (Henry et al. 2018). The specific methodology for the LA CoC PIT will be discussed in the Methods Chapter.

1.1.3 Hospital and medical center definitions

The difference between a hospital and medical center depends on naming and branding by healthcare providers. Medical centers and hospitals both offer a variety of services, including but not limited to emergency services, primary care, and numerous specialties. Many consumers differentiate the two based on their name. But contradictory to consumer opinion, there is no functional difference between hospitals and medical centers (Rivkin & Bauman 2011). Thus throughout this document, the labels are used interchangeably.

1.2 CoC Funding Allocation

HUD has developed specific guidelines as to how CoCs can acquire funding and what information must be provided to advocate for additional funding. Funding is distributed after considering the results of two community planning efforts that CoC administrators must prepare, the Consolidated Plans and Continuum of Care Plans.

The Consolidated Plans outlines the framework for the CoC to identify housing, homeless, community, and economic development needs and resources to develop a strategic plan that

meets those needs. This strategy lays out a three to five-year plan to implement the proposed efforts that requires the funding requested. Homeless population size and level of community need are crucial factors considered when allocating funds.

The second documentation required by HUD is the Continuum of Care Plan which details the housing and services proposed to meet the needs of the homeless as they move toward stable housing and maximum self-sufficiency. The CoC Plan focuses on providing actionable steps to end homelessness and prevent a return to homelessness. A majority of HUD's homeless assistance funds are awarded based on the CoC Plan (NCHV 2019).

Identifying local funding priorities and areas of need is a critical part of this plan. The current project seeks to identify areas within the LA CoC with large homeless populations and where access to healthcare is limited to pinpoint areas, medical facilities, and populations with demonstrated need where additional funding could prove beneficial.

1.3 Study Area

The state of California has a total population of 39.6 million, with 10.1 million, roughly 25 percent, of those individuals live in Los Angeles County (U.S. Census Bureau 2018). The County is approximately 4,084 sq. mi (California Department of Finance 2018). The City of Los Angeles is the largest city out of the 88 cities contained within LA County. The LA CoC shares boundaries with the county of Los Angeles, encompassing the same neighborhoods and census tracts. Pasadena, Glendale, and Long Beach are exceptions, as each have their own CoCs (Figure 1). In total, 2,161 census tracts compose the LA CoC (Figure 2).

Figure 1. Los Angeles CoC boundary

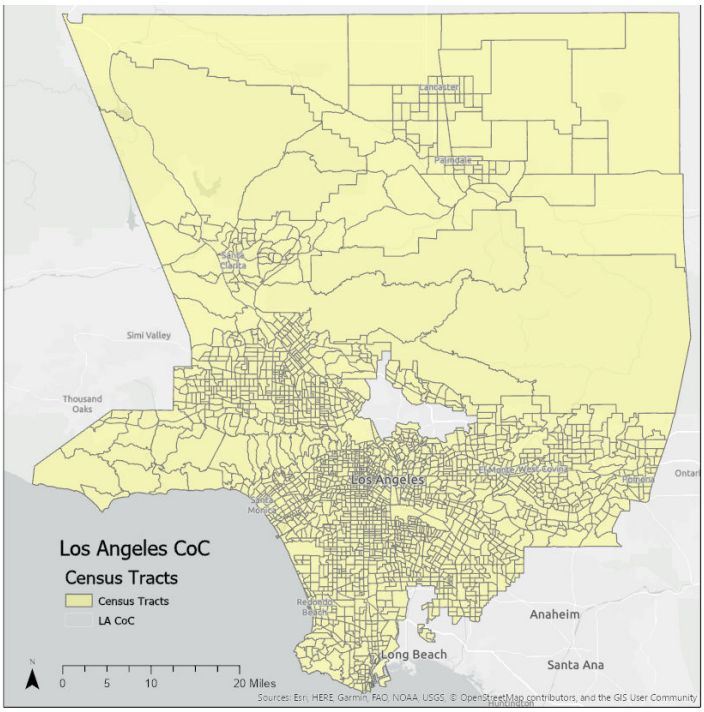


Figure 2. Los Angeles CoC with census tracts

1.4 Hospitals and Medical Centers

Los Angeles County maintains a database of officially recognized and accredited hospitals and medical facilities within Los Angeles. From this data source, 147 hospitals and medical facilities fell completely within the boundaries of the LA CoC (Figure 3). These facilities were considered when determining which hospitals and medical facilities are accessible to those residing in the LA CoC. Facilities falling outside the boundary were not included even if they were close to the border as they were not in the jurisdiction of the LA CoC, therefore, CoC funds would not be applied to increase access to these facilities.

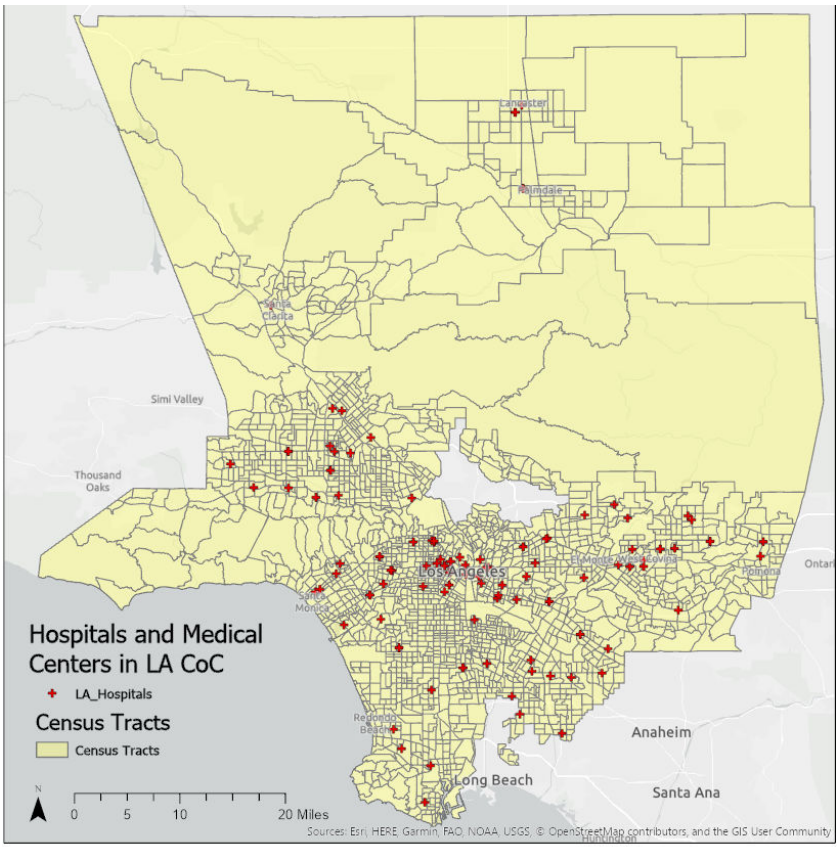


Figure 3. Hospitals and medical centers in the LA CoC

1.5 Data-driven homelessness studies

This study compares the locations of homeless populations with medical facilities and uses accessibility analysis to determine if the current resources are physically accessible to this subsection of the Los Angeles population. The results of this analysis are intended to be of use to LA CoC administrators when drafting the next CoC Plan for funding justification. Identifying areas and hospitals within the CoC that have large populations and/or low accessibility helps to inform where resources like transportation services and additional medical facilities should be stood up to improve medical care accessibility for homeless people.

Los Angeles commonly makes headlines for its homeless crisis. However, Los Angeles' efforts to address homelessness have increased over the years in response to the issue (Oreskes

2019). Los Angeles supports a variety of collaborative partnerships and projects, engages with the community, and pursues funding at various levels of government. Data-driven spatial analysis can help us understand what homelessness looks like in Los Angeles. This enables decisionmakers and interest groups to determine how to intervene most effectively.

An incredibly valuable, but not fully utilized source of data is the most recent 2019 PIT Count conducted for the LA CoC. Part of a HUD-mandated yearly PIT Count, the count creates an estimate of the number of homeless individuals by location, including demographic characteristics of sheltered and unsheltered individuals. This project leverages the statistical, demographic, and spatial data collected to provide an evaluation of the accessibility of LA medical facilities to the homeless population. Considering homeless populations when deliberating the allocation of funds for medical services or the establishment of a service like a shuttle transport program or new medical resource enables more informed decision-making on the part of program administrators. Having specific medical facilities and regions in their CoC in mind in terms of where more funding is required also provides greater justification to HUD in the LA CoC's plan documentation required for grants.

Identifying where homeless populations are located and how their location determines access to healthcare would benefit from the application of GIS. GIS helps visualize a phenomenon spatially and highlight the crucial role location plays. This project contributes to existing literature by analyzing the most up-to-date data within the LA CoC. The focus on accessibility to healthcare has historically been less of a focus in the LA CoC relative to housing, so it is the hope that program administrators utilizing this data would gain a geospatial assessment of healthcare accessibility they may not currently have access to. Measuring the walkability of these medical facilities is also less common within assessments of hospital accessibility, typically

considering motor transportation, but is nonetheless important and should be considered for individuals who do not have access to motor transportation (Vale et al. 2016).

1.6 Motivation

This project provides data-driven geographic analysis of the homeless population in the Los Angeles CoC and the degree to which the homeless can access to healthcare facilities. Ultimately, the intent of the project is to provide a survey of homelessness in the LA CoC and determine hospital access within the CoC based on walkability to a hospital from where individuals dwell. PIT counts are the primary means of data collection on homeless populations and the results of these studies are often used as indicators of government programs' effectiveness and used to justify resources allocation (Grumdahl 2019).

While PIT counts have obvious limitations as people are not stagnant points, the prevalence of this type of data and the current acceptance of this method by government organizations made it well-suited for the current study that aims to provide analysis of use to government bodies. In this initial analysis, areas with significant homeless populations and poor accessibility index ratings were identified to recommend where the LA CoC should add resources. This study utilized the most recent LA CoC PIT count which occurred January 2019, thus providing up-to-date information to LA CoC administrators and other interested parties.

The motivation for this project was to assist the LA CoC and other organizations, agencies, and individuals trying to better serve homeless populations. Identifying areas within the LA CoC with large homeless populations and/or low access to medical resources could be included in the next CoC Plan report submitted to HUD for funding justification. It is the hope that conducting this research will address healthcare accessibility, a major issue facing homeless individuals and

affecting their quality of life, and will encourage further research into this topic (Khandor et al. 2011). Most importantly, this project aims to draw conclusions to benefit homeless individuals who lack access to medical facilities and help provide them with the resources they need.

Chapter 2 Related Work

This project analyzed 2019 PIT data collected by LAHSA to provide insight into healthcare accessibility for LA's homeless population. Studies pertaining to homelessness throughout California and Los Angeles are referenced for context. The HUD CoC program is discussed and the efforts of the Los Angeles CoC are included to demonstrate past and current efforts and foci of the program. The inclusion of details about the HUD program includes recommendations so that they assist in current efforts and can be further implemented by the CoC in future interventions. The existing body of accessibility analysis research is discussed and adapted to the particular challenges of homelessness.

2.1 Homelessness in the United States

The most recent HUD 2018 Annual Homeless Assessment Report (AHAR), presented to Congress, provides an annual evaluation of homelessness and PIT estimates throughout the country. PIT counts were collected for the 398 CoCs, which cover nearly the entire United States. One-night counts were conducted during the last 10 days of January 2018 to provide an estimation of the number of people experiencing homelessness. The first part of the study provides the results of the PIT estimates of sheltered and unsheltered homelessness on a single night.

The 2018 HUD AHAR study had several key findings that provide a snapshot of homelessness (2018). On any given night in 2018, roughly 553,000 people experienced homelessness in the United States. Those included in this estimate were individuals staying in sheltered locations (emergency shelters or transitional housing programs) which comprised 65% of the total. The remaining 35% of the total homeless population were residing in unsheltered

locations such as on the street, in cars, in abandoned buildings, and in other locations deemed not suitable for human habitation (Figure 4). The results of this PIT count indicate a modest increase (0.3 percent increase in total population and 2 percent increase in unsheltered populations) in homelessness for the second year in a row (Henry et al. 2018).

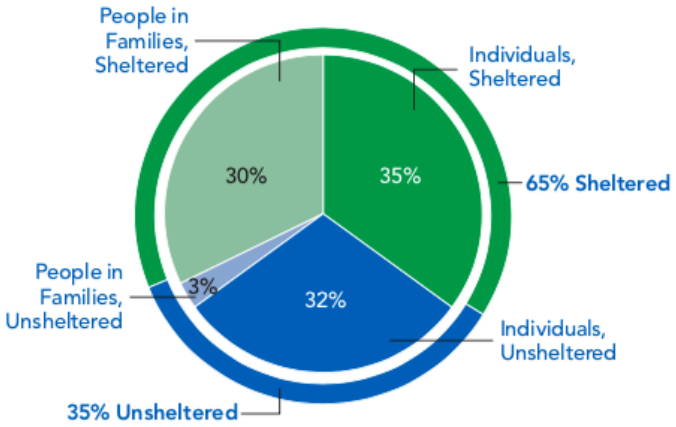


Figure 4. Homelessness by household type and sheltered status (2018)
Source: AHAR 2018

2.1.1 State estimates

When looking at homelessness across the country, the distribution of the population is not evenly divided between states, as certain states account for a disproportionate number of homeless individuals. Over half of all people experiencing homelessness were in one of the following five states: California, New York, Florida, Texas, or Washington (Figure 5). Of those states, California has the largest homeless population. 129,972 individuals were homeless in California according to the results of the national PIT homeless count conducted by the United States Interagency Council on Homelessness in 2018 (Figure 6) (USICH, 2018). Of California's homeless population, CA has the greatest percentage of unsheltered homeless with well over half of its homeless population being unsheltered (Figure 7).

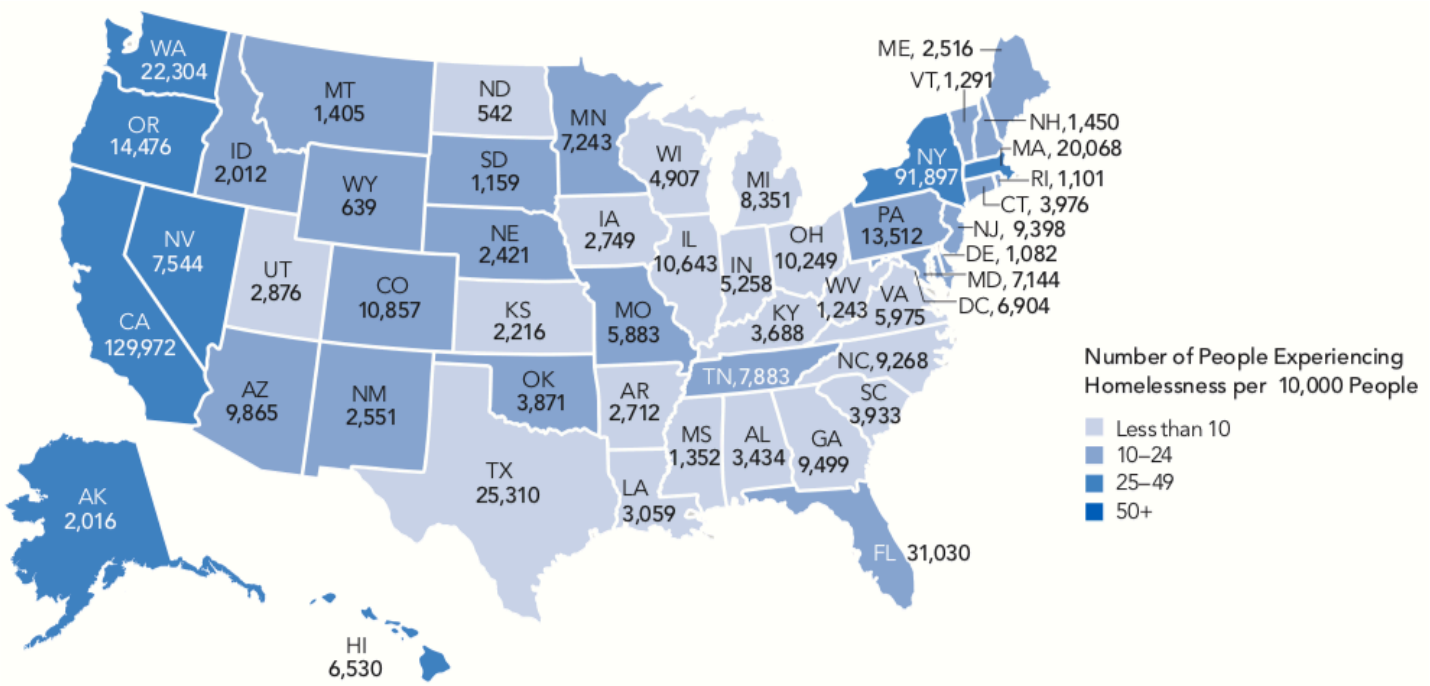


Figure 5. Estimates of homeless people by state (2018)
Source: AHAR 2018

Homelessness Statistics for **California**

Total Homeless Population	**129,972**
Total Family Households Experiencing Homelessness	**6,702**
Veterans Experiencing Homelessness	**10,836**
Persons Experiencing Chronic Homelessness	**34,332**
Unaccompanied Young Adults (Aged 18-24) Experiencing Homelessness	**12,396**
Total Number of Homeless Students	**246,296**
Total Number of Unaccompanied Homeless Students	**7,495**
Nighttime Residence: Unsheltered	**7,533**
Nighttime Residence: Shelters	**17,061**
Nighttime Residence: Hotels/motels	**10,095**
Nighttime Residence: Doubled up	**211,607**

Figure 6. California homeless statistics (2018)
Source: USICH 2018

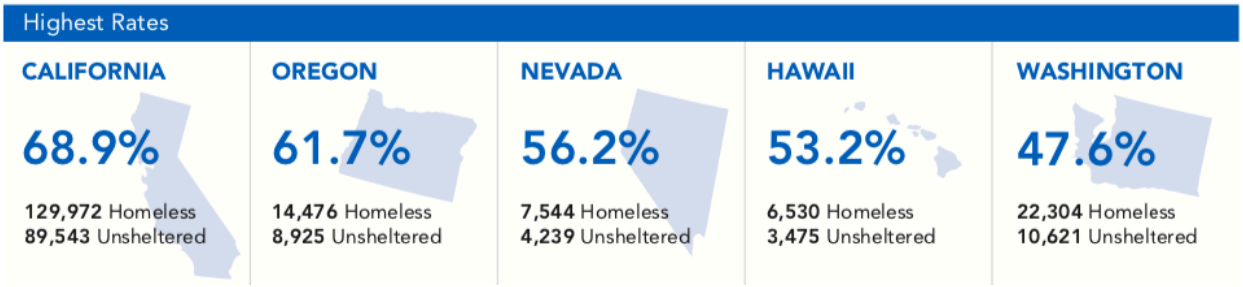


Figure 7. States with highest rates of unsheltered homeless people (2018)
Source: AHAR 2018

2.1.2 CoC estimates

In the PIT counts, it was found that over half of all unsheltered homeless people are in CoCs that include the nation's 50 largest cities. The Los Angeles City and County CoC have the second largest homeless population behind New York City (Table 1). At the time of this count, more than 1 in 5 people experiencing homelessness were living in New York or Los Angeles (Henry et al. 2018). Los Angeles had one of the highest rates of unsheltered homeless with 75 percent of the Los Angeles homeless population being unsheltered. The fact that a majority of Los Angeles' homeless population is unsheltered is uncharacteristic of urban CoCs, which tend to have the highest percentage of sheltered people. The unsheltered nature of LA's homeless population presents increased risks and needs that the planning body is tasked to address.

Table 1. Major city CoCs with highest homeless population (2018)
Source: AHAR 2018

CoC Name	Total People Experiencing Homelessness, 2018
Major City CoCs	
New York City, NY	78,676
Los Angeles City & County, CA	49,955
Seattle/King County, WA	12,112
San Diego City and County, CA	8,576
San Jose/Santa Clara City & County, CA	7,254

2.2 Homelessness in the Los Angeles CoC

2.2.1 LA CoC efforts

The Los Angeles CoC receives the most funding from HUD within the state of California, totaling $123,707,061 for LA City & County CoC during FY18 (Homeless Assistance Award Report 2018). The Los Angeles Homeless Services Authority (LAHSA) is the lead agency for the LA CoC, coordinating and managing more than $243 million annually in federal, state, county, and city funds (LAHSA, 2018). As a CoC, a local Homeless Management Information System (HMIS) is maintained to collect and report data on the characteristics of those comprising the LA homeless population. The CoC program's service use pattern for the resources is also collected and measured. Reports such as those compiled by the CoC help justify current and future funding and facilitate community-wide awareness of homelessness (LAHSA 2019).

In June 2019, Los Angeles officials released the results of the 2019 Greater Los Angeles Homeless Count. The trend was dramatic. Homelessness increased in LA County by 12 percent

and in the City of Los Angeles by 16 percent from 2018 to 2019. Based on the most recent data, LA County's homeless population sits at approximately 58,936 in the county and 36,300 in the city (LAHSA 2019). But while the numbers may not reflect it, government initiatives taken by the city of Los Angeles made great strides in addressing the issue. LA has increased program funding to provide more affordable housing and access to essential services (Cowan 2019).

2.2.2 LA CoC homeless count methodology

LAHSA partnered with USC's School of Social Work and the Leonard D. Schaeffer Center for Health Policy & Economics to design, implement, and analyze the Greater Los Angeles Homeless Count. The study provides PIT estimates of the homeless population in the LA CoC geographic area, fulfilling HUD's requirement for CoCs that an annual count and demographic characteristics estimates occur.

To generate count results, various sources of data were used (Figure 8). Estimates of the homeless population were extrapolated from data obtained via street counts of unsheltered people, a demographic survey of unsheltered adults, a youth count and survey, administrative data from the HMIS, and the MyOrg data collection system as it pertains to sheltered individuals. LAHSA conducted street counts by visually counting and recording people experiencing unsheltered homelessness, including those dwelling in cars, vans, RVs, tents, and makeshift shelters. These were conducted in all 2,160 census tracts of the LA CoC and was collected during the last 10 days of January 2019 for temporal consistency.

Demographic surveys were conducted on a sample of homeless adults. These surveys were used to estimate the characteristics of unsheltered homeless adults across the CoC and to determine number of people living in makeshift shelters captured in the Street Count. LAHSA expressed concerns about the accuracy of representation of homelessness at a large geographic

scale. This prompted USC to run preliminary estimates of sample sizes for different levels of standard error and precision at multiple geographic levels. For sample selection, the USC methodology implemented a two-stage stratified random sample. A decision was made to take council districts (CDs) into account when defining geographic strata. A reported 5 percent margin error was used to calculate a target sample size for surveys and the prior year's average population estimates were used to define the final sample size per census tract. A shelter count was conducted to provide the raw number of homeless individuals living in various shelter types. For the shelter count, LAHSA conducted a PIT that had a 100 percent enumeration of all shelters in the CoC, for which LAHSA asserted there was no sampling or sampling error.

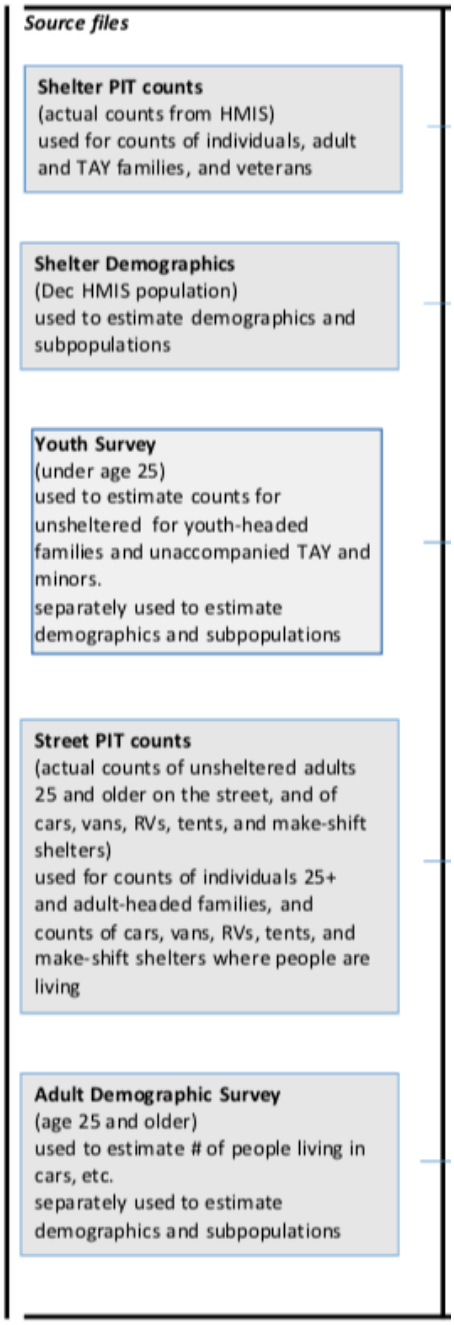


Figure 8. LAHSA and USC homeless source data

HMIS data was used to estimate subpopulations (individual v. family, type of shelter, etc.) and demographic estimates. Demographics collected included household composition, veteran status, gender, and age. Complete HMIS records with demographic characteristics were used to derive the distribution of demographic and subpopulation characteristics for the sheltered homeless population. Eliminating collection redundancies and screening for shelter used, demographic characteristics, and subpopulations was generated by estimating the proportion within the HMIS data for each type of shelter and household type (Henwood et al. 2018).

2.2.3 Homelessness in LA by the numbers

In the LA CoC, there was a total homeless population of 58,936 people in 2019, indicating a 12 percent increase in the total homeless population in LA County from the PIT count of 2018. This percentage change was deemed significant by LAHSA according to a significance test at the 95 percent confidence interval (LAHSA Count 2019). In addition to Los Angeles, Orange County, Ventura, San Bernardino, and Kern counties all reported significant increase in their respective homeless populations (Oreskes & Smith 2019). Veterans accounted for 7 percent of the total homeless population. Men were the majority gender represented, with 67 percent of the population. With respect to age, the vast majority (85 percent) were 25 years of age or older (Table 2).

Table 2. 2019 Greater Los Angeles Point-In-Time Count conducted in January 2019
Source: LAHSA

Greater Los Angeles Homeless Count

2019 Greater Los Angeles Homeless Count - Data Summary

Los Angeles County[1]

Population[1]	Sheltered	Unsheltered	Total	Prevalence of Homeless Pop. (%)	Percent Change 2018 - 2019	Significant Difference 2018 - 2019[2]
All Persons						
All Persons	14,722	44,214	58,936	100%	+12%	Yes
Household Composition						
Individuals *(Those not in family units)*	7,590	42,481	50,071	85%	+13%	Yes
Chronically Homeless	1,517	14,337	15,854	27%	+17%	Yes
Veterans	965	2,874	3,839	7%	+1%	No
Unaccompanied Minors *(Under 18)*	21	45	66	0.1%	+5%	No
Family Members *(Those in family units)*	7,111	1,688	8,799	15%	+6%	Yes
Children in Families (Under 18)	4,322	892	5,214	9%	+6%	Yes
Chronically Homeless	474	200	674	1%	+31%	No
Veterans	53	59	112	0.2%	+19%	Yes
Veterans						
All Veterans	982	2,896	3,878	7%	-0%	No
Chronically Homeless Veterans	92	1,208	1,300	2%	-15%	No
Gender						
Male	7,940	31,408	39,348	67%	+11%	Yes
Female	6,634	11,697	18,331	31%	+13%	Yes
Transgender	125	932	1,057	2%	+14%	No
Gender Non-Conforming	23	177	200	0.3%	+14%	No
Age						
Under 18	4,343	937	5,280	9%	+6%	Yes
18 - 24	1,511	2,124	3,635	6%	+17%	No
25 and Over	8,868	41,153	50,021	85%	+12%	Yes
Chronically Homeless						
Individuals (Those not in family units)	1,517	14,337	15,854	27%	+17%	Yes
Family Members (Those in family units)	474	200	674	1%	+31%	No
Total Chronically Homeless Persons	1,991	14,537	16,528	28%	+17%	Yes

2.3 Access and utilization of medical care

Much of the focus for the LA CoC and other organizations working to address LA's homeless crisis is on the provision of housing. A lack of stable housing is the primary issue faced by homeless individuals and is rightly prioritized (Sadowski et al. 2009). The phenomenon of the prioritization of homeless individuals' needs has long been recognized by researchers. Competing priorities refers to the phenomenon that basic needs such as the need for food, shelter, and safety tends to be prioritized over needs such as healthcare based on perceived necessity and importance to daily life. A study by Gelberg et al. (1997) offered empirical support for the phenomenon, recognizing the nonfinancial barriers to utilization of health services by homeless individuals. Housing also has a direct effect on other critical life-sustaining necessities like access and utilization to medical care.

LA CoC services have mirrored this prioritization, with the largest funding grants going to housing projects in FY19 (FY2019 LA CoC Project Priority List). In addition to funding for the housing issue, issue of access to medical care could be better demonstrated through an accessibility analysis to provide the documentation and identification of specific locations that would benefit from additional resources.

Kushel et al. 2011 found various factors associated with health care utilization by homeless people. The authors found that homeless individuals experience high rates of physical illness, mental illness, substance abuse, and early mortality. However, despite having a higher burden of illness, homeless people have fewer encounters with ambulatory care than non-homeless individuals. Ambulatory care refers to medical services performed as an outpatient without admission to a hospital, including specialty clinics and urgent care clinics (Heinrich 2017). The

authors associate this occurrence with the fact that health care directly competes with more immediate needs, such as obtaining shelter and food. The authors found that, given the opportunity, homeless individuals are willing to obtain health care for chronic conditions if they believe such care is important. Access was found to be a critical component of the decision to seek medical care. Of those surveyed in the study, one fourth of respondents reported that at some point in the past year they needed medical care that they had not been able to receive (Kushel et al. 2001).

2.3.1 Accessibility

Defining "accessibility" is necessary to determine the usability of healthcare clinics for homeless populations. Various factors contribute to accessibility, with unique considerations in determining accessibility for homeless adults. Access to health care is influenced by a multiple phenomenon, including the availability of health services in the area, the number of people living in the area, the population's health status, and its socio-economic standing (Chan et al. 2014).

Chan et al. (2014) looked at accessibility and community integration among homeless individuals. The researchers were motivated by the recognition there had been few empirical investigations into the proximity of community features on resource use and integration. GIS was used to examine how accessibility and proximity to community features related to the types of locations homeless people were able to access within the community. Overall, the authors concluded that the ability to navigate and use community resources was associated with better accessibility and feeling a part of the community.

A relevant concept from the Chan et al. study is the difference between "potential accessibility," which centers on probable utilization of services, as compared to "revealed accessibility," which documents the actual use of services (Chan et al. 2014). Determining the

potential accessibility of clinics considers the homeless population within a determined geographic and travel time span and assumed various methods of travel, including foot, public transit, and/or motor vehicle. Of those deemed to be able to use the resources, the percentage of individuals in that area who utilize the services can be determined from statistical data. Spatial accessibility is a factor considered for these two types of accessibility. The measurement of distance and time, as well as the importance of spatial separation between supply and demand as a barrier or facilitator of use are also key considerations (Wang 2012). These types of accessibility were considered when determining the accessibility of healthcare facilities in this thesis.

Potential accessibility is considered in this thesis as the entire homeless population within a determined walking distance from a hospital is considered to have access to the medical facility. Potential accessibility is more inclusive of a possibly larger group of individuals as it may overestimate the ability of all within a given range to actually access the facility. For the purposes of this study to supply the LA CoC with estimations of need according to area and hospital, it was determined that being more inclusive would be beneficial to advocate for funding in terms of all people the additional resources could potentially help.

2.3.2 Walkability

Yang and Diez-Roux et al. 2012 conducted a study to determine the acceptable walking distance (typically determined to be 0.25 mi) in U.S. research studies based on distance and purpose of movement. The researchers found an inverse correlation between longer walking distances and socioeconomic status. Of their nationally representative sample, the distribution of walking trips by distance had the highest frequency for 1 mile and nearly one-fifth of the sample

walked more than a mile (Yang & Diez-Roux et al. 2012). Considering the findings of this study, it could be inferred that he homeless population faces similar challenges to those of low socioeconomic status, with lack of funds for motor transportation and only occasion public transport options. The distance to a destination in "walking distance" for a homeless individual could subsequently be a longer distance than would typically be considered accessible.

2.4 2SFCA

Determining place-based accessibility via modeling has long been used to study the accessibility of a location with respect to its intended audience. The two-step floating catchment area model determines the accessibility of a location according to the density and/or proximity to surrounding target locations (Neutens et al. 2010). While 2SFCA was originally used to study healthcare accessibility (Luo and Wang 2003), the approach has been applied to a wider range of accessibility studies (Chen & Jia 2019).

2.4.1 2SFCA methodology

Luo and Wang's 2SFCA method is a form of the gravity model, which considers accessibility to be mediated by distance decay and the interactions between supply and demand. The authors' methodology integrates spatial and non-spatial factors that affect accessibility to provide a more accurate representation of the phenomenon. As Wang (2012) stresses, both spatial and non-spatial factors must be accounted for to develop a complete picture of health care accessibility. Utilizing GIS analysis, spatial access emphasizes the importance of spatial separation between the supply (the medical facility) and demand (the population). Non-spatial factors affect the spatial component, as demographics and socioeconomic status relate to location and influence how an individual and/or group engages with space.

This method was originally developed to evaluate spatial inequity of health care services, measuring the cost (distance, time, money, etc.) associated with getting to a medical facility based on one's location. Since the authors first implemented the methodology, its application has been seen in the field of urban planning and other fields modeling accessibility spatially. Several researchers have also modified the methodology to improve accuracy and account for important factors in their studies (Yang et al. 2006).

2.4.2 Enhanced 2SFCA methodology

Luo & Qi (2009) introduced an 2SFCA method in which weights were applied to differentiate travel time zones to account for distance decay. The consideration of distance decay and factors that affect accessibility measurements are commonly considered in current 2SFCA methodologies, including the present thesis. McGrail and Humphreys (2009), amongst others, adjusted the 2SFCA method to study rural areas. The authors of this study attempted to rectify two shortcomings of the 2SFCA, namely the use of only one catchment size for all populations and the assumption that proximity is undifferentiated within a catchment. Rural communities are the subject of the study, as they are often characterized by poorer health status and increased problems of accessing health services compared to cities (Humphreys and Solarsh 2008). Distance barriers and diminished local availability of health care services are identified as common accessibility issues in these areas.

McGrail and Humphreys' 2SFCA approach of tailoring the method to their subject matter provides an example for how to customize the 2SFCA. This study also emphasized the importance of considering one's area and topic of focus, and how a unique subject impacts how the study should be conducted. Identifying the weaknesses of the 2SFCA method also enables improvements to be made. Rural areas face similar disparities as homeless individuals, such as

limited resources within close proximity and a higher cost (time, distance, etc.) associated with gaining access. Thus this study serves as a good example for the current project when designing the 2SFCA methodology to account for the constraints on homeless individuals' mobility and financial resources.

Studies using 2SFCA studies typically look at health care accessibility for a geographic region's population. Variations exist with respect to methodology, subject, and type of provider, but using this technique for the study of homeless accessibility is less common. This gap in application of the methodology may be due in part to the difficulty of collecting estimates on this population and the lack of spatial analysis on the topic of homeless healthcare accessibility. Defining access in terms of walkability is one such modification that must be made, assuming a lack of motorized transport. Accounting for the nonspatial attributes of homelessness, spatial analysis via the 2SFCA has the potential to produce valuable results that researchers could leverage by using GIS.

2.5 Summary of Related Works

A literature review of the studies conducted in the United States to determine homeless counts provided the necessary context and justification for choosing the LA CoC as a location where the study of homelessness is timely and relevant. Understanding the methodology of prior research offered guidance for the current project. This background research established the credibility of this current thesis by verifying that the data used was collected and disseminated in a scientifically rigorous manner. The studies referenced influenced the methodology of the current study and helped to validate the results. From the PITs conducted, a picture of

homelessness in LA established an understanding of the population being considered by the current study.

Prior studies of accessibility provided guidelines when measuring health care accessibility as it applies to homeless populations. From this study, the 2SFCA methodology emerged as the preeminent technique. The original and adapted version of this methodology serve as examples for the modified 2SFCA used in the current study, though it was tailored to the study of homeless access to health care facilities.

Chapter 3 Methods

The objective of this study was to determine regions in the Los Angeles CoC that have hospitals accessible to the homeless population, and where there are concentrations of homeless individuals with limited or no access to medical facilities. Using the most recent LAHSA Homeless Count 2019, concentrations of homelessness in the LA CoC were determined at the census tract level. Studies of homelessness often use census tracts as the spatial scale due to the prevalence of data available at this scale and the utility of studies at this scale to policymakers to understand larger areas they serve (HRI, 2014). A series of analytical steps using ArcGIS were conducted to determine population densities to evaluate the status of their accessibility. The distances between the homeless populations and the nearest hospital were also calculated.

To conduct a healthcare accessibility analysis, a 2SFCA method was used to determine accessibility for homeless populations within a determined area surrounding the medical facilities. The accessibility index defines accessibility as the ratio of total homeless individuals within service range of healthcare facilities, considering the total bed count of these medical facilities per the total homeless population. As the ratio approaches 0, the higher the demand based on hospital bed availability per the homeless population within range. Areas of greater service need and were access was not available were identified to highlight were additional funding could improve access by providing transportation services or additional resources.

The service area distances considered were 0.25, 0.5, and 1-mile walking distances. These distances were chosen as 0.25 miles is typically viewed as an accessible distance to walk. 1-mile was determined to be more inclusive of homeless populations with potential access as homeless individuals typically have to walk longer distances to access resources. 0.5 miles served as a natural in-between distance to include more an additional measurement.

The homeless population counts by census tract were distributed by areal extent to account for the coverage of the service areas and to provide an estimated distribution of the population outside the centroid of the census tract. Population distribution by areal extent accounts for the population of homeless individuals that are in the intersection of the two feature classes (the census tract layer with population data and the service areas). This percentage of coverage was than applied to the total population number to determine the number of individuals falling within the service area.

Distances between the centroid of the census tract and the healthcare facility were measured to determine the distance via walkable routes to the nearest facility. The centroid of the census tract was used as exact points for the homeless populations were not available and the center point served as a uniform method for distance measurement. Euclidean distance was used because GIS tools available could not provide walkable distance for the number of hospitals being concerned.

3.1 Data

The data used for this project was collected and provided by various government organizations at the federal and local level. The data came as shapefiles and Excel sheets that were geocoded to produce shapefiles in ArcGIS pro (Table 3).

Table 3. Datasets used by name, description, and source

Dataset Name	Description	Source
Homeless Count 2019 Results by Census Tract	Captures a Point-In-Time (PIT) estimate of unsheltered, emergency sheltered, transitional housing, safe haven, and total homeless population. Collected at the census tract level on the last 10 days of 2019 from volunteer counts and surveys. Available as an Excel dataset.	Los Angeles Homeless Services Authority (LAHSA)
Los Angeles Hospitals and Medical Centers (2019)	Dataset of hospitals and medical centers in Los Angeles County as a shapefile. Contains various attributes such as site location, service type, total bed count, and contact information.	Location Management System (LMS) County of Los Angeles GIS Program
Los Angeles County Census Tracts (2010)	Data was downloaded from the Census Bureau website and clipped to LA County boundary. Census data from the 2010 census updated to the 2012 Census Geography Update.	Los Angeles County GIS Data Portal and U.S. Census Bureau
Los Angeles CoC Boundaries shapefile (2018)	Geographic boundaries for HUD's CoC areas by Year. Shapefile for California CoC provided with the Los Angeles CoC (CA-600) selected.	U.S. Department of Housing and Urban Planning (HUD)

3.1.1 Homeless Count 2019 Results by Census Tract dataset

The LAHSA 2019 Greater Los Angeles Homeless Count provides Point-In-Time estimates of the homeless population in the LA CoC geographic area as defined by HUD. Estimates of the homeless population were extrapolated from data obtained by a street count of the unsheltered and sheltered populations and further refined by demographic categorization (Henwood et al. 2018). LAHSA collected population counts and accompanying demographic data for the 2,160 census tracts in the LA CoC that are accounted for in the current study.

The dataset provided numerous subcategories of the homeless population identified in the CoC census tracts (various living situations, shelter status, etc.). The primary fields of interest for the current study was the tract code, community name, and total homeless population (accounting for sheltered and unsheltered individuals). The data was provided as an Excel sheet which was cleaned to remove additional fields.

3.1.2 Los Angeles Hospitals and Medical Centers (2019) shapefile

The LA Hospitals and Medical Centers shapefile was obtained from the Location Management System (LMS) via ArcGIS Hub. LMS is the County of Los Angeles GIS program that maintains a comprehensive geographic database of locations countywide. Data on the location as well as descriptions and contact information for each medical facility was provided. The dataset contains all hospitals and medical facilities in the county of Los Angeles. Of the complete dataset, 147 hospitals and medical facilities that fell completely within the CoC boundaries were selected to create a layer in ArcGIS. Attributes of particular interest included the location, services provided, care category, name of facility, and total bed count. The total bed count was used in the 2SFCA to determine the ratio of total beds per total homeless population in the service area. The facilities were presented as points and the symbology was changed to red crosses to indicate a medical facility.

3.1.3 Los Angeles Census Tracts (2010) shapefile

The census tract data for Los Angeles County was provided by the Los Angeles County GIS Data Portal using U.S. Census Bureau 2010 census data. Though the census data was collected in the latest 2010 census, the boundaries of the census tracts were updated to the 2012 Census Geography Update. Therefore, the CT10 (census tract ID number) field reflected the 2012 Census update. The shapefile was projected in NAD 1983 StatePlane California V FIPS 0405 Feet. The boundary shapefiles were the primary data of interest as opposed to the demographic data provided as the Homeless Count PIT demographic data was the population data of interest.

3.1.4 Los Angeles CoC shapefile (2018)

The shapefile for the Los Angeles CoC came from HUD's Continuum of Care GIS Tools. Since HUD provides competitive funding for homeless services through a CoC structure, all research submitted to acquire funding at the CoC level must use the geographic boundaries and related data provided by HUD (HUD Exchange 2018). This dataset was selected to ensure this project could be used as support for funding and meet the standards of HUD. The shapefile contains the geographic boundaries for all CoCs within the state of California projected in GCS North American 1983. Los Angeles is CoC number 600 within the state of California. CoC number CA-600 was selected by attribute and placed into a separate layer to focus the study area to Los Angeles.

3.2 Visualization of homelessness in Los Angeles

Various ArcGIS symbologies were used to visualize the spatial relationship between homelessness and location within Los Angeles. Choropleth maps were created to visualize the total homeless populations by census tract. A hot spot analysis map was prepared to display areas of concentration of homeless populations and analyze the density distribution of the homeless population in LA CoC.

3.2.1 Homeless population counts choropleth map

Homelessness counts at the census tract level were used to map the CoC's homeless population. The most recent LAHSA Homeless Count 2019 Results by Census Tract dataset was used for population data. The dataset was curated to only include data fields of interest, namely the tract number and the total population of sheltered and unsheltered homeless people (Table 4).

This dataset was imported into ArcGIS Pro as a table. The U.S. Census Tracts shapefile was imported into ArcGIS for the census tract polygons. The Join tool was used to merge the LAHSA data with the census tracts polygons based on the tract ID attribute. The updated census tract layer with the homeless data was then spatially joined with the Los Angeles CoC shapefile (2018) to only include census tracts completely within the CoC. The projection for both layers was set to NAD 1983 StatePlane California V FIPS 0405 Feet.

The census tracts that returned a Null value when merged were deleted in the attribute table as this indicated the census tract was not included in the CoC. The symbology of the CoC census tract layer was set to Graduated Colors with the total homeless population field selected, a Normal Breaks (Jenks) method, and five classes with a teal blue (small population) to bright pink (large population) color scheme. A choropleth map of the total homeless population normalized by the total population in the census tract was also included.

Table 4. Curated fields of LAHSA Homeless Count 2019 by Census Results by Census Tract

Column Name	Description
tract	2010 US Census Tract Code
Year	Year Tract was Counted
City	City Name
Community_Name	Community Name
totUnsheltPeople	Total population of unsheltered homeless persons
totSheltPeople	Total population of sheltered homeless persons
totPeople	Total population of sheltered and unsheltered homeless persons

3.2.2 Homeless population counts hot spot analysis map

To create a hot spot analysis of where homeless populations reside in LA CoC, the CoC census tract layer with the LAHSA homeless data was used. To create points that could be used

to make the hot spot map, the centroids of the census tracts were used as the location of the homeless population. This method was used as the exact location of the homeless individuals were not recorded in the count. The assumption was made that the population aggregates at the center of the census tract, so the XY Table to Point Data Management tool was used with the fields X_Center (longitude) and Y_Center (latitude). Using the LA Census Tracts data, the centroids of the census tract polygons were found to create the Los_Angeles_Census_Tract_Centroid layer by using the XY Table to Point tool with the X_Center and Y_Center fields.

The ArcGIS Optimized Hot Spot Analysis tool was used to create the hot spot map. The total homeless population field of the centroid layer was analyzed to determine where the largest concentration of homeless people was. The results are represented as the centroids color graded according to accessed hot spot to cold spot values. The symbology of the hot spot analysis map was a gradation from cold spot (blue) to hot spot (red).

3.3 Two-step floating catchment accessibility methodology

A 2SFCA methodology was used to measure healthcare accessibility for the homeless population in Los Angeles CoC. When conducting analysis for Los Angeles CoC, Glendale, Pasadena, and Long Beach were excluded as each has its own CoC. Catalina and San Clemente Island were removed to contain the analysis to the Continental United States (CONUS). Two areas of coverage, or catchments, were created in this multi-step process and layered over each other, “floated”, to produce representations of spatial accessibility. The methodology used in the current study is adapted from the Vo et al. (2015) 2SFCA process. The two steps included the following:

Step 1: Given a 0.25, 0.5, and 1-mile distance (catchment) from a healthcare provider, sum up the total homeless population that the provider can reach within that distance. Determine a provider-to-population ratio. In the case of each medical facility, the provider ratio is the total bed count of the hospital to the total homeless population reached.

Step 2: Obtain the previously computed provider-to-population ratio of each healthcare 1-mile service area. Compute accessibility index of the census tract by summing up all provider-to-population ratios of the hospital service areas that fall within the boundaries of the census tract .

3.4 2SFCA Methodology Caveats

Modifications were made to the Vo et al. (2015) 2SFCA methodology. Analysis was informed by other practitioners' methodologies, and adaptations were made to accommodate the unique considerations when looking at homeless accessibility. ArcGIS Pro was used for analysis.

3.4.1 Walkable distance determination

When determining the catchment size, a service area of 1-mile was chosen to represent the area surrounding the hospital considered to be within "walking distance." The distance of 1-mile was selected based on existing literature and from considering the nature of the study population. Drawing on studies of walkability such as that conducted by Yang & Diez-Roux et al. 2012, it was determined that 1 mile was an acceptable distance to classify as accessible considering the transient lifestyle of homeless individuals.

A 1-mile service area around the healthcare facility was used to determine the homeless population within range of the facility. To account for the standard 0.25-mile distance, the service areas were broken up into 0.25, 0.5, and the 1-mile outer limit to allow for additional inferences to be made about accessibility based on the varying distances. The service areas were created using ArcGIS Network Analyst to only account for walkable paths, assuming homeless individuals would lack motor transportation.

3.4.2 Census tract population by areal extent

To determine the number of homeless individuals within a given service area, population by areal extent of the service area was used. The ArcGIS tool "Tabulate Intersection" was used weight census tract population by areal extent that was covered by the 3-ring (0.25, 0.5, 1 mile) service areas to allocate the population. The areal extent was determined to be the percentage of each census tract within a given service area. Within the Tabulate Intersection tool, the Service Areas were selected as the Input Zone Feature, the Input Class Features was the Census_Tracts_2010 layer and the Sum Field was the total population to add the populations from the census tracts that fall within the same service area.

This tool provided the percentage of the census tract within a service area. That percentage was then multiplied by the total population of the census tract to get the areal extent of the population that falls within the census tract. For service areas that covered multiple census tracts, the Dissolve tool was used to sum the populations from the various census tracts to obtain the total population in the service area. This methodology allowed for a good estimate for the number of homeless individuals potentially within the range of the service areas based on census tract area and potential dispersion. This approach clearly takes liberty in allocating the

population when precise locational data for the individuals is not known, however, this approach emerged as the most even-handed method to determine potential population within the service areas.

3.5 Overview of 2SFCA methodology

The following 2SFCA method leveraged the LAHSA Homeless Count 2019 by Census Tract and Los Angeles Hospitals and Medical Centers (2019) datasets in conjunction with the Los Angeles Census Tracts (2010) and Los Angeles CoC (2018) shapefiles. The first catchment, with a 1-mile service area from a healthcare provider, sums the total homeless population that the provider can reach within that distance to determine a provider to population ratio. In the case of each medical facility, the provider ratio is total bed count of the hospital to the total homeless population reached. The second catchment is produced from the census tract total population based on areal extent to obtain the previously computed provider-to-population ratio of each hospital that resides within the service areas. The provider-to-population ratios for hospitals' service areas that were in the same census were summered together to determine accessibility at the census tract level.

3.6 2SFCA data preparation

First, the data and shapefiles were loaded, cleaned, and modified in ArcGIS Pro (Figure 9). The LAHSA Homeless Count 2019 Results by Census Tract excel sheet was added to ArcGIS as a table and joined to the Los_Angeles_Census_Tracts (2010) shapefile by tract ID. The LA_Census_Tracts shapefile was then spatially joined with the Los_Angeles_CoC Shapefile (2018) to exclude census tracts not in the CoC. The results layer was named

Los_Angeles_CoC_Census_Tracts. Lastly, the Los Angeles Hospitals and Medical Centers (2019) shapefile was added and hospital locations outside the LA CoC were excluded (Los_Angeles_CoC_Hospital_and_Medical_Centers layer). All layers came projected or were changed to the NAD 1983 StatePlane California V FIPS 0405 Feet projection.

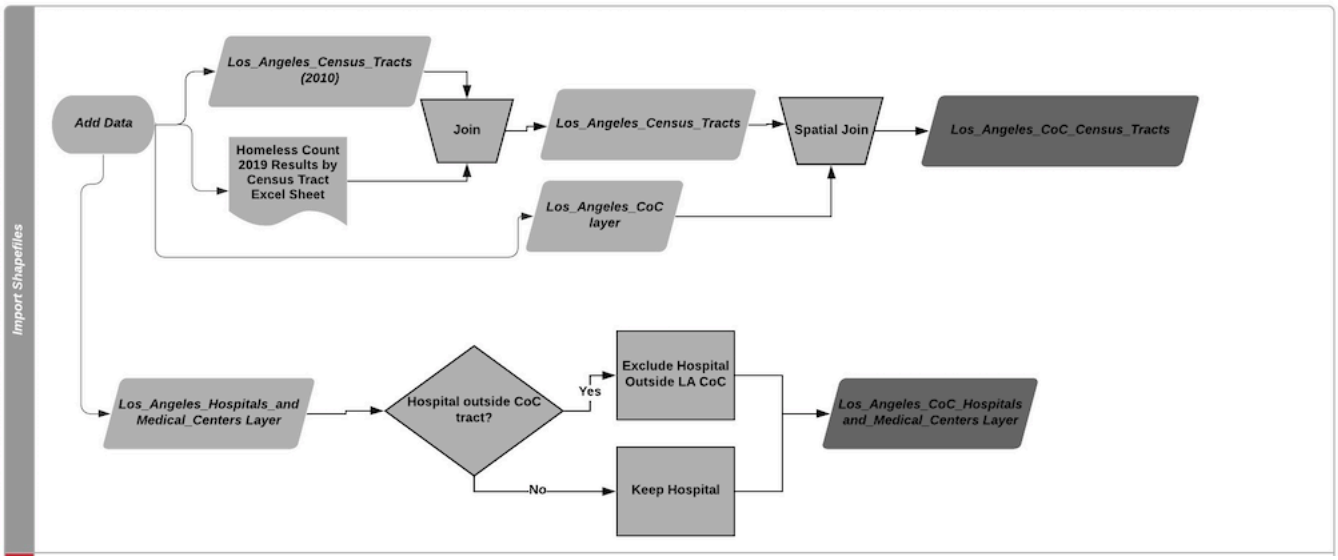


Figure 9. Import and update shapefiles stage

3.7 First catchment

For the first catchment, 1-mile walking route service areas (broken up into 0.25, 0.5, and 1-mile) around the Los_Angeles_CoC_Hospital_and_Medical_Centers points were created using the ArcGIS Network Analyst Service Area tool. The next steps were to calculate the provider-to-population ratio. First, the population within each service area had to be determined. This was done by using the Tabulate Intersection tool to find the population by areal extent of the census tract covered by the service area. Once the percentages were determined, the total population of the census tract was multiplied by the percentage covered. For service areas that covered multiple census tracts, the populations from each census tract were added together. This process determined the total homeless population within the service areas. The resulting output feature

class was the LA_First Catchment. To create the provider-to-population ratio, a new field was added to the LA_First_Catchment layer. The provider-to-population ratio was calculated by using the Total Bed Count divided by the homeless population count (Figure 10).

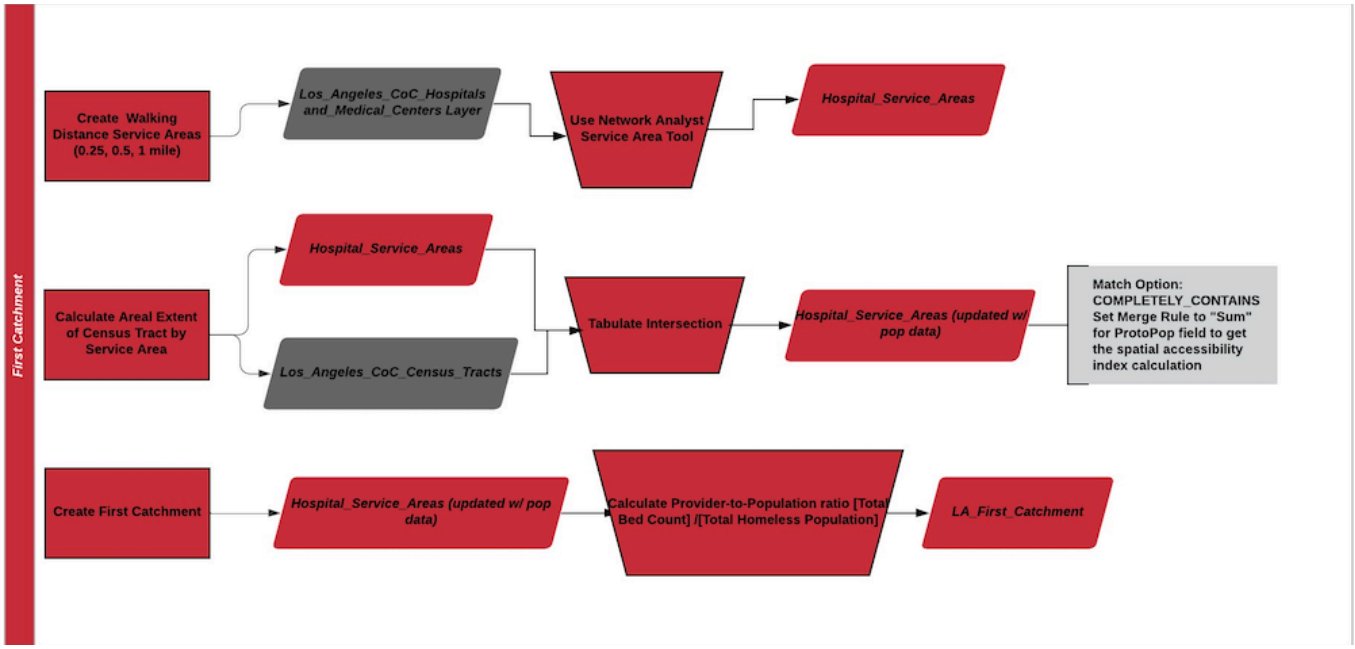


Figure 10. First catchment

3.8 Second catchment

For the second catchment, the accessibility index for each census tract was computed by summing up all provider-to-population ratios from the 1-mile service areas of the healthcare facilities that were within the tract (Figure 11). For the provider-to-population field, the Merge Rule was set to “Sum” to obtain the spatial accessibility index calculation. Populations within the census tracts that did not fall within a service area were added into the population figure for the tract. The provider-to-population ratios were joined to the LA_CoC_Census_Tract_Buffer shapefile. The Buffer shapefile was then joined to the LA_CoC_Census_Tract layer according to shared GEOID. The resulting output is the LA_2SFCA layer with the data and ratios calculated

being incorporated into the census tract polygons. The symbology was then changed to Graduated Colors for the Provider-to-Population field to represent the differences in accessibility as a gradation of colors.

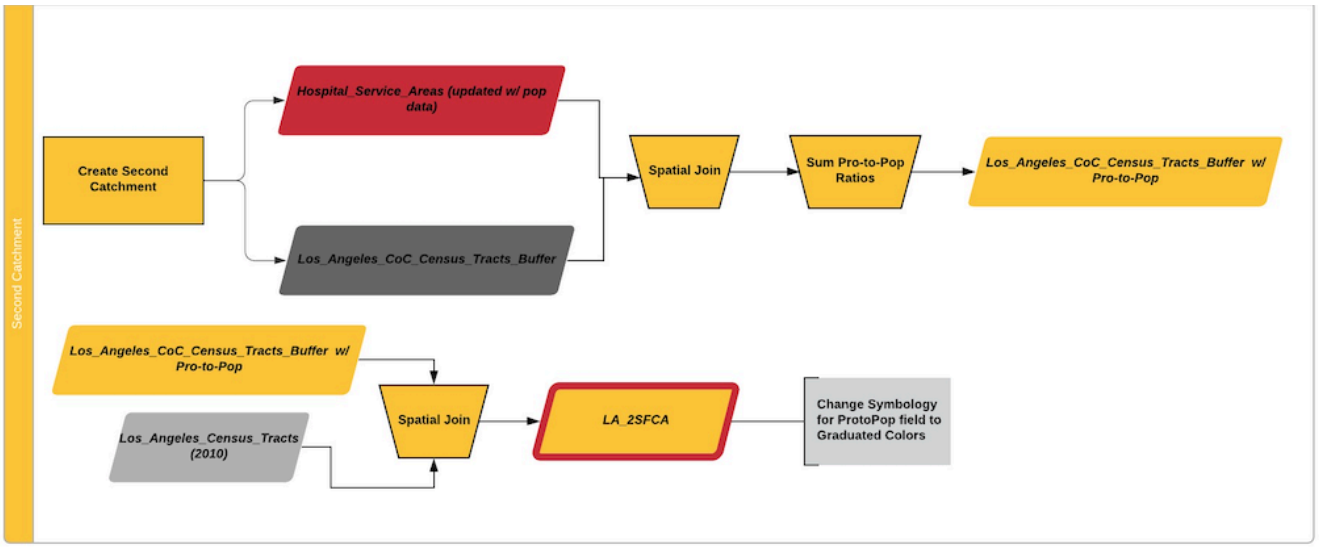


Figure 11. Second catchment

3.9 Distance to nearest hospital

The distance from the homeless populations of each census tract to the nearest hospital was measured as another determinate of accessibility. The location of the homeless population was represented as the census tract centroid. The distance between the centroid to the nearest hospital was measured using the ArcGIS Near tool which measures the distance between input features. In the Near tool, the LA_Census_Tracts_Centroid layer was used as the "Input Features" and the Los_Angeles_CoC_Hospital_and_Medical_Centers was set as the "Near Features." From this tool, the NEAR_DIST (near distance) was calculated which represents the Euclidean distance from the centroid point to the hospital point that is the shortest distance. The NEAR_FID field identified the medical center ID number of the closest hospital.

Chapter 4 Results

This chapter presents the results of the homeless population distribution analysis and the 2SFCA methodology for accessibility analysis. Hospital accessibility and distance measurements from the nearest medical facilities to the census tracts' populations are also included. The results are presented in a collection of maps and tables.

4.1 Homeless population distribution

4.1.1 Homeless population counts choropleth map

The Los Angeles CoC on CONUS is comprised of 2,161 census tracts. These census tracts were weighted based on total number (shelter and unsheltered) of homeless individuals within the tract. The largest population, and the only community in the highest tier between 707-3,180, was in Skid Row with 3,180 homeless individuals. Thirteen communities comprised the next tier of 300 to 706. 61 communities were in the third tier with populations of 111 to 259. With homeless populations between 34 and 110, there were 272 communities. Lastly, with homeless populations of 33 people or less, there were 1,810 communities with 375 communities having no recorded homeless individuals. These values were compared in a choropleth map with graduated colors representing total homeless population. The color scale ranged from teal blue (0-32), medium blue (33-109), dark blue (110-258), purple (259-705), and pink (706-3179). The resulting choropleth map is displayed in Figure 12.

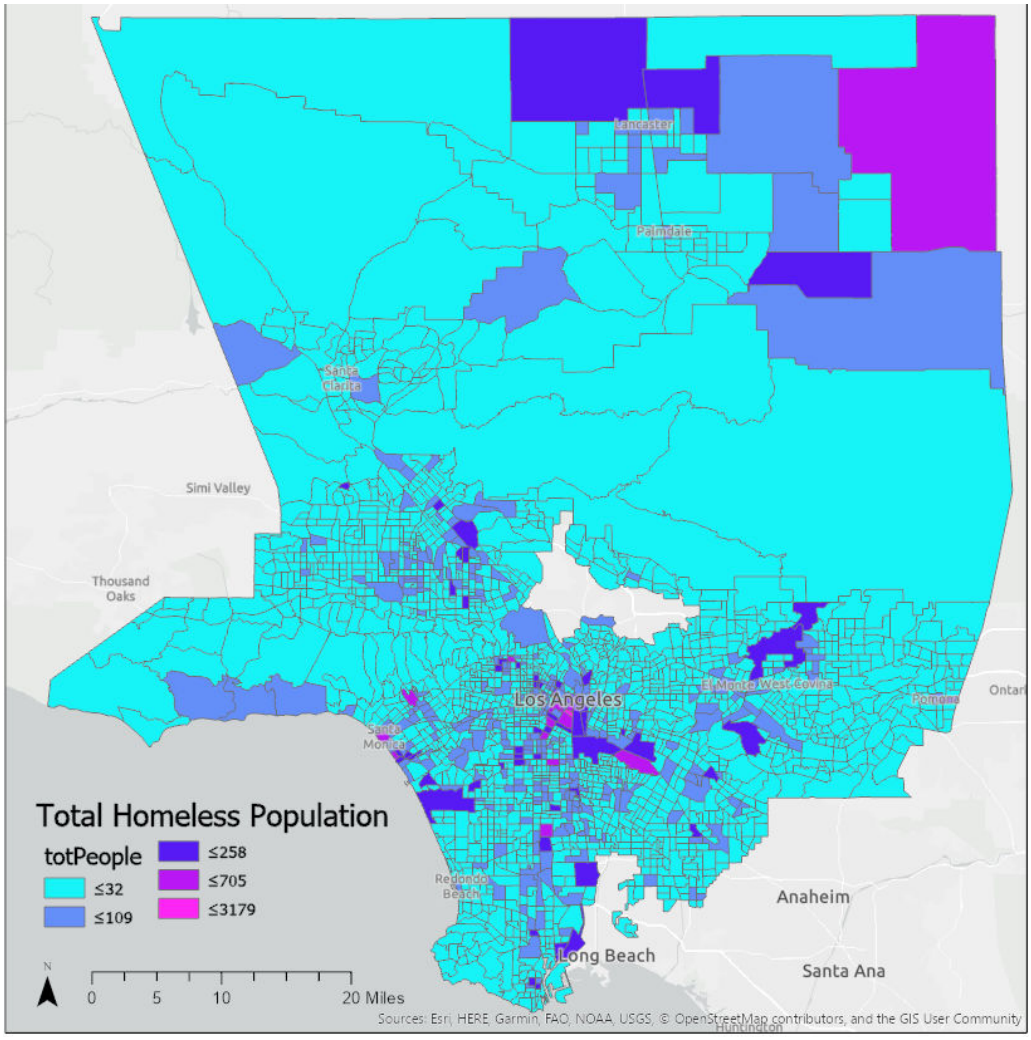


Figure 12. Choropleth map of total homeless population (# of individuals) by LA CoC census tract

The same color scheme was used in the results were normalized according to total population of the census tracts (Figure 13). The results of the normalized choropleth were the percentages of the homeless population relative to the total population, ranging from 0-6.2%.

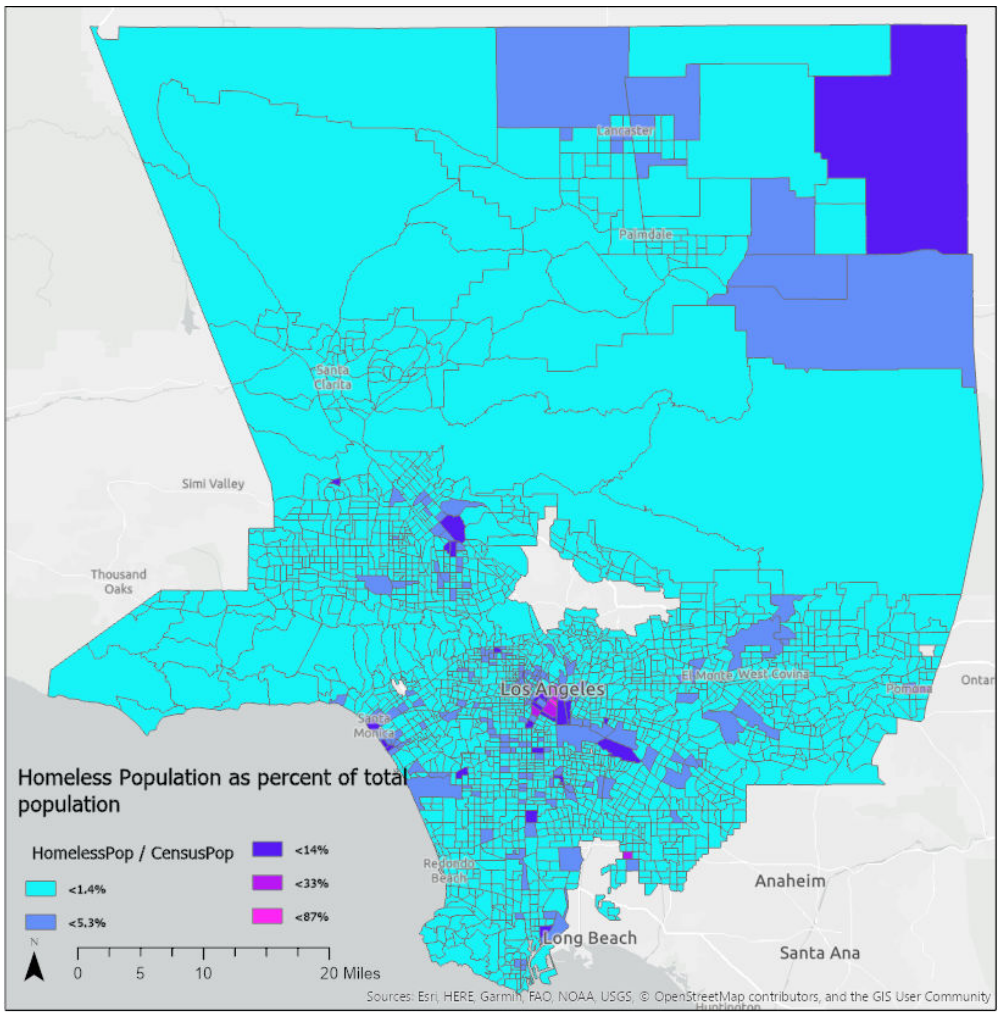


Figure 13. Total homeless population (# of individuals) normalized by total population of census tract

4.1.2 Homeless population counts hot spot analysis

An optimized hot spot analysis map was created to illustrate which census tracts had the largest homeless populations and where populations tended to cluster geographically. The density of census tracts is represented using a color scale from blue to red indicating cold spots, statistically irrelevant zones, and hot spots (Figure 14). The census tracts with the largest homeless populations in the densest areas in the Los Angeles CoC are observed in the downtown Los Angeles and Santa Monica areas. In general, the southern region of the LA CoC is denser

compared to the sparser northern region of the CoC, with the exception of Hi Vista in the upper northeast corner of the CoC.

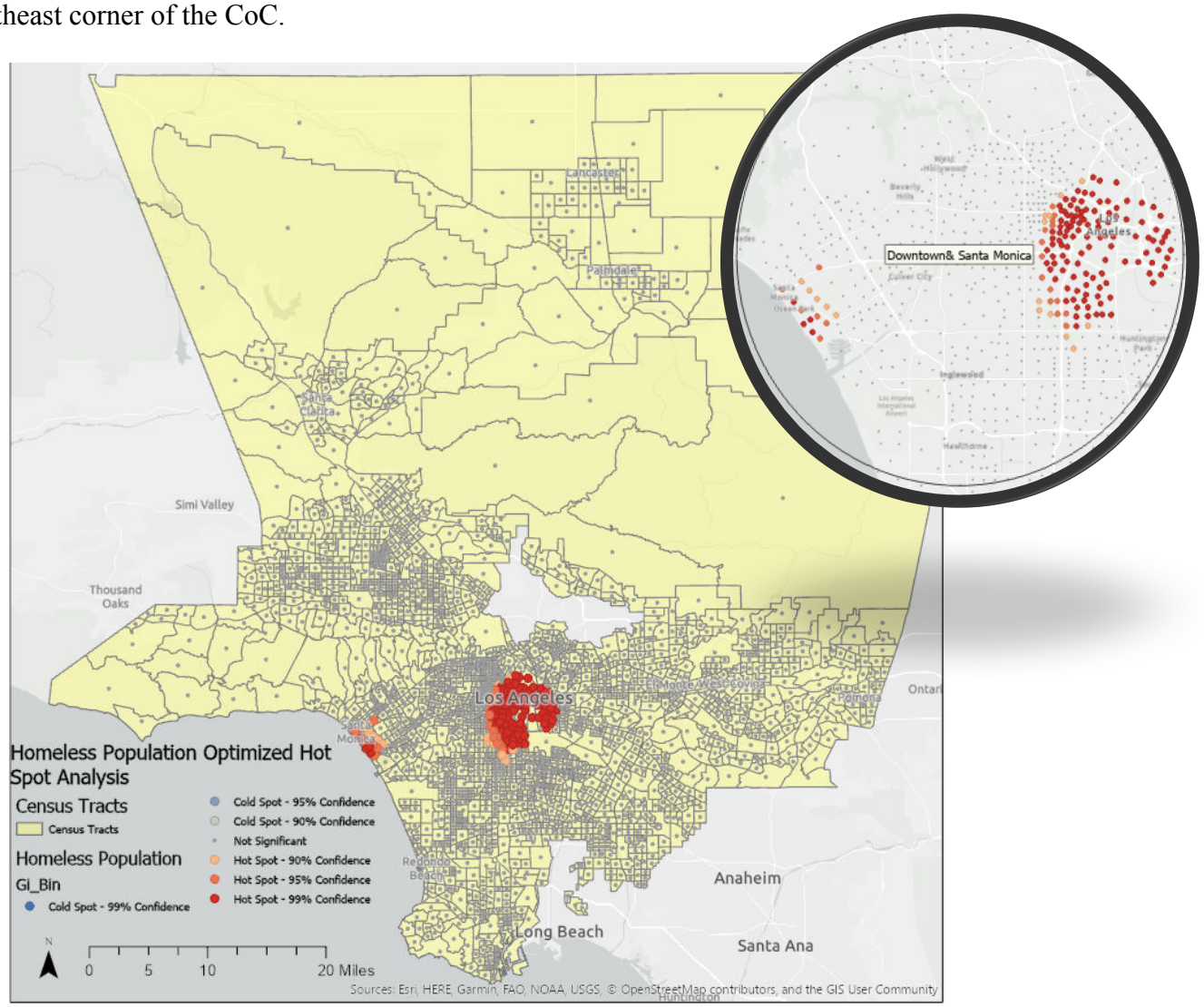


Figure 14. Hot spot analysis of homeless population by census tract

4.2 2SFCA and Accessibility Index

Using the 2SFCA method, measurements of the accessibility of the hospitals and medical facilities to homeless populations were made for the LA CoC. The accessibility index measured accessibility as a ratio of the total number of beds per hospital to the total population of homeless individuals within 0.25, 0.5, and 1-mile service areas. The population counts from the census

tracts within the service areas were summed together to represent the total potential homeless population the hospitals can service. Access was determined as to whether the total homeless population within the service area could potentially be cared for by a hospital based on their total bed count.

To look at access within each service area, an accessibility index was established for the services areas of the hospitals. The ratio of the accessibility index was the total number of beds per hospital to the total homeless population within the service areas surrounding each hospital The scale was broken down into five Natural Breaks ranges (from greatest demand to least) as well as areas of no access (Table 5). The larger the homeless population within the service area relative to the number of beds at the facility, the smaller the accessibility index value. This step allows for accessibility to be observed at the hospital level.

Table 5. Accessibility index for hospital service areas

Accessibility Index (Hospital)
0.1-39
40-131
132-321
322-560
560-1035
0 (No Access)

Each hospital service area within the LA CoC was coded by color according to the accessibility index (Figure 15 & 16). 3 service areas had an accessibility index of less than 1, signifying the homeless population of the area was greater than the number of available beds. 95 service areas had an accessibility index greatest than 1 and less than or equal to 39. 42 service areas had an accessibility index of 40-131. 30 service areas had an accessibility index between

132-321. 17 service areas had an accessibility index between 322-560. 8 service areas had an accessibility index between 560-1035, indicating least demand. 24 service areas were determined to have no population therefore no accessibility index value was assigned to them (Figure 16 & 17).

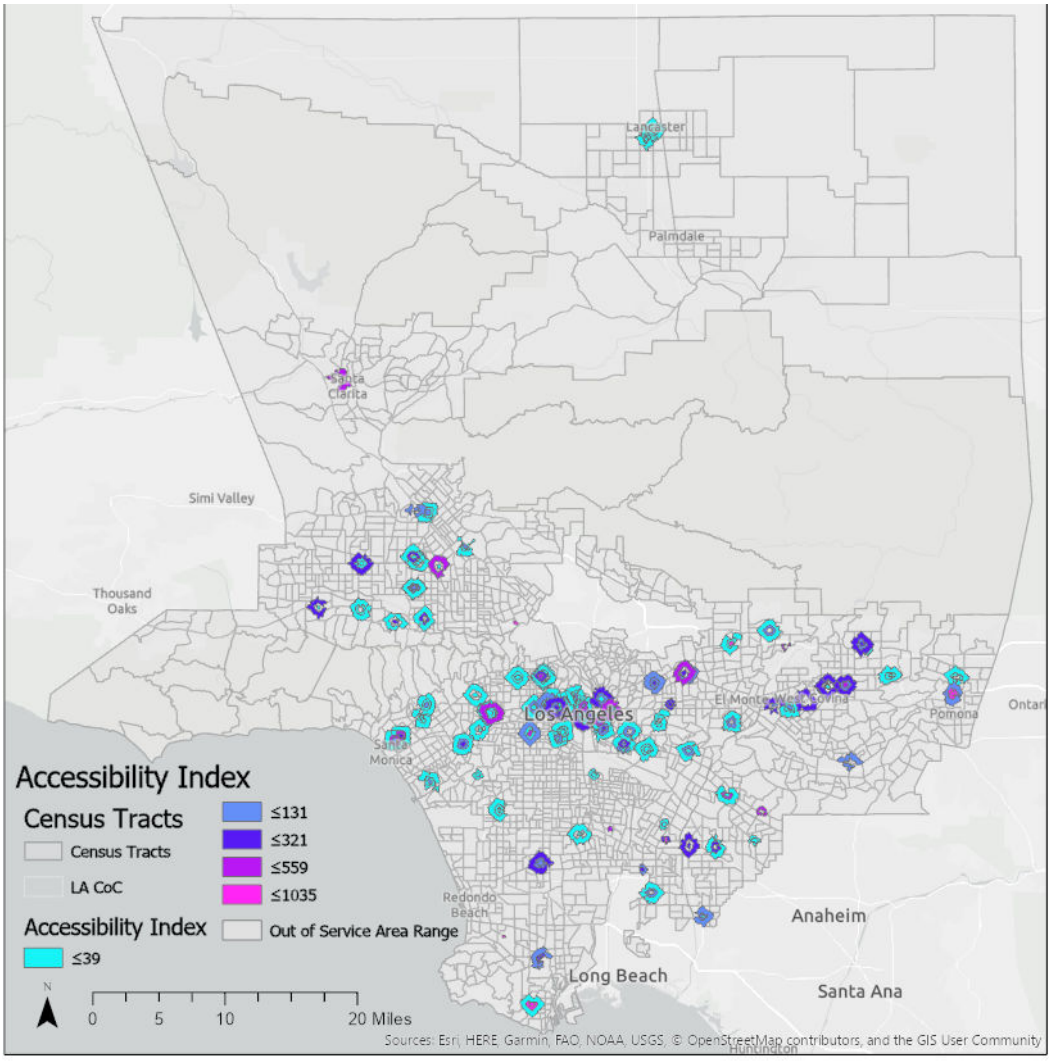


Figure 15. Hospital service areas by accessibility index

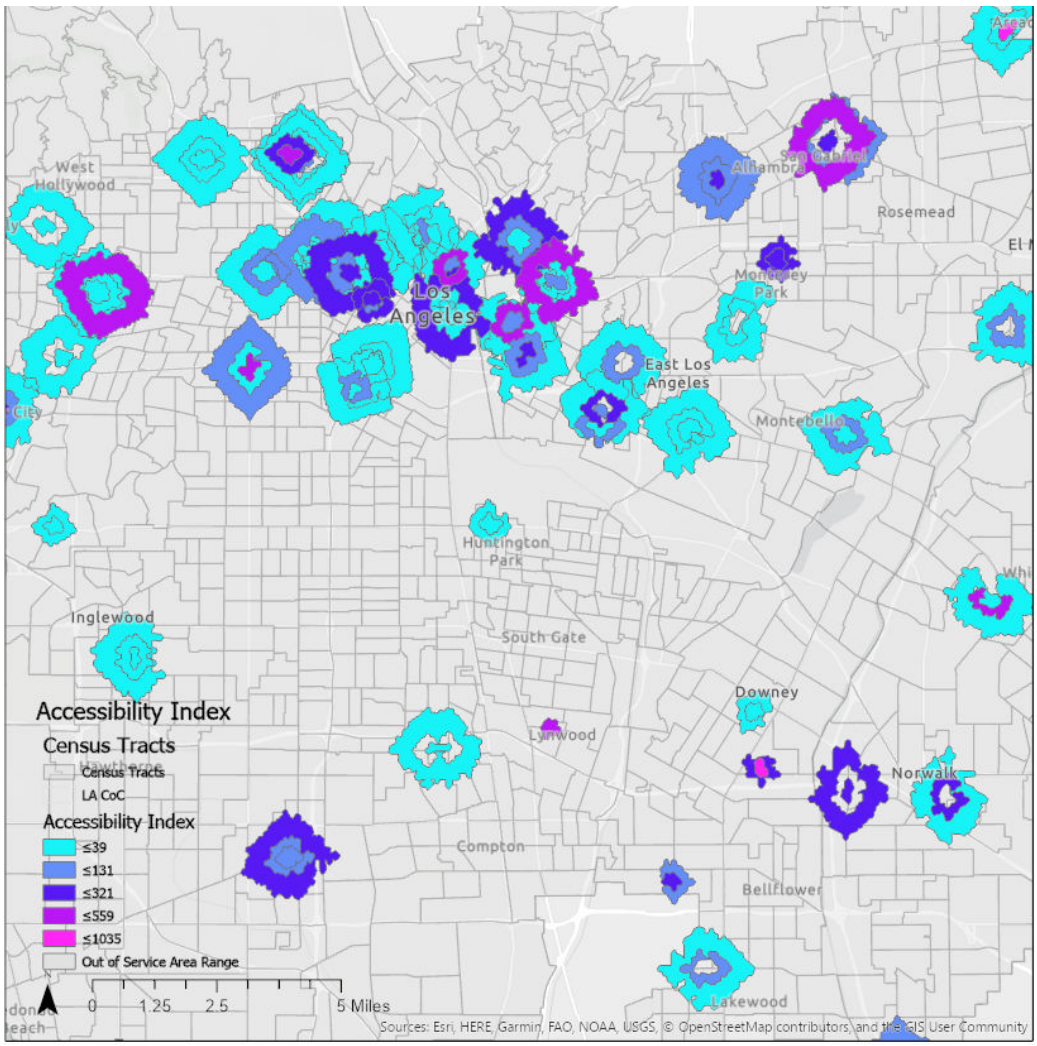


Figure 16. Downtown hospital service areas by accessibility index

For the 2SFCA, the accessibility index measured the ratio of number of beds from each hospital per census tract to the total homeless individuals. Census tracts with no homeless individuals within a 1-mile service area of a hospital had a value of 0, or no access. Populations of one individual or more within a 1-mile walking distance to a hospital had a value on the accessibility index. The smaller the accessibility index value, the larger the total homeless population relative to the number of beds at all the hospitals within each census tract. The scale was broken down into five Natural Breaks ranges (from greatest demand to least) as well as areas of no access (Table 6).

Table 6. 2SFCA Accessibility Index

2SFCA Accessibility Index
0.1-71
72-185
186-361
362-668
669-1765
0 (No Access)

Accessibility index values were assigned to census tracts with homeless populations that were in a 1-mile walking distance of hospitals within the census tract. The accessibility values assigned to each census tract and the distribution of the indexes according to census tract are observed in Figures 17 & 18.

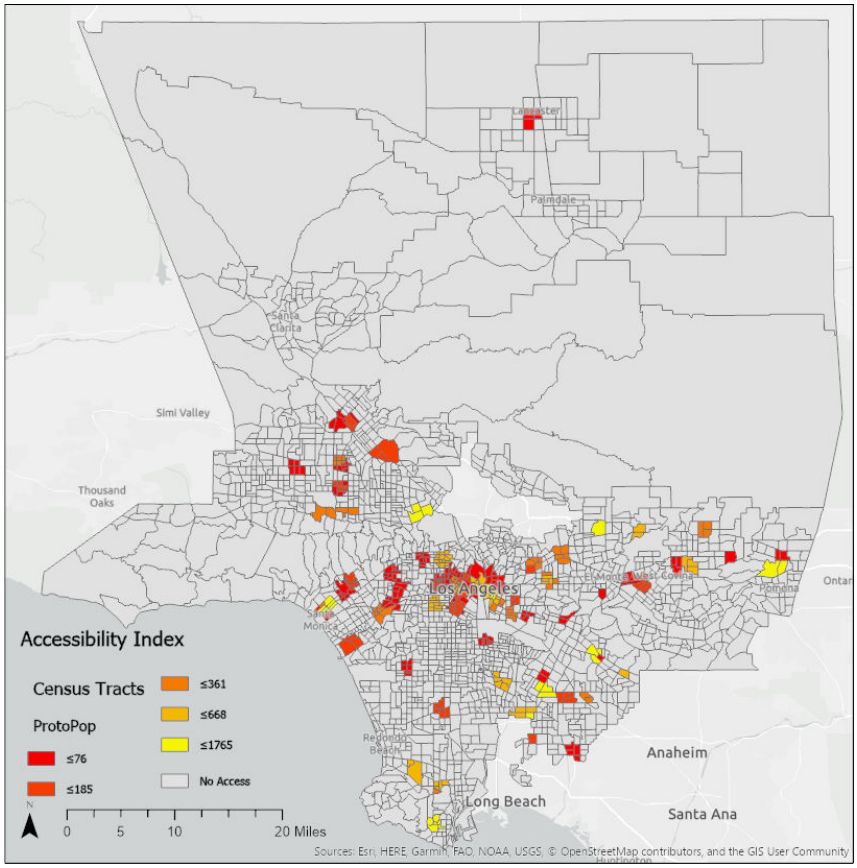


Figure 17. Census tracts by 2SFCA accessibility index

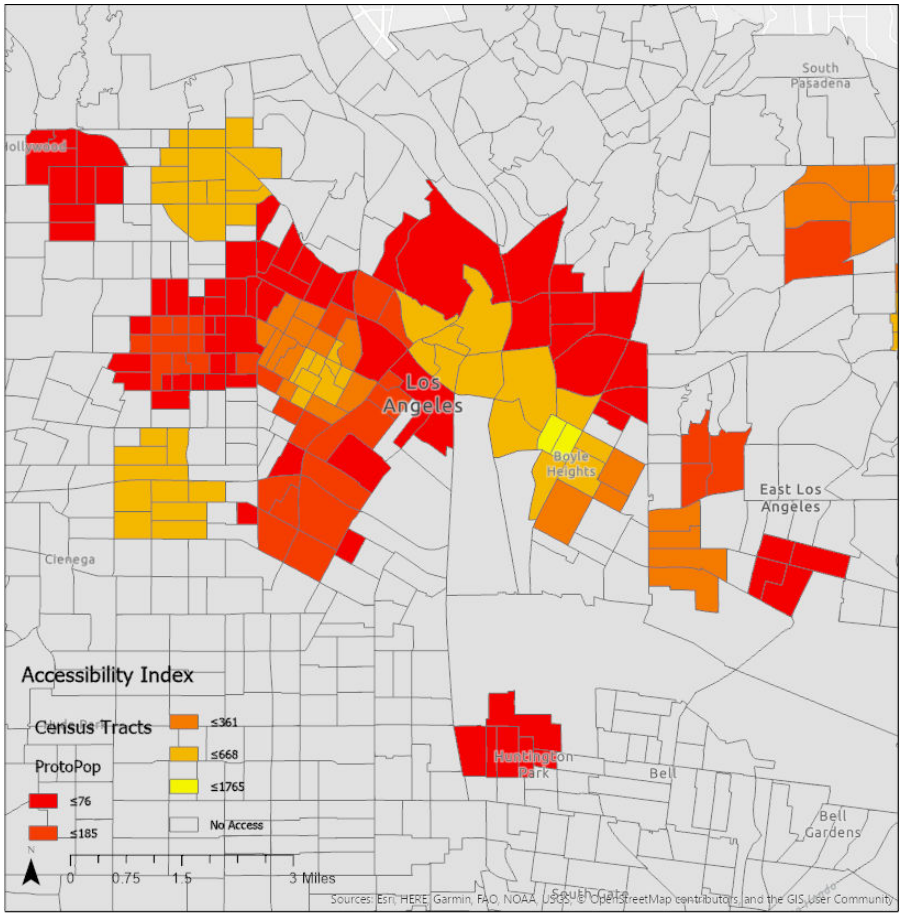


Figure 18. Downtown LA census tracts by 2SFCA accessibility

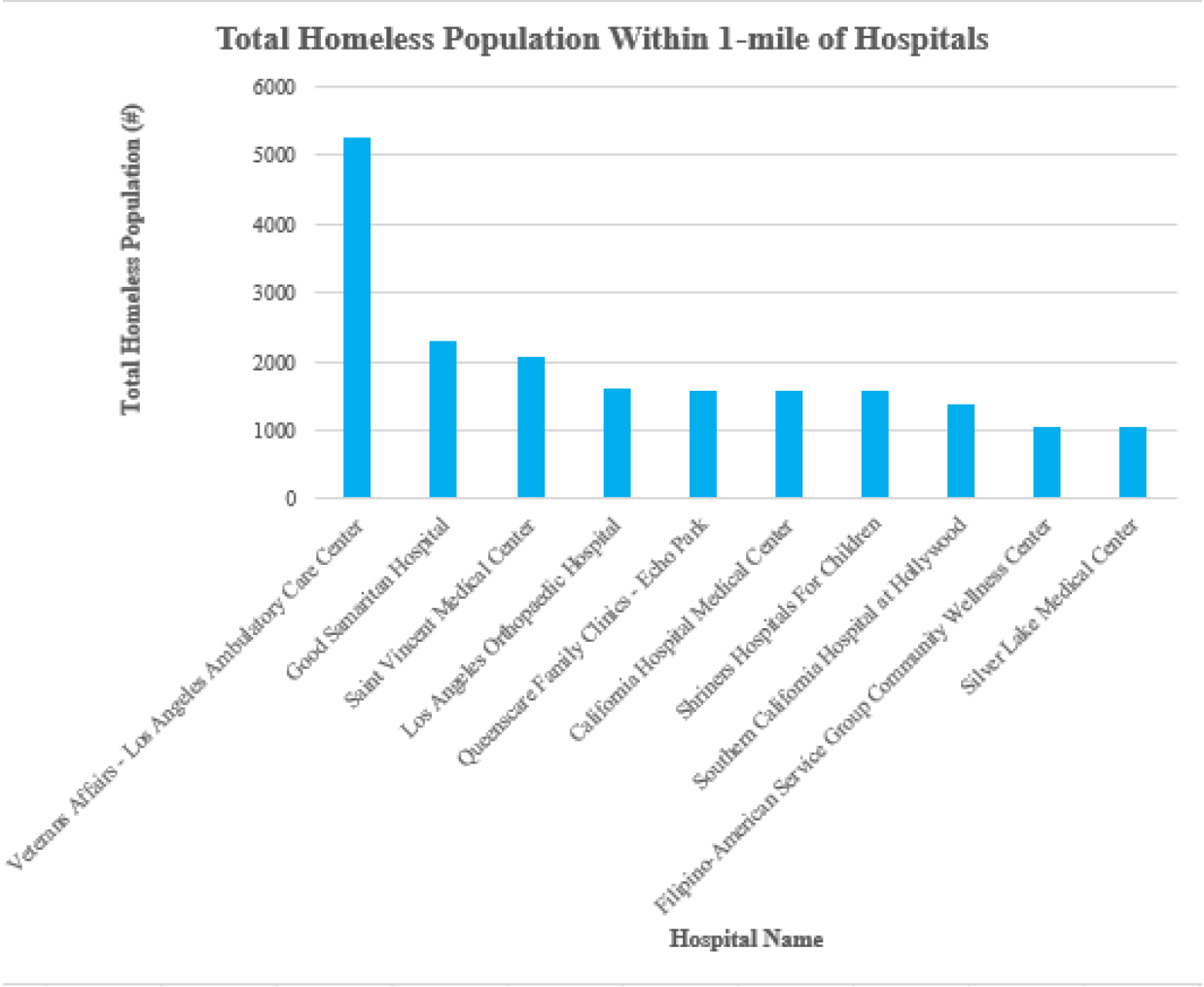
4.3 Hospital accessibility

From the 2SFCA methodology used, the potential accessibility of each hospital was determined by the total number of homeless individuals the facility could service within its 0.25, 0.5, and 1-mile service area. In total, 147 hospitals and medical facilities in the LA CoC were included. 100 of these facilities had homeless individuals within a 1-mile service area of the location. The accessibility index with the same Natural Breaks classification was used to measure the accessibility of the hospitals.

The U.S. Department of Veteran Affairs (VA) Los Angeles Ambulatory Care Center was the hospital with the greatest homeless population within a 1-mile diameter, with 5,264 people.

The top ten hospitals and medical facilities with the largest potential population reach were: Good Samaritan Hospital (2299), Saint Vincent Medical Center (2052), Los Angeles Orthopedic Hospital (1617), Queenscare Family Clinics in Echo Park (1569), California Hospital Medical Center (1567), and Shriners Hospitals for Children (1562), Southern California Hospital at Hollywood (1,389), Filipino-American Service Group, Inc. Community Wellness Center (1059), Silver Lake Medical Center (1047) (Table 7).

Table 7. Top ten hospitals by the total number of homeless individuals within a 1-mile range



4.4 Distance to nearest hospital

The distances between the census tract centroids to the nearest hospitals were measured. The distances were divided into mileage ranges from 0 to 25 miles (Table 8). The total homeless population layer was used as a base layer to compare the distance with the total homeless population (Table 9). The centroids were color-coded according to distance from the nearest hospital (Figure 19).

Table 8. Distance measurements

Distance to Nearest Hospital (mi)
0-1
1.01-2
2.01-5
5.01-10
10.01-25

Table 9. Total homeless population

Total Homeless Population
0-33
34-110
111-259
300-706
707-3180

913 census tracts were within a 1-mile distance from the nearest hospital. 506 communities were within 2 miles away from the nearest hospital. Within a range of 2-5 miles from the nearest hospital, there were 321 census tracts. 41 communities were 5-10 miles away from the nearest hospital. 16 tracts were the furthest away with a distance of 10-25 miles from the population location to the nearest hospital.

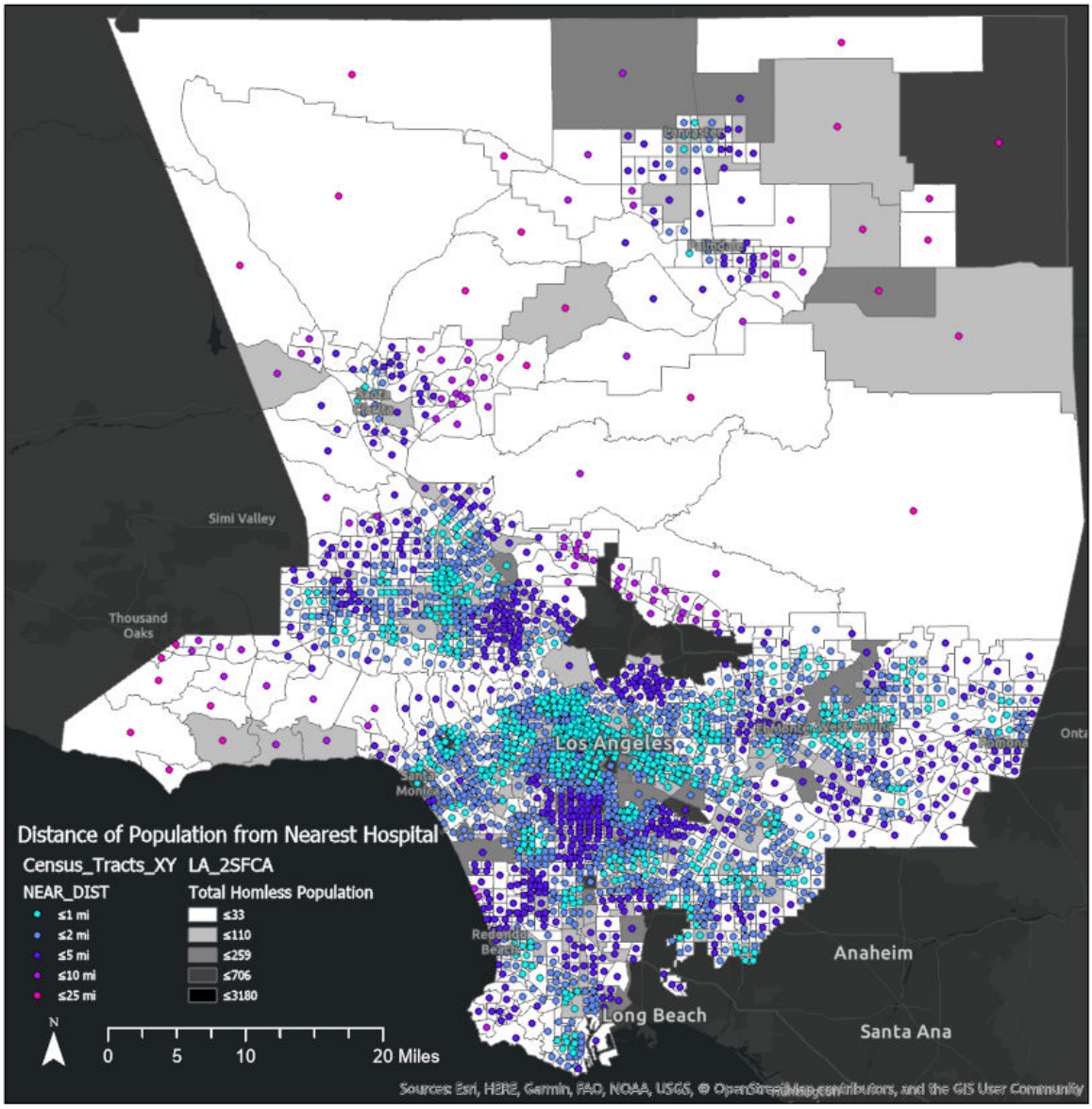


Figure 19. Distance from census centroid to nearest hospital

Chapter 5 Discussion and Conclusion

This study's primary objectives were to analyze the distribution of the homeless population in the Los Angeles CoC and conduct an accessibility analysis of the hospitals within it. These objectives were met using a methodology modeled on previous research pertaining to homeless initiatives. This project focused on creating a population distribution and hospital accessibility analysis.

To better understand the distribution of the homeless population, the most recent PIT count data collected by the City of Los Angeles was examined at the census tract level and visualized using various symbologies in ArcGIS. Observing the distribution of homeless individuals by census tracts helped to identify areas within the CoC that may be in more need of CoC resources based on number of individuals and current access. Analyzing the population distribution provides insights into homeless living patterns that could inform future studies.

The 2SFCA method was chosen to study accessibility by census tract according to the number of beds from hospitals within the census tract to homeless within a 1-mile walking distance. The 2SFCA method, originally developed to study healthcare accessibility, was modified for the purposes of this study to look at a population, homeless individuals, that presented unique accessibility challenges necessitating the tailoring of the method to the project. Access was determined to be a ratio of the number of beds at a hospital per the number of homeless individuals within the various services areas. The maximum walking distance of 1 mile was chosen considering the limited means of transportation homeless individuals tend to have and prior research into what distance is deemed "accessible." By using the 2SFCA method, this study created an accessibility index categorizing the census tracts and service areas surrounding medical facilities by potential access accounting for the bed count of each hospital.

This study found that for individual hospitals, potential access was lesser in the downtown area as hospitals had a greater homeless population to potentially service relative to their bed availability. The demand was greatest in the downtown area, as determined by the larger homeless population, creating a potential issue of the hospitals' ability to accommodate these populations in addition to non-homeless individuals.

The 2SFCA accessibility index determined that access by census tract varied in the downtown region as a result of the varying sizes and number of hospitals in each census tract. Census tracts in northeast LA and south LA tended to lack accessibility entirely with few to no hospitals in walking distance. It is recommended that additional funding be allocated to select hospitals in the downtown area with potentially high burden to service homeless individuals and that transport routes are established in various geographically areas in the CoC to enable better medical care access.

Distance measurements between census tracts and their nearest hospital were calculated to provide a general operating picture of what hospital distribution in Los Angeles looks like. A concentration of hospitals was observed in the metropolitan area while available medical resources were sparser in the more rural areas of Los Angeles. Providing LA CoC administrators with this information identifies census tracts that generally lack easy access to medical facilities. Providing this data could potentially prompt the establishment of transportation services for homeless people or the empirical data to support any requests to the city, local government, or private companies for the addition of more medical facilities in the area.

The following chapter discusses the results of the study, the potential implications of the findings, and future research recommendations for the LA CoC administrators and stakeholders. Areas identified with large homeless populations and low access to medical facilities are

recommended to be highlighted in the LA CoC's future CoC Plan for funding justification. The core intent of this project was to provide these parties with spatial analysis of homelessness within their boundaries using the most up-to-date PIT data available. The results will ideally be used to inform distribution of funding and services to areas identified as having greater need in terms of population size and/or accessibility.

5.1 Analysis Discussion

The homeless population distribution by census tract and 2SFCA accessibility analysis provided insights into the state of homelessness and access to healthcare within the LA CoC as of the 2019 PIT study.

5.1.1 Homeless population distribution

Understanding where homeless populations reside at the census tract level enables analysis of where service needs are and where accessibility to medical facilities is an issue. The homeless population choropleth maps showing the census tracts according to total homeless population show a concentration of the population in the downtown area (Figure 20). This result was not surprising as larger citizen populations tend to be in the metropolitan area of large cities. The area within the LA CoC that emerged with the largest homeless population by a substantial amount (3180 followed by 705) was Skid Row.

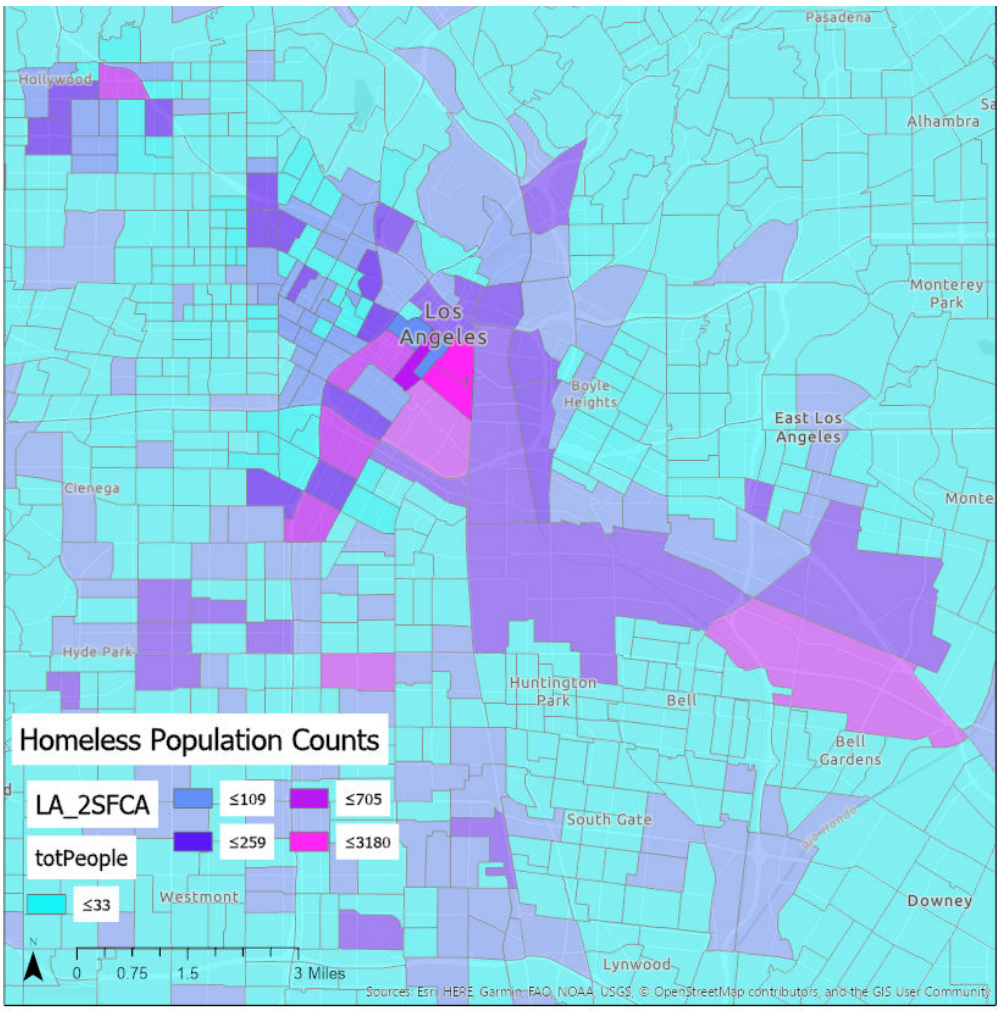


Figure 20. Downtown Los Angeles by census tract with homeless population counts

Skid Row is an area a vast majority of Los Angelinos and those familiar with the homeless crisis in America associate with homelessness due to the sheer size of the homeless population and the dire humanitarian situation there. Within the 0.4 square mile zone of Skid Row, approximately 3% of the county's entire homeless population resides (Figure 21) (CRA/LA 2005). Historically, Skid Row has been an area where homeless shelters established locations to service the homeless population, primarily starting efforts in 1981 due to the recession and rise of unemployment. Throughout the following decades, the number of homeless

individuals steadily increased and the need for shelter and services outgrew the capacity of local shelters. People resorted to sleeping on the streets and in public areas surrounding the shelters and in the greater Skid Row area, thus contributing to the establishment of Skid Row as a hub of homelessness in LA (Flaming and Blasi 2019).

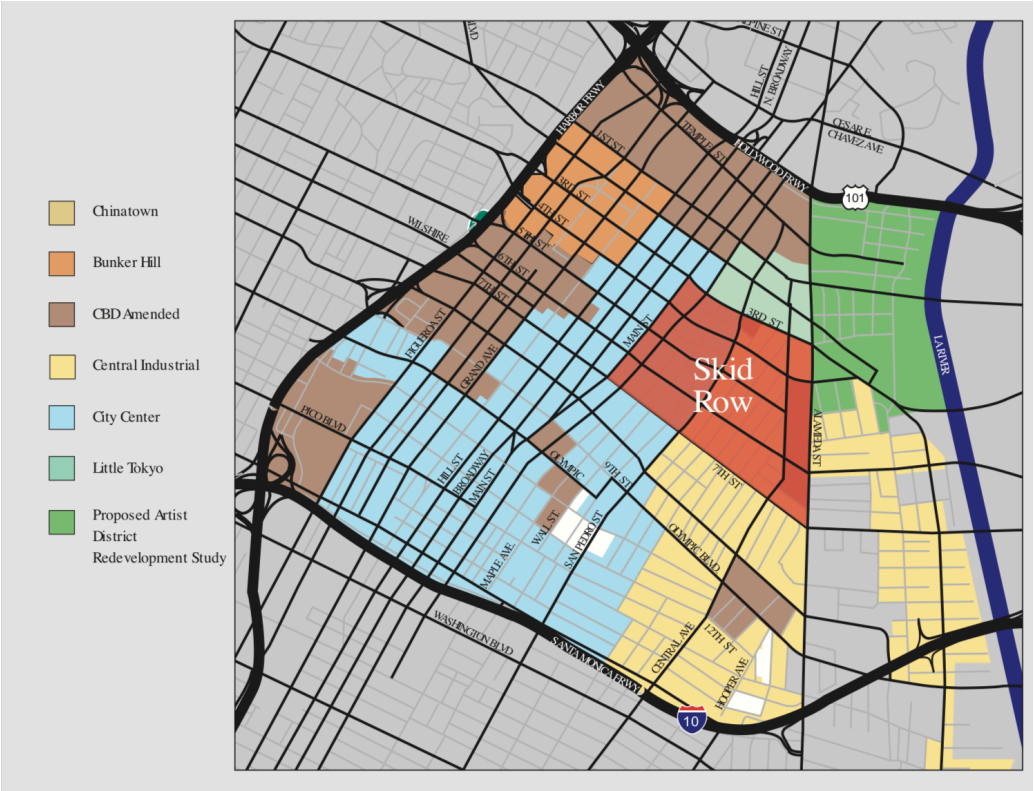


Figure 21. Downtown Los Angeles with Skid Row boundaries
Source: Community Redevelopment Agency of the City of Los Angeles

In totality, the area of Skid Row has been the focus of many LA homeless initiatives and efforts to provide shelter and aid. The results of this study further supports the need in the area and identifies Skid Row as an area of high priority for service providers. Due to the large amount of individuals in the area and the burden placed on local homeless service providers, it is recommended that the LA CoC continue to provide funds to Skid Row services and possibly add

transportation services that could take people to outside service providers to reduce the burden within Skid Row.

A cluster of high density, large population census tracts were observed in the downtown area of the CoC as well as Santa Monica (Figure 22).

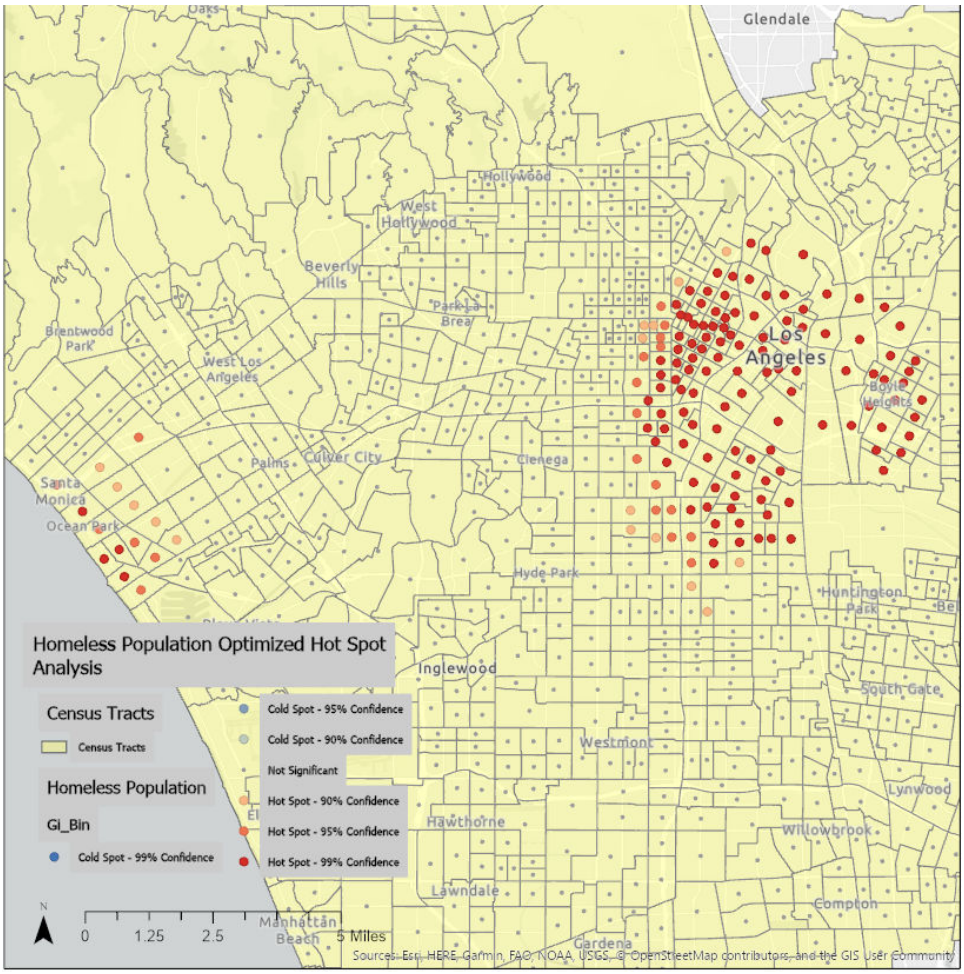


Figure 22. Hot spot analysis of downtown LA and Santa Monica

Santa Monica has been an area of Los Angeles that has fluctuated with the size of its homeless population throughout the years. In 2019, the city witnesses a 3 percent increase in its homeless population to a total of 985 people. The City Council has implement a funding strategy to address its homeless issue and has seen the benefits of efforts to provide low-income housing

and provide medical services for mental and physical health issues (Pauker et al. 2019). Additional LA CoC resources dedicated to Santa Monica could prove valuable to their efforts and have high impact results as is an area of concern due to its larger homeless population. Santa Monica's homeless infrastructure is not as developed as Skid Row's, so establishing additional medical service provider sites in the city would be valuable to enable access to medical professionals.

Overall, the distribution of homelessness was consistent with what would be expected with larger populations in the more metropolitan downtown part of the city and smaller to no individuals in more rural areas. Skid Row, Santa Monica, Brentwood, and Hollywood should be prioritized in terms of providing services to the greatest number of individuals with Skid Row and Santa Monica being areas of the highest density of homeless individuals to more efficiently consolidate efforts. This concentration of the population in the downtown area offers the LA CoC administrative bodies the opportunity to reach a significant portion of the homeless population in a fairly compact area. Infrastructure and means to access resources, such as transit and established service locations, tend to be in the central downtown area, potentially enabling more immediate and efficient resource distribution and allocation.

The other region with a large homeless population which was more surprising was the Palmdale/Lancaster area in the northeast corner of the LA CoC boundary. Specifically, Hi Vista in the upper left corner of the CoC boundaries with a homeless population of 309 individuals. This area may be a lesser known area that could benefit from more attention and funding from the CoC. These cities do comprise larger areas and have high population counts at the census tract level which may account for the larger homeless population. Further inquiry into the

homeless population in this area and the regional causes and contributions to the issue of homelessness in the area would be beneficial on the part of local officials.

5.1.2 Accessibility analysis by Service Area

The resulting maps of accessibility by service area provided visualizations of how many people were within three varying distances from hospitals throughout the LA CoC and where there wasn't potential access. As observed previously, resources such as medical facilities tend to aggregate in more metropolitan areas, as seen with the concentration of service areas in the downtown LA region. The service areas within the downtown area also tended to have lower accessibility indexes indicating a high demand from the population able to be serviced relative to the number of beds at the hospitals. This aligns with the observation that the homeless population of the LA CoC tended to be greater in the downtown area, resulting in more potential burden on hospitals in that area. This result also matched existing literature such as the 2018 AHAR study that found that the median percentage of the population living in urban areas among major city CoCs (like Los Angeles) was 70 percent (Henry et al., 2018). A greater number of walkable paths were found in the more developed, metropolitan communities, enabling greater access to hospitals and providing individuals more options of service within a shorter distance.

Hospital bed counts depended on the type of hospital. All hospitals were scored on the accessibility index, however, this did not account for the fact that some hospitals were specialty clinics or provided services that not all people in the area would necessarily need or qualify for. No observable pattern was identified regarding if accessibility varied according to the various distances from the medical facilities. The results of this accessibility analysis are more useful to CoC administrators to evaluate individual hospitals in terms of where the burden for homeless

care potentially falls and which hospitals may qualify for CoC support funding or in what areas transportation options should be established to take people to less busy hospitals.

5.1.3 2SFCA Accessibility analysis

The results of the 2SFCA accessibility analysis showed potential access to hospitals within each census tract. Census tracts scored, thus having homeless population within walking distance of a hospital, tended to be in the downtown and southern region of the LA CoC. Figure 23 provides regional names in the LA CoC referenced.

Figure 23. Regions of LA
Source: The Los Angeles Times' Mapping LA Project

Looking at the accessibility values of the census tracts relative to each other, the census tracts of Antelope Valley had no access to hospitals. The communities of Antelope Valley also had the longest distances to the nearest hospital, with most being in the 20 mile or greater distance range from a hospital. Additional medical facilities and transportation options to connect individuals to medical resources would improve accessibility, but for fewer people as the homeless population in the area is relatively small.

The communities in the San Fernando Valley were generally shorter on beds relative to the other regions of LA. Compared to Antelope Valley, there were a greater number of hospitals in the region, however, there was also a larger homeless population in this region as well. Increasing medical resources available in the San Fernando Valley could alleviate some of the burden the medical resources in the area face and would increasingly encounter should use by homeless individuals increased. The addition of ambulatory services catering to homeless individuals could provide an opportunity to provide resources tailored to common afflictions those who live on the streets face. CoC funding to an additional site could be proposed as there is demonstrated need and demand in the region.

The Westside and San Gabriel Valley had medical resources in place and generally varied in accessibility as homeless population greatly varied by census tract. Additional funding from the CoC or any other government or private entity could provide the support hospitals would welcome to provide care to all their patients.

In terms of access, the census tracts in the downtown region varied in accessibility. The census tracts composing Boyle Heights had high accessibility values with attributed to the multiple high capacity hospitals within the area providing potential service even though the population here was large. Other areas such as Lincoln heights had large homeless populations but less hospitals in the area and service area overlap in the census tract to provide access (Figure 24). The results of this accessibility index map indicate that while homeless populations tend to be higher in the downtown region, potential access to medical care is not evenly disbursed and not universally greater in the downtown area.

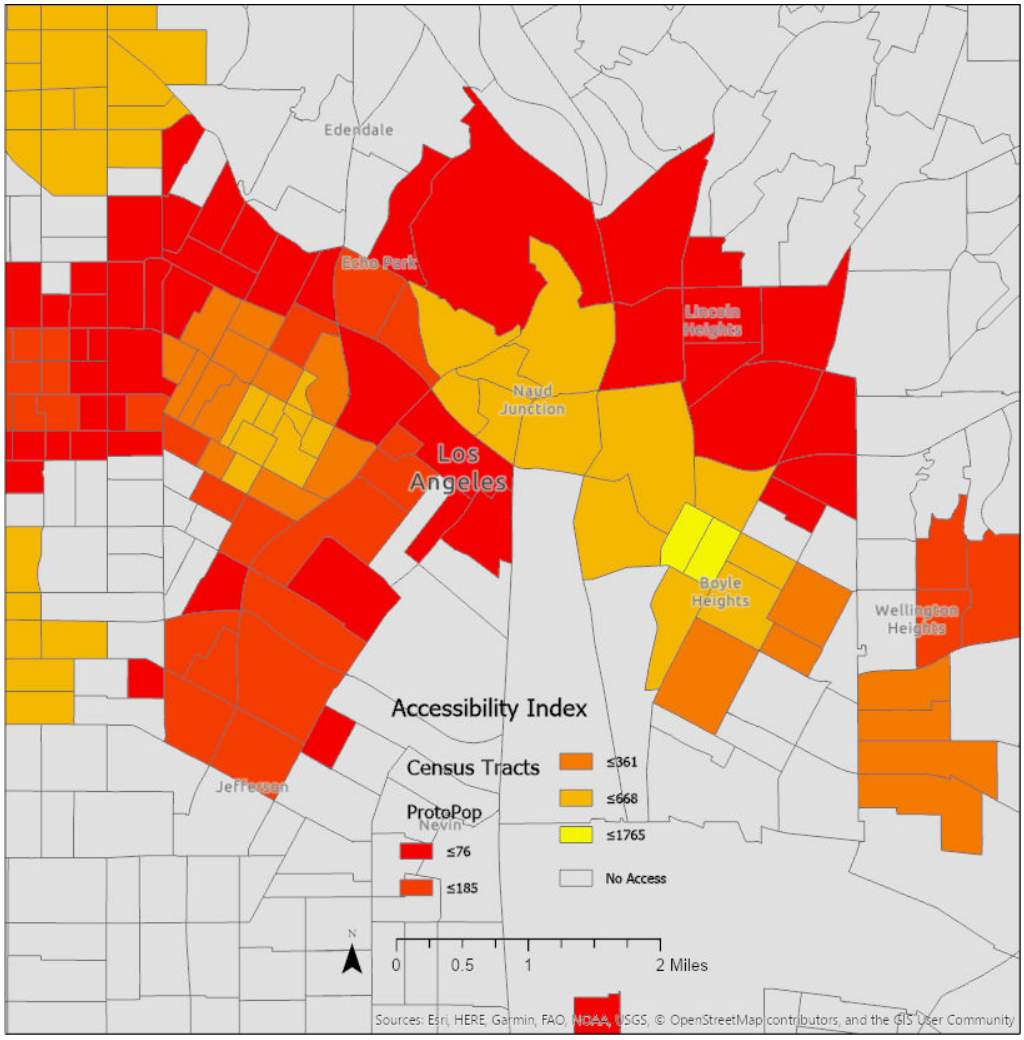


Figure 24. 2SFCA accessibility in Downtown Los Angeles

5.1.4 Accessibility by Hospital

When considering access to hospitals, type of hospital is an important consideration as not all hospitals and medical centers offer the same services and accessibility to certain services may differ from access to simply the nearest facility. The 147 hospitals and medical centers were ranked by population within service range, however, the actual accessibility to target patients or by specialty of care effects accessibility. For instance, the hospital with the largest population within a 1-mile walking distance was a VA clinic with 5264 people within the service areas surrounding the facility. Many of the people included within this accessibility measurement may

not be able to utilize the resources of this clinic or the facility may not offer the type of care needed.

For type of services provided, only 20 of the hospitals had emergency services which is a service that homeless individuals tend to rely on due to cost limitations of receiving preventative care and other financial access considerations (Baggett and O'Connell 2016). Support to emergency service providers could enable greater support on behalf of the medical facilities to accommodate a greater number of patients. However, this study offers limited insights into access based on hospital type but recommends future studies with access to more detailed hospital data consider this aspect of healthcare accessibility.

The hospitals with the greatest homeless populations in range, less accessibility according to amount of potential burden, and general service options were the Good Samaritan Hospital, Saint Vincent, and California Hospital Medical Center. It is recommended these hospitals be considered for funding allocation when applying for funds and crafting the next LA CoC Plan to encourage partnership between the facilities and the CoC and enable the ability of these hospitals to provide services.

5.1.4 Distance measurements to hospitals

The intent on calculating distance measurements from the census tracts to their nearest hospital was to give LA CoC administrators a sense of which locations might have a general issue with hospital accessibility for their entire population, not necessarily just the homeless population. Systemic accessibility issues could influence the issues facing homeless individuals, so providing administrators with a more complete operating picture could enable more informed

decision-making and provide opportunities to partner with local government and community efforts to improve conditions for all citizens.

Falling in line with expectations based on prior research and urban design, census tracts in the downtown region tended to have shorter distances to the nearest hospital. This result was attributed to the concentration of hospitals within the downtown area and the smaller area of the census tracts in the area. Larger census tracts and more rural locations experienced greater distances to reach the nearest hospital. The areas in which the nearest hospital was in the double digit range for mileage are identified as high priority communities to service, regardless of homeless population within the area as this indicates that all citizens of that region are without potential walking access, including homeless individuals.

West Antelope Valley, Hi Vista, and Juniper Hills were notable as the distances for these communities were in the 20 mile plus range. For these locations, the establishment of a clinic would be preferable. Hi Vista (most northeast census tract in the LA CoC) is identified as a community of high priority with a large homeless population of 309 individuals and a distance of 22 miles to the nearest hospital (Figure 16). Additional resource allocation and funding would be well-spent to increase accessibility through the establishment of local healthcare services and/or a transportation service to a hospital. Within the city, distances from hospitals were typically within a zero to two-mile distance. This indicates that the need for transportation may be less than a more rural location. However, considering the large populations and proximity of the hospitals, a transportation system may be more easily established and have more effect. The establishment of a shuttle circuit that pickups in various communities and services different types of hospitals has the potential to improve access for more people.

5.2 Limitations

This project achieved its objective of providing an analysis of homeless accessibility using the data gathered in the LAHSA 2019 PIT study. There are, however, limitations in the use and accuracy of the study created by the data used, methodology implemented, and resources available.

A primary limitation of the results of this study is the generalizations made by the need to aggregate homeless populations to the census tract level. The methodology and the results of the PIT count data used limits the spatial accuracy of the individuals' locations to the census tract so no further refinement in location was possible. To account for population distribution throughout a census tract, population by areal extent was used to allocate populations. However, this method does not divide people based actual location. For the purposes of this study, estimation at the census tract level was sufficiently accurate to give CoC administrators and stakeholders an operational picture of homeless population distribution and hospital accessibility at the community level. However, should more detailed and specific resource allocation requirements arise necessitating greater accuracy for population locations, this study is not suited for such analysis.

The 2SFCA methodology used also has some drawbacks. The service area modelling for the 2SFCA methodology was limited to walkable routes, which was an overgeneralization of the transportation options of homeless individuals. It was assumed that homeless individuals would only be able to walk to hospitals and the distances they would walk would be 1 mile or less. This is clearly a generality made that potentially excludes individuals who have motor transportation (public or private) available or who are able and do walk more than this limited distance to reach their destinations. Conversely, some individuals may not be able to walk such distances and

could only access needed resources via transportation which is not considered in the current study.

For measurements of distance to the nearest hospital, method used to determine the distance was not exact due to the use of Euclidean distance. The distance between the population centroid and the hospital point was measured as a straight line. This is problematic as it does not account for geographic barriers or actual roads or walkways that would be used to more accurately represent distance. Using the census tract centroid as the "location" of the homeless population of a census tract is also problematic as the entire homeless population in a community does not reside in the center of the community.

5.3 Future Research

This project demonstrates the insights that can be garnered from PIT data when spatial analysis is leveraged. Applying the 2SFCA methodology to the study of homeless healthcare accessibility is also relatively new in the variations of this method. Further research and improvements in the data used, methodology implemented, and analytical tools leveraged would only improve the accuracy of the results and provide higher fidelity spatial analysis for those looking to use the results for funding justification or other administrative purposes.

PIT data at a finer spatial skill would greatly improve the positional accuracy of the individuals and would result in more accurate population distribution analysis. In addition to the study of homeless healthcare accessibility, higher fidelity PIT data would benefit the study of homelessness by enabling a greater sense of where people are and what demographic characteristics they have to better tailor services to these populations.

Creating various types of services areas surrounding the hospitals and medical centers would be valuable to see how accessibility differs according to transportation type. Further data collection and research would need to be conducted to gain a better understanding of homeless transportation availability and options. Looking at how LA CoC services, like shelter and transportation, are distributed would also be interesting to see how government efforts effect accessibility and if there are gaps in current services that create accessibility.

Conducting accessibility analysis based on type of medical services offered would provide more tailored medical care accessibility analysis and may provide more accurate measurements of accuracy. Gaining a better understanding of accessibility based on medical care type would also inform where gaps in certain types of care exist and could provide homeless services the opportunities to establish locations that offer this type of care or motivate hospitals in the area to add this type of care.

For distance measurements between individuals and hospitals, more precise locations for the individuals would greatly benefit this analysis as opposed to mass generalizations such as that the entire population of a community being located at the center of a census tract. This generalization was made due to lack of more precise location data for the homeless individuals, however, with more accurate data, improved distance measurements could be made. Measuring distance in non-Euclidean terms would also improve the accuracy of the distance measurements and provide a more realistic determination of separation between individuals and hospitals. More tailored distance analysis to a smaller region and/or fewer hospitals would allow for more accurate distance measurements.

5.4 Final Conclusions

This project achieved several of the stated goals and objectives. Through geospatial analysis, conclusions were drawn about the distribution of homelessness throughout the LA CoC and the accessibility of hospitals in the area. It was determined that communities in downtown LA had a higher density, large-population census tracts and the largest homeless populations. Specific communities with large homeless populations were identified as areas LA CoC administrators might consider allocating more resources to. Access to hospitals and medical centers was also considered, resulting in the conclusion that there was a concentration of hospitals in the downtown area which had greater accessibility for larger populations as opposed to more rural locations. These hospitals were also closer in terms of distance to communities. Accessibility according to census tract showed more variation, reaffirming that tailored responses to homelessness need to be created and adopted in communities to best meet the needs of their people.

A primary intent was to demonstrate the utility of geospatial analysis through the creation of several maps for the visualization of homeless data and analysis of large datasets otherwise not easily translated to actionable information. Visualizing data in terms of location helped to transform the data into a form useful and more readily understandable to stakeholders such as CoC administrators and city planners. The development of a relatively simple 2SFCA methodology was intended to provide an approach to spatial analysis that city GIS specialists and individuals with access to GIS platforms could replicate with different data. The hope is that this project will encourage local governments, non-profits, and any organization collecting data on a topic of concern to use spatial analysis to provide an added layer of clarity into a situation.

The project was designed to be of value to LA CoC administrators in their efforts to allocate resources and request funding. All data and methods used were ensured to be compliant with HUD's data standards so that the results could be used as justification for budget and resource allocation. Using the most recent PIT count data collected by the CoC, this project provided timely analysis that remains relevant to the situation LA faces with homelessness today.

This project contributed valuable analysis of the homelessness crisis that Los Angeles faces. Positioning the LA CoC to best advocate for increased funding and more targeted resource allocation would help to relieve some of the burdens associated with homelessness and get individuals the medical care they need. Spatial analysis as applied to homelessness is relatively limited, so studies like this should continue to be conducted to build a greater body of literature and improve our understanding of the issue.

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