A Spatial Analysis of the Pedestrian Safety Crisis in the United States Sunbelt

by

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ABSTRACT

CHAPTER 1: INTRODUCTION

1.1 General introduction

The number of pedestrians struck and killed by cars in the United States has reached its highest level in more than forty years (Governor's Highway Safety Administration, 2022). Within the last decade, pedestrian fatalities have increased by 55% according to analysis from the Insurance Institute for Highway Safety (2022). This rise in pedestrian fatalities corresponds with a general increase in road deaths throughout the country. In 2021, the US saw the largest number of roadway fatalities since 2005, and the largest single-year increase in the Federal Department of Transportation's Fatal Analysis Reporting System's history (NHTSA, 2022). Undoubtedly, the dramatic rise in popularity of the sport utility vehicle (SUV) since the 1980s allowing drivers to *feel* safer in larger, heavier vehicles, has contributed to this. For pedestrians, this rise in usage is particularly dangerous. Data has shown the odds of death when struck on foot by an SUV is nearly double that of a sedan (Simms & Wood, 2006), primarily due to the design of the front end of SUVs that remains unregulated (Monfort & Mueller, 2020).

With the signing of the Infrastructure Investment and Jobs Act by the federal government in 2021, some $200 million USD per year has been specifically designated to fund projects in the United States to bring these numbers down, which puts the responsibility on state and local governments to find out where, when, and how these collisions occur, and address them directly.

At any geographic scale, fatal pedestrian collisions cluster in the United States. At the most broad level, most pedestrian fatalities occur in the Sunbelt, the region encompassing the lower half of the country with around half the national population. According to the bi-yearly Dangerous by Design report by Smart Growth America, of the top 10 most dangerous states, 9 lie within this region. When expanded to the top 25 most dangerous states, 17 Sunbelt states make the list. On a smaller, metropolitan-area scale, a similar trend emerges. Among the top 10 most dangerous metropolitan areas, all 10 are in the Sunbelt. This same rule applies to the top 25 most dangerous metropolitan areas.

Even within metropolitan areas, fatal collisions cluster. According to the Insurance Institute for Highway Safety, 82% occur in urban areas, and around 50% happen along major arterial roads, often 4-6 lanes designed to let cars travel uninterrupted at high speeds. In addition, many of these arterials lie in low-income, marginalized communities where a disproportionate amount of fatal pedestrian collisions occur (2022).

The concentration of fatal pedestrian collisions in the Sunbelt specifically is worrying for three main reasons. Firstly, the Sunbelt is capturing most of the United States' population growth, and is growing at a much faster rate than the rest of the country. From 2000 to 2016, the metropolitan areas of the Sunbelt grew 25%, adding nearly 15 million people (Fulton et. al, 2020). Comparably, large metropolitan areas in the coastal/mountain regions of the country only grew by 11%, and areas in the Rust Belt (the former-industrial region near the Great Lakes) only grew by 6%. Secondly, the urban sprawl-dominant growth patterns of Sunbelt cities have been proven to be more dangerous for both drivers and pedestrians (Ewing et. al, 2003; Ewing & Hamidi, 2015). Thirdly, the concentration of pedestrian fatalities in the Sunbelt cannot be explained by merely sprawl and size. Among Sunbelt cities, there is a clear tendency for cities in the southeastern part of the country (and the eastern part of the Sunbelt) to be the most dangerous, and extreme variation among seemingly-indifferent metropolitan areas. For example, the most dangerous major metropolitan area in the Sunbelt, Tampa-St. Petersburg-Clearwater, Florida, has a fatality rate 92% higher than the "safest" comparable major Sunbelt metropolitan area of San Jose-Sunnyvale-Santa Clara, California. The institutional, physical, social, and political differences that can explain the stark variation among cities in the Sunbelt, and between the Sunbelt and the rest of the country, are still relatively unknown to researchers, and are cited as a priority for further research (Paulozzi, 2006).

1.2 Research Aim and Questions

The aim of this thesis is to determine the factors responsible for the concentration of pedestrian fatalities in the Sunbelt region of the United States, and the barriers that prevent cities from reducing them. I will first seek to understand what common physical, spatial, and temporal characteristics pedestrian collision clusters exhibit, and how they differ from cities

outside of the Sunbelt. This will be helpful to determine if the Sunbelt shows entirely different patterns than other comparable cities in the United States, or if the Sunbelt simply shows a mere intensification of the problems exhibited throughout the country. I will then seek to understand the barriers that prevent Sunbelt cities from making interventions to improve pedestrian safety, why they exist, and whether or not other cities have been able to overcome them. Finally, I will seek to understand if there are any factors that allow non-Sunbelt cities to more easily make interventions, and whether or not they could be replicated in the chosen cities.

1.3 Thesis structure

Chapter One provides context on the pedestrian safety crisis and its nuances among different regions in the United States. Chapter Two will provide a context of which cities were chosen to analyze, why they were chosen, and appropriate context to understand each city in relation to typical United States metropolitan areas. Chapter Three will include an overview of existing relevant scholarship related to urban development, transportation planning, and pedestrian safety in the United States. Chapter Four will provide the methodology employed, as well as how the data were sourced, cleaned, and analyzed. Chapter Five will include the findings of the full quantitative and qualitative analysis, as well as one case study from each city highlighting key aspects of the findings. Finally, Chapter 6 will conclude by including a discussion of the findings, as well as recommendations for cities in the Sunbelt in order to make their streets safer for those walking.

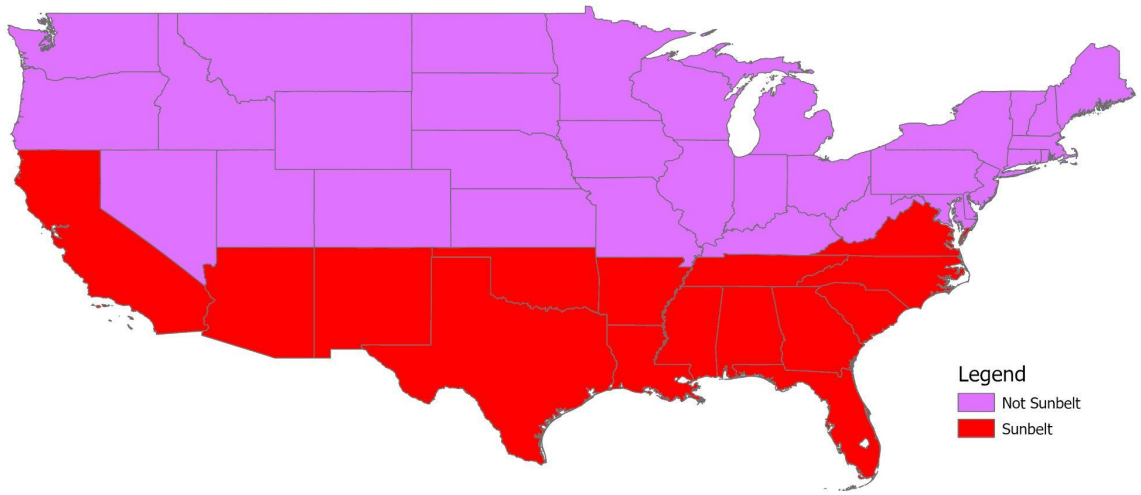
CHAPTER 2: CONTEXT

In this chapter I discuss the physical and political context of the chosen major metropolitan areas in the United States. I first define specifically what states encompass the Sunbelt, and which cities were chosen as the basis for this study. After this is the justification for each Sunbelt city chosen, as well as which cities non-Sunbelt cities were chosen to compare along with the justifications for their inclusion. The remainder of the chapter is an overview of the demographic, physical, political, and historical context of the cities chosen. Importantly, "metropolitan areas" and "cities" are used interchangeably in the following chapters. Many metropolitan areas in the United States are not consolidated, meaning much of the population lies outside of the actual city-proper municipal boundaries. When the namesake city is referred to directly, it is referred to as the "city proper".

2.1: Definition of the Sunbelt

The definition of which states encompass the Sunbelt can vary depending on the source. Some sources characterize it as a region independent of states, with some states having portions of its territory inside and outside the Sunbelt, while many sources include a set of states in their entirety. In this study, the Sunbelt is defined as the entirety of the following states: Alabama, Arizona, Arkansas, California, Florida, Georgia, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

Map 2.1: Map of the United States Sunbelt and Non-Sunbelt regions



2.2: City sample and justifications

Five metropolitan areas were chosen to study: three in the Sunbelt (Atlanta, Georgia; Orlando, Florida; Jacksonville, Florida) and two outside of the Sunbelt (Portland, Oregon; Seattle, Washington).

Cities in the Sunbelt were chosen systematically based on the following rationale: First, a list of the five most dangerous Sunbelt states (according to the 2022 Dangerous by Design report) was compiled, those being Florida, Georgia, Louisiana, Mississippi, and South Carolina. Because of the heavy involvement of State Departments of Transportation in transportation planning in the United States, a dangerous state is always accompanied by one or more of their major cities in the top 25 most dangerous metropolitan areas. This can show potential large-scale, state-wide issues that intensify in large urban areas. Following this, metropolitan areas were prioritized by population, with emphasis given to the cities that had the highest pedestrian fatality rates. This provided the following list of metropolitan areas to choose from:

Table 2.1: Proposed Sunbelt metropolitan areas

Metro Area	**Metro Population**	**Pedestrian Fatality Rate**
Atlanta, Georgia	6,150,000	2.53 Deaths per 100k Population per Year
Jacksonville, Florida	1,640,000	3.44 Deaths per 100k Population per Year
Orlando, Florida	2,700,000	3.37 Deaths per 100k Population per Year
Tampa, Florida	3,200,000	3.55 Deaths per 100k Population per Year

Due to the limited scope of this project, I wanted to survey 5 cities: 3 in the Sunbelt, 2 not. From this final 4, Tampa was excluded because of the two neighboring metropolitan areas (Lakeland-Winter Haven and North Port-Sarasota-Bradenton) that integrate with the Tampa

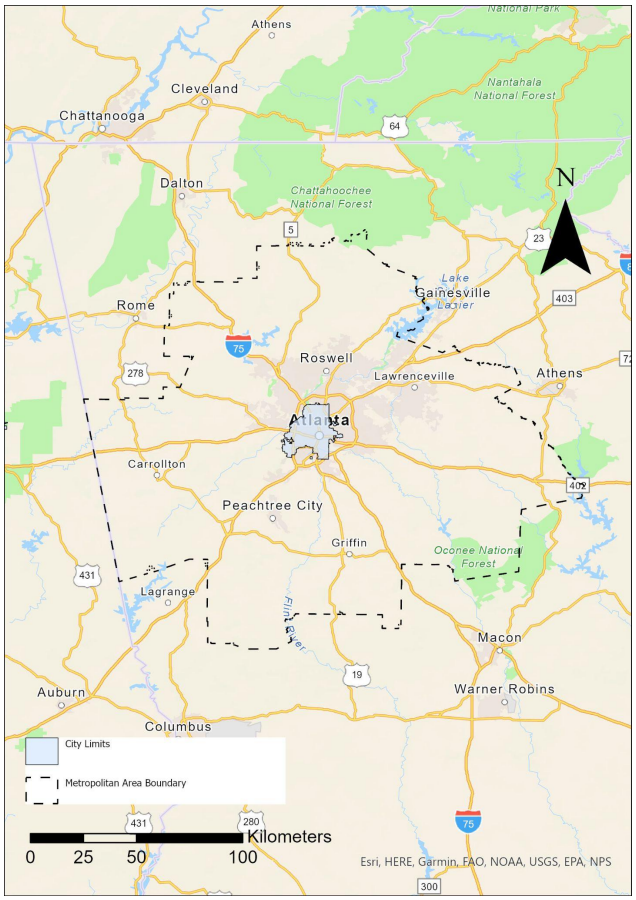
metropolitan area to form a region of relatively seamless metropolitan areas. This is quite different from the typical configuration of all other metro areas chosen, i.e. that one dominant city center is surrounded by suburbs. Therefore, the final three metropolitan areas of Atlanta, Jacksonville, and Orlando were chosen.

The criteria for which non-Sunbelt cities were chosen followed a different rationale. Importantly, cities in the northeastern United States like Boston, Philadelphia, and New York City, while being comparably much safer for pedestrians than the rest of the country, have a fundamentally different urban form compared with the rest of the country. It is highly unlikely that the compact urban form of pre-automobile Northeastern cities will ever be adopted in the auto-oriented urban sprawl that is nearly universal among major cities in the Sunbelt, and therefore might be more challenging to translate than if comparably-safer cities outside of the Northeast were selected instead. Due to this, Portland, Oregon, and Seattle, Washington were chosen for this role. Portland is comparable in metropolitan population (2.51 million) to Orlando and Jacksonville with a pedestrian fatality rate at nearly half the amount (1.83 annual pedestrian deaths per 100k population). Additionally, Seattle is among the most populous metropolitan areas in the country (4 million inhabitants), similar to Atlanta, but with a pedestrian fatality rate nearly half of Atlanta, and 60% lower than Jacksonville/Orlando. These cities both feature the car-dependent urban growth similar to cities in the Sunbelt, while being comparably much safer for pedestrians, and therefore might be more likely to address similar problems faced in Atlanta, Orlando, and Jacksonville.

The following sections will help to provide context to each metropolitan area selected for this study. For each section, relevant information about the size and scale of each metropolitan area will be given, as well as key historical, political, and demographic indicators relevant to the findings of this study. Generally, Sunbelt cities are categorized for their rapid growth in the last fifty years, both in physical size and in population, as auto-oriented suburban growth rapidly pushed the metro area boundaries past their historical city limits. Sunbelt cities, generally speaking, have higher poverty rates, higher proportions of People of Color, higher rates of driving, and lower median incomes than cities outside of the Sunbelt.

2.3 Atlanta, Georgia: 2.53 Annual Deaths per 100,000 People

Map 2.2: Atlanta metropolitan area pedestrian crashes and fatalities



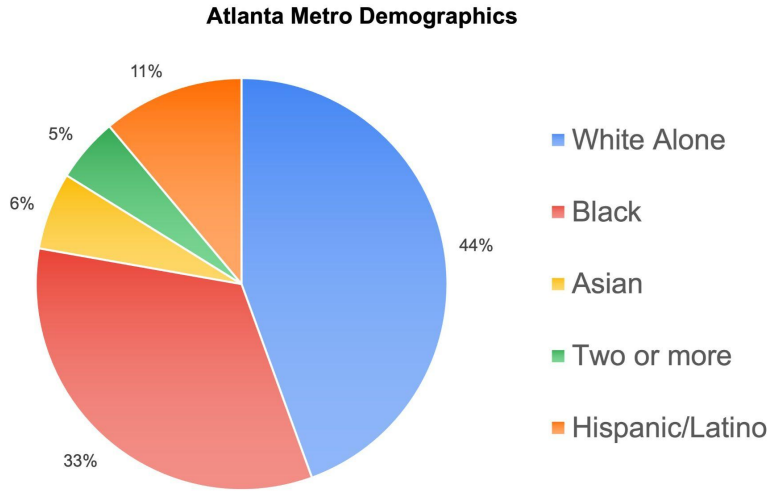
The Atlanta metropolitan area is one of the largest in the country at 6.15 million people.. In 1972, the Atlanta metro had just 1.26 million people. Having nearly quintupled in population in the last half-century, most of Atlanta's population growth has been in its suburbs and exurbs, which take up a combined 8,339 square miles (US Census Bureau, 2010). While this is similar in physical size to other Sunbelt metros, compared to comparable Northeastern metro areas like Philadelphia-Camden-Wilmington, Atlanta sprawls much farther. The Philadelphia-Camden-Wilmington metropolitan area contains around 200,000 more people within an area nearly half the size (US Census Bureau, 2010). The built form of the City of Atlanta as well as the metropolitan area exhibit the typical characteristics of a Sunbelt metro area. Most of the growth in the Atlanta metro came in the automobile era in the second half

of the twentieth century, where large highways, wide roads, and strip malls became the dominant pattern of American urban development. Because of this, Atlanta has very low public transit ridership, in and out of the city, and therefore is noticeably more car dependent than large metros elsewhere in the country (Fulton et. al, 2020).

Table 2.2: Atlanta regional characteristics

	City Proper	**Metropolitan Area**
Approximate Population	500,000	6,150,000
Modeshare of Walk/Transit/Bike to Work	7%	2%
Median Annual Household Income (USD)	$64,179	$77,589
Poverty Rate	19.2%	11.6%
Persons Per Square Mile	3,675	708

Figure 2.1: Atlanta Metro racial demographics

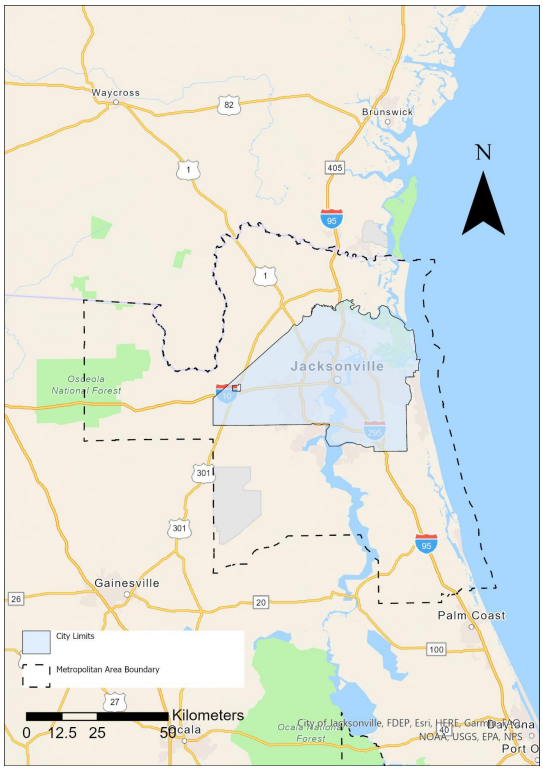


The political environment of Atlanta is also important to note to understand similar phenomena in other large Sunbelt metros. Notably, only around 8% of the Atlanta metro population actually lives within the city limits of Atlanta. In the United States, municipalities hold the most control over the public roads within their borders, with the exception of

roadways designated as state or federal highways, which are controlled by their State Department of Transportation. In some instances where no municipality exists, known as unincorporated areas, the local county authorities act as the municipality. The Atlanta metro straddles over ten different counties, with dozens of municipalities, and many inhabitants in unincorporated areas. These county borders were drawn for the most part over a century ago, and while arbitrarily defined, they provide major challenges for coordinating projects in the region. A regional transportation authority technically exists, but only directly controls the operation of commuter buses. Within the metro, there are eight different transit operators, and many counties have no public transit authority at all. The Georgia State Department of Transportation controls the majority of major arterials, highways, and Interstates throughout the metro, and are governed by a 14-member State Transportation Board elected by the state legislature. Historically, the Georgia state legislature has favored projects that further auto-oriented development. Notably, the State of Georgia only started allocating state funding to mass transit projects in 2022, being among the last states with a major metropolitan area to do so.

2.4 Jacksonville, Florida: 3.44 Deaths per 100,000 People per Year

Map 2.3: Jacksonville metropolitan area pedestrian crashes and fatalities

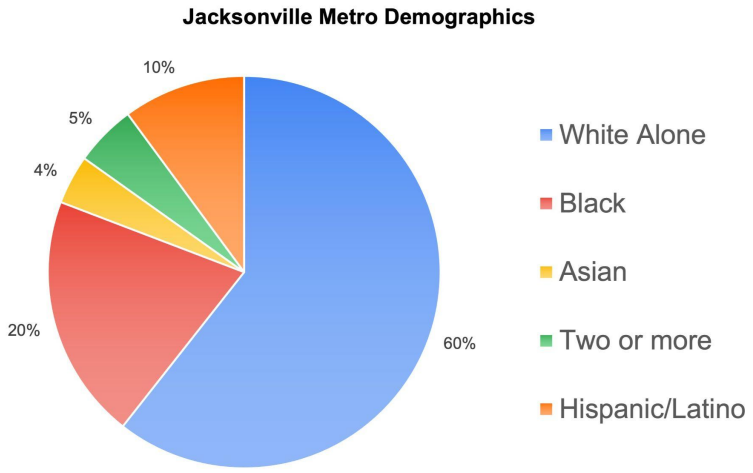


The Jacksonville metropolitan area is physically very similar to the Atlanta metro, but on a smaller scale. Jacksonville is much less dense than Atlanta, at the city and metro scale, with similarly low levels of public transit ridership and auto-oriented growth. In the last fifty years, the Jacksonville metro has tripled in size from around 540,000 people in 1972 to around 1.6 million in 2022. Physically, Jacksonville takes up 3,201 square miles, which is roughly double the area than the comparably-populated Providence-Warwick metro area in the Northeast. In keeping with the Sunbelt pattern, the majority of Jacksonville is low-density, single-family suburban development, connected by wide, mostly state-controlled arterials and highways designed primarily to expedite automobile-oriented mobility.

Table 2.3: Jacksonville regional characteristics

	City Proper	**Metropolitan Area**
Population	950,000	1,640,000
Modeshare % of Walk/Transit/Bike to Work	2%	2%
Median Annual Household Income (USD)	$55,531	$68,394
Poverty Rate	15%	12.2%
Persons Per Square Mile	1,270	552

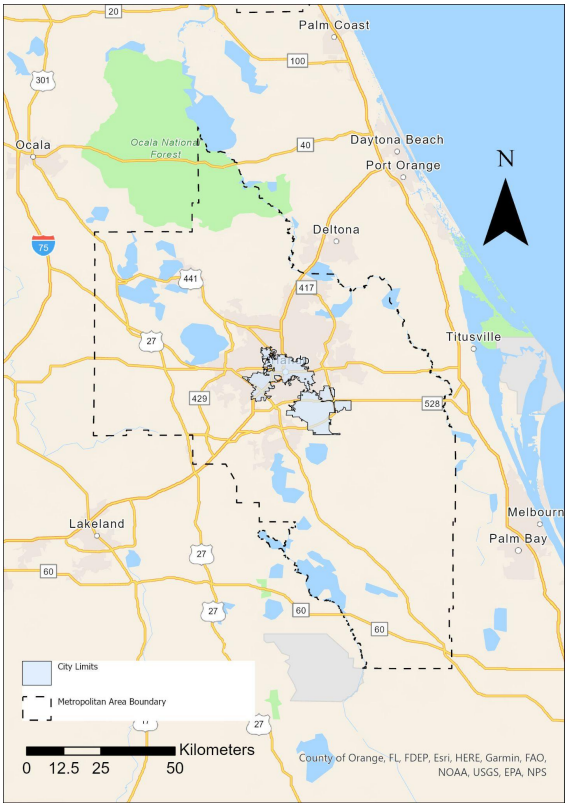
Figure 2.2 Jacksonville Metro racial demographics



Although Jacksonville exists in a similar state political climate to Atlanta, Jacksonville consolidated its county and city governments in 1968, which means around 57% of the current metro population actually lives within the City of Jacksonville, compared to 8% in Atlanta. Most of Jacksonville's major arterial roads, highways, and Interstates are controlled by the Florida State Department of Transportation (FDOT). FDOT is arranged in a decentralized structure, with district managers overseeing projects in each of the seven geographic semi-autonomous districts distributed throughout the state. These district managers are accountable to the central office, led by the governor-appointed Secretary of Transportation. The Florida State Government has historically placed the majority of their funding towards auto-oriented projects.

2.5 Orlando, Florida: 3.37 Deaths per 100,000 People per Year

Map 2.4: Orlando metropolitan area pedestrian crashes and fatalities



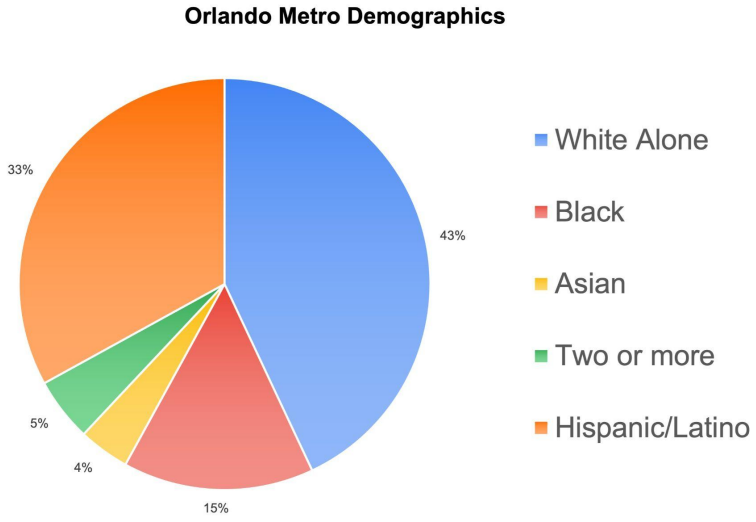
Orlando is the final Sunbelt metropolitan area chosen, and shows broadly similar characteristics to the previous two areas. Over the last fifty years, the Orlando metro has

grown by nearly 800% in population. Like the previous two cities, this growth has been dominated by auto-oriented, suburban sprawl. Physically, Orlando takes up 3,492 square miles. Comparably, the Baltimore-Columbia-Towson metro area in the Mid-Atlantic region contains around 100,00 more people in around 74% of the total area.

Table 2.4: Orlando regional characteristics

	City Proper	**Metropolitan Area**
Population	310,000	2,700,000
Modeshare % of Walk/Transit/Bike to Work	3%	2%
Median Annual Household Income (USD)	$55,183	$64,936
Poverty Rate	16.1%	12.9%
Persons Per Square Mile	2,780	771

Figure 2.3 Orlando Metro racial demographics

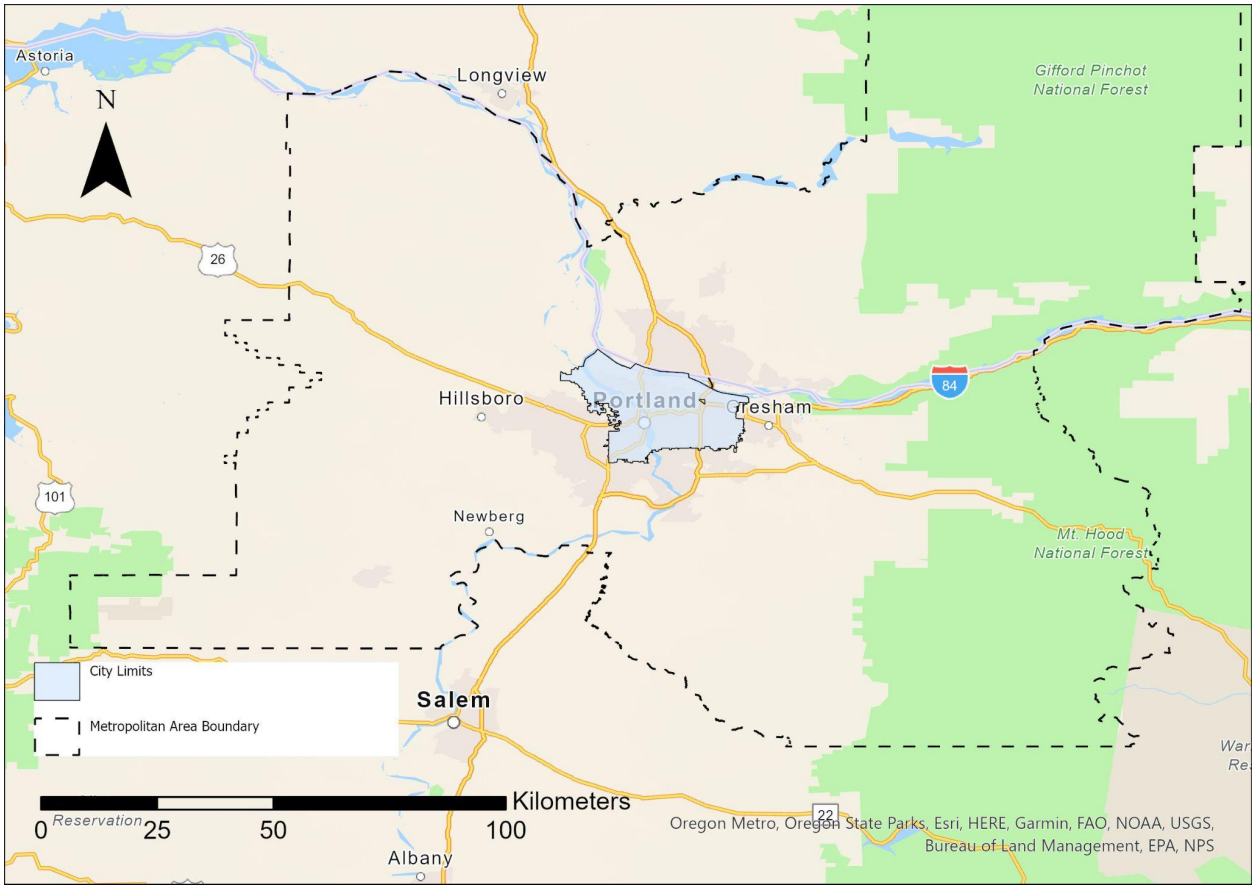


Being in the same state as Jacksonville, the political environment in Orlando is similar to Jacksonville. However, Orlando follows a similar pattern to Atlanta in terms of municipal organization, in that only 11% of residents in the Orlando metro actually live in Orlando (Jacksonville consolidated many of its suburbs with its urban center in the 1960s into one

local government). Jacksonville is an exception to this trend, as the norm in many Sunbelt cities is to have vastly more people outside of the city limits as few cities consolidated their far-flung suburbs as those areas grew rapidly in the last fifty years. While being in the State of Florida, Orlando lies in a different FDOT district than Jacksonville. Since FDOT districts act semi-autonomously, it cannot be concluded that what happens in Jacksonville is indicative of what happens in Florida, and vice versa.

2.6 Portland, Oregon: 1.83 Deaths per 100,000 People per Year

Map 2.5: Portland metropolitan area pedestrian crashes and fatalities



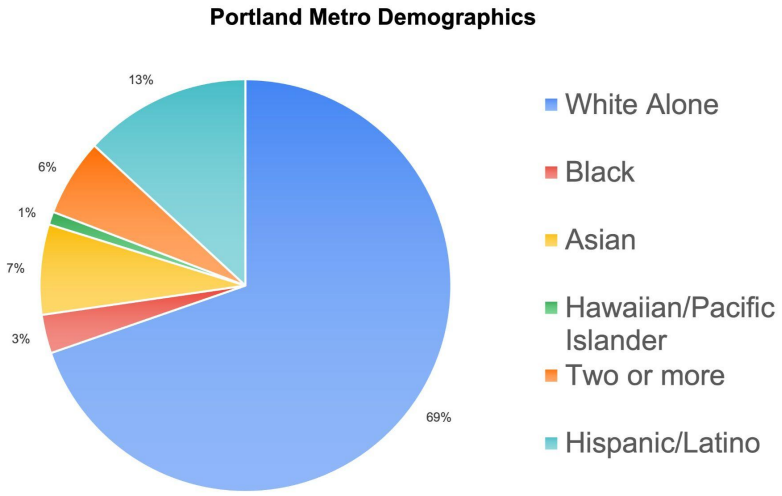
As the first non-Sunbelt metro detailed in this study, Portland shows some characteristics similar to the previous three metros, but also a few key differences. Firstly, Metro Portland has roughly tripled in population in the last fifty years, with much of that growth being

similar to the auto-oriented suburban sprawl seen in the Sunbelt. Having said that, the City of Portland is still much denser than any of the three previous cities, with a much larger share of commuters walking, biking, or taking public transit. Though the US Census Bureau defines the Portland metro area as 6,687.5 square miles, much of this land is national forest, national scenic areas, or other federally-protected, uninhabited land, which makes physical comparisons with the previous three metro areas difficult. However, using the US Census Bureau's "Urbanized Area" distinction instead of the metropolitan area still shows a much denser urbanized area, with 3,970.4 people per square mile, compared with 2,953 in Orlando, 2,270 in Jacksonville, and 1,979 in Atlanta (all using the Urbanized Area geographies). Large arterial roads in the Portland metropolitan area are still common, but are mostly owned by local municipalities, with less Interstates and highways controlled by the Oregon State Department of Transportation (ODOT) present. These roads tend to be smaller in size than their counterparts in the Sunbelt with cars traveling at lower speeds. Portland lies somewhere in the middle between the auto-oriented Sunbelt and the dense, pre-automobile Northeast. While being much denser, Portland is much closer to the density of Atlanta, Jacksonville, and Orlando than it is to Philadelphia (11,692 people/square mile), San Francisco (18,581 people/square mile), or Washington, D.C. (11,158 people/square mile). While Portland has a higher percentage of commuters walking, biking, or taking transit than the previous three cities (and their respective metro areas), the overwhelming amount of Portlanders and Metro Portland residents still commute in a personal automobile.

Table 2.5: Portland regional characteristics

	City Proper	**Metropolitan Area**
Population	640,000	2,500,000
Modeshare of Walk/Transit/Bike to Work	11%	5%
Median Annual Household Income (USD)	$55,531	$83,943
Poverty Rate	15%	10%
Persons Per Square Mile	4,889	375

Figure 2.4 Portland Metro racial demographics



Portland, Oregon is politically different from the previous three metro areas. Importantly, while around 26% of the Portland metro's population lives within the city limits, the parts of the metro area contained in Oregon (much of the metro also lies in the neighboring state of Washington) are governed by a regional government, Metro, that coordinates and plans investments in the transportation system. The Oregon Department of Transportation (ODOT), still however retains control of the arterials, highways, and Interstates that run throughout the metro area. While in recent history ODOT has been willing to hand over control of state-owned roads to the City of Portland, many roads are still owned and controlled by ODOT. ODOT itself is overseen by the governor-appointed Oregon Transportation Commission, which guides and establishes policies that ODOT carries out. Oregon historically has invested in public transit, biking, and pedestrian-oriented projects in the Portland area.

2.7 Seattle, Washington: 1.38 Deaths per 100k People per Year

Map 2.6: Seattle metropolitan area pedestrian crashes and fatalities

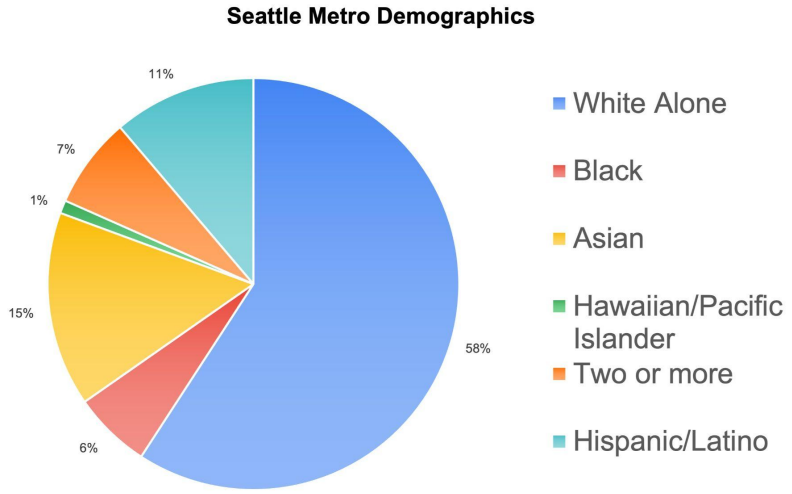
Seattle, Washington is the final metropolitan area chosen in this study. Having grown by roughly 2.5x in the last fifty years, Seattle is among the largest metropolitan areas in the United States at 4.1 million residents. Its physical area, similar to Portland, contains vast areas of the Cascade Mountains, within it housing hundreds of square miles of federally-protected land, which makes physical size comparisons difficult to justify. However, an analysis of the Seattle Urbanized Area from the US Census Bureau compared to the Atlanta, Jacksonville, Orlando, and Portland Urbanized Areas shows a similar trend to Portland. With 3,526 people per square mile, Seattle is still much denser in its urbanized area compared to the three Sunbelt cities. The City of Seattle itself is quite dense, with 8,791 people per square mile, placing it closer to cities like Philadelphia and Washington, D.C. than

Atlanta or Jacksonville. Also despite having much higher comparable proportions of commuting by bike, walking, or public transit, a significantly larger population of the city and metro still commute by private automobile.

Table 2.6: Seattle regional characteristics

	City Proper	**Metropolitan Area**
Population	730,000	4,100,000
Modeshare % of Walk/Transit/Bike to Work	15%	7%
Median Annual Household Income (USD)	$97,185	$101,721
Poverty Rate	10.2%	8.6%
Persons Per Square Mile	8,791	683.4

Figure 2.5 Seattle Metro racial characteristics



Seattle is similar to Portland in its built form, being mostly auto-oriented, but with a distinctively different arrangement than found in the Sunbelt. Most of the streets in Metro Seattle are owned by the local municipalities, with relatively few major arterials being owned by the Washington State Department of Transportation (WSDOT). All major highways and Interstates are still owned by WSDOT, headed by the governor-appointed Secretary of

Transportation. Washington has historically, at the local and state level, invested heavily in public transit, bike, and walking infrastructure in the last two decades.

CHAPTER 3: LITERATURE REVIEW

Research into pedestrian safety has been undertaken since at least the early 1980s (Haight et. al, 1981), where in the United States around 8,000 pedestrians were killed by automobiles every year. From the 1980s onward, pedestrian fatalities in the United States steadily declined (Insurance Institute of Highway Safety, 2022), before rebounding in 2004. Since then, fatalities have, as stated in Chapter 1, reached their highest level since the 1980s, with an estimated 7,485 people struck and killed by drivers in 2021. Relevant literature can be broadly split into two main camps. The first, and perhaps most logical, avenue for research has been into the physical and temporal characteristics of where fatalities occur. Research has been comprehensive in identifying common characteristics of pedestrian fatalities. Most occur at night, on unlit roadways in urban areas (Campbell et. al, 2003; IIHS 2022; Ferenchak et. al 2021). The overwhelming majority occur along major urban arterial roads, which are often primarily designed to be forgiving to drivers. In urban areas, this has not been shown to increase driver safety (Potts et. al, 2007; Council & Mohammedshah, 2004), while it does worsen safety for pedestrians, as drivers are enticed to travel at higher speeds (Dumbaugh & Li, 2010; Leaf & Preusser, 1998). These high speeds also serve as a major hindrance to generate walking trips, as research has shown traffic speed to be a main reason many Americans feel walking is unsafe (Soto et. al, 2022). Importantly, traffic speed has an exponential effect on the odds of dying when struck on foot. At 50 km/h, the fatality risk is twice as high than at 40 km/h, and five times higher than at 30 km/h (Rosén & Sander, 2019). Therefore, even a relatively small increase in traffic speed can have a large effect on the risk posed to pedestrians, especially with the aforementioned advent of larger, heavier SUVs that dominate American roads. Much research has also shown the characteristics typical of American urban sprawl that characterize large swaths of metropolitan areas in the United States are associated with increased risk for pedestrians (Ewing et. al, 2011; Ewing et. al, 2002; Dumbaugh & Li, 2010; Miles-Doan & Thompson, 1999). These characteristics are familiar to almost anyone familiar with the stereotypical American city and suburb: big box stores and strip malls interconnected by major arterial roads designed to move as many cars as quickly as possible.

The second major camp of study in pedestrian fatality research is the demographic characteristics, not only of the areas in which fatalities occur, but of the victims themselves. Broadly speaking, a person struck and killed by an automobile in the United States is more likely to be low-income and/or a Person of Color (Ha & Thill, 2011; Cubbin & Smith, 2002; Sanders & Schneider, 2022). There is even evidence to suggest that drivers are less likely to yield to non-White pedestrians who step in the roadway (Coughenour et. al, 2017). In addition to this, low-income and/or minority neighborhoods in the United States experience a disproportionate amount of pedestrian fatalities (Smart Growth America, 2022). Evidence throughout the country confirms this, spanning across the many different regions of the United States (Cottrill & Thakuriah, 2010; Chakravarthy et. al, 2010; Delmelle et. al, 2011).

Using this basis, one can now explore the literature related to the subject of this study: the Sunbelt. Sunbelt cities are, on average, less segregated than cities in the Northeast and Midwestern parts of the United States. Sunbelt cities are not only less racially segregated, but they are less economically segregated, with a wealth gap between city-and-suburb much less than comparable cities in other parts of the country. Both poverty and wealth look fundamentally different in the southern half of the country. The spatial organization of the Sunbelt is completely different than that of the typical industrial city, with the rapid growth and lax planning starting in the 1950s contributing to a much different built environment than found in the rest of the country (Strom, 2017). This built environment, however, is predominantly the urban sprawl linked to higher instances of pedestrian crashes and fatalities. This trend has been long established, as even in the 1980s the Sunbelt experienced higher pedestrian fatality rates than the rest of the country (Baker et. al, 1992). Despite this body of research, little is concretely known about why the United States has been largely unable to control this rising tide of pedestrian fatalities, particularly in the Sunbelt. While there is research regarding the growing size of vehicles' relationship to pedestrian fatalities (Saylor 2021; Basem et. al, 2003), this does not explain the sharp geographic divide in the country comprehensively enough to be the only, or most important, factor. In reference to the aforementioned Dangerous by Design report, 13 of the 15 states with the largest long-term rise in pedestrian fatalities over the last decade are Sunbelt states. Among the 25 metropolitan areas with the largest long-term increase, 22 are in the Sunbelt (Smart Growth

America, 2022). This presents a serious concern that has been left largely unexplained by researchers, and therefore left largely without any large-scale proposed solutions.

CHAPTER 4: METHODOLOGY

4.1 Quantitative and spatial analysis

Geospatial crash data was gathered from the Departments of Transportation in the states of Florida, Georgia, Oregon, and Washington. For the purposes of this project, all "crashes" and "fatalities" refer to pedestrians who were struck and/or killed by automobiles. These data all contained pedestrian-car collision point data starting from January 1, 2016 until December 31, 2021. At first, the data contained variables measured in different ways depending on the state, so data were cleaned and formatted in a way to standardize attributes across the dataset. After this process, approximately 27,650 points remained, each containing the following variables:

- Latitude/Longitude
- Metro Area
- County
- City
- Date
- Time
- Roadway Name
- Intersecting Roadway Name
- Traffic Level
    - Categorical high, medium, or low variable based on the functional classification of the road in which the crash occurred.
- Light Conditions
- Weather Conditions
- Road Conditions
- Number of Fatalities
- Number of Serious Injuries

The majority of the variables used were already included in the crash report in each state. In some instances, variables like light/weather/road conditions represented the same condition with different wording, so the data was re-coded to standardize these attributes. In the State

of Florida, municipalities were not attached to the data, so a spatial join was performed with municipal boundary shapefiles from the US Census Bureau to attach this information to the full database. In cases where no join was performed, it is assumed that the crash happened in an unincorporated area.

U.S. census data were gathered directly from the U.S. Census Bureau for the 2020 census pertaining to race, income, and method of travel to work for each census tract within the boundaries of the 5 metropolitan areas selected. Historical census data from 1990 were gathered from the Geolytics Neighborhood Change Database pertaining to race, which contained data from the 1990 U.S. census normalized within the tract boundaries of the 2010 census. One of the analyses conducted was to measure the relationship between pedestrian safety with a measure of racial neighborhood change from 1990 to 2020, therefore the boundaries of 2020 census data had to be fitted into the 2010 tracts. This process was fairly straightforward: since census tracts are split into smaller pieces of the original tract when they reach a certain population, an intersect function was able to match the 2010 tract that corresponded to the 2020 tracts that occupied the same space. All the data in the 2020 tracts were combined, recalculated, and then attached to the original 2010 tract shapefile.

Once the data were cleaned, they were imported into ArcGIS Pro where a point density analysis was performed, to be shown in the result section. Additionally, an Optimized Hot Spot Analysis (OHSA) was performed on the dataset, which used the Gi* statistic to identify non-fatal and fatal crash clusters (the function refers to them subsequently as “cold” and “hot” spots, signaling either the absence or prevalence of fatal crashes in comparison to the total volume of crashes). OHSA showed a much greater level of detail than a point density map, as it was able to separate clusters of fatal crashes from clusters of non-fatal crashes. Since no comprehensive dataset exists to track pedestrian flows across the spatial scale used for this project, the amount of crashes can serve as a proxy for pedestrian activity. In downtown areas, many more crashes happen, but that almost certainly happens due to the large concentration of pedestrian activity, whereas smaller clusters outside the city center that may have a higher ratio of fatalities to crashes may be overlooked in normal cluster analysis.

Additionally, a variable calculating the distance in kilometers from the crash point to the city center was added to each OHSA point.

Once the OHSA fatal crash clusters were identified, they were aggregated to the 2010 census tract they lay in by an aggregate points function in ArcGIS Pro. This table was joined with the combined data from the aforementioned 2020 census tracts and imported into R for further statistical modeling. For each census tract, the following data were available:

- The number of points identified to be in a fatal crash cluster by OHSA
- The total number of crashes
- 2020 Census Data
    - Race/Ethnicity
    - Mode of transport to work
    - Median Household Income
- 1990 Census Data
    - Race/Ethnicity
- Non-White Differential Variable
    - This variable consists of the non-white proportion of the tract in 1990 subtracted by the non-white proportion in 2020. Therefore, a negative value shows diversification of the tract, while a positive value shows an increase in the white proportion. While positive values can show areas identified in the literature as undergoing gentrification, the goal of this variable was to examine areas people who have been gentrified out of their original neighborhoods have moved into.

Once the data were imported into R, they were separated into two subsets: Sunbelt and Non-Sunbelt. Then, a negative binomial regression was performed on the data. While incident count data are typically incorporated into poisson regression, this data did not fit the assumptions needed for poisson regression, and a negative binomial model was therefore a better fit for the data.

4.2 Qualitative Analysis

A total of 7 virtual interviews were conducted. A pedestrian safety advocate and a public employee responsible for pedestrian safety were interviewed from Jacksonville and Portland. A pedestrian safety advocate was interviewed from Seattle and Orlando, and a state employee related to pedestrian safety was interviewed in Atlanta. All interviews were transcribed, each lasting around 30-45 minutes, and were subsequently coded according to four main themes:

1. Structure of power:

   This theme applies to quotes that describe the relationship between different levels of government bureaucracy in American cities. Examples of this include the relationship between the local and state Departments of Transportation, the role of elected politicians in decision making, and the state ownership and transfer of major arterial roads in urban centers.

2. Inequality

   This theme applies to quotes that describe social, racial, or economic inequality as it relates to the development and governance of American cities. Examples of this can include the particular areas a city is focused on improving safety in, or the indicators used by the government to prioritize areas for pedestrian projects.

3. Popular support

   This theme applies to quotes that describe the relationship between local governments and their constituents, particularly as to the current status of local trust in the government, and the way that state actors can affect and are affected by local residents' support and perception of their government. Examples of this can include the process of public outreach and consultation, and how that affects when/where/how pedestrian projects are carried out.

4. Built environment

This theme applies to quotes that directly describe the built environment of their cities, and how the built environment can affect pedestrian safety. Examples of this can vary from the existence of sidewalks and crosswalks in a neighborhood all the way to the street network and density of an area.

CHAPTER 5: RESULTS

Once the data were cleaned and compiled, a preliminary analysis was done on the amount of crashes and fatalities in each metropolitan area standardized by their population. This was compiled into the table below:

Table 5.1: Per-capita crash and fatality statistics (Sunbelt cities are bolded)

	Atlanta, GA	**Jacksonville, FL**	**Orlando, FL**	Portland, OR	Seattle, WA
Fatalities	922 (272)	298 (175)	453 (250)	226 (39)	361 (22)
Crashes	11432	2024	3205	3064	7939
Annual fatalities per 100,000 population	2.50	3.03	2.80	1.50	1.50
Annual crashes per 100,000 population	31.01	20.60	19.84	20.34	32.98
Fatality to Crash Ratio	0.08	0.15	0.14	0.07	0.05

Using the table shown above, we can see that Sunbelt cities do not necessarily have more crashes than their non-Sunbelt counterparts when controlled for population. In fact, Seattle has the highest crash incident rate of the entire sample, but is tied for the lowest fatality rate. Comparing Atlanta to Seattle, both major metropolitan areas among the country's largest, the two regions have nearly identical crash incident rates, but Atlanta's fatality rate is 67% higher than Seattle's, which is reflected in their fatality-crash ratio. Comparing the two Florida metros with Portland, all of them being midsize metropolitan areas, we can also see that the crash incident rate among them is nearly identical, but Jacksonville and Orlando's fatality rates are nearly double that of Portland. This is also reflected in the fatality-crash ratio, in that Jacksonville and Orlando's are double that of Portland. From this, one cannot

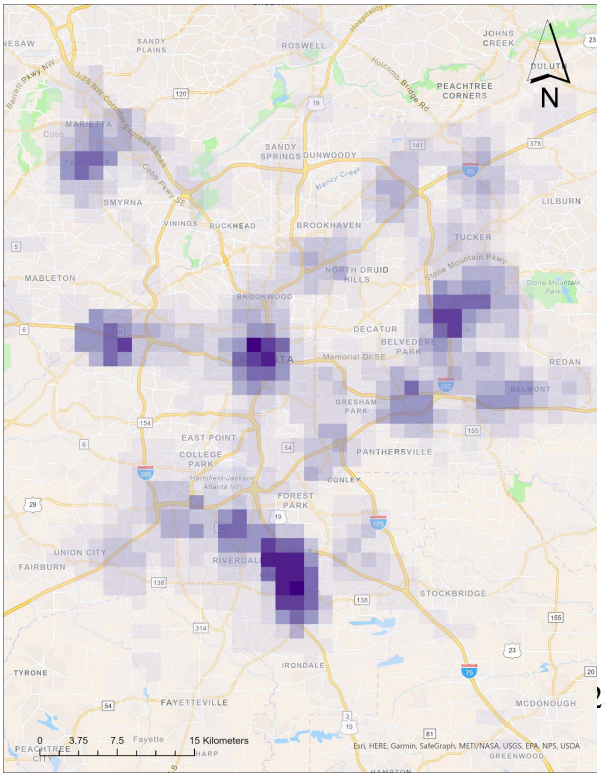
suggest that the reason the Sunbelt is more dangerous is because they have more crashes. The Sunbelt cities chosen have nearly identical rates of crashes to their corresponding Non-Sunbelt city, but of those crashes, a much larger portion of them are fatal.

The only noteworthy finding from the crash reports themselves was that around 45% of crashes in the Sunbelt and 41% in the Non-Sunbelt happened in the dark. However, around 88% of those crashes in the Non-Sunbelt happened in places where street lighting was present. In the Sunbelt, only around 60% happened on roadways where there was street lighting. When you look at fatalities, around 25% happened during the daytime in the Non-Sunbelt, compared to 14% in the Sunbelt. A similar trend emerges with street lighting at night - around 42% of total fatalities in the Sunbelt happened on unlighted roadways in the dark, compared to 18% in the Non-Sunbelt.

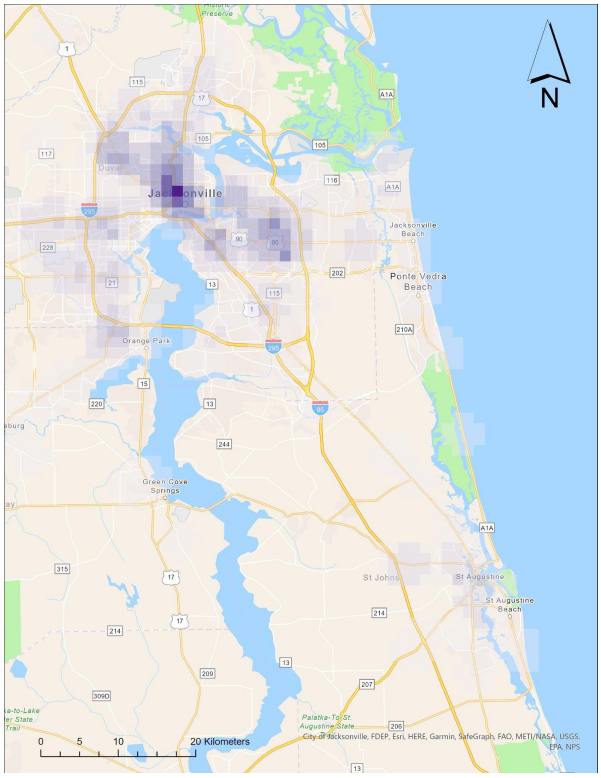
The next step in finding out why this difference exists was to analyze *where* fatalities cluster in each area. To do this, a point density function was performed to find clusters of fatalities in each city, shown on the maps below:

Point Density of **Fatal Crashes (maps 5.1/.2/.3/.4/.5)**

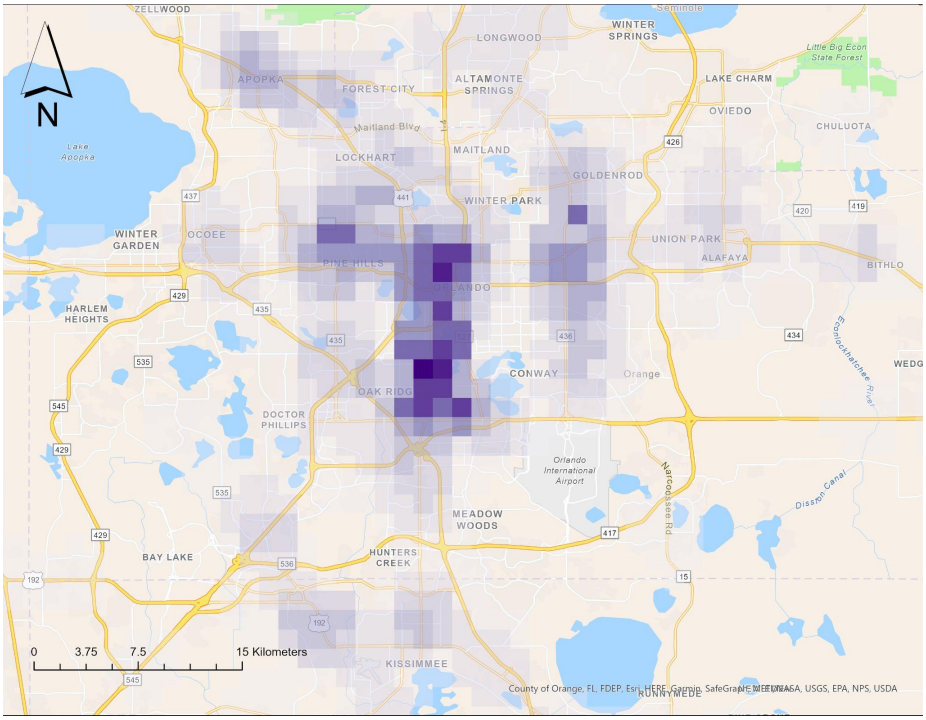
Atlanta



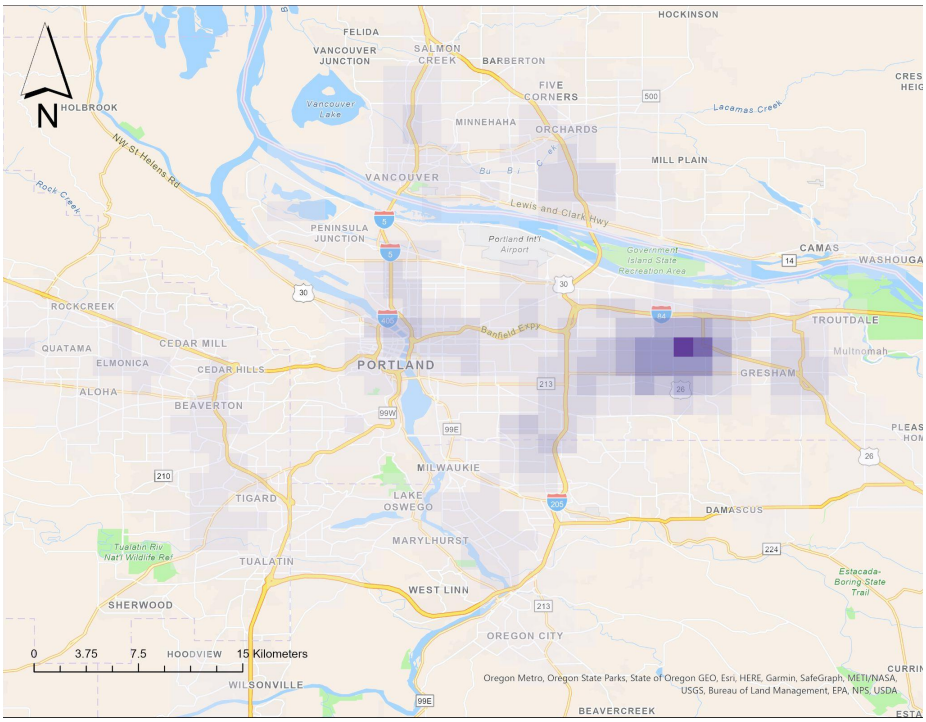
Jacksonville



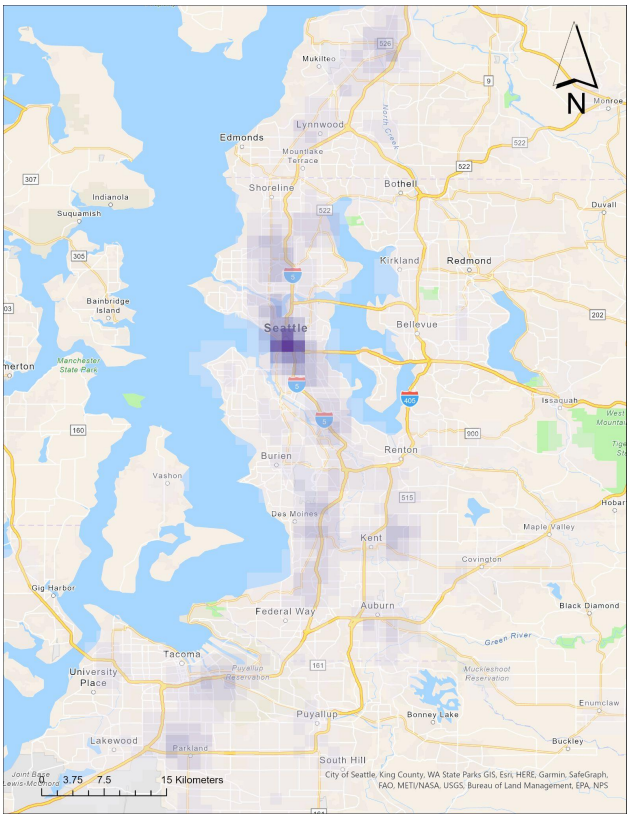
Orlando



Portland



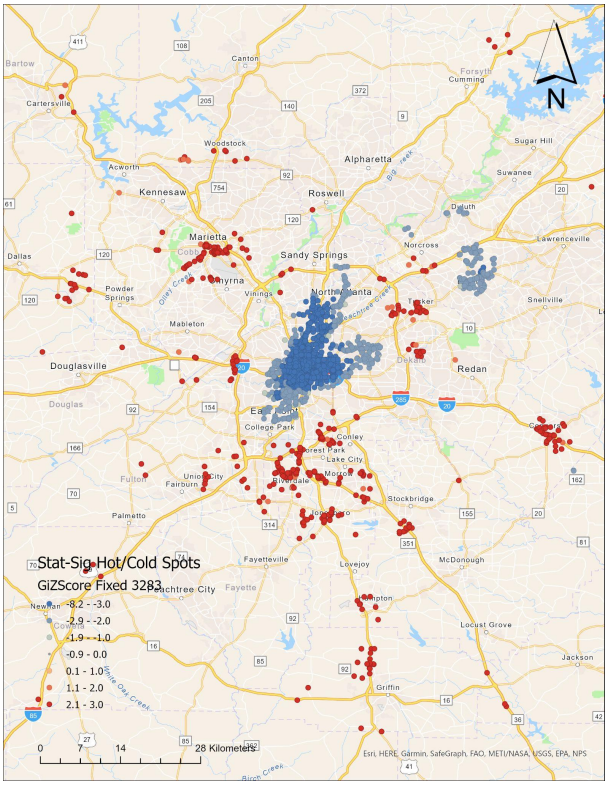
Seattle



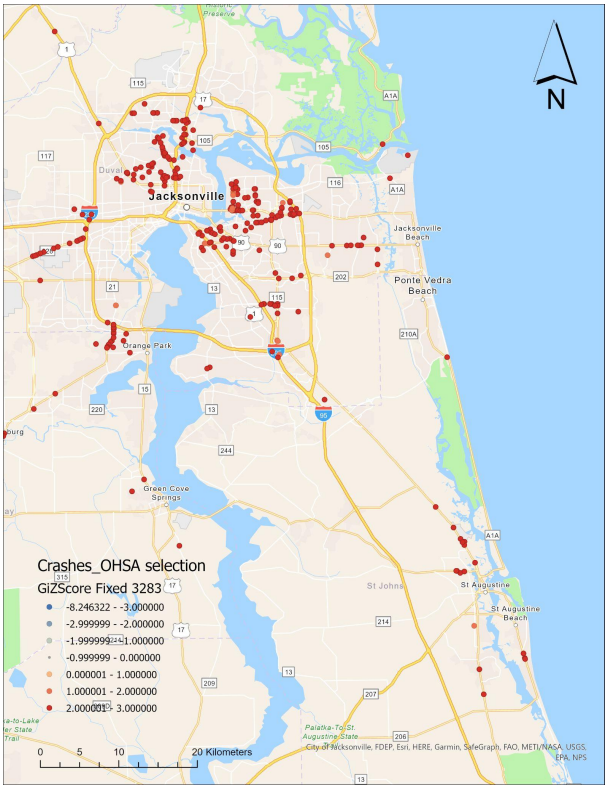
This analysis is helpful in seeing the clusters that exist throughout each metropolitan area. Every city has clusters in the downtowns, undoubtedly because of the concentrated volume of pedestrian activity present. However, the Sunbelt does not necessarily have *more* clusters outside of the downtown, but where they exist, they're much stronger, showing that Sunbelt clusters are likely to be much more dangerous than in the Non-Sunbelt. To inquire further into these clusters, a Hot Spot Analysis was performed on the datasets using fatalities as an analysis field. This tool uses the Gi* statistic to judge whether or not high or low values (in this case, fatalities) cluster spatially. Statistically significant fatal crash clusters (high values) and non-fatal crash clusters (low values) were found across the dataset, and are presented on the following maps:

Maps of Hot Spot Analysis (maps 5.6/.7/.8/.9/.10)

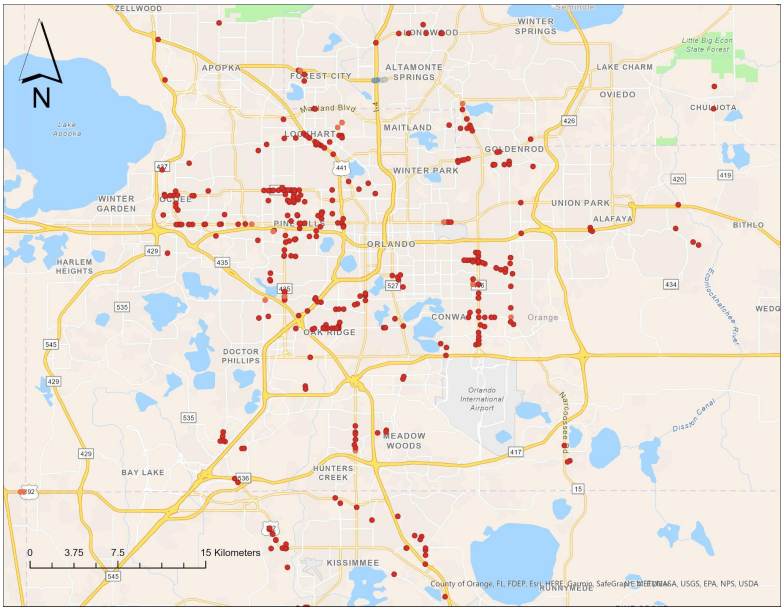
Atlanta



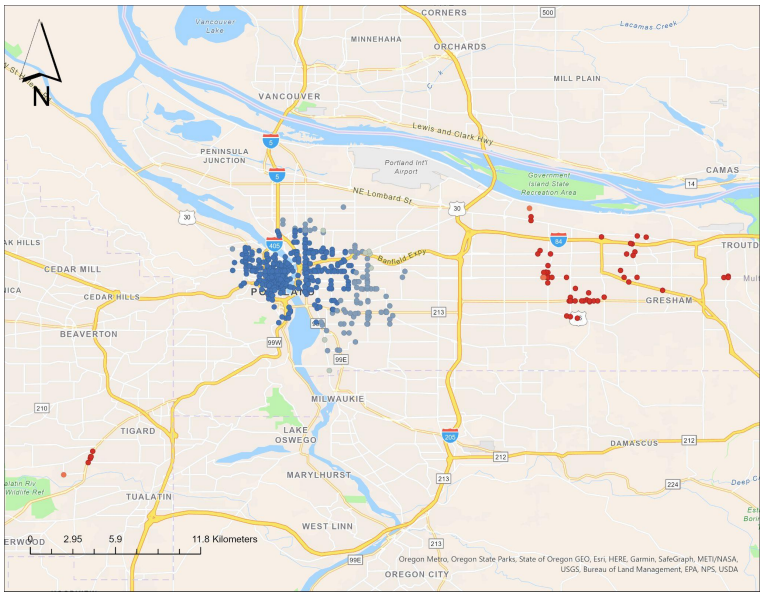
Jacksonville



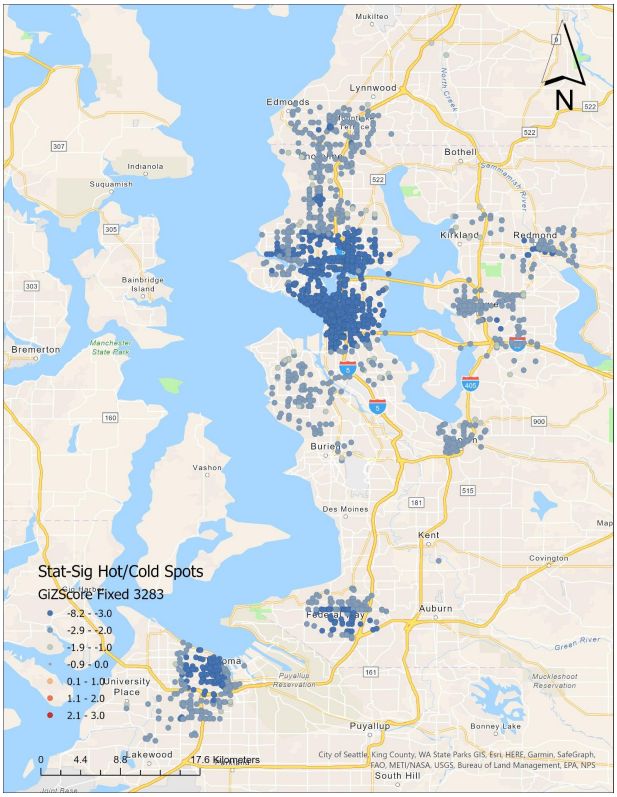
Orlando



Portland



Seattle



This analysis provides more clarification as to where the most dangerous clusters are in each metropolitan area. Clearly shown is the vastly greater amount of fatal crash clusters in the Sunbelt that all lie outside of the downtown areas. Atlanta's downtown is comparable to Seattle's, in that there are large clusters of non-fatal crashes, but Seattle has nearly zero fatal crash clusters throughout the entire region, whereas Atlanta shows a large concentration of them in the areas outside of the city center. Orlando and Jacksonville have no non-fatal crash clusters, and mainly clusters of fatal crashes in the same peripheral areas.

Roughly 10,000 of the 27,000 crash points lay in a statistically significant cluster of either high or low values. 41% of fatal crashes in the Sunbelt lie in the high-value fatal crash clusters identified in this analysis. In the Non-Sunbelt, that amount is just 10%. If one removes the fatalities that lie in fatal crash clusters from both groups, the discrepancy between the two regions is almost eliminated. The Sunbelt would have an annual fatality rate of 1.46 deaths per 100,000 population, compared to 1.35 in the Non-Sunbelt. As it stands, the Sunbelt's combined fatality rate is 2.66, compared to the Non-Sunbelt's rate of 1.49. Therefore, it is incredibly likely that the discrepancy between the Sunbelt vs. the Non-Sunbelt can be explained by the hyper-prevalence of these fatal crash clusters in the Sunbelt that are mostly absent in the Non-Sunbelt. Broken down by each city, this becomes even clearer: In Atlanta, around 30% of all fatalities lie in these clusters. In Jacksonville and Orlando, that amount is 59% and 55% respectively. This differs from the other two cities starkly: In Portland, the amount is only 17%, and even lower at 6% in Seattle.

The amount of influence suburban areas have on this figure is particularly strong when you add up the number of fatalities that occur in the city proper, i.e. within the literal municipal boundaries of Atlanta, Jacksonville, Orlando, Portland, and Seattle. Around 3% of fatalities within the City of Atlanta happen within fatal crash clusters, 11.6% in Orlando, 36% in Portland, and 0% in Seattle. In Jacksonville, which consolidated most of their suburbs into one municipality in the 1960s, this figure is 77%. The fatal crash clustering that concentrates so heavily in the Sunbelt almost never happens within the region's namesake city.

The next question one would logically ask is: what are the characteristics of these areas with fatal crash clusters? Once the negative binomial was used on the aggregated tracts, there are two main characteristics that stick out:

Table 5.2: Negative binomial regression output of crash and hot spot characteristics

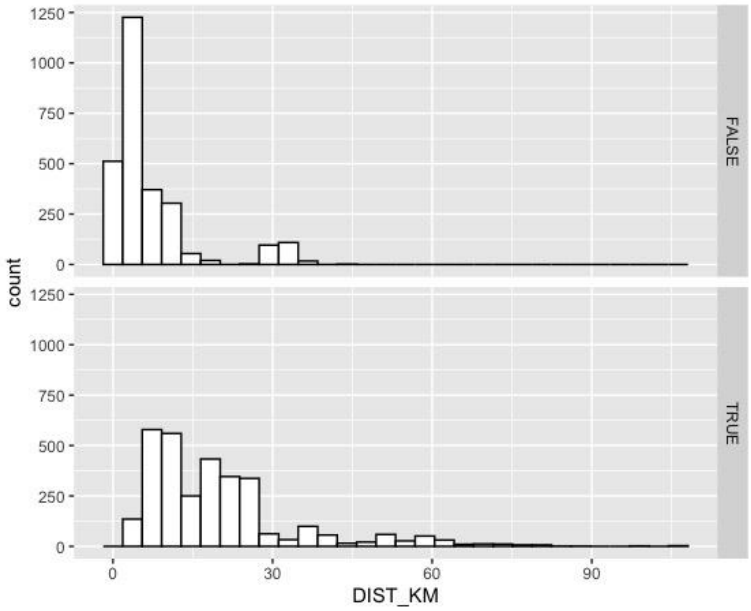
	Hot Spots				All Crashes			
Characteristic	**IRR[1]**	**95% CI[1]**	**p-value**	**VIF[1]**	**IRR[1]**	**95% CI[1]**	**p-value**	**VIF[1]**
Car_Per	8.35	1.66, 39.2	0.003	1.1	0.03	0.02, 0.05	<0.001	1.2
NW_DIFF2	0.27	0.15, 0.48	<0.001	1.1	0.63	0.52, 0.76	<0.001	1.1
Median_HHI_20	1.00	1.00, 1.00	<0.001	1.0	1.00	1.00, 1.00	<0.001	1.1

[1] IRR = Incidence Rate Ratio, CI = Confidence Interval, VIF = Variance Inflation Factor

Firstly, the amount of driving has a completely different effect when predicting fatal crash clusters. For all crashes, the model shows that as more people drive, less people are hit by cars. This is fairly straight-forward: there are fewer people to be hit by cars when most of them are not walking. However, this effect is reversed when predicting fatal crash clusters. This likely signals that the people hit while walking in these areas are walking because they have to, and are likely forced to use poor pedestrian infrastructure or are walking on roadways that were not built to prioritize pedestrians (i.e. no street lighting). Secondly, the non-White differential between 1990 and 2020 was also a predictor of fatal crash clustering. This aligns with the literature that People of Color are more likely to be struck and killed by cars (Coughenour et. al, 2017). Notably, there was no effect of median household income when controlled for by the other two variables. In addition, none of these variables were statistically significant for predicting total crashes or fatal crash clusters in the non-Sunbelt.

Another characteristic that seems to differentiate between fatal and non-fatal clustering is the distance from downtown, shown on the graph below:

Figure 5.1: Distance to city center histogram of fatal (TRUE) and non-fatal (FALSE) clusters



Throughout the Sunbelt, the average distance from the city center of a fatal crash cluster is 19.95km. The average distance of a non-fatal crash cluster is less than half of that, at roughly 7km. A much greater proportion of fatal crashes in the Sunbelt happen further from downtown, a phenomenon which is not exhibited at the same scale in the Non-Sunbelt. The area of East Portland, notably, is the only area in the Non-Sunbelt where fatal crashes cluster, and exhibits every one of these characteristics, also lying far from downtown.

CHAPTER 6: DISCUSSION AND CONCLUSION

6.1 Individual examples of findings

The fatal crash clusters identified in the Sunbelt, along with the lack of street lighting, aid in explaining a large part of the discrepancy between the pedestrian fatality rates in the Sunbelt and non-Sunbelt. In this chapter, I want to discuss further why these clusters exist, the built environments found within them, what governments can do about them, and the barriers that exist to fixing it using some of the quotes gathered during the interviews.

Using Google Street View, one can see from looking at roadways in the Sunbelt that the distance from downtown is almost certainly a proxy for sprawling, car-oriented development and street design. In the state of Florida, transportation planning mechanisms like concurrency standards have been shown to push new developments farther out from city centers over time (Kim et. al, 2014), which substantiates this claim. In the following two images, the same state-owned roadway in Jacksonville, Florida is shown at two different intersections:

Figure 6.1: Jacksonville fatal cluster Street View

Figure 6.2: Jacksonville non-fatal cluster Street View

In the two tracts that each point lies in, the racial demographics (and overall population) are nearly the same, being overwhelmingly Black-majority areas at 92% and 96% respectively. However, the first tract (Figure 6.1) has 20 of 21 crashes lying within a fatal crash cluster, while the second (Figure 6.2) only has 1 of 17. One can reasonably suspect that a large part of this difference is down to the street design. The site of Figure 6.1 is 9.5km from Downtown Jacksonville in its suburban sprawl, while Figure 6.2 is only 2.5km away in one of the historic urban neighborhoods. While having the same amount of lanes, the first roadway's speed limit is 50% higher in the first image (45mph vs. 30mph), the lanes themselves are much wider, and sidewalk coverage is much more sporadic. The distance between crosswalks on the roadway in the first image is around 800 meters or one-half mile. In the second image, the distance between crosswalks is much less, at around 160 meters or one-tenth of a mile. The advocate in Jacksonville interviewed spoke on this:

> "If you look at the maps on Dangerous by Design, I think you can see that the fatalities are in the outer ring of Jacksonville more than the inner neighborhoods."

> "There's a huge infrastructure imbalance between the disadvantaged and advantaged neighborhoods, it's not merely that they took I-95 and used it to

> remove housing without replacing it. The drainage is bad, they don't have septic tanks and the roads are built to minimal design standards. Pavement condition is bad, street lighting is bad, and the grid itself is chopped up."
>
> "We have a lot of issues that are more typically Southern. And there's a lot of, I think, racial issues that are on the line. The number one project on our pedestrian/cyclist master plan was a road diet in an economically disadvantaged neighborhood. So the city went out and said, 'look what we're going to do for you'' And there was a lot of pushback, like 'you know we deserve a highway just as much as everyone else doe.'"

Situations like this are nearly exactly mirrored in the other two Sunbelt cities. While these situations exist in the non-Sunbelt, they are few and far between in comparison. East Portland is perhaps the best example of these circumstances found in the non-Sunbelt, and also the only area where fatal crash clusters are found. From interviewing the advocate and planner from Portland, a very similar story arises:

> "Portland has a part in it, East Portland, which is the area east of the freeway. Most of our fatal crashes happen in that part of Portland and that area also has a lot more big, wide streets." - advocate
>
> "[East Portland] is a part of town that was only incorporated in the 80s. It was unincorporated county land before, so the development patterns and regulations were very different back then. Gentrification has also happened and the people who have been displaced have moved there too. So all of these compounding factors create the situation we're faced with currently." - planner

In summary, the prototypical fatal crash cluster in the Sunbelt largely responsible for the elevated rate of pedestrian fatalities compared to other parts of the country is:

> 1.) In auto-oriented sprawl, far from the city center, in another municipality or formerly-unincorporated area.

2.) In a suburban, minority neighborhood that has shifted from majority White to majority Black or Hispanic over the last thirty years.
3.) In an area with high rates of driving on large, wide, and fast arterial roads owned by the state government, in which cars can drive at speeds that nearly guarantee death in the case of a pedestrian collision.

These three factors are substantiated in nearly every fatal crash cluster in Atlanta, Jacksonville, Orlando, and Portland. Seattle stood out as not having any substantial fatal crash clusters, which is likely due to two main factors:

Firstly, Seattle is a dense, geographically-constrained metropolitan area, without many of the large, wide arterial roads seen in the rest of the cities:

> "We don't have six or eight lane arterials, like Detroit or Atlanta has, that we can repurpose as we want to, right? We have a very limited number of corridors and a lot of choke points on bridges and such. We've got a lot we want to fill them with, so you're competing for the same space." - Seattle advocate

Additionally, Seattle has the highest metropolitan median household income and lowest metropolitan poverty rate of all five cities, so there are likely fewer people who cannot afford to drive and are forced to walk in the auto-centric suburbs of Seattle.

The interaction between race, driving, and the built environment is fundamentally different in Seattle, and largely similar between the other four cities. While Atlanta, Orlando, and Jacksonville have many different areas that correspond to the factors identified in predicting fatal crash clusters, Portland only has one, which happens to be the only area in which fatal crash clusters lie. Therefore, it is likely true that the comparably higher level of racial segregation, lower incomes, greater proportion of Black and Hispanic people, and higher proportion of driving make the Sunbelt unique

in addressing rising pedestrian fatalities. However, from the case of East Portland it can be shown which of the Sunbelt's regional differences are most important in addressing pedestrian safety, and that the Sunbelt's problems can exist in the rest of the country, but, crucially, at a much smaller scale.

6.2 Barriers to improvement

A large part of the interviews were spent discussing the challenges that cities face reducing pedestrian fatalities. Frequently, the role of the state government was mentioned:

> "If you look at the crash locations, it's going to be 70-80% on state roads. If we brought our [fatalities] to completely zero, there's a lot of work that FDOT [Florida Department of Transportation] has to do, so we can't work in silos. One of the performance targets on all state roads is, 'the roadway has bicycle facilities' or 'the roadway has pedestrian facilities'. But it doesn't specify, like, what kind of facility is that?" - Jacksonville Planner

> "I can tell you that 75% of our high-injury network is on state-maintained roads. Even on some of my projects that are state projects here in the city, depending on the project manager I can get different results. I can ask for traffic calming on one project and the PM Is like yes, let me get a new designer on this, but on another one I have to fight for my life to get a rudimentary pavement marking that would increase safety." - Orlando planner

> "A couple highways that went through Portland were limited to us because we couldn't compel the State Department of Transport to abide by our safety standards, because they had different safety standards and models. So that was very limiting to actually address those safety concerns on those major corridors." - Portland advocate

> "Any street that is not a business district or residential street is over 35mph, and we don't want any of those in our city. To do that [reduce speed limit] on

> state roads, we need approval from the state, and that takes a long time. It'll often take a number of years and we've been rejected a number of times." - Portland planner

> "It's not so much the opportunity [to talk with the government], but when do they want to plug you in as an advocate? You want to be as close to the beginning as possible. The longer they wait to decide if they want the input, the more the professionals have decided that this is the way that it should go. The further along they get in the design, the more time and energy and money they've spent, the less that they're likely to say 'you know what? You're right. We kind of blew this. We should do it differently.'" - Seattle advocate

Clearly, the state governments that control the roads in which most crashes and fatalities occur can be a barrier to implementing safety projects. Ultimately, it appears to be that these large arterials are responsible for the higher fatality-crash ratio in the Sunbelt due to the much higher speed drivers can travel at which exponentially increase the likelihood of serious injury or death for struck pedestrians, therefore implementing measures to reduce speed can make a substantial difference. Addressing the street design within these clusters directly can greatly reduce the amount of fatalities that occur throughout each metropolitan area and make streets safer for vulnerable pedestrians who are almost certainly presented with no other choice to get around than to walk on large, fast, and unsafe arterial roadways.

> "Somewhere around 80% of crashes happen mid-block, often without a crossing. And that's to deal with, when we first designed these roads, pedestrians were not the main focus." - Georgia planner

Additionally, it appears that the lack of public support, and frequent public opposition, to safety projects are a major barrier in the Sunbelt. This is important particularly in areas where disadvantaged and/or minority communities have historically been neglected or harmed by government projects, which are the areas likely to be among the most dangerous for pedestrians. This was stressed by interviewees in Jacksonville and Orlando:

> “I think some elements of the designs that they've [past city officials] brought to communities in the past, they've made them really complicated, where it's almost like an information overload. And you have these engineers saying, ‘well, the gradient on this turn is going to be this and the radius is going to be this.’ And you have regular residents in the neighborhood that say, ‘I don't understand this and it's going to cost a lot of money, and I'm confused and just don't want it.’ I've seen a couple of routes where I said, ‘hey what happened to the bike lane or sidewalks that were going to be here?’ And they said, ‘Yeah it didn't pass. The people didn't want it.’” - Jacksonville planner

> “No matter where the community is, based on what you're trying to do you have to gauge at the beginning the level of trust that there is. This relates to the communities of concern because those areas have been marginalized for so many years that the trust for their government isn't there. So you've got to do more work at the beginning to get them to understand.” - Orlando planner

6.3 Conclusion

In order to reduce pedestrian fatalities in the Sunbelt, two main factors must be addressed. Firstly, state governments need to reduce speeds on their arterial roads and improve pedestrian facilities, like mid-block crossings and street lighting. This needs to be done not only in the urban core of cities, but in outlying suburban areas where a smaller proportion of people may be walking, but a far higher proportion of them are being killed when they are hit, and where fatal crash clustering is primarily centered. Secondly, when the government presents these projects to residents, particularly in areas or within communities where previous government intervention has resulted in displacement or other community harm, projects need to be transparent and simple. This can help in repairing the lack of trust many communities justifiably have for their local and state governments, and make it more likely that communities will accept and push for pedestrian-oriented safety projects. As the Sunbelt continues to be the fastest growing part of the country, the trends that accelerate the uptick in pedestrian fatalities throughout the region will likely continue to play a bigger and bigger

role. To get ahead of this, local, regional, and state governments should get ahead of the curve and try to address not only where fatalities cluster now, but where they'll likely cluster in the future.

Along with the Sunbelt's general growth is the rise in gentrification that affects many inner-cities across the United States. Research has been done showing the dramatic rise in poverty in "recently turned poor suburbs" (Murphy, 2007), and the general demographic shift of where poverty concentrates in urban America. Given that the Sunbelt is both disproportionately poorer and auto-oriented, these are exactly the areas in which fatal crash clustering most concentrates, and are likely to grow as gentrification displaces inner-city residents to the suburbs. By understanding where, why, and how these fatal clusters emerge, suburban municipalities (along with the state governments controlling the roadways that pass through them), can better predict where new clusters are likely to emerge, and be proactive in limiting the effect of poor roadway design, shown in the example from Jacksonville.

6.4 Limitations

The main limitation of this study lies in the fact that not every Sunbelt city was able to be analyzed and its residents interviewed due to the scope of the project. However, given the shared demographic and development patterns across the region which are known to researchers, I believe it is likely that much of the region shares the same challenges that Atlanta, Orlando, and Jacksonville do.

Additionally, there is no feasible way to collect data on pedestrian volumes and average traffic flow on every road used in this analysis, so these variables had to be left out of the analysis. Using total crash volume as a proxy for pedestrian activity can aid in measuring which areas have more activity than others, as other measures of exposure are absent or difficult to source on the scale needed for this project, but is certainly not perfect.

Although the influence of the growing size and adoption of Sport Utility Vehicles (SUVs) and other light trucks on American roads is certainly helping to drive up pedestrian fatalities (Simms & Wood, 2006), many of the crash reports used did not include data on vehicle type,

so that was not able to be used in the analysis. While some may assume that there are more SUVs and trucks on the road in Atlanta compared to Seattle, there was no way to make this connection given the data available at the time this study was conducted.

REFERENCES