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**Redlining and Opioid Overdose Outcomes:
Do Historical Housing Policies Still Impact Health Today?**

by

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A Proposal to the Honors Council

For Honors in The Interdisciplinary Studies of Mathematics and Economics

April 12, 2023

Approved by:



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Thank you all for making this honors thesis possible. It is my sincere hope that this work contributes to a better understanding of the Opioid Epidemic and the urgent need to address racial health disparities in our society.

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Introduction

In recent years, the Opioid Epidemic has become a pressing public health issue in the United States. While the epidemic has affected people from diverse backgrounds and circumstances, it has disproportionately affected certain communities, specifically those that have been historically marginalized. In this thesis, I aim to highlight the impact of opioid overdose in the redlined areas of New Jersey. Redlining is the practice of labeling certain areas as risky or unsafe and has been linked to a range of negative health outcomes. This historical practice has translated into present-day health inequity. The concentration of opioid overdose deaths in redlined areas, controlling for demographic information, will illuminate the association between the geographic region and its health outcomes. This analysis will then inform targeted interventions and policies that can more justly address these disparities and promote equitable access to health care for all.

Life expectancy in the United States has declined by nearly a *year* from 2020 to 2021. This trend is particularly concerning as it is a key indicator of a population's overall health and well-being (Shameek et al., 2022). This is the lowest life expectancy at birth since 1996. The pandemic is the main driver for this change; however, according to the Centers for Disease Control and Prevention (2022), an estimated 16% of the decline from 2020 to 2021 is due to unintentional injuries resulting from unintentional events or occurrences. Drug overdose deaths comprise almost half of these unintentional injuries. Post-pandemic, these deaths have increased and continue to persist. A study done in Milwaukee County, Wisconsin investigated the monthly opioid overdose deaths before and after the "stay-at-home" order. It concluded that there was a significant increase in

overdose deaths, not only in regions where the increase was expected but also in regions that were previously unaffected by the Opioid Crisis (Ghose, 2022). The researchers of this study hypothesize that the unaffected population is now experiencing a disruption in the ease of access to care which is increasing their risk of overdose death. There remains a significant racial disparity in the health outcomes of opioid overdose, however, the pandemic has highlighted how the social and healthcare systems have failed for various levels of healthcare access.

In this thesis, using data on death records from the state of New Jersey, I will be matching deaths within a specific census tract with historical redlining scores to test whether there is a correlation. Redlining scores were a way of quantifying the potential “risk” of investing in a particular region. By applying this score to a census tract based on opioid overdose outcomes, we will denote the relationship between this historical phenomenon and present-day health outcomes that are perceptibly worsening.

The structure of this thesis is as follows: first, to provide a definition and context for the history of Redlining, and then to examine its application specifically within the state of New Jersey. The next section will define opioids, overdose trends, prescribing behaviors, pharmaceutical marketing, and pain management in the healthcare system. Following this, the theory will be presented, comparing two potential outcomes of opioid overdose that could be observed in the analysis. The Data & Methods section will describe the data in detail along with any limitations that I encountered. The analysis will then include the various tests performed, graphs, and maps to help visualize the

relationships between variables. Finally, the conclusion will discuss the results and pose some targeted recommendations for tackling the Opioid Crisis.

Chapter 1: Redlining

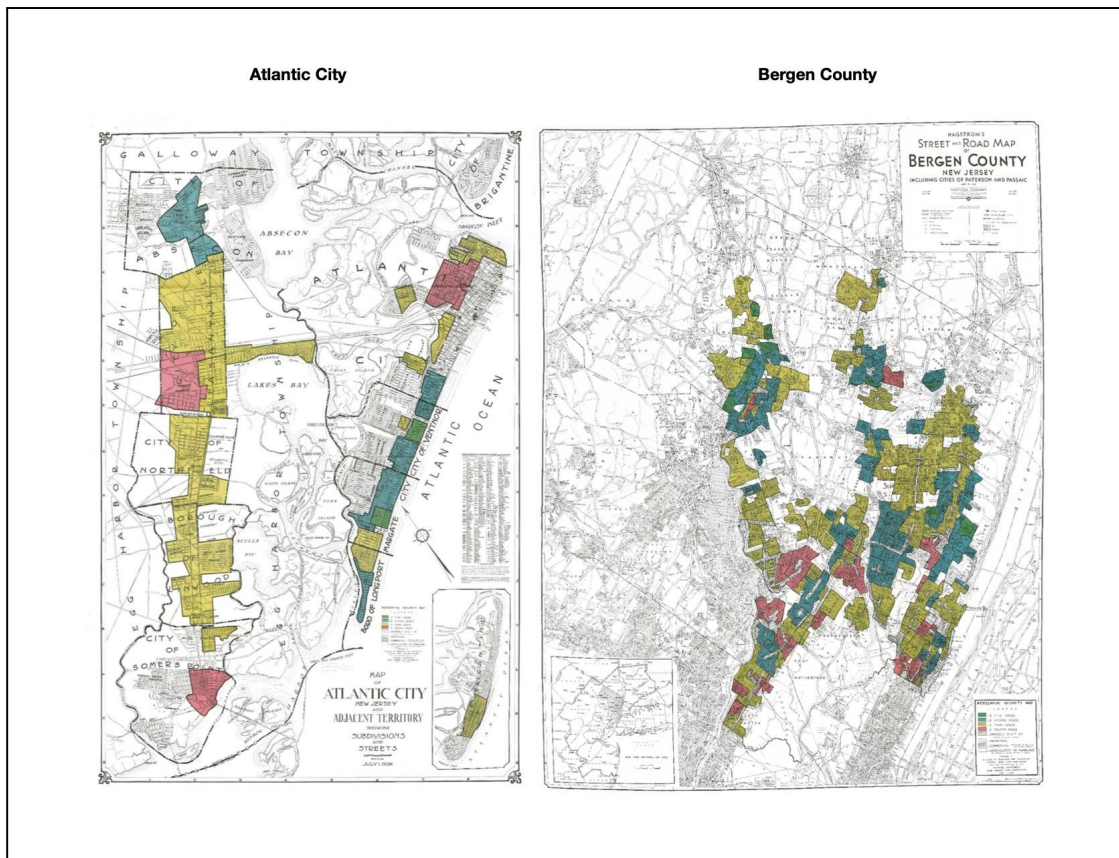
Research suggests that there is a structural disadvantage that contributes to opioid overdose. “Healthcare systems, community leaders, and policymakers addressing the Opioid Epidemic should focus on upstream structural factors including education, economic opportunity, social cohesion, racial and ethnic disadvantage, geographic isolation, and life satisfaction” (Singh et al., 2019). Practices such as redlining have created geographic divisions in which some communities have accumulated wealth and others have not. Redlined neighborhoods typically lack access to healthy food options, safe recreational spaces, and quality healthcare. As a result, residents of these areas face higher rates of chronic diseases such as obesity, diabetes, and heart disease (Richardson et al., 2021). This section will discuss the history and implications of redlining in the US.

History of Redlining & Timeline

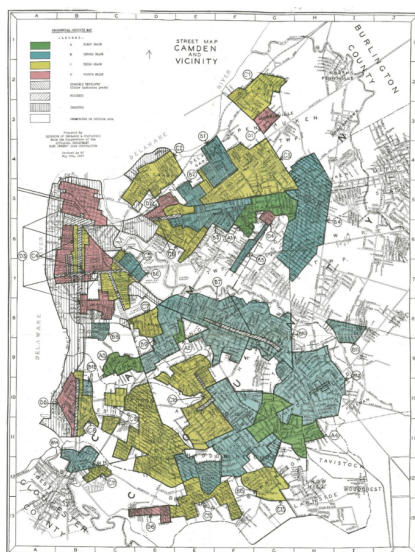
For decades, minority communities have suffered from the implementation of historic discriminatory policies and financial disinvestment. This practice is known as redlining, originating in the 1930s; it refers to the systematic denial of financial services, such as mortgages or insurance, to people based on their race or ethnicity. It was *formally* defined in categories created by the Home Owners’ Loan Corporation (HOLC) in 1933. This neighborhood ranking system legitimized the unethical decisions made by banks and investors when they chose not to invest in a community based on its demographics. The categories ranged from “Best” to “Hazardous” where neighborhoods with predominantly African Americans, immigrants, and other minorities were labeled as undesirable

(Mitchell, 2022). During Post War America, this federal housing policy denied many communities of color access to the resources from state-sponsored growth and protected the economic privileges of “whiteness”. As a result, these areas were often marked by poverty, substandard housing, and limited access to healthcare and nutritious food (Weinstein et al., 2017). These poor conditions have had a profound impact on the health of residents in these communities and have contributed to persistent racial health disparities.

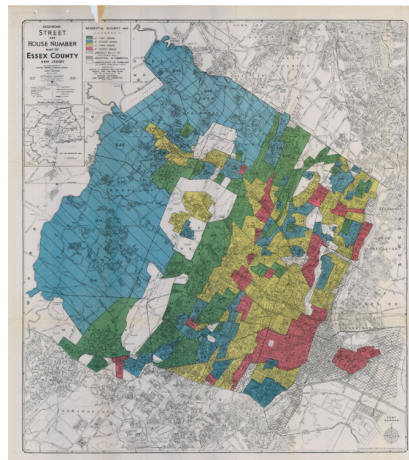
Below are seven available redlining maps of the state of New Jersey, provided by the University of Richmond's "Mapping Inequality" Project (Nelson et al., 2015). Red sections indicate "risky", yellow areas represent "declining", blue represents "still desirable", and green represents "best" neighborhoods.



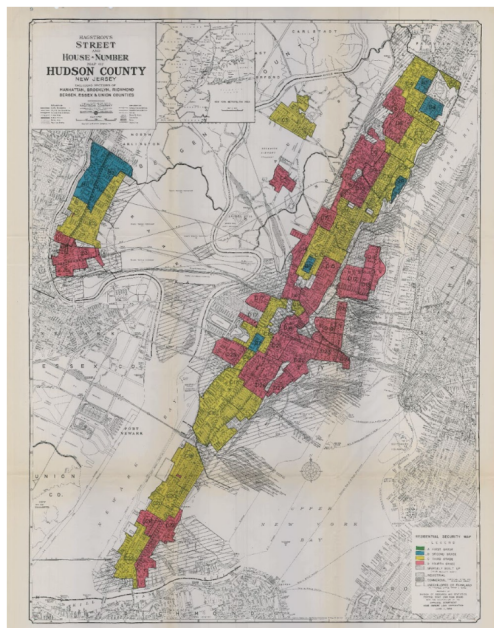
Camden



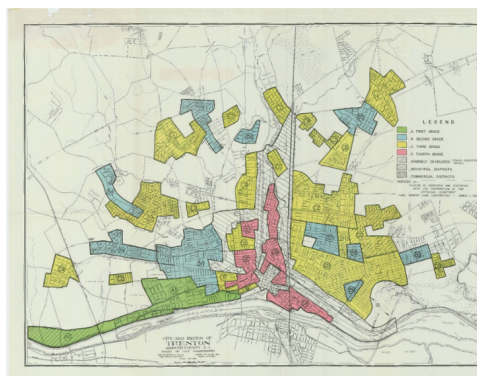
Essex County

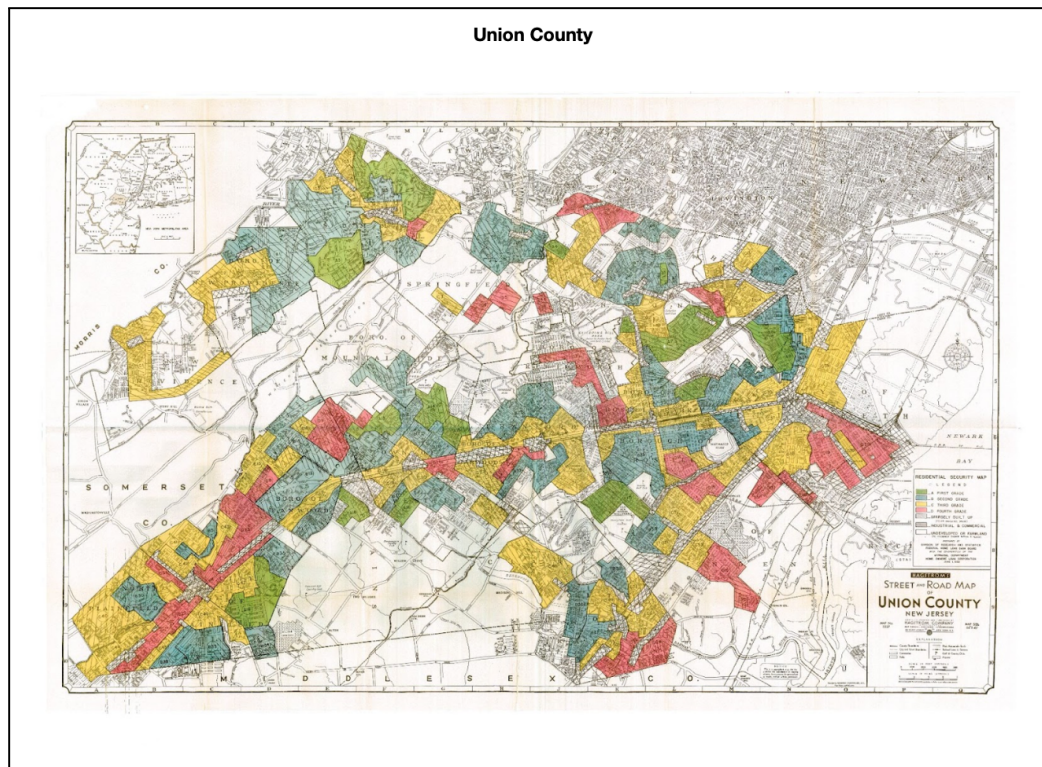


Hudson County



Trenton





To better understand the impact of redlining on American cities, it is essential to look at its historical context and how it evolved. Refer to Appendix A for a brief overview. The most prominent court cases and other events are presented in the following table:

Table 1. Timeline of Redlining in the US

<p>1917: Buchanan v. Warley</p> <p>The Supreme Court unanimously held that racial discrimination through residential zoning practices is unconstitutional. For example, in Louisville, Kentucky, a “colored” person was forbidden to move into a neighborhood with a majority white population.</p>
<p>1933: HOLC was established</p> <p>There was a housing shortage. State-sponsored system of segregation: Federal government implemented a program (HOLC) to increase and segregate housing stock. HOLC was exclusively designed to provide housing to white, middle-class, and lower-middle-class families. The Federal government began providing federally insured home loans, which were managed by the HOLC. This reinforced negative stereotypes about non-white neighborhoods and limited access to home ownership and business development in those neighborhoods.</p>
<p>1934: Federal Housing Administration Created</p> <p>On June 27th, 1934, the National Housing Act was signed into law by President Franklin D. Roosevelt. This is where the Federal Housing Administration (FHA) and the Federal Savings and Loan Insurance Corporation (FSLIC) were established. Following the Great Depression, the FHA aimed to make it easier for people to obtain financing for their homes, enhance the quality of housing, and generate more job opportunities in the home-building sector (Hunt, 2022). Despite these initiatives, the FHA did not benefit all individuals. The FHA established a "system of valuation"</p>

which categorized the most favorable residential areas as those with tightly clustered property values, on the premise that they were more stable. Additionally, the FHA presumed that neighborhoods of the same racial groups would be the most stable over time, and generate the highest returns in terms of property values (Fritz, 2019). These policies allowed redlining by using maps to determine which areas were deemed "risky" for investment, and which were not. The FHA has provided insurance for more than 35 million home mortgages and 47,205 multifamily project mortgages since its inception in 1934. Presently, the FHA's portfolio includes 4.8 million insured single-family mortgages and 13,000 insured multifamily projects (Fair Housing Center, 2019).

FHA underwriting manual

Used by the FHA underwriters to determine the soundness of a loan application and endorsed the practice of redlining, which marked African-American neighborhoods as ineligible for FHA mortgages (Fair Housing Center, 2016).

1937: Housing Act (Wagner-Steagall Act)

Deemed the United States Housing Administration responsible for building publicly subsidized housing. This enforced that for every new public housing construction there must be a removal of a substandard unit. It allowed for an increase in better housing rather than the amount of housing. However, the operational decisions of these projects were left to local authorities who determined the areas where they wanted public housing. This perpetuated racial segregation.

1938: The Fair Housing Act is passed

The first federal law in the United States aimed to combat housing discrimination based on race, religion, and national origin. The act prohibited discriminatory practices by landlords and real estate companies and established the Fair Employment Practices Commission to investigate complaints of housing discrimination. While the act was a significant step forward, it had limited impact due to weak enforcement mechanisms and limited funding significantly, it did not address redlining which continued to spread during this time. However, it laid the foundation for later fair housing legislation, including the more comprehensive Fair Housing Act of 1968.

1944: GI Bill

Low-interest home loans for service people returning from WWII. This program's structure prevented Black people from fully accessing these benefits. Black veterans were thus left out of the post-war housing boom. It became a key source of intergenerational wealth for the White middle class.

1946: The Massachusetts Fair Housing Law passed

Outlawed discrimination based on race, color, national origin, ancestry, and religious creed.

1948: Shelley v. Kraemer

In 1945, a Black family called the Shelleys bought a house in St. Louis, Missouri, unaware of a racially restrictive covenant on the property that had been in place since 1911. According to the Legal Information Institute of Cornell Law School, the

covenant prohibited "people of the Negro or Mongolian Race" from owning property. Local residents sued to prevent the Shelleys from taking possession of the property. In the case of Shelley v. Kraemer, the Supreme Court decided that private agreements that excluded people based on their race from owning or occupying property for residential purposes did not violate the Fourteenth Amendment. However, state courts enforcing such agreements would be discriminatory and violate the Equal Protection clause of the Fourteenth Amendment. This meant that racially restrictive covenants were not unconstitutional in themselves, but the state enforcement of them was illegal. Despite the ruling, the practice of racial covenants continued, although they were no longer legally enforceable.

1949: American Housing Act

The federal government increased its involvement in housing by providing substantial funding and allowing the use of eminent domain to remove slums. This led to the completion of 2100 urban renewal projects by 1974. Unfortunately, over 300,000 families, of which more than half were nonwhite, were compelled to relocate due to this initiative.

1956: National Interstate and Defense Highways Act

Construction of the Interstate Highway System for 10 yrs for \$25 billion accelerated and subsidized suburbanization which benefited the white middle class. Highways cut through or demolished urban areas, displacing and further impoverishing residents in these neighborhoods who were predominantly racial outgroups.

1960: Civil rights activists begin to draw attention to redlining, and the issue is soon taken up by Congress.

1968: Federal Fair Housing Act

This act outlawed any form of prejudice in the purchase, rental, or financing of residential properties on the grounds of race, religion, national origin, sex, handicap, or family status (Fair Housing Center, 2019).

1977: The Community Reinvestment Act is passed

Required banks to invest in low and moderate-income neighborhoods and required federal institutions to meet the credit needs of communities, especially non-affluent households.

1980s-90s: Redlining continued to be a widespread problem, despite legal efforts to combat it.

2007-2008: The housing market collapses, leading to widespread foreclosures of homes in minority neighborhoods that had been targeted by subprime lenders. This crisis further highlights the ongoing effects of redlining and the unequal access to credit in minority communities.

Today: Redlining continues to be a significant problem, and many communities are still grappling with the aftermath of the housing crisis. Efforts are underway to address the lingering effects of redlining, including the creation of community land trusts, the adoption of inclusive zoning policies, and the implementation of community reinvestment programs (Swope et al., 2022).

The impact of specific practices outlined in Table 1 is summarized as follows:

The Fair Housing Act of 1968 made it illegal to discriminate against a person when it comes to housing on the basis of their religion, race, national origin, sex, handicap, or family status (Fair Housing Center, 2019). Despite this, many Black individuals were coerced into neighborhoods with poorer neighborhood characteristics. “On any given encounter between a Black home-seeker and a realtor, the odds are at least 60 percent that something will happen to limit that Black renter or buyer's access to housing units that are available to white persons” (Massey, Gross, and Shibuya, 1994). This signifies that even though there was a housing policy implemented to prevent racial discrimination, the inequity continued. Disaffected communities have experienced more injustice regarding access to resources and opportunities. Studies show that Black individuals have higher rates of morbidity than White individuals for a majority of physical health indicators.

The building of the New Jersey Turnpike is an illustration of how the National Interstate and Defense Highways Act affected the state of New Jersey. The Turnpike is a major highway that stretches about 122 miles through the state, connecting major cities and serving as a crucial transportation system for commerce and travel. It was built in the 1950s as part of the national highway system established by the Act. It provided a faster, more efficient way for people and goods to move between major cities and helped to spur economic development in New Jersey. However, the construction of the turnpike also had significant environmental and social impacts on the communities through which it

passed, particularly low-income and minority communities that were often displaced or had their neighborhoods divided by the highway.

Redlining has been involved in many court cases over the years. One of the most significant cases include the Fair Housing Act of 1968, which finally made housing discrimination illegal and acknowledged the impact of redlining. Another key case is *United States v. City of Louisville*, in which the city was found to have engaged in redlining practices that denied African American residents access to investment and resources, leading to a cycle of disinvestment and poverty in these neighborhoods (Mitchell, 2022). More recently, the National Fair Housing Alliance has brought several lawsuits against banks and other financial institutions, alleging that they have engaged in redlining by denying access to credit and other financial services to residents of communities of color (Almeida, 2021).

Redlining in New Jersey

In New Jersey, the COVID-19 pandemic further exposed these patterns of institutionalized racism that have resulted in poverty-related health disparities and substantial racial inequities in accessing health care (Núñez et al., 2021). Turning to redlining in New Jersey, in the redlined map of Trenton, we can see the impact of redlining as the areas that were marked as hazardous are still primarily Black. Two other counties, Willingboro and Lawnside had two completely different developments in the post-WWII era. Willingboro was first established by William Levitt whose intention was to replicate a community like the other Levitt communities around the country, specifically majority white. However, a Black civil rights activist named Daisy Myers sued to racially integrate the neighborhood. This matter reached the Supreme Court which ruled in favor of diversifying the neighborhood which led to a large influx of Black homeowners. In response, realtors quickly engaged in a classic behavior known as “blockbusting”: invoking fear in white families of declining property values and quality of life (Holom-Trundy et al., 2021). This county then became a Black majority community suffering from the same inequity we see in areas deemed “Hazardous” today.

Lawnside was historically a majority-Black neighborhood that was originally founded with the assistance of abolitionists and Quakers as a “free haven”. It became a location along the Underground Railroad in 1926 (Holom-Trundy et al., 2021) but remained subject to racist forces of urban planning. They partitioned the county by the placement of highways which had negative implications on the value of homes in the area. Willingboro and Lawnside are examples of successful Black middle-class

communities. But even in these communities, we see a stark contrast to their more affluent majority-white neighbors based on measures of wealth.

A number of legal cases have been filed to challenge discriminatory practices such as redlining. A notable example is a settlement between the state of New Jersey and Wells Fargo in 2018 (Grewal et al., 2018). The lawsuit alleged that the bank had engaged in redlining practices. The settlement was a provision of mortgage loans to the affected communities and investment in organizations that work to reduce the impacts of redlining.

Neighborhood Health Racial Disparities in Health

The demographic characteristics of a neighborhood play a huge role in the economic development of that neighborhood and have a direct impact on health outcomes for its residents. Poor air and water quality, proximity to hazardous substances emitted by factories or chemical plants, low-quality housing, and lack of access to healthy food and healthy infrastructure affects the quality of life in a community. A neighborhood with these characteristics tends to have higher poverty rates and limited access to resources than those without (Acevedo-Garcia, 2001). In this case, residents might experience a range of challenges, listed in the National Community Reinvestment Coalition (Richardson et al., 2021), that negatively impact their health:

1. **Lack of access to healthy food options:** Poverty-stricken neighborhoods, also known as food deserts, might not have access to grocery stores that offer healthy food options. This might lead to diet-related health problems.
2. **Poor air quality:** Neighborhoods located near highways, power plants, and industrial facilities, can experience poor air quality. Living in these conditions over a long period of time can lead to respiratory problems.
3. **Limited access to healthcare:** Neighborhoods that lack access to affordable healthcare and preventive services, also known as healthcare deserts, make it difficult to promptly address health issues. This can lead to higher mortality and health complications.
4. **Higher stress levels:** Experiencing poverty can be stressful and may result in a higher prevalence of mental health problems, such as depression and anxiety.
5. **Poor housing conditions:** Neighborhoods with substandard housing can be overcrowded, and contaminated with lead and other toxic substances, leading to health problems such as asthma and other respiratory issues.

These social determinants of health have a direct effect on neighborhood health outcomes. The next section will explore opioids and various pathways to overdose.

Chapter 2: Opioids

In the last two decades, the number of deaths from opioid overdoses has skyrocketed, leading to a significant increase in premature deaths and a reduction in overall life expectancy. Opioids, which include prescription painkillers and illegal drugs such as heroin and fentanyl, are highly addictive and can easily lead to overdose, even when taken as prescribed. Examining the trajectory of opioid overdose deaths for just one year, between 2020 and 2021, there were 20,000 more deaths (CDC, 2022). The racial disparities in opioid overdoses are also quite alarming. The epidemic has a disproportionate impact on marginalized populations, including those living in poverty and those experiencing addiction and mental health challenges (Moore et al., 2008). Over 50% of deaths are non-Hispanic whites, and other racial outgroups account for roughly 30% of deaths (Latoya et. al., 2023).

What is an Opioid?

An Opioid is a drug found in the Opium poppy plant. One of its main uses in medicine is to affect the brain's reward system, which makes people feel euphoric. However, it is also known for its potential abuse and addiction. The brain, and the body, have Opioid receptors on cells that control a person's ability to digest, experience pain, and other functions. One of the main uses of this drug in medicine is to block pain signals between the brain and the body. Some commonly known Opioids include morphine, fentanyl, and oxycodone. The widespread use of opioids has led to a public health crisis, with overdoses and deaths becoming an epidemic in the United States.

General Rates, Disparities, and Paths to Addiction

Opioid addiction is a major public health crisis in the United States, affecting individuals of all ages, races, and socioeconomic backgrounds. According to the CDC, in 2019, there were over 49,000 opioid-related overdose deaths in the United States, representing a significant increase from previous years. Despite the broad impact of the Opioid Epidemic, certain groups have been disproportionately affected (Volkow, 2021). For example, individuals who live in rural areas, those with lower income, and those with a history of trauma or mental health disorders may be at higher risk for developing addiction. The path to addiction can vary widely and often involves a combination of factors. Some individuals may become addicted after being prescribed the drugs for pain management, while others may turn to opioids as a way to self-medicate or manage

emotional distress. Additionally, the illicit use of opioids, such as heroin or fentanyl, can also lead to addiction.

Specific Cases of Opioid Overdose in New Jersey

The Opioid epidemic has had a significant impact on the state of New Jersey. According to data from the New Jersey Department of Health, there were 2,089 opioid-related deaths in the state in 2019, and the number of overdose deaths has continued to rise in recent years. In response to this crisis, New Jersey has taken a number of steps to address opioid use and abuse. One of the key initiatives in New Jersey, announced by Governor Phil Murphy in 2019, has been to increase access to addiction treatment and recovery services. This includes expanding access to medication-assisted treatment (MAT), which is effective in helping individuals overcome addiction. The state has also implemented programs to reduce the amount of opioid prescriptions being written, as well as programs to educate healthcare providers and the general public about the dangers of its use. Additionally, New Jersey has taken steps to improve the tracking of opioid-related data and to coordinate efforts between state agencies and local communities. This includes the creation of a statewide prescription monitoring program and the development of a public health campaign to raise awareness about the dangers of opioid use (Metzger, 2023).

Despite these efforts, the epidemic continues to be a major challenge in New Jersey, and much work needs to be done to address this complex problem. The rising number of overdose deaths in New Jersey can be attributed to several factors, including

the availability of highly potent opioids, such as fentanyl, on the illicit drug market; the high number of prescriptions being written; and the lack of access to effective addiction treatment and recovery services (Chau, 2020). One case study of Opioid overdose in New Jersey involves a 25-year-old man who had a history of abuse. He was prescribed Opioids for a back injury and became addicted to the medication. Despite his attempts to seek help for his addiction, he struggled to find effective treatment options. He eventually turned to purchase illicit opioids and suffered a fatal overdose (Chau, 2020). This case highlights the complex nature of addiction and the challenges faced by individuals in seeking help. The man's initial prescription for Opioids, although intended to manage his pain, ultimately led to a destructive cycle of addiction and overdose. This is a common story among those affected by the Opioid Epidemic and highlights the importance of addressing the root causes of addiction, including over-prescription and the lack of access to effective addiction treatment and recovery services.

Medical Doctor's Prescriptions Decisions

Overprescribing and underprescribing are two significant problems in the medical field. Overprescribing refers to the practice of prescribing more opioids than are medically necessary for a patient's pain management (National Academies of Sciences, 2017). This can occur for various reasons, including a lack of education and understanding about the risks associated with opioids, pressure from patients to receive a prescription or financial incentives for the prescriber. Overprescribing can lead to patients becoming dependent on opioids and can contribute to the epidemic (National Academies

of Sciences, 2017). Prescription rates are often influenced by marketing tactics directed by pharmaceutical companies.

Underprescribing refers to the practice of not prescribing *enough* opioids to manage a patient's pain effectively. This can occur due to concerns about the risk of addiction, concerns about the side effects, or a lack of trust in the patient (National Academies of Sciences, 2017). Underprescribing can result in patients suffering needlessly and can lead to increased disability, decreased quality of life, and longer recovery time.

Pharmaceutical Marketing

Prescription behaviors, particularly over-prescriptions, typically occur in the face of heavy pharmaceutical marketing. A study done from 2013-2015 investigated the pharmaceutical industry's marketing of opioids to physicians to see if there was an association with mortality from prescription opioid overdose (Hadland et al., 2019). This direct-to-physician marketing was measured by the monetary value of marketing from a pharmaceutical company, the medication, the type of marketing, and the location of the physician's practice. The study concluded that pharmaceutical company marketing of specific products may be associated with increased prescribing of those products. Therefore, with respect to opioids, when pharmaceutical companies invest millions into direct-to-physician marketing, it is highly unlikely that they do so without the guarantee that there will be either the same, if not more, prescriptions handed out.

Based on a study conducted in 1951, we are able to understand the thought process behind the adoption of new medicines and the disregard of the old (Britten and Ukoumunne, 1997). There are various ways that pharmaceutical companies update clinicians about new developments in medicine. The most impactful is “primary media” where the information is spread directly from the manufacturer or the research lab. This can be done through the use of detailed men, direct mail, or journal publications that reach doctors directly. The second method of exposure to a pharmaceutical innovation is through “secondary media”. This includes those who have already been contacted by the primary media outlets: colleagues, conferences, patients, and conventions. This is significant because, in 1951, we were able to target the various marketing strategies that make the pharmaceutical industry so successful (Chressanthis et al., 2014).

Now, in 2020, we are amidst a new era of technology. Technology has exponentially increased the effect pharmaceutical advertising has on consumers because of how unregulated and misleading the information is. Currently, the marketing industry has taken preemptive action which decreased the amount of sales representative visits from 77% to 55% in 5 years (Manz, Ross, and Grande, 2014). This was a change that contributed to the crisis. The marketing schemes have only matured with the increasing expansion of advertising outlets. We now have easy access to technology on which pharmaceutical companies spend around 25% of their budget (PEW, 2013). At the marketing level, Big Pharma has more control than it should. In the early stages of the Epidemic, it is likely that these harmful pharmaceutical companies’ marketing practices might have contributed to the rate of opioid overdoses (Hadland et al., 2019). Recently,

more studies show that opioid-related overdoses are linked to drugs like heroin and illicit fentanyl (Volkow, 2021).

The United States is one of the leading countries in opioid prescribing and many individuals first come into contact with this drug through their primary care. Some actions have been taken to reduce the need to prescribe, despite the influence of marketing tactics (Haffajee et al., 2017). In New Jersey, there was a \$10,000 annual limit placed on the total payment allowed for physicians (Laugesen, 2011). Even with this limit, the study showed that the number of physicians receiving payments and overdose mortality are more closely associated than the *value* of marketing and overdose mortality (Cerda, 2019). Therefore, the data suggest that the influence of pharmaceutical companies is widespread through many low-payment agreements such as meals.

Another significant reason why the pharmaceutical industry is such an influential business is because of the strength they hold within the health economy. Shannon Brownlee, the vice president of the Lown Institute, announced that the Pharmaceutical Industry, as a whole, has spent around 1.5 billion dollars to influence federal lawmakers and keep the prices high for their products (Lown Institute, 2020). By eliminating regulations and policies that reduce the risk of over-prescription, pharmaceutical companies have the power to release a drug into the market without facing a considerable backlash. When a company makes a new medicine, there is simply no way to know for sure how that drug would react with a variety of different individuals (Hadland et al., 2019). A combination of this variability and the marketing power that pharmaceutical

companies have allowed them to successfully distribute their product. The influence that companies hold in convincing patients to use a certain drug and encouraging clinicians to promote that same drug is what causes unfortunate growth in the Pharmaceutical Industry. They control where and how fast their product reaches an individual. Brownlee has confirmed that Pharma has spent about \$26 billion on marketing toward patients and their providers. They use promotional techniques such as free samples to clinicians, free lunches to endorse a branded product over the generic one, and visits from their sales representative to the office. This, in conjunction with patient priming, is another problem that increases the chances that a clinician prescribes that branded medicine (McFadden 2007).

Pain Management

Pain management in the healthcare system is not always equitable, and racial disparities exist in the treatment of pain. Studies have shown that people of color, particularly Black Americans, are more likely to experience inadequate pain management compared to White Americans (Ezenwa, 2012). These disparities may be due to a variety of factors, including implicit biases held by healthcare providers (Akbar et al., 2019), differences in pain perception, and systemic inequities in access to healthcare. Additionally, Black Americans are more likely to live in areas with limited access to pain specialists and face financial barriers that limit their ability to access pain management treatments (Meints et al., 2019). The undermanagement of pain may have two effects on the likelihood of overdosing on opioids; on the one hand, to the extent that prescriptions

are a “gateway” to addiction, Black Americans may be less likely to overdose. On the other hand, if Black Americans are self-medicating with illicit drugs instead, these factors may lead to more overdoses in this community.

With this historical context and understanding of the Opioid Epidemic, the next section highlights the complex social relations in health care that influence the control over science.

Chapter 3: Theory

By understanding the economy's development through the lens of labor and productivity, this class-based approach highlights the systemic barriers faced by people of color due to historical and ongoing discrimination in housing, employment, and healthcare. Redlining and unequal access to quality healthcare are just two examples of how racism has been embedded into the structures of our society and continue to perpetuate inequality. The financial implications stemming from redlining in the 1930s allowed the White ruling class to control banking systems and cut access to loans for marginalized groups. By refusing to provide loans and other financial services to these communities, banks effectively cut off access to credit and capital, making it extremely difficult for residents to start businesses, purchase homes, or invest in their education and future (Zweig, 2012). This created a cycle of poverty and disenfranchisement that has persisted for generations, as families were unable to accumulate wealth and pass it on to their children. At the same time, in the healthcare industry, physicians, hospitals, and government agencies, which are often dominated by the wealthy White ruling class, may have disproportionate influence and power compared to working-class entities. The reliability and trustworthiness of these healthcare entities provide a safe and dependable option for consumers to seek medical care, which is crucial for maintaining a profitable healthcare system. When a consumer trusts their healthcare provider, they are more likely to return to them for future healthcare needs and rely on their medical advice regarding medication and other treatments. This helps to establish a sense of consistency and trust in the healthcare system, which is necessary for its success.

The assumptions are that these power differences vary by race. Communities that have been historically disinvested tend to be people of color. These communities lack the accumulation of wealth that their counterparts have acquired. With regard to healthcare, unequal access to healthcare instantly leads to a difference in health outcomes by race. Access to healthcare is a critical factor in determining an individual's health outcomes. When some groups have limited access to healthcare, they may not receive preventive care or timely treatment for health problems, leading to poorer health outcomes. In the United States, race and ethnicity have been linked to disparities in healthcare access and outcomes, with people of color generally experiencing worse health outcomes compared to white individuals.

For example, studies have found that Black and Hispanic patients are less likely to receive recommended preventive services such as cancer screenings or flu shots. They may also experience longer wait times to see a doctor, leading to delays in diagnosis and treatment. In addition, people of color are more likely to live in areas with limited access to healthcare facilities, which can further limit their ability to access care.

Applying Marxist principles to the healthcare system, Vicente Navarro (1986), a Spanish sociologist who analyzes the social, political, and economic determinants of health and life quality, describes the “crisis of medicine” as driven by different agents within medicine holding dominance over medicine. He argues that the scientific knowledge produced in society is not neutral or objective, rather, it is shaped by the political and economic interests of those who control the means of production. Describing this critique, using the social relations of production, will illuminate the

complexity of these relations. Medical power is rooted in the control over science; however, considering the historical implications of the upper class in the US, the bearers of knowledge and power tend to be white and male physicians. Those with medical power have the ability to optimize their interests by institutionalizing their power through the control of the knowledge, practice, and institutions of medicine (Navarro, 1986). This is one imbalance of power in the healthcare system. In the same manner, pharmaceutical industries hold control over scientific research, advertising, policies, and regulations that govern the use of medication. This often occurs at the expense of public health and safety with higher regard for political and economic gains.

Within this framework, two competing hypotheses emerge from the discussion on opioid overdose: one suggests that individuals not getting prescriptions have contributed to a decrease in overdose rates, while the other posits that the lack of access to good treatment forces individuals to turn to illicit opioids, consequently, increasing the overdose death rates.

Theory 1: Redlining Practices May Decrease Opioid Overdose

Theory 1 presents the hypothesis that decreased opioid overdose is due to having access to healthcare services and not being prescribed the drug or being prescribed at the *lowest* possible dose for the shortest period of time. To the extent that neighborhoods rated as low-risk have more health resources today, individuals here may be more likely to receive a prescription, become addicted, and be more at risk for an overdose. Another reason could be differences in healthcare provider attitudes and beliefs about pain management with opioids. Additionally, variations in patient demographics and healthcare access may also contribute to differences in prescribing rates between neighborhoods. For example, patients in redlined areas may be less likely to be prescribed opioids due to a medical practitioner's concern about the risk of addiction and overdose.

Theory 2: Redlining Practices May Increase Opioid Overdose

Theory 2 hypothesizes that increased opioid overdose is due to a lack of access to good treatment which leads individuals to illicit opioids and increases overdose deaths. In this scenario, individuals who are in racial outgroups tend to have less access to care due to the historical redlining practices and their impact on neighborhood health. Looking through the lens of housing discrimination, it is evident that redlining plays a significant role in determining the individual's health. Redlining practices limit socio-economic status and create health-damaging conditions in residential environments.

In addition, housing discrimination can lead to restricted access to desirable services such as medical care and can increase the impact of unemployment and financial strain. The negative neighborhood consequences of race-based housing discrimination contribute further to residential segregation and restrict people of color to living in less desirable areas (Rosigno et al., 2009; Williams and Jackson 2005). There are strong links between residential segregation and negative health outcomes, including a higher risk of mortality, low birth weight, and cancer (Landrine et. al., 2017). A study done in 2018 to investigate the impact of housing discrimination on neighborhood health highlights that housing discrimination denies people access to various life opportunities, restricts people's housing choices, prevents people from accumulating wealth, and limits housing options to areas with high exposure to crime and violence. The association between redlining and neighborhood health can lead to less access to care. In turn, might cause higher rates of self-medication with illicit drugs. The prescription rates will likely

be lower for racial outgroups who have been distanced from “healthier” communities with more opportunities to access treatment programs and health care.

This decreased rate might be visible in wealthier neighborhoods that can afford to treat and support individuals out of addiction. Harm reduction strategies focus on reducing the negative consequences of drug use, such as overdose deaths, without necessarily requiring abstinence. One common harm reduction strategy is the provision of naloxone, a medication that can reverse an overdose. Additionally, harm reduction strategies may involve providing education and resources to individuals who use drugs, such as clean needles, to reduce the risk of infection and other health complications. The implementation of these harm reduction strategies may lead to a decrease in overdose deaths by providing individuals with the tools and resources to use drugs more safely and by increasing access to life-saving interventions in the event of an overdose. The areas that were rated as risky may have less access to these harm reduction strategies than areas rated as low risk, leading to a higher risk of overdoses.

Discussion

The mechanisms in both theories might be present; however, these mechanisms lead to competing outcomes. In Theory 1, the overdose rates will be higher in areas that are rated low risk than in the more risky areas. In Theory 2, the overdose rates will be *lower* in areas rated low risk than in the risky areas. The Opioid Epidemic is closely tied to redlined areas in New Jersey and highlights the lasting impact of discriminatory housing policies on communities of color. Redlined areas have historically been characterized by disinvestment, limited access to healthcare and other resources, and higher levels of poverty and unemployment. These factors have contributed to the development of a range of social and health disparities, including the disproportionate impact of the Opioid Epidemic on these communities. Addressing the Epidemic in redlined areas requires a multifaceted approach that includes addressing underlying structural inequities, increasing access to healthcare and addiction treatment, and implementing harm reduction strategies to reduce the negative consequences of drug use.

Chapter 4: Data and Methods

Data

What follows is a retrospective observational study that analyzed data collected by the Department of Health in the state of New Jersey from death records at the census tract level between the years 2015-2020. The New Jersey death records were obtained from the Office of Vital Statistics and Registry (OVSR). Additionally, the NHGIS data (National Historical Geographic Information System) was utilized, which provides access to a wide range of census data and other geospatial data. The data was collected from a variety of sources, including the US Census Bureau, the National Center for Health Statistics, and the Bureau of Economic Analysis. I received approval for the study protocol by both the Bucknell University IRB and the Rowan University IRB. The OpenICPSR redlining data was also sourced from several historical redlining maps created by the federal government's Home Owners' Loan Corporation (HOLC) in the 1930s, as well as other redlining maps created by private organizations during that time period.

The redline score was calculated on a scale from 1 to 4. Scores of 1 and 2 represent neighborhoods rated as low risk while scores of 3 and 4 are high risk. They are weighted averages as some neighborhoods don't match up perfectly with the census tract data. New Jersey has over 2,000 census tracts; many of these tracts do not have scores because these areas are largely rural. In my analysis, I created a categorical variable where the categories included unrated, low risk (scores between 1 and 2.99) and high risk (scores of 3 and above).

The target population for this study was primarily adults aged 18 years and older, with a focus on census tracts. The final dataset contained over 650,000 data points over the seven-year period. However, some census data was missing, and some redlined areas were missing as well. Data cleaning was performed for both the death record dataset and the NHGIS dataset, and variables were renamed to match the death record data. Data analysis involved creating an opioid indicator variable and a count variable, which sums up all opioid-related overdose deaths by county, census tract, and year. The overdose rate was then created by dividing the count by the total population given by the NHGIS dataset. The overdose rate was multiplied by 10,000 to scale it to a rate per 10,000 people. Once the rates were created, the data was converted from the individual death records to the census tract as the unit of observation and the demographic information from the NHGIS data were attached.

Limitations of this analysis include the presence of missing data, specifically with regards to the underestimated counts due to the large number of observations that did not contain the census tract identifier, which may be particularly problematic for areas that were historically redlined. The methods utilized in this study included t-test and regression analysis of the form below. The redlined score does not have a year and is consistent from year to year. Additionally, a redline missing indicator was included for when the redline score was missing.

Regression Equation

The ordinary least squares regression analysis allows for additional demographic controls and takes the following form:

$$\begin{aligned} \text{Overdose rate}_{j,t} = & \beta_0 + \beta_{1A}(\text{Low Risk})_{j,t} + \beta_{1B}(\text{High Risk})_{j,t} \\ & + \beta_2(\% \text{ Black})_{j,t} + \beta_3(\% \text{ AIAN})_{j,t} + \beta_4(\% \text{ Asian})_{j,t} + \beta_5(\% \text{ NHOPI})_{j,t} \\ & + \beta_6(\% \text{ Other Race})_{j,t} + \beta_7(\text{Median Household Income})_{j,t} + \beta_8(\% \text{ Insured})_{j,t} \\ & + \beta_9(\% \text{ Male})_{j,t} + \beta_{10}(\% \text{ Poverty})_{j,t} + \beta_{11}(\text{Year}) + \epsilon_{j,t} \end{aligned}$$

Where j represents the census tract and t represents the year; the omitted redline category is *not* rated. The interpretation of the coefficients β_{1A} and β_{1B} are therefore relative to the unrated census tracts, and the differences in these two values will indicate whether rates in the low risk tracts are different from risks in the high risk tracts. The overdose rate indicates the opioid overdose death rate per 10,000 people within a given census tract by year. Percent Black, American Indian and Alaskan Native, Asian, Native Hawaiian, and Other Pacific Islander, other race, and Male are calculated per 10,000 individuals in a census tract. Median household income indicates the per capita income in past 12 months in dollars. Percent insured represents the individuals who have some type of health insurance. Percent poverty represents individuals who live below the poverty line in New Jersey.

Table 2. Variable Definitions for New Jersey Department of Health Data

Variable Name	Definition
amfYearDeath	Year of Death
amfCountyResidence	County Code
amfCensusTract	Census Code
GEOID	Geographic Identifier
odrate	Opioid Overdose Death Rate
totalpop	Total Population
pctwhite	Percent White
pctblack	Percent Black
pctaian	Percent American Indian and Alaskan Native
pctasian	Percent Asian
pctnhopi	Percent Native Hawaiian and Other Pacific Islander
other_race	Percent Other Race
totalpov	Percent in Poverty
hhi	Median Household Income
redline_score	Redline Score
redline_cat	Generated Redline Categories
pctinsured	Percent Insured
pctmale	Percent Male
pctfemale	Percent Female

Table 3. Variable Definitions for NHGIS Data

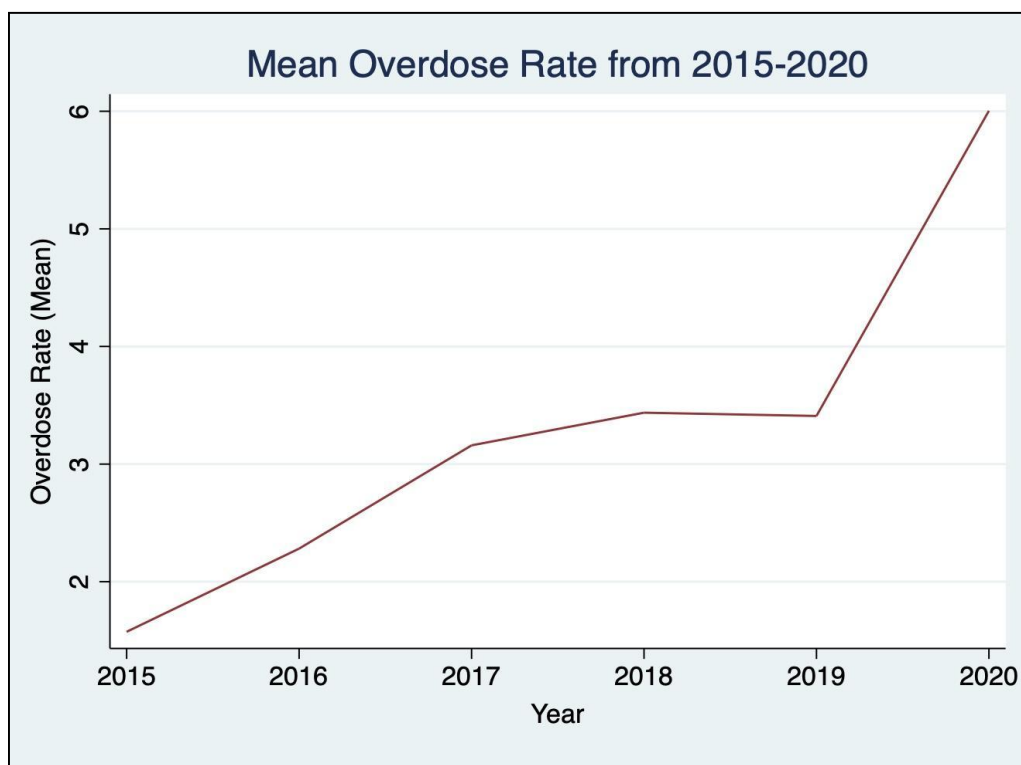
NHGIS Variables
B01003. Total Population
B01001. Sex by Age
B19013. Median Household Income in the Past 12 Months (in 2014 Inflation-Adjusted Dollars)
C17002. Ratio of Income to Poverty Level in the Past 12 Months
B19083. Gini Index of Income Inequality
B27010. Types of Health Insurance Coverage by Age

Note: Variables were collected from the NHGIS database, the identifiers are in reference to this database.

Chapter 5: Results

In this section I will cover some of the trends in the data and descriptive statistics followed by the group mean test and the regression analysis. In Figure 1, the mean overdose deaths are increasing over the 6-year time period. There seems to be a plateau from the years 2017 to 2019. Then in 2020, the mean overdose death rate increases significantly. This is very similar to opioid overdose trends in the US, which also show a stark increase from 2020 onwards.

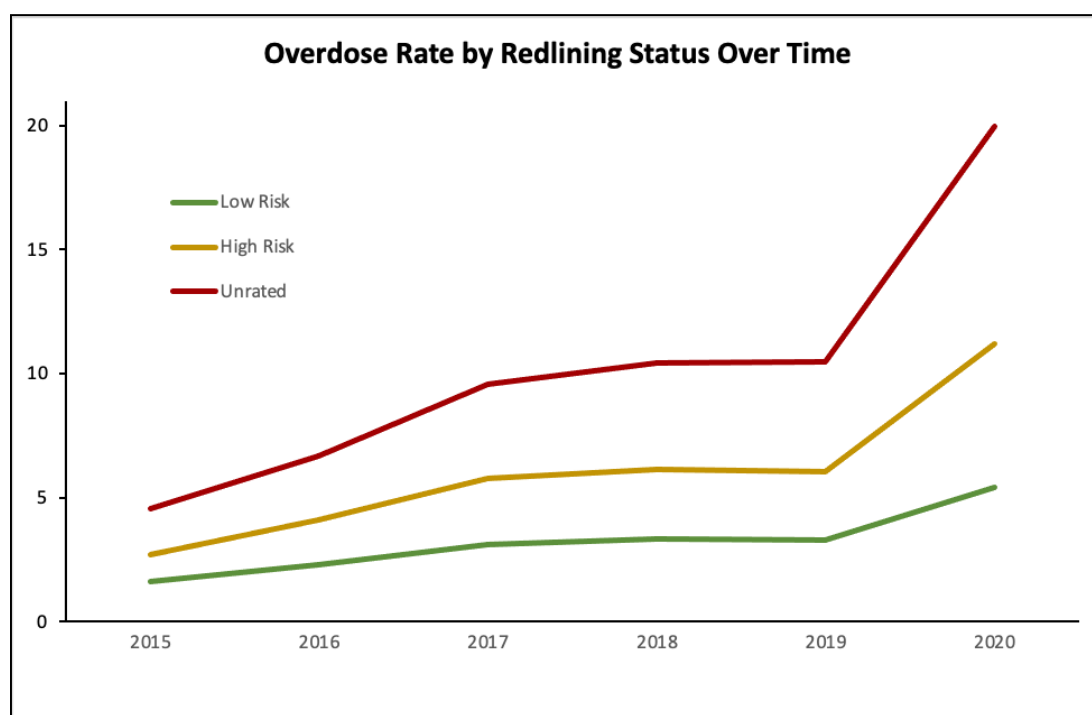
Figure 1. Time-Series Line Graph: Opioid Overdose* Deaths Over Time in New Jersey



* Overdose deaths were identified using ICD-10 multiple cause-of-death codes stated in the data and methods section. The overdose rate is calculated per 10,000 residents within a census tract.

The overdose death rate seems to be distinctly different within each status category. The rate was calculated as a mean within each category per year. As we can see, the “Risky” status has a higher tendency for overdose deaths over time, on average. The “Low Risk” tracts seem to be slightly lower in overdose deaths, followed by the unrated tracts.

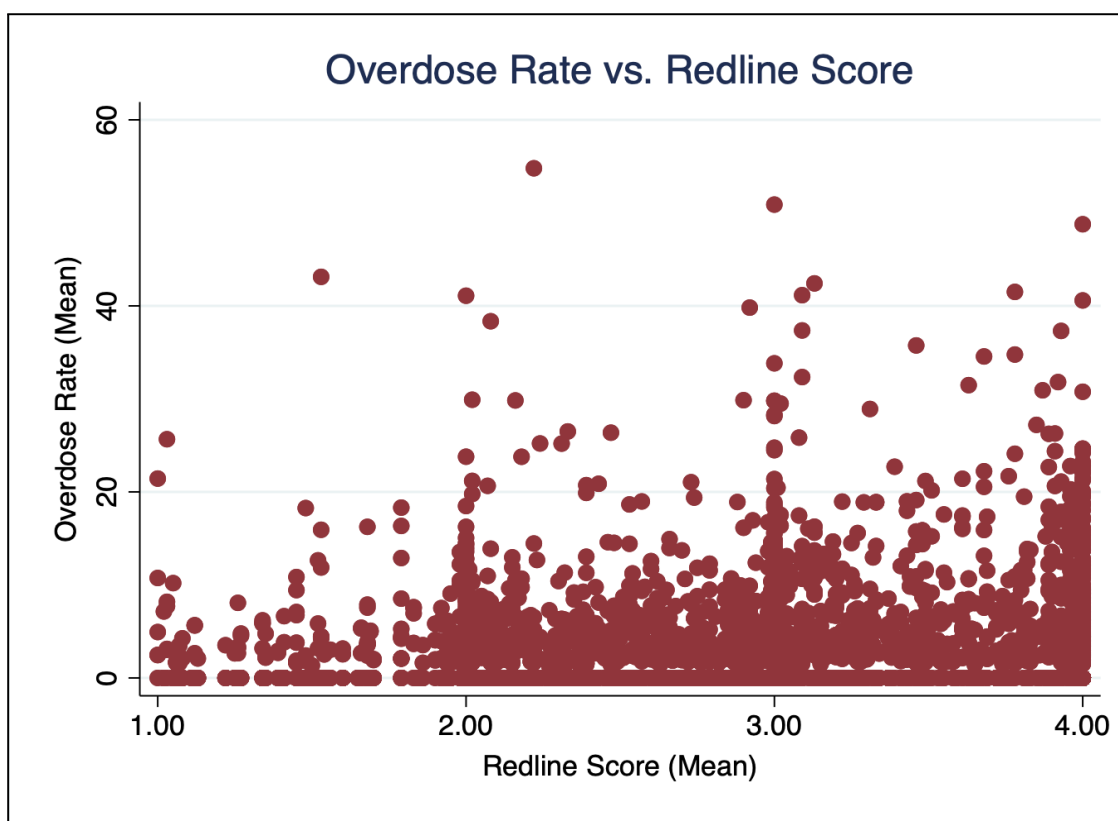
Figure 2. Time Series Line Graph: Redline Status and Overdose Rates Over Time in New Jersey



* Redlining Categories are calculated as stated in the data and methods section. Overdose deaths were identified using ICD-10 multiple cause-of-death codes stated in the data and methods section. The overdose rate is calculated per 10,000 residents within a census tract. Tracts with redlining scores of above 3.00 were rated as “risky”, between 1 and 3 were rated as “low risk”, and unrated.

We can see that there is a pattern in the data; however, it is unclear how linear the relationship is. This graph depicts the redline scores as non-integer values ranging from 1-4 as they are weighted to include the scoring of areas that surround their respective census tract. The categories indicated by the HOLC are integer values ranging from 1-4. These data indicate that we should model the score as categories rather than the score which will allow us to see the precise differences in score gradations and does not force a linear relationship between the redlined score and the overdose rate.

Figure 3. Scatter Plot: Overdose Death Rate vs. Redline Categories



* Redlining Categories are calculated as stated in the data and methods section. Overdose deaths were identified using ICD-10 multiple cause-of-death codes stated in the data and methods section. The overdose rate is calculated per 10,000 residents within a census tract.

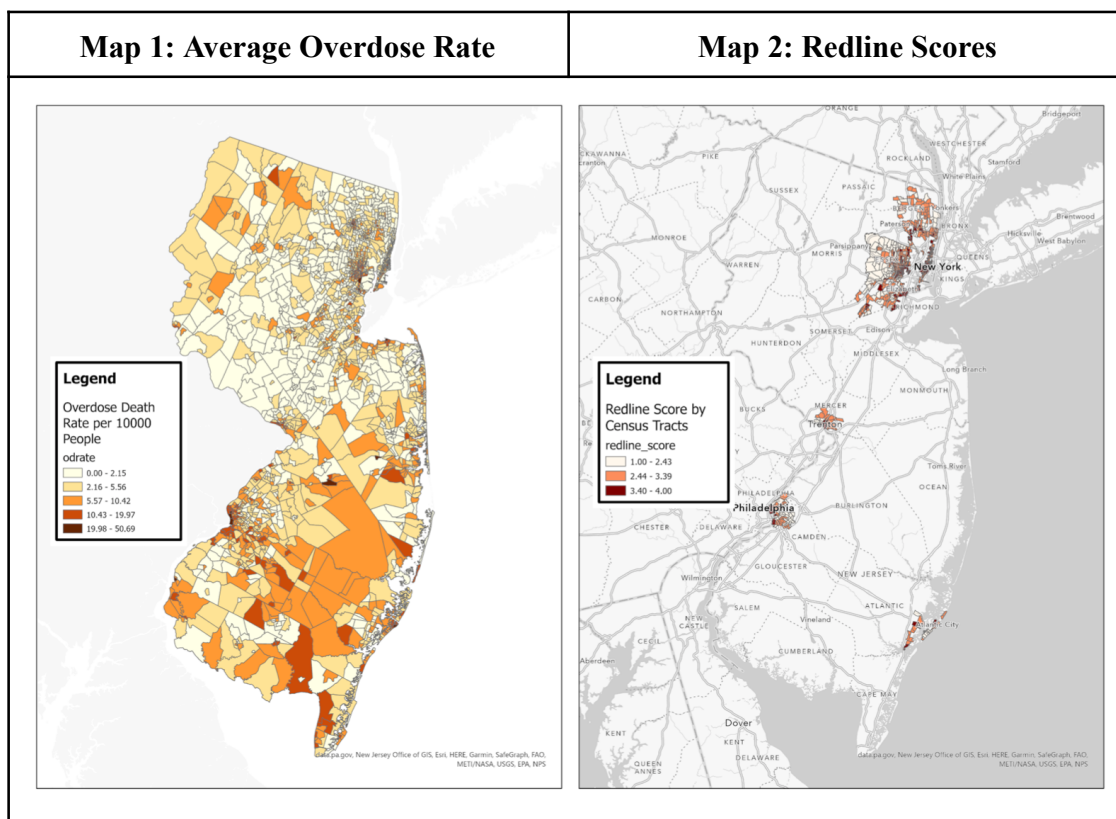
In this table, there is a slight increase in drug overdose as the redline score becomes riskier for Black individuals. Additionally, the household income for these riskier neighborhoods is significantly lower than in other neighborhoods.

Table 4. Descriptive Statistics By Redline Score Category

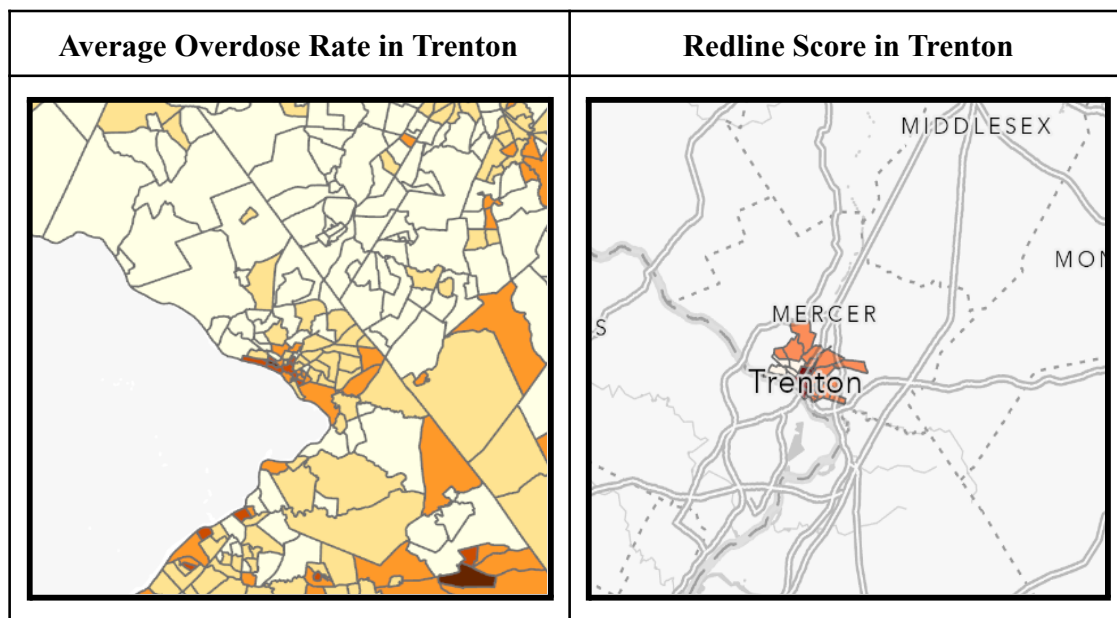
Mean (std. dev.)	Unrated Tract	Low Risk Tract	High Risk (Redlined) Tract
Overdose Death Rate (per 10,000)	3.22 (4.89)	2.82 (4.56)	4.28 (5.93)
Total Population	4513.01 (1956.54)	4396.17 (1403.24)	3781.89 (1436.41)
% White	0.74 (0.21)	0.59 (0.28)	0.45 (0.28)
% Black	0.10 (0.14)	0.23 (0.28)	0.29 (0.31)
% American Indian Alaskan Native	0.00 (0.01)	0.00 (0.00)	0.00 (0.01)
% Asian	0.09 (0.12)	0.08 (0.09)	0.08 (0.13)
% Native Hawaiian Pacific IslanderI	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
% Other Race	0.10 (0.11)	0.13 (0.10)	0.20 (0.15)
% Poverty	0.01 (0.01)	0.01 (0.01)	0.02 (0.01)
Median Household Income	89106.53 (37087.59)	93395.38 (49938.99)	55461.80 (26820.95)
% Insured	0.70 (0.10)	0.68 (0.08)	0.61 (0.11)
% Male	0.49 (0.05)	0.48 (0.03)	0.49 (0.05)
% Female	0.51 (0.05)	0.52 (0.03)	0.51 (0.05)
N	10,167	1,816	2,192

Mapping

Map 1 shows the overdose rates in New Jersey, with specific areas showing higher rates of overdoses. The clustering of overdoses highlights the severity of the Opioid Crisis in certain regions of the state. Some more rural areas have high rates as well as some in the areas with redlined scores. Map 2 displays the redline scores for identifiable regions in the state of New Jersey.



Presented below is an enlarged image of the aforementioned map.



The zoomed-in map with the drug overdose death rate and low-rated redlined areas side by side provides a powerful visual representation of the longstanding effects of systemic racism in Trenton County. There seem to be higher rates in the lower-rated redlined areas.

The results of the comparison of means analysis indicate that there is a statistically significant difference between the mean values of the low risk and high risk groups. Specifically, the mean value for the low risk group was 2.82 (SD=0.10), while the mean value for the high risk group was 4.27 (SD=0.12). The difference between these mean values was found to be significant ($t(3915) = -8.46$, $p < .001$), indicating that the high risk group had a significantly higher mean value than the low risk group. These findings suggest that there may be a meaningful difference between these two groups, and further investigation may be warranted to explore potential factors contributing to this difference.

Table 5. Comparison of Means Analysis

Group	Mean Overdose Rate	Std. dev. (Std. err.)
Low Risk	2.82	4.55 (0.10)
High Risk	4.27	5.93 (0.12)
Difference	-1.45	

t = -8.46*
H_0 : diff = 0

When other demographic variables are controlled for, the differences in the overdose death rates by redlined category decrease relative to the group mean t-test analysis. In Table 3, the low-risk tracts have a slightly lower overdose death rate than unrated tracts and the high-risk tracts are statistically indistinguishable from the unrated tracts. A ten percentage point increase in the poverty rate in the tract is correlated with a 0.9 increase in the overdose death rate per 10,000 people. Tracts with a higher percentage of the population that is Black have higher overdose death rates than tracts with higher percentages of the population that are White, holding all other races constant. However, in magnitude, the race effect is less than the poverty effect or the redlined effect. A ten percentage point increase in the percent insured is correlated with a 0.15 increase in the overdose death rate, along with a 0.37 increase if the individual is male as opposed to female.

Table 6. Regression Results

	Coefficient	Standard Error	P-values
Low Risk	-0.52	0.13	0.000***
High Risk	-0.22	0.13	0.094
% Black	2.15	0.26	0.000***
% AIAN	6.42	7.15	0.369
% Asian	-4.68	0.38	0.000***
% NHOPI	12.22	19.82	0.537
% Other Race	3.40	0.47	0.000***
% In Poverty	89.56	7.03	0.000***

	Coefficient	Standard Error	P-values
Low Risk	-0.52	0.13	0.000***
High Risk	-0.22	0.13	0.094
Median Household Income	-0.00016	0.000000158	0.000***
% Insured	1.56	-0.59	0.000***
% Male	3.70	1.13	0.001***
Year	0.80	51.28	0.000***

Total number of observations is 12,119 with *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ and the categories that are omitted are % White and the unrated tract category

Chapter 6: Discussion

Based on the research conducted, it can be concluded that there is a potential association between redlined areas that are rated as risky and an increased drug overdose rate. The results of this study highlight a relationship between redlining and drug overdose deaths in the United States. The analysis of Figure 1 shows a significant increase in overdose deaths in 2020, which corresponds to the onset of the COVID-19 pandemic. This suggests that the pandemic may have exacerbated the existing Opioid Epidemic, highlighting the need for targeted interventions and resources to address this issue. The findings from Figure 2 shows that there are distinct differences in overdose death rates between different status categories, with the "Risky" status having a significantly higher tendency for overdose deaths over time. This underscores the importance of addressing the factors that contribute to redlining and disinvestment in these communities, including limited access to resources and opportunities.

While the regression analysis shows a smaller direct effect of redlining on opioid overdoses, it does not imply redlining practices have no effect. The analysis of Table 2 further confirms the importance of socioeconomic factors in the risk of drug overdose, with higher poverty rates correlating with higher overdose death rates. Since the comparison of means analysis in this study suggests that there is a significant difference between the mean values of redline scores less than three, this result from the regression analysis suggests that one mechanism through which redlining is impacting drug overdoses is poverty. This finding suggests that the redlining score may be an important factor in understanding the risk of a drug overdose, and further research is needed to

explore the potential mechanisms that contribute to this relationship. Due to time constraints, I was not able to do age and gender-adjusted rates and explore other mechanisms that may affect overdoses that could also be related to redlining, such as access to health care. Future research could include these assessments in their analysis to obtain a better understanding of these other effects.

Chapter 7: Conclusion

Most of the preliminary research that I did for this project centered the Opioid Epidemic around rural white individuals (Netherland et al., 2016), however, my study suggests that there are similar rates for formerly redlined urban neighborhoods which have higher percentage of Black residents.

The results provide insight into the complex relationship between redlining and drug overdose deaths in the United States. It suggests that this historical practice has long-lasting effects on the health outcomes of communities of color (Roberts, 2008). These communities continue to experience disproportionate rates of addiction and overdose, even as the Opioid Epidemic has become more widely recognized as a public health crisis. The dynamic between the roles of power and healthcare access has created a large disparity in health outcomes for racial outgroups. It has impacted the trust and reliability of physicians which further exacerbates the inequality.

Some recommended approaches to addressing drug addiction and overdose in the United States might include *building* on health research that recognizes historical structures that have limited opportunities for communities of color (Ruqaiijah, 2021), targeting policy towards populations that are underrepresented in the media (Williams, 2000), and establishing a healthcare approach that acknowledges and addresses racial inequities that are essential for improving the quality of treatment available to underserved communities.

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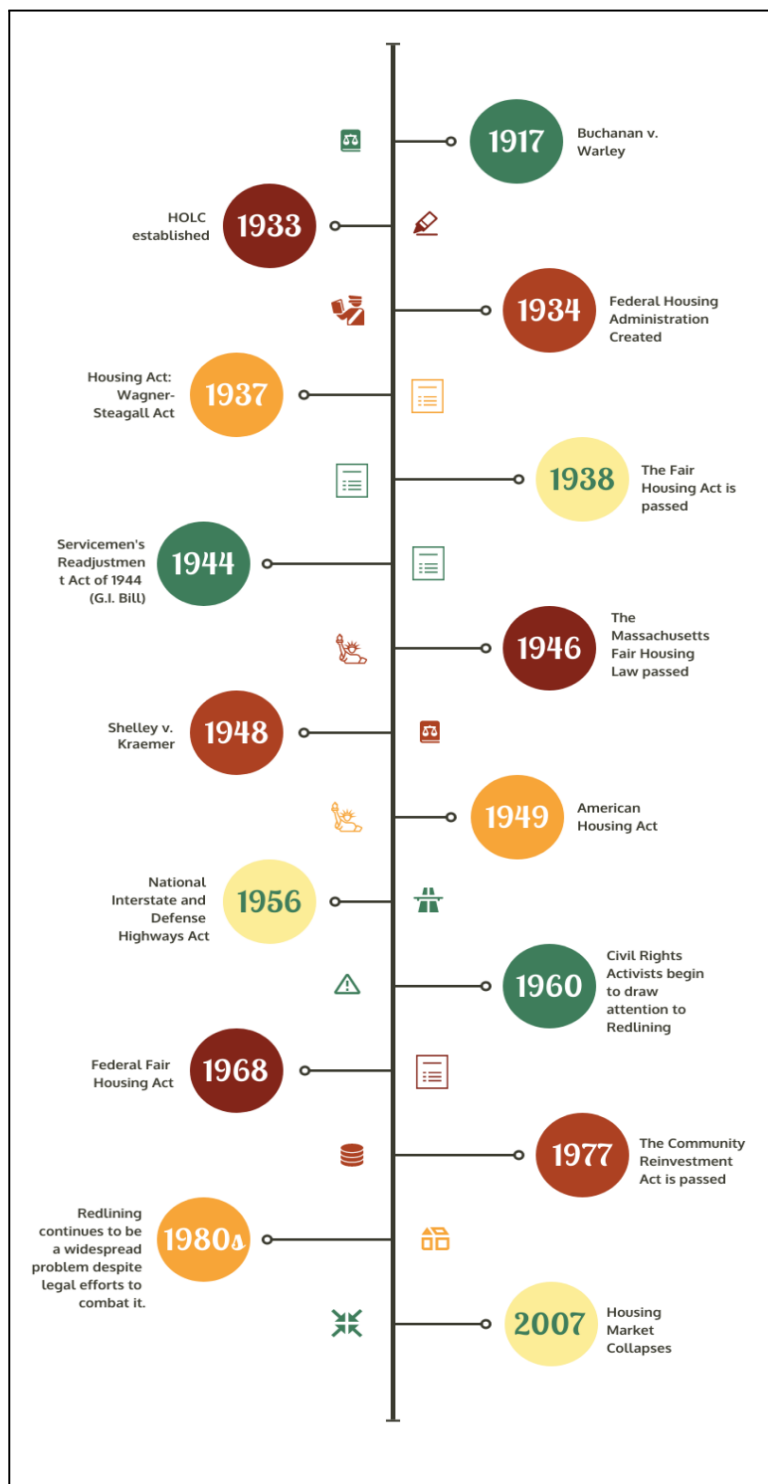
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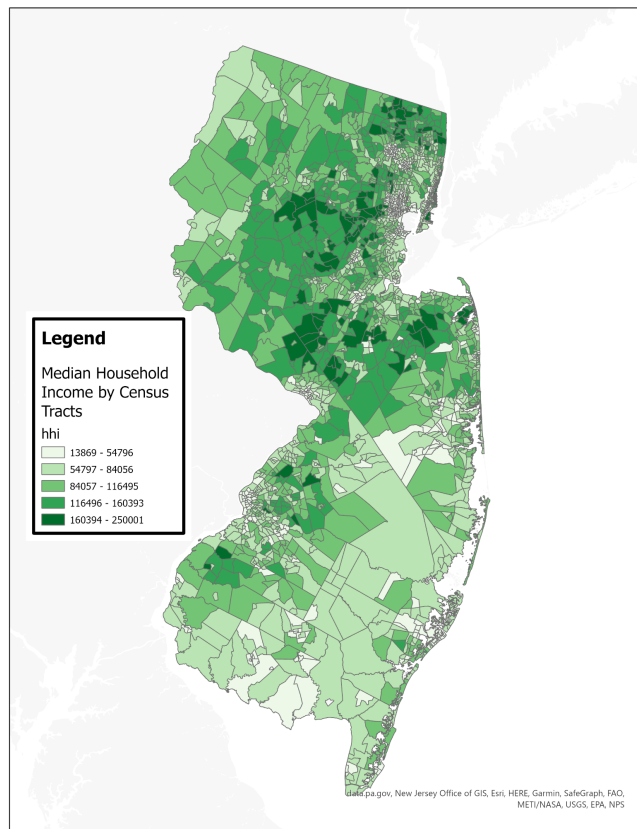
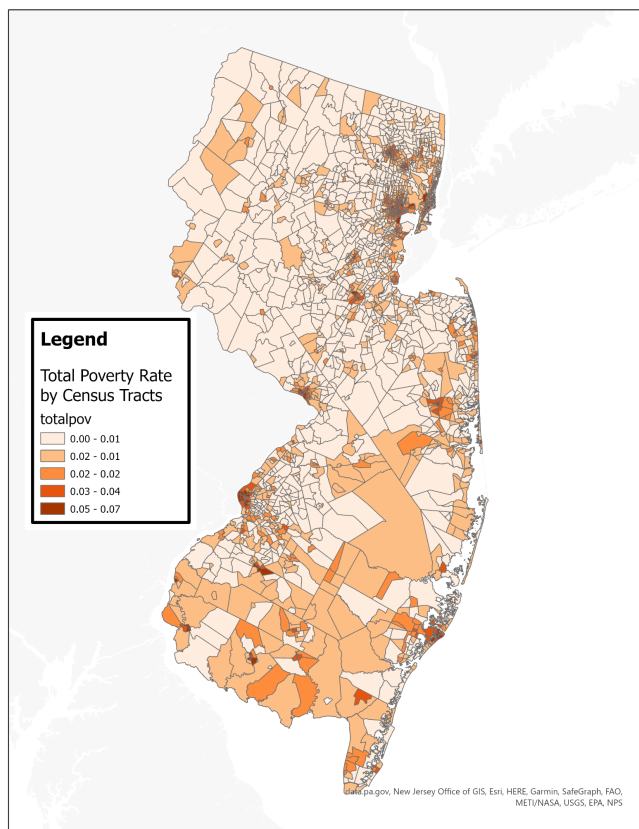
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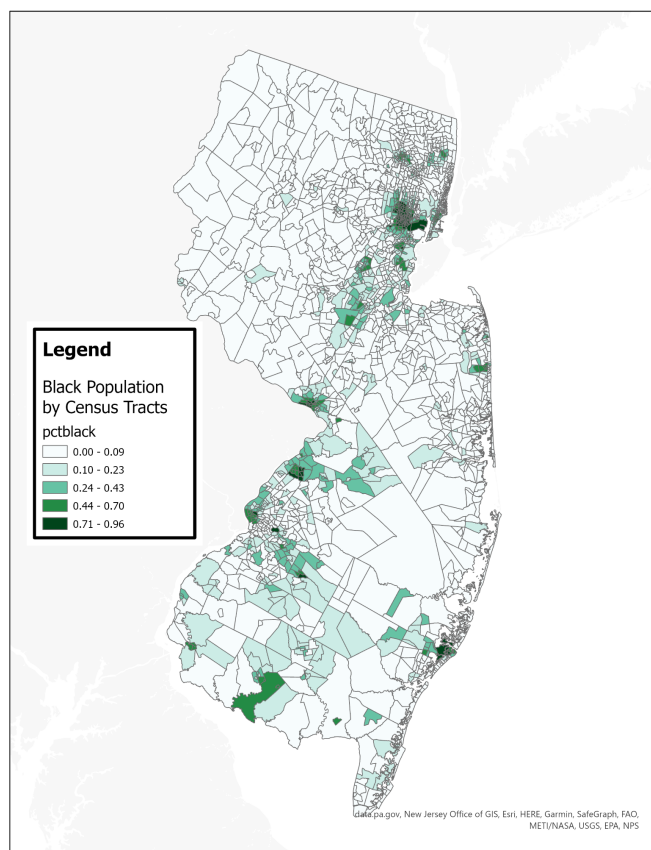
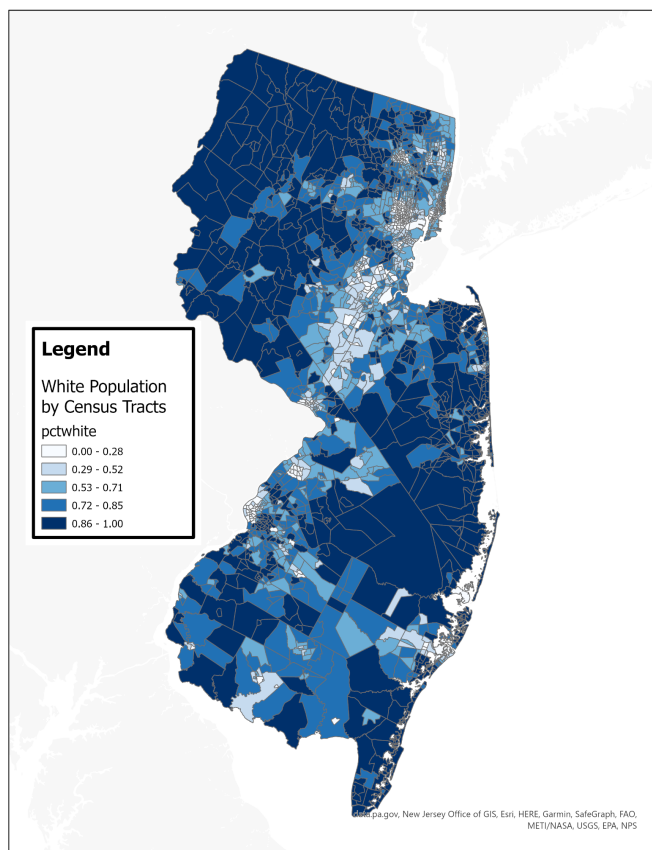
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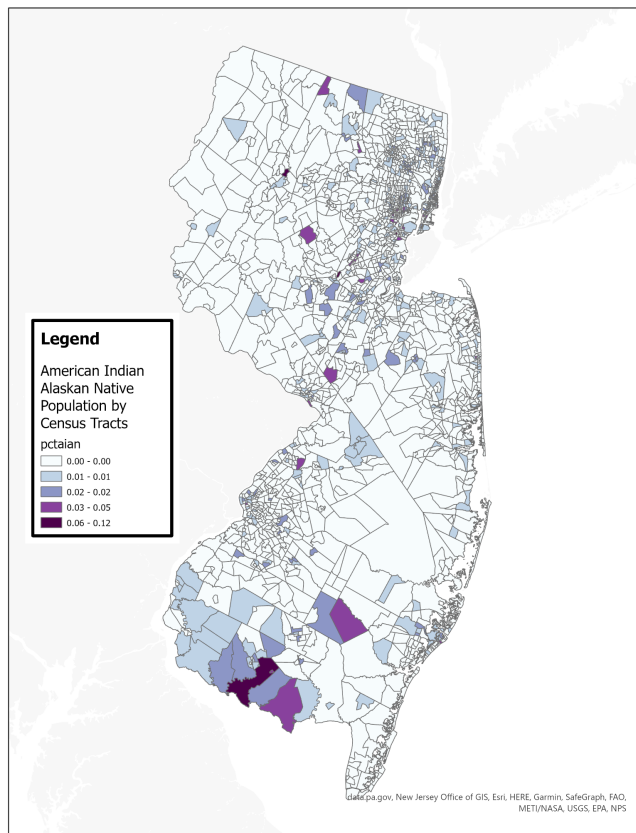
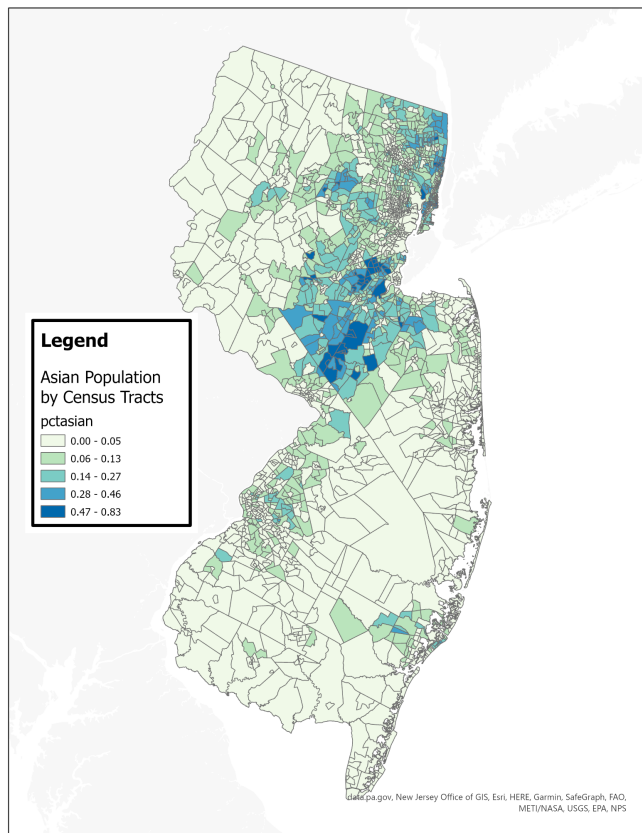
Appendix A: Redlining Timeline

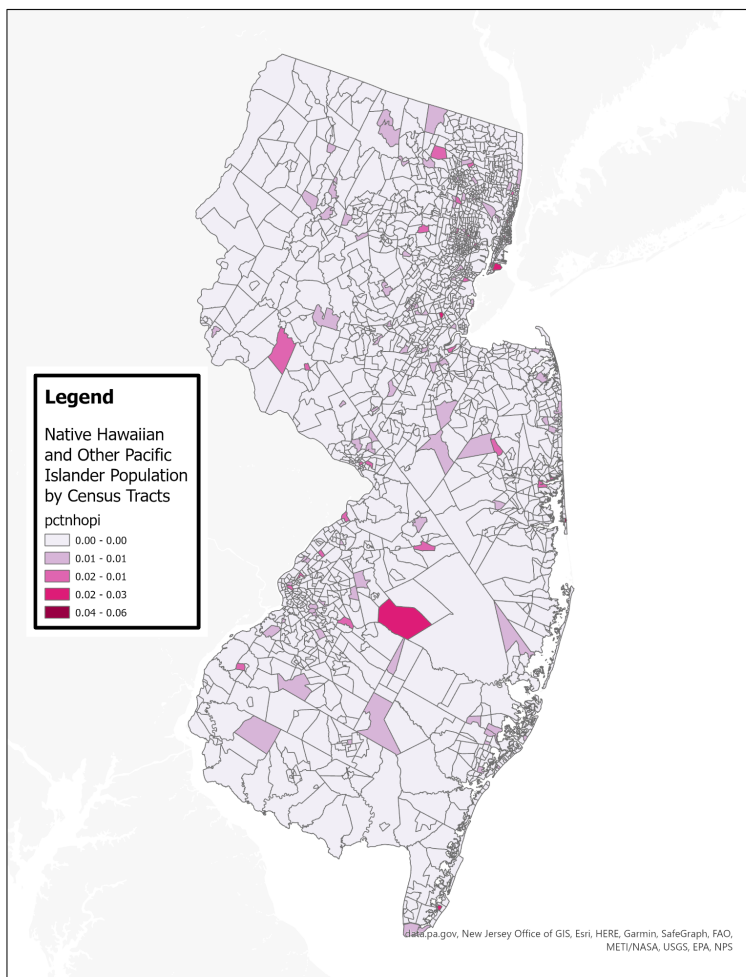


Appendix B: Maps of New Jersey









Appendix C: Opioid Treatment Centers (OTP) and Substance Abuse Treatment Centers (SA)

