Environmental Justice Considerations in New York City: The Racial Disparities in Adverse Birth Outcomes, Air Pollution, and Public Housing Developments

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ABSTRACT

This thesis argues that there are structural and systematic connections between history and geography that create and influence the differences between the lived experiences of Black people living in the U.S. and those of White people living in the U.S. The patterns of residency that occur in the U.S. have a historical context, and it is vital to understand this context in order to understand the distribution of demographics that we see today: race, socioeconomic status, health outcomes, etc. The history of Black people is at the root of how racism formed and took shape in America. By using public health data and Geographic Information Systems (GIS), this thesis explores the importance of history and race, and what contribution these two factors might have towards generating the pattern that we see in adverse birth outcomes today. This thesis covers the topics of history of New York City, racial disparities in health, adverse birth outcomes and air pollution exposure, and environmental justice. I argue that the racial disparities we see in exposure to air pollution and incidence of adverse birth outcomes are due to institutional and environmental racism that persists today.

CHAPTER 1: Introduction

My Connection to this Thesis

New York City is the place that I have called home for the past twenty-two years. While I have had the privilege of having good health, ever since I was a young girl I noticed that was not the case with everyone. During my junior year at Tufts I took a course entitled "Introduction to Community Health" with Professor Jennifer Allen. Our first assignment was to write about a problem facing our community. Accordingly, I defined my community as New York City and explored the issue of infant mortality. What I found was that there are shocking differences between the infant mortality rate in the White population and the infant mortality rate in the Black population. In "Introduction to Community Health" I learned about the social determinants of health and the impact they have on health outcome. The same semester in "Race in America" I learned about my position in society as a White woman. After learning about the racial disparities in infant mortality I felt compelled to use the privilege that I have to conduct more research into why these disparities occur and to hopefully help to ameliorate them.

It is important to recognize that White/Black racial disparities in health are not the only racial disparities that exist. However, I chose these populations because they have been studied extensively in New York, where the Black population consistently suffers from worse health across a range of different outcomes than the White population and than various other racial groups.

In talking about race, I make an intentional decision to capitalize both Black and White. In this thesis, these two groups are race names and entities. The literature sometimes only capitalizes non-White racial groups, but doing this would normalize White and make all other racial groups not normal.

Throughout this thesis you will see the term 'people of color', but you will not see the term 'minority.' This is a deliberate choice because not only are people of color not always in the 'minority' numerically in terms of demographics, but also because the term minority perpetuates the idea that people of color are of lesser status than Whites, and it normalizes Whites while 'othering' and making other racial groups seem not normal.

Objectives of this Thesis

This thesis argues that there are structural and systematic connections between history and geography that create and influence the differences between the lived experiences of Black people living in the U.S. and those of White people living in the U.S. The patterns of residency that occur in the U.S. have a historical context, and it is vital to understand this context in order to grasp the distribution of demographics that we see today: race, socioeconomic status, health outcomes, etc. The history of Black people is at the root of how racism formed and took shape in America. My goal is to understand how history matters and how race matters, and what contribution these two factors might have towards generating the pattern that we see in adverse birth outcomes today. It is not my goal to answer the question, "what causes the adverse birth effects." Rather, it is my goal to explore what some of the a priori influences are, and these influences begin with

where you live. This thesis explores the topics of history of New York City, racial disparities in health, the association between adverse birth outcomes and air pollution exposure, and environmental justice.

The significance of my historical chapter (Chapter 3) is to trace the immigration and migration patterns of the Black and White populations, development of the highway system, and housing and residential patterns in New York City. This chapter will set the foundation for observing the distribution of Black and White people throughout New York and why certain racial groups are more concentrated in certain area of the City.

The chapter on racial disparities in health (Chapter 4) aims to give the reader a foundational understanding of social determinants of health and the resulting racial disparities in health. A plethora of poor health outcomes are seen in a greater extent in the Black population than the White population. Healthy People 2020 defines health disparities as "a particular type of health difference that is closely linked with social, economic, and/or environmental disadvantage. Health disparities adversely affect groups of people who have systematically experienced greater obstacles to health and preventative care based on [factors such as] their racial or ethnic group."[1] It is of the utmost importance that the reader understands the importance of social determinants of health on a person's health outcome, which is what this chapter sets out to do.

The chapter on adverse birth outcomes and air pollution reviews the evidence for the link between air pollution and adverse birth outcomes. I argue that just as Chapter 3 established that there are racial disparities in health outcomes, there is also racial

[1] Healthy People, Office of Disease Prevention and Health Promotion. (2015). Disparities. Retrieved from

disparity in adverse birth outcomes and I begin to construct reasoning to show this disparity arises at least in part from differential exposure to air pollution.

The methods chapter (Chapter 5) explains the data and processes I used to create maps in ArcGIS. My results chapter (Chapter 6) discusses the links that have already been established between adverse birth outcomes, air pollution, proximity to highways, race, and the links that have yet to be established. I will be using maps I made using ArcGIS in order to explore the links that have yet to be established and should be studied further. I produced maps of the White population, the Black population, air pollution exposure, adverse birth outcomes, and traffic in New York City. ArcGIS is a very powerful tool in that it allows data to be visualized. While I am not doing a statistical analysis of the data, I am hoping that these maps will prompt others to ask questions regarding the associations I find and study the data more in depth.

My discussion (Chapter 7) seeks to emphasize the importance of addressing and discussing race when examining adverse birth outcomes and air pollution exposure. Race is often controlled for or not part of the central argument in studies, but my discussion chapter argues that the racial disparities we see in exposure to air pollution and incidence of adverse birth outcomes are due to institutional and environmental racism that persists today.

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CHAPTER 2: History

Brief History of New York City

This section will provide an overview of the historical components that are most relevant to my thesis, and will draw my reader's attention to what I believe are the most important pieces of history that shape the racial distribution of New York City today.

Before New York was settled it was occupied by indigenous people. More specifically, the Algonquins and the Haudenosaunee were the two main tribes living in what is now New York State. The Haudenosaunee were also known as the Iroquois, and the Lenape people, whom many assume were their own group, belonged to the Algonquian group.[2] In 1624, the Dutch West India Company settled the region that is now known as Manhattan. Over a century later, during the Revolutionary War, British troops occupied New York City, and promised freedom to enslaved Black people who moved to the city for refuge. By 1780, approximately 10,000 Blacks lived in New York City. As the city grew, streets became necessary.[3] So in 1811, the "Commissioner's Plan" created a grid system for the streets and avenues of Manhattan north of Houston Street. Slavery was practiced in New York until 1827 when all enslaved Black people in New York were freed, and in 1832 the first horse drawn streetcars ran through New York.[4]

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[2] New York City Department of Education. (2008). *Native Americans: First Inhabitants of New York State*. Office of Curriculum and Professional Development. Retrieved from http://schools.nycenet.edu/offices/teachlearn/ss/41.pdf

[3] New York City History. (2015). Retrieved from http://www.history.com/topics/new-york-city

[4] Lambert, T. (2015). A Brief History of New York City. Retrieved from http://www.localhistories.org/newyork.html

Immigrants entered the United States through several ports. Europeans mostly came through the East Coast and Asians through the west coast, but more than 70% of immigrants came through New York City, which was also known as the "Golden Door."[5] Between 1820 and 1892, more than 11 million immigrants entered the United States.[6] In 1890, Castle Island closed and the Barge Office was utilized until Ellis Island opened in 1892.[7] Immigrants entering via Ellis Island mostly originated from Southern and Eastern Europe, which is reflected by the fact that over two million Italians and two million Jews from Russia and Eastern Europe, in addition to Poles, Hungarians, Austrians, and Greeks entered through this port. The Irish potato famine, which began in 1845, caused incredible desperation among the Irish people.[8] So by 1850, a quarter of the New York population was Irish, largely due to immigration caused by the devastating potato famine.[9] By 1898, the City consisted of approximately 3,350,000 people[10] and New York was so densely populated that many people lived in crowded tenements.[11] The demographic composition of New York is crucial to note because as immigration

[5] HERB: Resources for Teachers. (2015). *Background Essay on Late 19th and Early 20th Century Immigration*. American Social History Project/Center for Media and Learning. Retrieved from http://herb.ashp.cuny.edu/items/show/513.

[6] U.S. Immigration Before 1965. (2015). Retrieved from http://www.history.com/topics/u-s-immigration-before-1965

[7] U.S. Immigration Before 1965. (2015). Retrieved from http://www.history.com/topics/u-s-immigration-before-1965

[8] Smith, Betty. (1943). *A Tree Grows in Brooklyn*. New York, New York: Harper & Brothers.

[9] U.S. Immigration Before 1965. (2015). Retrieved from http://www.history.com/topics/u-s-immigration-before-1965

[10] U.S. Immigration Before 1965. (2015). Retrieved from. http://www.history.com/topics/u-s-immigration-before-1965

[11] Smith, Betty. (1943). *A Tree Grows in Brooklyn*. New York, New York: Harper & Brothers.

continued in following decades, the City became increasingly more heterogeneous as it was populated by people of various races.

Throughout this period (19th century) of European immigration to New York City, the transition toward a modern industrial city was almost complete. Various adverse effects of modernization manifested as the increase in population added pressure on limited housing resources, and immigrants, workers, and the urban poor found themselves forced into tightly packed apartments, tenements, and cellars.[12] New York City residents experienced cholera, typhoid, and yellow fever. Poverty, unemployment, violence, and crime became common. Riots were clear signs of the social, economic, and racial tensions that would only intensify as time went on.

By the mid 19th century, New York was no longer a developing city, as it had become a modern industrial city. From 1860 to 1920, New York was reshaped by technology, transportation, and economic development. However, as the city continued to grow in size, it became more socially divided by economic status and residentially segregated by race.[13] Residential segregation by race initially occurred in the early 1900s, and the lived experiences of people of color were drastically different from the lived experiences of White people in part because of the differences in where they lived.

By the end of the 19th century and beginning of the 20th century, a mass immigration of Jews from Central Europe to New York occurred.[14] The lower east side of

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[12] Mohl, R. (2002). *The Interstates and the Cities: Highways, Housing, and the Freeway Revolt* (Research Report). University of Alabama at Birmingham. Retrieved from http://www.prrac.org/pdf/mohl.pdf

[13] Mohl, R. (2002). *The Interstates and the Cities: Highways, Housing, and the Freeway Revolt* (Research Report). University of Alabama at Birmingham. Retrieved from http://www.prrac.org/pdf/mohl.pdf

[14] Berlin, I., Arendt, H., Einstein, A., Lazarus, E., Potter, A., Smulewitz, S., … Razovsky, C. (2004, September 9). A Century of Immigration, 1820-1924 - From Haven to Home: 350 Years of Jewish Life in America |

Manhattan became a haven for Jewish people, who became major owners and workers in the garment industry. However, this period of immigration came to a halt in 1921 and 1924 with the passage of restrictive immigration.[15] The laws enacted by the Johnson Reed Immigration Act limited the numbers of immigrants gained entry to the U.S by imposing quotas based on country of birth. The act slowed immigration from eastern and southern Europe to a trickle; and in 1924, Chinese and Japanese immigrants were completely excluded.[16,17] The immigration act of 1924 reinforced the 1882 federal Chinese Exclusion Act that barred specific groups from immigration and naturalization based on race. The United States supported the institutionalization of racism even after Blacks were freed.

Ian Haney Lopez, a scholar of critical race theory, defines

> "'race' as a vast group of people loosely bound together by historically contingent, socially significant elements of their morphology and/or ancestry. [He] argues that race must be understood as a *sui generis* social phenomenon in which connected systems of meaning serve as the connections between physical features, races, and personal characteristics. In other words, social meanings connect our faces to our souls. Race is

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Exhibitions (Library of Congress) [web page]. Retrieved February 5, 2015, from http://www.loc.gov/exhibits/haventohome/haven-century.html

[15] Berlin, I., Arendt, H., Einstein, A., Lazarus, E., Potter, A., Smulewitz, S., … Razovsky, C. (2004, September 9). A Century of Immigration, 1820-1924 - From Haven to Home: 350 Years of Jewish Life in America | Exhibitions (Library of Congress) [web page]. Retrieved February 5, 2015, from http://www.loc.gov/exhibits/haventohome/haven-century.html

[16] The Immigration Act of 1924. (2015). Retrieved from https://history.state.gov/milestones/1921-1936/immigration-act

[17] US Immigration Legislation Online. (2015). Retrieved from http://library.uwb.edu/guides/usimmigration/1921_emergency_quota_law.html

> neither an essence nor an illusion, but rather an ongoing contradictory, self-reinforcing process subject to the macro forces of social and political struggle and the micro effects of daily decisions…Referents of terms like Black, White, Asian, and Latino are social groups, not genetically district branches of humankind… There are no genetic characteristics possessed by all Blacks but not by non-Blacks; similarly, there is no gene or cluster of genes common to all Whites but not to non-Whites. One's race is not determined by a single gene or gene cluster, as is, for example, sickle cell anemia. Nor are races marked by important differences in gene frequencies, the rates of appearance of certain gene types."[18]

Race is a social construct.[19] There is no biological basis for racial categories and there are no physical traits or a combination of physical traits that put people into the racial categories as they are commonly understood. In the U.S., the term social construct means that the idea of race is produced by human thought and interaction. Different racial categories only exist in comparison to White people, so without White people, there would be no races. Whites have social dominance, and they created the concept of race out of a desire to cement power and authority over those of different skin color.

When the period of European and Asian immigration into the United States came to a halt, a period of domestic migration began. 1915 marked the start of The Great Migration, which was characterized by the relocation of millions of African Americans

[18] Ian Haney-López. (1994). *The Social Construction of Race: Some Observations on Illusion, Fabrication, and Choice*. Berkeley Law Scholarship Repository: Berkeley Law. Retrieved from http://scholarship.law.berkeley.edu/cgi/viewcontent.cgi?article=2815&context=facpubs

[19] PBS. (2003). *Race, The Power of an Illusion* (Vol. Episode One). California Newsreel. Retrieved from http://newsreel.org/transcripts/race1.htm

from the southern states of the U.S. to northern states and California. Approximately five million Blacks moved out of the Deep South in an effort to escape oppressive economic conditions and segregationist laws that were often reinforced violently. Blacks sought to gain greater prosperity in the north in cities such as New York City and Chicago, in addition to going west to California. This era witnessed a large migration of Black people to formerly mostly-White cities.

World War I created a huge demand for work in the north, and southern Blacks capitalized on this opportunity to migrate.[20]

> "Over the course of six decades, some six million black southerners left the land of their forefathers and fanned out across the country for an uncertain existence in every other corner of America. The Great Migration would become a turning point in history. It would transform urban America and recast the social and political order of every city it touched. It would force the South to search its soul and finally to lay aside a feudal caste system. It grew out of the unmet promises made after the Civil War and, through the sheer weight of it, helped push the country toward the civil-rights revolutions of the 1960s."[21]

The Great Migration did not end until the 1970s when Jim Crow laws in southern states ceased to have legal force and "when the South began finally to change [as] the whites-only signs came down, the all-white schools opened up, and everyone could vote.

[20] The Great Migration (1915-1960). (2015). Retrieved from http://www.Blackpast.org/aah/great-migration-1915-1960

[21] Wilkerson, Isabel. (2010). *The Warmth of Other Suns, the Epic Story of America's Great Migration*. New York, New York: Random House.

By then nearly half of all black Americans —some forty-seven percent—would be living outside the South, compared to ten percent when the Migration began."[22] During this time, the population of Blacks in New York exceeded 6 million.[23]

These waves of migration contributed to reshaping New York City by introducing current White New York City residents to significant numbers of people of color. "The increasing numbers of racial minorities in the city threatened the social order as racist explanation of degraded black housing and living environments began to flourish. In some cities, Black tuberculosis mortality rates were up to second times higher than those of White. Thus, these higher rates of disease 'amplified middle-class antipathy toward the 'lower classes' and heightened anxieties over immigration and racial mixing'"[24] During this time, race relations between Blacks and Whites were tense, and the introduction of the urban expressway only added to the racial divide by creating a physical separation of the two races.

Introduction of the Urban Expressway

The City of New York experienced incredible change throughout the 18th and 19th centuries, but it was not until after World War II that Manhattan developed into the city it is today. The introduction of urban expressways catalyzed dramatic changes in American cities, as they eliminated the need for the omnibuses and horse cars of the 1820s, the

[22] Wilkerson, Isabel. (2010). *The Warmth of Other Suns, the Epic Story of America's Great Migration*. New York, New York: Random House.

[23] Mohl, R. (2002). *The Interstates and the Cities: Highways, Housing, and the Freeway Revolt* (Research Report). University of Alabama at Birmingham. Retrieved from http://www.prrac.org/pdf/mohl.pdf

[24] Sze, Julie. (2007). *Noxious New York*. Cambridge, Massachusetts: Massachusetts Institute of Technology.

cable cars of the 1880s, and gone were the trolleys of the 1920s. Soon enough, above and below ground, New York City was overtaken by trains, the motorbus, the subway, and eventually the car.[25] Urban planners claimed that the U.S. was yearning for a national highway system after cars became widely available to the mass public. However, the changes brought about by the national highway system included a racial turnover that left American cities with a large Black population, and the suburbs with the deconcentrated White population. Housing segregation increased due to the introduction of the urban expressway.

In 1956, the Federal Aid Highway Act was enacted and signed by President Eisenhower in order to aid the development of the Interstate Highway System, a plan that would take 10 years to complete. This bill authorized 25 billion dollars for the construction of 42,500 miles of highway, and the money would be generated through taxes on fuel, automobiles, trucks and tires.[26] The national interstate highway system was meant to link cities across the country, but it did so much more than that, as highway engineers and policy makers designed the highway system to "penetrate cities and divide neighborhoods."[27] It is clear now that even if the main purpose of the highway system was not to destroy low-income and predominantly Black neighborhoods, such an outcome was certainly welcome by policy makers as a way to reshape the racial landscapes of American cities. Black and Brown bodies were seen as vagrants and threats

[25] History of Public Transportation in New York City. (2015). Retrieved from http://www.transitmuseumeducation.org/trc/background

[26] Federal Aid Highway Act of 1956. (2014, October 1). In *Wikipedia, the free encyclopedia*. Retrieved from http://en.wikipedia.org/w/index.php?title=Federal_Aid_Highway_Act_of_1956&oldid=613986391

[27] Mohl, R. (2002). *The Interstates and the Cities: Highways, Housing, and the Freeway Revolt* (Research Report). University of Alabama at Birmingham. Retrieved from http://www.prrac.org/pdf/mohl.pdf

to White supremacy. Policymakers, who were all White at the time, did everything in their power to reduce what they felt was a threat to White supremacy, even if it resulted in the homelessness of thousands of people.

Displacement of over one million people and the destruction of Black and Brown "ghettos" was not an unintended consequence of the Interstate Highway System. To the contrary, the interstate highway system was seen as the perfect opportunity for "slum" clearance.[28] The terms slum and ghetto are in quotes because they have meaning ascribed to them that implies dirty, impoverished, and largely communities of color. These terms were used to make the public think that city officials were doing them a favor by getting rid of such communities, when really these were just communities of color that White city officials, such as Robert Moses, did not want in the City. In fact, the American Road Builders Association "praised the construction as a way to eliminate 'deteriorated' areas, thereby countering the 'threat posed by slum housing to the pubic health, safety, morals and welfare of the nation.'"[29] The destruction of urban residential spaces led to tremendous citizen protests known as the highway revolts. These revolts took place during the 1960s and 1970s, and occurred mainly in cities such as New York, Philadelphia, Baltimore, Washington D.C, and San Francisco. As a result of these riots, the federal government was forced to pass a new regulation ensuring relocation assistance

[28] Brewman, J. (2015). Racism, The Interstate Highway System, and Urban Renewal. Retrieved from http://www.democraticunderground.com/discuss/duboard.php?az=show_mesg&forum=258&topic_id=2983&mesg_id=5081

[29] Brewman, J. (2015). Racism, The Interstate Highway System, and Urban Renewal. Retrieved from http://www.democraticunderground.com/discuss/duboard.php?az=show_mesg&forum=258&topic_id=2983&mesg_id=5081

or the rebuilding of housing units that were destroyed by highway construction. While these regulations were enacted in the 1960s, they have yet to be implemented today.[30]

Even though people who could afford cars were equipped to drive from Baltimore to New York City to Atlanta and more, people of color were left with nowhere to live in urban areas. Limited access to urban housing was exacerbated by the fact that racial discrimination in suburban areas prevented people of color from obtaining housing in the suburbs. The National Housing Act of 1934, a component of the New Deal, was passed in order to make housing and mortgages more affordable. What resulted, however, was redlining, also known as mortgage discrimination, which is housing segregation and discrimination based on race.

White Flight and Housing Discrimination

In the mid-twentieth century, White people began moving to the suburbs in a widespread pattern that was referred to as 'White flight'. During this era, the suburbs were symbolic of the idealized American dream as they boasted perfect lawns and white picket-fence homes. The Federal Housing Act of 1934 was created in order to aid homebuyers, but in actuality it only aided White homebuyers. Simultaneously, the Home Owners Loan Corporation designed a rating system for neighborhoods where the highest rating was green, the lowest was red, and in between was blue and yellow. The higher ratings were deemed as good investments because they had higher property values, and they were assigned to White, suburban areas far away from communities of color. The

[30] White Flight and Urban Riots. (2014). Retrieved November 5, 2014, from http://www.urbanoasis.org/temple/?q=Whiteflight

lower ratings were deemed as bad investments because they were ascribed to areas that were dominated by people of color. Thus, the term redlining came about. Banks abided by these ratings, and viewed the redlined areas as high risk and a poor investment. Therefore, the banks only granted loans to White people looking to move to the green and blue-rated suburbs.[31]

Redlining is a form of institutional racism, "where the practices and policies of an institution systematically benefit one group at the expense of another."[32] Properties were valued differently specifically based on race, and because of this, Whites benefitted financially from keeping Blacks out of predominately White neighborhoods. Racism was present more than ever, and it was significantly impacting where people could live.

In 1975, the Home Mortgage Disclosure Act was passed to require transparency in loans that were granted and the review of loan practices. After the Act revealed banks' discriminatory practices, the Community Reinvestment Act of 1977 was passed, which encouraged banks to lend money to people in low and moderate-income neighborhoods.[33] Unfortunately, however, racism and housing segregation still continue.

[31] Redlining. (2014, November 5). In *Wikipedia, the free encyclopedia*. Retrieved from http://en.wikipedia.org/w/index.php?title=Redlining&oldid=624415597

[32] Institutional Discrimination: The Case of Redlining. (2014). Retrieved November 5, 2014, from http://www.thesociologicalcinema.com/1/post/2012/12/institutional-discrimination-the-case-of-redlining.html

[33] Community Reinvestment Act. (2014, November 1). In *Wikipedia, the free encyclopedia*. Retrieved from http://en.wikipedia.org/w/index.php?title=Community_Reinvestment_Act&oldid=631458205

"Urban Renewal"

During the 1940s through the 1960s, the term "urban renewal" created great controversy. While the term 'redevelopment' never made the public flinch, 'urban renewal' always captured someone's attention. To Whites, urban renewal meant fewer Black people and less poverty, but to Blacks, urban renewal translated to no more housing. Urban renewal promised three things to White people: advocating "the economic modernization of cities," employing "the arts and practices of aesthetic moderns, and "[representing] a new time and space of urban modernity."[34] Urban renewal became a model of what cities could look like – flourishing with jobs, arts, and space for Whites.

The Merriam-Webster dictionary defines urban renewal as "a process by which old buildings or buildings that are in bad condition in part of a city are replaced or repaired."[35] However, this definition does not encompass the consequences that often resulted from urban renewal. In New York City, those who did not like the influx of Black and Brown residents found their prejudice against these groups intensified. These White residents were the strongest proponents of urban renewal, and they planned on using the power of eminent domain, the legal doctrine that allowed governments to take private property for public purpose, for slum clearance, modern architecture, and rational city planning. They hoped for a new cityscape, no longer rife with slums that were crowded with dirty, poor, sick, people of color; urban renewal would encourage White

[34] Institutional Discrimination: The Case of Redlining. (2015). Retrieved November 5, 2014, from http://www.thesociologicalcinema.com/1/post/2012/12/institutional-discrimination-the-case-of-redlining.html

[35] Merriam Webster. (2015). Urban Renewal. Retrieved from http://www.merriam-webster.com/dictionary/urban%20renewal).

middle and upper class shoppers back to the city and away from the suburbs. Proponents of urban renewal, a movement led by Robert Moses, felt the current status of New York City left it vulnerable to poverty, decay, war, urban migration, and overcrowding.[36]

In the 30 years after World War II, New York City experiences positive and negative transformations that changed it forever. The post-World War II era was a time when the power elite were disappointed by New York City's cityscape. The elite felt they were living in a city where they couldn't breathe, "where light and air had no chance of reaching people sealed away in tightly packed tenements with narrow air shafts and dingy, weed-choked backyards."[37] The urban renewal movement had sufficient incentive to manifest and it focused on transforming New York into a city that catered to the wealthy White men in positions of power and authority.

It is important to note that not all ordinary New Yorkers were in favor of urban renewal, but they were not the ones in power. Robert Moses was responsible for leading the efforts of urban renewal in New York City and was known as the 'master builder' of New York in mid 20th century. According to a *New Yorker* article from 1974, "In the seven years between 1946 and 1954, seven years that were marked by the most intensive public construction in the city's history, no public improvement of any type – no school or sewer, library or pier, hospital or catch basin – was built by any city agency unless Moses approved its design and location."[38] Overall, Moses supervised the building of "13

[36] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[37] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[38] The Power Broker III - How Things Get Done. (1974, April 12). Retrieved March 19, 2015, from http://www.newyorker.com/magazine/1974/08/12/the-power-broker-iii-how-things-get-done

bridges, 416 miles of parkways, 658 playgrounds, and 150,000 housing units, spending $150 billion in today's dollars."[39] Moses was never elected to any public office, but when the 1949 Housing Act was enacted he became chairman of the New York City Slum Clearance Committee, and filled the rest of the seats on the committee with his financial, political, and real-estate acquaintances. While Moses sought to rebuild Manhattan's cityscape, the story of New York City's urban renewal truly reveals that it grew to become the political, cultural, and financial capital of the world while simultaneously becoming an 'urban crisis' during the 1960s.[40]

At a very basic level, urban renewal was strongly associated with politics and policy while also a solution to physical and economic problems. New York City was faced with the dissipation of capital and people as Whites fled to the suburbs. In terms of infrastructure, New York City's urban renewal was meant to reduce air and water pollution and renovate sewer systems, in addition to increase investment in highways, slum clearance, and the rebuilding of projects that would result in profit. However, the suburbanites that drove cars into New York City each day contributed to a considerable net importation of air pollution into the City proper. Additionally, there were also social aspects of urban renewal that were not explicitly stated within the urban renewal plan, but they were not necessarily unexpected. Rather, the social aspects of urban renewal were not advertised to the public as the main goals of the project despite the fact that they were specifically planned consequences. "For those officials [such as Moses], [projects such as

[39] Great Cities Need Great Builders - The New York Sun. (2007). Retrieved March 19, 2015, from http://www.nysun.com/arts/great-cities-need-great-builders/47012/

[40] . Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

these] increased prosperity and economic growth…[which] meant more votes on election day"[41] Building highways and clearing projects were efforts to attract White, middle and upper-class residents, "particularly women," back downtown from the suburbs, given that many proponents of urban renewal feared that downtown would transform into "Negro shopping districts.'"[42]

Housing in New York City

When clearance began in the 1930s and 1940s, clearance site evacuees were disproportionately poor Blacks and Puerto Ricans. Urban renewal earned the term "Negro removal" because poor Black and Puerto Rican enclaves were continually targets for clearance.[43] This clearance process marked yet another act of racial discrimination whereby White people in power originating from wealth and public authority uprooted people with less power, not unlike the removal of American Indians and other cases of racial displacement throughout American history.

Advocates of slum clearance and modern housing had a similar goal of building a more beautiful cityscape, meaning a cityscape without slums. Most proponents of urban renewal and slum clearance were under the impression that slums were at the root of poverty, family instability, crime, and other social problems. Therefore, city planners felt

[41] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[42] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[43] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

that if they cleared slums and rebuilt communities, they would "encourage the poor to be better citizens."[44] Eventually, advocates of slum clearance and modern housing joined together under the creation of the New York City Housing Authority (NYCHA). The NYCHA provided these advocates with the power to accomplish their goal as they worked together to change the cityscape with the power of government-backed slum clearance.[45]

Mayor Fiorello La Guardia, mayor of New York City, established the New York City Housing Authority in 1934 and in December of 1935, the first public housing development known as the First Houses was opened.[46] With the help of proponents of modern housing, the NYCHA created its own brand of houses: cruciform-shaped, red-brick modern towers that were built as superblocks. City planners acted upon the belief that in order for new housing to succeed, they needed to be simultaneously big enough to make a difference, and small enough to still foster a sense of community. As a result, neighborhood units were created via eminent domain and street closures, which allowed the NYCHA to build large tower-block housing superblocks. In 1941, this vision came to fruition with the NYCHA's East River Houses (also known as the Harlem River Houses): 6, 10, and 11 story towers located in East Harlem that provided a model for what the rest of the cityscape would soon become.[47] Soon enough, NYCHA units were occupied by

[44] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[45] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[46] About NYCHA. (2015). Retrieved from http://www.nyc.gov/html/nycha/html/about/nycha70.shtml.

[47] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

Blacks and Puerto Ricans who were displaced by urban renewal. The First Houses and the East River Houses were funded by the New Deal, but it was really the 1949 U.S. Housing Act that helped transition New York into what it is today – Whites prospering economically in Manhattan, while Blacks struggle to find housing and jobs in other boroughs.[48]

The 1949 Housing Act was introduced as part of President Truman's domestic legislation encompassed in the Fair Deal. Title 1 of the Housing Act directly provided funding for slum clearance that was associated with urban renewal in U.S. cities, even though the term 'urban renewal' wasn't introduced into the Act until 1954. "The Act was a response to city governments' years of largely unsuccessful attempts at slum clearance and rebuilding."[49] Shortly after the Act was passed, slum clearance began to increase rapidly, and "horizontal" neighborhoods were replaced with "vertical" projects.[50]

In 1943, prior to the enactment of the Housing Act, however, the "suburb in the city" was built as a privately backed urban renewal project[51]. Robert Moses partnered with Frederick Ecker, the head of Metropolitan Life, in order to create Stuyvesant Town. Stuyvesant Town was city and state-funded, and established a partnership between public and private funding, which would set the backdrop for the 1949 Housing Act. Moses and Ecker felt that Stuyvesant Town was the perfect opportunity to attract middle-class White

[48] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[49] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[50] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[51] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

people back to downtown New York City from the suburbs.[52] It was a way to bring wealth and Whites back to the City, and ensure that Blacks did not have a place to live in the City. Ultimately, Stuyvesant town became a White-only housing project on the Lower East Side of Manhattan.

The creation of Stuyvesant Town and the East River Houses marked the beginning of racial segregation New York City and in public housing. The East River Houses were located in Harlem and were made specifically for working-class Blacks, whereas Stuyvesant Town was located in downtown Manhattan, only 20 blocks south of the new United Nations building.[53] This residential pattern can still be seen today. Urban renewal became the term used to describe massive slum clearance that targeted Black communities in order to increase property values and attract middle-class Whites. From the creation of two of the first housing developments, racial segregation was already occurring in New York City. Planners used the word "slum" in order to encourage slum clearance and instill in the White public the idea that slums were dangerous neighborhoods filled with poverty and crime, and that the only way to get rid of crime and filth was to get rid of slums. Slum became synonymous with Black or Puerto Rican neighborhoods, regardless of any other characteristics.[54] Robert Moses' plans for massive slum clearance and the erection of mammoth projects perpetuated the division between

[52] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[53] Cooper, L. E. (1945, March 3). Uprooted Thousands Starting Trek From Site for Stuyvesant Town; Vans Rumble Through Lower East Side in City's Greatest Mass Movement, With New Quarters a Problem. *The New York Times*. Retrieved from http://query.nytimes.com/gst/abstract.html?res=9B07E5D71739E23ABC4B53DFB566838E659EDE

[54] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

classes and between races. To this day, the racial segregation patterns created by urban renewal and slum clearance prevail. But housing wasn't the only feature of the built environment that disproportionately affected certain racial groups. Highways, and the air pollution caused from those highways, also disproportionately affected certain racial groups.

Highways in New York City

In 1919, the Bureau of Public Roads (BPR) was established in order to build inner-city expressways. By the 1930s, Americans preferred to travel by automobile as urban mass transit was on the decline and traveling by automobile was convenient, private, and flexible. The automobile industry also had a huge interest in the creation of additional highways to the urban landscape. The BPR was led by Thomas MacDonald, who wrote a report entitled, "Toll Roads and Free Roads" which advocated for the introduction of the new highway system connecting people within cities and between cities. The report acknowledged the relationship between highways and urban reconstruction, and sought to gain support by encouraging the construction of highways as a catalyst to promote slum clearance and urban renewal.[55,56] Moses had the support of the BPR in order to develop a highway plan that could be an integral part of the urban renewal of New York City. With careful routing, the highways would cut through and

[55] Mohl, R. (2002). *The Interstates and the Cities: Highways, Housing, and the Freeway Revolt* (Research Report). University of Alabama at Birmingham. Retrieved from http://www.prrac.org/pdf/mohl.pdf

[56] Sutton, Stacey. (2008). *Urban Revitalization in the United States: Policies and Practices*. Graduate School of Architecture, Planning and Preservation, Columbia University. Retrieved from http://www.columbia.edu/cu/c2arl/pdf_files/USURRP_Phase_I_Final_Report.pdf

clear out areas that were deemed slums, resulting in "the elimination of unsightly districts."[57] More specifically, the removal of colored bodies and implementation of racial segregation were integral parts of the plan for new highways in New York City.

Robert Moses changed the way New York City looked and operated forever. By 1965, a plethora of buildings and projects were constructed with the supervision of Moses and his committee. These new projects included the construction of Bay Parkway, Belt Parkway, Bethpage State Parkway, Brooklyn-Queens Expressway, Bruckner Expressway, Caumsett State Parkway, Cross Bronx Expressway, Cross County Parkways, Cross Island Parkway, Gowanus Expressway, Grand Central Parkway, Harlem River Drive, Heckscher State Parkway, Henry Hudson Parkway, Hutchinson River Parkway, Interstates 78, 87, 295, 495, 698, and 895, Major Deegan Expressway, Mosholu Parkway, New York State Routes 135 and 878, Northern State Parkways, Ocean Parkway, Palisades Interstate Parkway, Ponquogue Parkway, Prospect Expressway, Robert Moses Causeway, Robert Moses State Parkway, Saw Mill River Parkway, Shore Front Parkway, Sound Shore Parkway, Southern State Parkway, Sprain Brook Parkway, Staten Island Expressway, Sunken Meadow State Parkway, Trans-Manhattan Expressway, and Wantagh State Parkway.[58] These are now some of the highways that have the highest volume of vehicle traffic in New York City, and most of them cut through areas predominantly inhabited by people of color.

[57] Sutton, Stacey. (2008). *Urban Revitalization in the United States: Policies and Practices*. Graduate School of Architecture, Planning and Preservation, Columbia University. Retrieved from http://www.columbia.edu/cu/c2arl/pdf_files/USURRP_Phase_I_Final_Report.pdf

[58] Category:Robert Moses projects. (2014, October 6). In *Wikipedia, the free encyclopedia*. Retrieved from http://en.wikipedia.org/w/index.php?title=Category:Robert_Moses_projects&oldid=559878534

From 1949 to the early 1960s, Moses built 16 privately backed projects across New York City. And by 1965, the NYCHA had 152 buildings. By 1959, Moses' New York City Slum Clearance Committee had uprooted over 100,000 Black New Yorkers and forced them into Harlem and Bedford-Stuyvesant in Brooklyn.[59] The construction of highways and housing projects reinforced the same segregation that slum clearance officials said they hoped to disperse, as these developments exclusively displaced poor people of color, forcing them into slums and public housing. Eventually, urban renewal was referred to as "urban crisis" when it became apparent that it was perpetuating racial segregation and racism rather than diminishing it.[60] However, it was too late and the adverse effects of urban renewal were widespread as New York came to be known as the "city destroying itself."[61] Moses' 16 private projects, which included the United Nations on the lower east side of Manhattan and the creation of Lincoln Center on the upper west side of Manhattan, were meant to be in the public's eye, transforming New York City into the city representing a new America. However, the contrast between the glistening towers and the dark ghettos created by slum clearance and the construction of highways was too great to miss. It became obvious that the White New York City officials did not want Blacks living in their city, and that they had taken considerable measures to ensure that this population had disproportionate access to resources.

[59] Slum Clearance. (2015). Retrieved from http://www.pbs.org/wnet/newyork//laic/episode7/topic3/e7_t3_s2-sc.html

[60] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

[61] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

There is a strong correlation between the structural and systematic connections between history and geography that created and continue to influence the lived experiences of Black people in the United States, which differ greatly from those of White people living in this country. An understanding of the urban renewal process and creation of the highway system in New York City is central to identifying the patterns of residency that occur in the U.S., which have a nuanced historical context that sheds light on the geography of demographic groups that are prevalent in American society today. More specifically, race, socioeconomic status, and health outcomes can largely be understood via the history of how racism developed in America. The remaining chapters of this thesis seek to explore what specific contributions history and race have made in generating the patterns that have manifested in adverse birth outcomes today.

CHAPTER 3: Racial Disparities

What are Health Disparities?

Health disparities are defined as "preventable differences in the burden of disease, injury, violence, or opportunities to achieve optimal health that are experienced by socially disadvantaged populations."[62] Populations can be defined by many factors, including race, ethnicity, gender, sexual orientation, religion, and education. Health disparities are "unjust, unfair, unnecessary and avoidable,"[63] and they are related to historic and current unequal distribution of resources.[64]

There are some known genetic determinants of health, which is why physicians ask patients for a family history. This is true for individuals and families, but it cannot be applied to large groups. It is the opinion of the authors of *Race, The Power of an Illusion*, that race is an illusion from a biological standpoint. There are some scholars who disagree with this concept, but many agree with the following:

> "You can identify people by just looking at them. You don't even have to look at their genes because one manifestation of their genes is there – namely skin color or eye shape or hair shape. The idea of race assumes that simple external differences, rooted in biology, are linked to other, more complex internal differences. Like athletic ability. Musical aptitude.

[62] Center for Disease Control. (2015). Health Disparities - Adolescent and School Health. Retrieved February 9, 2015, from http://www.cdc.gov/healthyyouth/disparities/

[63] World Health Organization. (2015). Glossary of terms used. Retrieved February 9, 2015, from http://www.who.int/hia/about/glos/en/index1.html

[64] Center for Disease Control. (2015). Health Disparities - Adolescent and School Health. Retrieved December 26, 2014, from http://www.cdc.gov/healthyyouth/disparities/

> Intelligence. This belief is based on the idea that race is biologically real. All of our genetics now [are] telling us that that's not the case. We can't find any genetic markers that are in everybody of a particular race and in nobody of some other race. We can't find any genetic markers that define race."[65]

Despite the aforementioned, however, it remains true that lived experiences are a social determinant for people who are racially classified.

Social determinants of health are "the circumstances in which people are born, grow up, live, work, and age, as well as the systems put in place to deal with illness."[66] Many social determinants lead to health disparities, or health inequities. The reality that certain people of color, particularly Blacks, experience worse health outcomes due to social determinants of health when compared to non-Hispanic Whites is a health disparity, and more specifically, a racial disparity. Access to health care, housing, and educational opportunities are examples of social determinants that often influence the presence or absence of these inequities.[67] Despite improvements, differences in health care still persist among populations of color when compared to non-Hispanic Whites, and low-income people still receive care of lesser quality. [68]

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[65] PBS. (2003). *Race, The Power of an Illusion* (Vol. Episode One). California Newsreel. Retrieved from http://newsreel.org/transcripts/race1.htm

[66] Center for Disease Control. (2014). Social Determinants of Health. Retrieved January 28, 2015, from http://www.cdc.gov/socialdeterminants/

[67] Hebert, P. L., Chassin, M. R., & Howell, E. A. (2011). The contribution of geography to black/white differences in the use of low neonatal mortality hospitals in New York City. *Medical Care*, *49*(2), 200–206. http://doi.org/10.1097/MLR.0b013e3182019144

[68] Association of State and Territorial Health Officials. (2012). *Issue brief: Disparities and inequities in maternal and infant health outcomes.*

This chapter highlights that real disparities exist with respect to access to healthcare, which result in differential health outcomes across racial groups. Access to healthcare includes both the operation of health care systems and the clinical encounter.[69] Adverse birth outcomes are not equally distributed across all racial group and there are widely cited statistics that point to large racial disparities. In 1999, Congress directed the Agency for Healthcare Research and Quality (AHRQ) to produce an annual report on the status of healthcare in America, primarily focusing on the quality of care.[70] The majority of the figures presented in this chapter originate from the AHRQ report.

U.S. Demographics

In 2000, 33% of the U.S. population identified as members of a racial or ethnic group other than non-Hispanic White. By 2050, half of the U.S. population is expected to consist of people of color. If the health disparities continue at the current rate, and continue to be associated with race, many more Americans suffer from poor health in the coming decades. According to 2013 Census data, the U.S. population reached over 300 million people in 2013, 62.6% of which identified as non-Hispanic White, 17.1% as Hispanic or Latino, 13.2% as Black or African American, 5.3% as Asian, 2.4% as two or more races, 1.2% as American Indian and Alaska Native, and 0.2% as Native Hawaiian and Other Pacific Islander. The census data indicate that people of color were more likely

[69] Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. (2002). Retrieved December 28, 2014, from http://www.iom.edu/Reports/2002/Unequal-Treatment-Confronting-Racial-and-Ethnic-Disparities-in-Health-Care.aspx

[70] 2012 National Healthcare Disparities Report. (2013, May 7). [Text]. Retrieved December 26, 2014, from http://www.ahrq.gov/research/findings/nhqrdr/nhdr12/

than non-Hispanic Whites to be of lower socio-economic status.[71] Please note that while the categories used by the U.S. Census to describe race have changed over time, I am working with the census categories currently used to categorize data.[72]

Disparities in Access to Healthcare

According to the Institute of Medicine (IOM), access to care is having "the timely use of personal health services to achieve the best health outcomes."[73] Access to healthcare includes the location of medical practitioners, translation services, fragmentation of healthcare systems ("minorities are disproportionately enrolled in lower-cost health plans that place greater per-patient limits on healthcare expenditures and available services,") and formal incentives to contain costs. There are also less obvious obstacles to access to health care including "bias or prejudice against people of color, greater clinical uncertainty when interacting with patients of color, and beliefs or stereotypes held by the provider about the behavior or health of people of color."[74] The Agency for Healthcare Research and Quality (AHRQ) found that access to health insurance is the most significant barrier to quality healthcare. People who are uninsured

[71] United States Census Bureau. (2014). *United States Census Bureau QuickFacts*. Retrieved from http://quickfacts.census.gov/qfd/states/00000.html

[72] Krogstad, J. M., & comments, D. C. (2015). U.S. Census looking at big changes in how it asks about race and ethnicity. Retrieved from http://www.pewresearch.org/fact-tank/2014/03/14/u-s-census-looking-at-big-changes-in-how-it-asks-about-race-and-ethnicity/

[73] Access to Health Care. (2010). *Agency for Healthcare Research and Quality*. Retrieved February 9, 2015, from http://www.ahrq.gov/research/findings/nhqrdr/nhdr10/Chap9.html

[74] Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. (2015). Retrieved December 28, 2014, from http://www.iom.edu/Reports/2002/Unequal-Treatment-Confronting-Racial-and-Ethnic-Disparities-in-Health-Care.aspx

are less likely to have access to health care, and uninsured people are less likely to receive recommendations for disease prevention, flu vaccines, and disease management. The AHRQ identified three main steps to having access to health care: entry into the health care system, access to sites of care, and providers who meet patients' needs.[75] Without the ability to have control over these three factors, an individual is not considered to have access to health care. Unfortunately, the aforementioned three steps do not shed light upon the intricacies that are associated with attaining proper care.

Barriers to the access of healthcare are engrained in institutional racism. Institutional racism, which is defined as "societal patterns that have the net effect of imposing oppressive or otherwise negative conditions against identifiable groups on the basis of race or ethnicity."[76] Institutional racism is the mechanism by which racial disparities in health exist. Several barriers to acquiring access to health care disproportionately affect low-income people and people of color.[77] According to the AHRQ, these barriers include health insurance, the cost of healthcare, the role of bias, miscommunication, lack of trust, and lower educational attainment.[78]

People who do not have health insurance are less likely to receive care and are more likely to be in poor health. These same people are also diagnosed at later stages of a

[75] Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. (2002). Retrieved December 28, 2014, from http://www.iom.edu/Reports/2002/Unequal-Treatment-Confronting-Racial-and-Ethnic-Disparities-in-Health-Care.aspx

[76] What Is Institutional Racism and How Is It Relevant to Us Now? (2015). Retrieved March 20, 2015, from http://civilliberty.about.com/od/raceequalopportunity/g/inst_racism.htm

[77] Howell, E. A., Hebert, P., Chatterjee, S., Kleinman, L. C., & Chassin, M. R. (2008). Black/white differences in very low birth weight neonatal mortality rates among New York City hospitals. *Pediatrics*, *121*(3), e407–415. http://doi.org/10.1542/peds.2007-0910

[78] What Is Institutional Racism and How Is It Relevant to Us Now? (2015). Retrieved March 20, 2015, from http://civilliberty.about.com/od/raceequalopportunity/g/inst_racism.htm

disease, they are sicker when hospitalized, and they are more likely to die while at a hospital. According to the AHRQ, Blacks consistently had worse access to care than Whites across various measures of access such as health insurance, cost and bias.[79]

Education and income are also contributing factors to the racial disparities in health outcomes, as income is associated with insurance and consistent primary care physicians, and education is associated with preventive services and longer life. In 2010, poor, low-income, and middle-income people were significantly less likely to have insurance, and Blacks and Hispanics under the age of 65 were less likely to have health insurance compared with non-Hispanic Whites. In 2012, 30.1% of Hispanics were uninsured, 19.5% of Blacks were uninsured, 16.8% of Asian Americans were uninsured, and 11.1% of Whites were uninsured. Whites had the lowest rate of being uninsured. Additionally, Blacks and Hispanics are twice as likely to live in poverty as Whites and Asian Americans. Across races, poorer people had worse access to care when compared to high-income people for 89% of the AHRQ's measures. Blacks and Hispanics also have lower rates of educational attainment than Whites and Asian Americans.[80,81] There are a variety of factors that contribute to gaining access to healthcare, and it is clear that Blacks fare the worst across these factors.

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[79] What Is Institutional Racism and How Is It Relevant to Us Now? (2015). Retrieved March 20, 2015, from http://civilliberty.about.com/od/raceequalopportunity/g/inst_racism.htm

[80] Mead, H., Cartwright-Smith L., Jones, K. Ramos, C., Siegel, B.. (2008). *Racial and Ethic Disparities in U.S. Health Care: A Chartbook*. The Commonwealth Fund: Department of Health Policy, School of Public Health and Health Services, The George Washington University. Retrieved from http://www.commonwealthfund.org/usr_doc/mead_racialethnicdisparities_chartbook_1111.pdf

[81] Todd, S,. Sommers, B. (2012). *Overview of the Uninsured in the United States: A Summary of the 2012 Current Population Survey Report*. U.S. Department of Health and Human Services. Retrieved from http://aspe.hhs.gov/health/reports/2012/uninsuredintheus/ib.cfm

Disparities in Health Outcome

It is important to emphasize that the differences in health outcomes that occur between races are due to social determinants such as income, education, and access to care. The racial disparities that occur across health outcomes are shocking:

> "The study committee [from the IOM] was struck by the consistency of research findings: even among the better-controlled studies, the vast majority indicated that [people of color] are less likely than Whites to receive needed services, including clinically necessary procedures. These disparities occur in a number of disease areas, including cancer, cardiovascular disease, HIV/AIDS, diabetes, and mental illness, and are found across a range of procedures, including routine treatments for common health problems."[82]

The rest of the chapter discusses some of these disparities.

Life expectancy is shorter for Blacks than for Whites, as in 2003 life expectancy (for males and females) at birth for Whites was 78 years and for Blacks it was 73. Furthermore, the infant mortality rate for Whites in 2007 was 5.6 per 1,000 live births, for Hispanics it was 5.5, and for Blacks it was a shocking 13.3, more than double that of Whites.[83] Overall, people of color are less likely to be in good health than Whites. Blacks are the most likely to self-report being in poor health as 20% of Blacks claimed to be in

[82] Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. (2015). Retrieved December 28, 2014, from http://www.iom.edu/Reports/2002/Unequal-Treatment-Confronting-Racial-and-Ethnic-Disparities-in-Health-Care.aspx

[83] Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. (2002). Retrieved December 28, 2014, from http://www.iom.edu/Reports/2002/Unequal-Treatment-Confronting-Racial-and-Ethnic-Disparities-in-Health-Care.aspx

poor health and only 11% of Whites claimed to be in poor health in 2010.[84] That said, Blacks perceive themselves as being in poorer health than Whites, which may be due to the disparities in healthcare access that cause Blacks to be more likely than whites to have a chronic illness or disability. This occurs at low-income levels, but it also occurs at higher income levels, given that "Blacks at or above 20% of the federal poverty level are 40% more likely to have a chronic illness or disability than Whites."[85]

These racial disparities hold true for risk factors, characteristics that make an individual more likely to develop health problems, as well. Risk factors – such as obesity – for chronic diseases such as diabetes and cardiovascular disease are unevenly distributed among Blacks and Whites. According to the American Diabetes Association, 69% percent of Blacks are overweight or obese, compared with 54% of non-Hispanic Whites. Furthermore, 18.7% of all Blacks 20 years or older have diagnosed or undiagnosed diabetes, as compared with 7.7% of Whites. The risk of developing diabetes was 77% higher among Blacks than among non-Hispanic Whites in 2008. [86] The American Diabetes Association also found that 11.8% of Hispanics have been diagnosed with diabetes, and 8.4% of Asian Americans have diabetes. The risk of developing diabetes was lower for Hispanics or Latinos and Asian Americans than it was for Blacks, but still higher than the risk for Non-Hispanic Whites. Studies report that diabetes is also

[84] Holly Mead, Lara Cartwright-Smith, Karen Jones, Christal Ramos, Bruce Siegel. (2008). *Racial and Ethic Disparities in U.S. Health Care: A Chartbook*. The Commonwealth Fund: Department of Health Policy, School of Public Health and Health Services, The George Washington University. Retrieved from http://www.commonwealthfund.org/usr_doc/mead_racialethnicdisparities_chartbook_1111.pdf

[85] 2012 National Healthcare Disparities Report. (2013, May 7).. Retrieved December 26, 2014, from http://www.ahrq.gov/research/findings/nhqrdr/nhdr12/

[86] Holly Mead, Lara Cartwright-Smith, Karen Jones, Christal Ramos, Bruce Siegel. (2008). *Racial and Ethic Disparities in U.S. Health Care: A Chartbook*. The Commonwealth Fund: Department of Health Policy, School of Public Health and Health Services, The George Washington University. Retrieved from http://www.commonwealthfund.org/usr_doc/mead_racialethnicdisparities_chartbook_1111.pdf

a significant risk factor for many other diseases including heart disease.[87,88] This pattern holds true for cancer as well, which is the number two cause of death in the United States.[89,90]

Certain racial groups are disproportionately affected by cancer, which is a largely preventable disease when given adequate medical attention. Blacks are more likely to have colorectal, prostate, and cervical cancer than non-Hispanic Whites. Blacks are also more likely to die from these three types of cancer than Whites. It is interesting to note that non-Hispanic White women have the highest incidence of breast cancer, but Black women have the highest mortality rate for breast cancer.[91] The pattern that breast cancer follows exemplifies how strongly social factors, such as access to care, affect health outcomes.

The racial disparities that occur in breast cancer incidence and mortality can in part be explained by differential access to care between Black women and White women. Black women and White women are almost equally likely to have a mammogram, but Black women are less likely to receive adequate communications of the results,

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[87] Chow, E. A., Foster, H., Gonzalez, V., & McIver, L. (2012). The Disparate Impact of Diabetes on Racial/Ethnic Minority Populations. *Clinical Diabetes*, *30*(3), 130–133. doi:10.2337/diaclin.30.3.130

[88] Peters, S. A. E., Huxley, R. R., & Woodward, M. (2014). Diabetes as risk factor for incident coronary heart disease in women compared with men: a systematic review and meta-analysis of 64 cohorts including 858,507 individuals and 28,203 coronary events. *Diabetologia*, *57*(8), 1542–1551. http://doi.org/10.1007/s00125-014-3260-6

[89] American Heart Association. (2010). *Cardiovascular Disease Health Disparities*. Retrieved from http://www.heart.org/idc/groups/heart-public/@wcm/@hcm/@ml/documents/downloadable/ucm_429240.pdf

[90] FastStats. (2014). Retrieved February 9, 2015, from http://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm

[91] National Institute of Allergy and Infectious Diseases. (2013). Minority Health. Retrieved from http://www.niaid.nih.gov/topics/minorityHealth/Pages/disparities.aspx

especially if the results are abnormal.[92] This reality is due to various factors including differences in access to care, differences in quality of care, the role of bias, and trust in the medical system.[93] Other diseases that follow this pattern include asthma, Hepatitis C, HIV/AIDS, and sexually transmitted infections.[94]

The Black community in the United States also experiences more social stress and mental health issues than does the non-Hispanic White population. Racism and poverty are two factors that affect the Black population more than the White population.[95] According to the U.S. Department of Health and Human Services, Blacks are 20% more likely to report having serious psychological distress than Whites, despite the fact that Whites are more than twice as likely to receive antidepressant prescription treatments as are Blacks.[96] It is clear that people of color suffer from worse health across several different health outcomes, and these differences and inequities are due to social factors that result from racism.

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[92] Holly Mead, Lara Cartwright-Smith, Karen Jones, Christal Ramos, Bruce Siegel. (2008). *Racial and Ethic Disparities in U.S. Health Care: A Chartbook*. The Commonwealth Fund: Department of Health Policy, School of Public Health and Health Services, The George Washington University. Retrieved from http://www.commonwealthfund.org/usr_doc/mead_racialethnicdisparities_chartbook_1111.pdf

[93] Burgess, D., Ryn, M. van, Dovidio, J., & Saha, S. (2007). Reducing Racial Bias Among Health Care Providers: Lessons from Social-Cognitive Psychology. *Journal of General Internal Medicine*, *22*(6), 882–887. http://doi.org/10.1007/s11606-007-0160-1

[94] Holly Mead, Lara Cartwright-Smith, Karen Jones, Christal Ramos, Bruce Siegel. (2008). *Racial and Ethic Disparities in U.S. Health Care: A Chartbook*. The Commonwealth Fund: Department of Health Policy, School of Public Health and Health Services, The George Washington University. Retrieved from http://www.commonwealthfund.org/usr_doc/mead_racialethnicdisparities_chartbook_1111.pdf

[95] U.S. Department of Heath and Human Services Office of Minority Health. (2015). Mental Health and African Americans. Retrieved from http://www.minorityhealth.hhs.gov/omh/browse.aspx?lvl=4&lvlid=24

[96] U.S. Department of Heath and Human Services Office of Minority Health. (2015). Mental Health and African Americans. Retrieved from http://www.minorityhealth.hhs.gov/omh/browse.aspx?lvl=4&lvlid=24

Implications of Health Disparities

In 2002, the Institute of Medicine produced a report titled *Unequal Treatment: Confronting Racial and Ethnic Disparities in Healthcare*. This report was created in order to answer the following question: 'Do racial and ethnic minorities receive lower quality of healthcare?' Strikingly, the report concluded that yes, "bias, prejudice, and stereotyping on the part of healthcare providers may contribute to differences in care."[97] More specifically, the IOM found that there are two main sources of health care disparities, apart from access to care: the operation of healthcare systems, and the clinical encounter. Contrary to common belief, no significant variation exists within different racial groups' attitudes towards healthcare and preference for treatment. The IOM reported that within the operation of healthcare systems, factors such as cultural or linguistic barriers, fragmentation of healthcare systems, and where people of color tend to receive care may contribute to these disparities. Furthermore, there may be a lack of interpretation services, people of color are more often enrolled in lower-cost health plans or not enrolled in health plans at all, and people of color are less likely to get care in a private physician's office.[98]

With respect to clinical encounters, providers may have bias or prejudice against people of color, more uncertainty about the interaction with patients of color, and may have beliefs or stereotypes about the behavior or health of people of color, which may all

[97] Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. (2015). Retrieved December 28, 2014, from http://www.iom.edu/Reports/2002/Unequal-Treatment-Confronting-Racial-and-Ethnic-Disparities-in-Health-Care.aspx

[98] Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. (2015). Retrieved December 28, 2014, from http://www.iom.edu/Reports/2002/Unequal-Treatment-Confronting-Racial-and-Ethnic-Disparities-in-Health-Care.aspx

affect treatment.[99] A study by Schulman et al. in 1999 showed a video of recorded "patient" interviews (actors portraying symptoms) describing heart symptoms to 720 physicians. The physicians viewed the videos and reviewed patient data and then gave recommendations for cardiac catheterization. Women and Blacks were less likely to be referred for treatment than men and Whites, respectively. Black women were the least likely to be referred for catheterization. This study concluded that the race and sex of patients influences physicians' decisions.[100] Studies since 1999 that have cited the Schulman article have found similar results.[101] A study in 2000 "found that doctors rated Black patients as less intelligent, less educated, more likely to abuse drugs and alcohol, more likely to fail to comply with medical advice, more likely to lack social support, and less likely to participate in cardiac rehabilitation with White patients." A more recent paper by the Schulman et al. indicates that Blacks are continuously less likely to be referred for treatment.[102,103,104]

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[99] Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. (2002). Retrieved December 28, 2014, from http://www.iom.edu/Reports/2002/Unequal-Treatment-Confronting-Racial-and-Ethnic-Disparities-in-Health-Care.aspx

[100] Schulman, K. A., Berlin, J. A., Harless, W., Kerner, J. F., Sistrunk, S., Gersh, B. J., … Escarce, J. J. (1999). The effect of race and sex on physicians' recommendations for cardiac catheterization. *The New England Journal of Medicine*, *340*(8), 618–626. doi:10.1056/NEJM199902253400806

[101] Hatzenbuehler, M. L., Phelan, J. C., & Link, B. G. (2013). Stigma as a Fundamental Cause of Population Health Inequalities. *American Journal of Public Health*, *103*(5), 813–821. doi:10.2105/AJPH.2012.301069

[102] Sheifer, S. E., Escarce, J. J., & Schulman, K. A. (2000). Race and sex differences in the management of coronary artery disease. *American Heart Journal*, *139*(5), 848–857.

[103] Van Ryn, M., Burgess, D., Malat, J., & Griffin, J. (2006). Physicians' Perceptions of Patients' Social and Behavioral Characteristics and Race Disparities in Treatment Recommendations for Men With Coronary Artery Disease. *American Journal of Public Health*, *96*(2), 351–357. http://doi.org/10.2105/AJPH.2004.041806

[104] Einbinder, L. C., & Schulman, K. A. (2000). The effect of race on the referral process for invasive cardiac procedures. *Medical Care Research and Review: MCRR*, *57 Suppl 1*, 162–180.

Most notably, it is crucial to understand that these disparities are avoidable. They are "preventable differences in the burden of disease, injury, violence, or opportunities to achieve optimal health that are experienced by socially disadvantaged populations."[105] These disparities are inequities that are unjust because they are attributed solely to differences in race, which are not biological differences given that race is a social construct. According to the American Medical Student Association Statement on Health Equity, "health inequities are unjust, unnatural, and avoidable differences in health status, in the distribution of disease and illness, and in mortality rates across population groups. They are beyond the control of individuals, meaning they are systemic problems."[106]

I deliberately chose to use the word 'equity' as opposed to 'equality.' Equity is the language that is used in the field of public health because equality signifies that everyone is at the same level, while equity represents fairness. Equity implies the issue of social justice. Equality aims to give everyone the same amount regardless of the circumstances, while equity tries to give people what they need. Therefore, "equality only works if everyone starts from the same place and needs the same things,"[107] but unfortunately that's not the case. People of color have been the victims of racism for hundreds of years, which has manifested as people of color having worse health outcomes, for example.

[105] Center for Disease Control. (2015). Health Disparities - Adolescent and School Health. Retrieved February 9, 2015, from http://www.cdc.gov/healthyyouth/disparities/

[106] American Medical Student Association. (2014). AMSA's Mission & Aspirations. Retrieved from http://www.amsa.org/amsa/homepage/About/Priorities.aspx

[107] Distinguish between Equity and Equality | SGBA e-Learning Resource. (2015). Retrieved from http://sgba-resource.ca/en/concepts/equity/distinguish-between-equity-and-equality/

Institutional racism has exacerbated the prevalence of health inequities in American society. However, these disparities can be ameliorated if the populations that are being disproportionately affected are made a priority by healthcare professionals and policy makers. Furthermore, researchers must recognize that race plays a central role in health outcomes; therefore, more efforts need to be directed to studying race in relation to health outcomes.

This chapter indicates that there are a myriad of health outcomes in which there are severe racial disparities. The following chapter discusses the association between air pollution and adverse birth outcomes. While the racial differences in incidence of preterm birth and low birthweight are considered to be racial disparities, this thesis argues that some of the potential mechanisms through which these disparities exist, are not considered racial issues, although they should be.

CHAPTER 4: Adverse Birth Outcomes and Air Pollution

What are Adverse Birth Outcomes?

An adverse birth outcome "is an event which reduces the chance of having a healthy baby."[108] Therefore, a normal pregnancy is one without adverse birth outcomes. The two most important factors for a normal pregnancy are birth weight and length of gestation. Together, these factors are the most crucial determinants for an infant's health and survival, as preterm birth and low birthweight are risk factors for infant mortality. A normal term pregnancy is carried between 37 and 41 weeks, and preterm, or premature birth is defined by the U.S. Centers for Disease Control and Prevention (CDC) as the birth of an infant prior to 37 weeks of pregnancy. Babies who are born premature are also likely to be born with low birthweight, which is defined as being born weighing less than 2,500 grams (approximately 5 pounds, 8 ounces).[109] Although there are additional adverse birth outcomes apart from preterm birth and low birthweight, this paper will discusses these two as they are the most prominent and important indicators of infant health, in addition to the fact that they are the two adverse birth outcomes on which the most extensive statistics are available.

Despite medical advances, the incidence of adverse birth outcomes in the United States is seemingly increasing. Existing information is conflicting, but various studies

[108] Adverse Pregnancy Outcome & Preterm Birth Evaluation and Prevention Program: What are Adverse Pregnancy Outcomes? (2015). Retrieved from http://www.winthrop.org/departments/institutes/family/ob-gyn/Maternal-Fetal-Medicine/Adverse-Pregnancy-Outcomes

[109] Center for Disease Control. (2014). Infant Health. Retrieved November 12, 2014, from http://www.cdc.gov/nchs/fastats/infant-health.htm

suggest that the incidence is rising due to harmful environmental exposures caused by air pollution, pesticides and herbicides, and lead and methylmercury.[110]

Infant Mortality

A total of 25,000 infants die every year in the United States, out of almost 4 million live births.[111] According to the Central Intelligence Agency's (CIA) World Factbook, as of 2013 the United States ranked 50th in the world for infant mortality, compared to 49 countries had lower infant mortality rates. In other words, the U.S. is behind all other developed countries for infant mortality.[112] This is a jarring fact considering the U.S. is one of the wealthiest countries across the global platform and is generally presumed to be among the world's leaders in high quality medical care. Most of these deaths are due to risk factors such as being born premature and/or at a low birthweight, or as a result of suffering the consequences of Sudden Infant Death Syndrome, being affected by maternal complications of pregnancy, or being victims of injury.[113] Other such risk factors for infant mortality include smoking, exposure to

[110] Environmental Protection Agency. (2011). Health: Adverse Birth Outcomes. Retrieved from http://www.epa.gov/ace/ace3draft/draft_pdfs/ACE3BirthOutcomesReviewPackage3-02-11.pdf

[111] Center for Disease Control. (2014). Infant Health. Retrieved November 12, 2014, from http://www.cdc.gov/nchs/fastats/infant-health.htm

[112] Central Intelligence Agency. (2014). *The World Factbook: Infant Mortality Rate*. Retrieved from https://www.cia.gov/library//publications/the-world-factbook/rankorder/2091rank.html

[113] Center for Disease Control. (2014). Infant Mortality - Maternal and Infant Health - Reproductive Health. Retrieved January 28, 2015, from http://www.cdc.gov/reproductivehealth/maternalinfanthealth/infantmortality.htm

secondhand smoke, and using street drugs and alcohol all during pregnancy.[114] However, preterm birth and low birthweight remain the second leading cause of infant mortality in the U.S. after birth defects. Preterm birth and low birthweight are such strong risk factors that the infant mortality rate for preterm birth babies is three times that of the infant mortality of term babies, and the infant mortality rate for low birthweight babies is twenty five times the infant mortality rate for normal weight babies.[115]

Preterm Birth and Low Birthweight

Preterm birth affects 500,000 American babies every year, as one of every eight infants is born preterm. Preterm-related causes accounted for 37% of infant deaths in the U.S. in 2009[116] It is estimated that 7 out of 10 low-birthweight babies are premature, and the earlier a baby is born, the lower the birthweight will be.[117] Low birthweight is considered to be birthweight of less than 5.5lbs, or 2500 grams.[118]

Preterm birth and/or low birthweight infants are at greater risk for a plethora of developmental problems and complications such as acute respiratory, gastrointestinal,

[114] Infant Mortality in North Carolina: Causes and risk factors. (2014). Retrieved November 12, 2014, from http://www.nchealthystart.org/infant_mortality/causes.htm

[115] *Adverse Birth Outcomes*. (2015). Retrieved from http://www.epa.gov/ace/pdfs/Health-Adverse-Birth-Outcomes.pdf

[116] Center for Disease Control. (2014). Preterm Births — United States, 2006 and 2010. Retrieved December 26, 2014, from http://www.cdc.gov/mmwr/preview/mmwrhtml/su6203a22.htm?s_cid=su6203a22_w

[117] Low birthweight | March of Dimes. (2015). Retrieved May 4, 2014, from http://www.marchofdimes.com/baby/low-birthweight.aspx#

[118] Health Effects Reproductive and Birth Outcomes - CDC Tracking Network. (2014). Retrieved February 9, 2015, from http://ephtracking.cdc.gov/showRbMain.action

immunologic, and central nervous system problems. Some effects of preterm birth and low birthweight persist longer than developmental problems such as motor, cognitive, visual, hearing, behavioral, social-emotional, and growth issues.[119],[120] The complications that may result from preterm birth and low birthweight, including infant mortality, can result in serious emotional and economic challenges for families. Deaths due to preterm birth and low birthweight, however, cannot always be attributed to standalone causes. More often than not, there are root causes that lead to preterm birth, low birthweight, and infant mortality, such as the disproportionate exposure to environmental toxins across racial groups, which, thus, lead to health inequities.

Disparities in Adverse Birth Outcomes

In 2007, non-Hispanic Blacks had an infant mortality rate of 13.31 per 1,000 live births, whereas non-Hispanic Whites had an infant mortality rate of .00563:1, or 5.6 per 1,000 live births.[121] Furthermore, the risk of preterm birth in the U.S. for Non-Hispanic Black women is 1.5 times the rate of their White counterparts.[122] And in 2013, the percent of low birthweight babies was 13% for Black mothers compared to 6.5% for

[119] *Adverse Birth Outcomes*. (2015). Retrieved from http://www.epa.gov/ace/pdfs/Health-Adverse-Birth-Outcomes.pdf

[120] Moster, D., Lie, R. T., & Markestad, T. (2008). Long-Term Medical and Social Consequences of Preterm Birth. *New England Journal of Medicine*, *359*(3), 262–273. http://doi.org/10.1056/NEJMoa0706475

[121] MacDorman, M., & Mathews, T. J. (2011). *Understanding Racial and Ethnic Disparities in U.S. Infant Mortality Rates*. Center for Disease Control. Retrieved from http://www.cdc.gov/nchs/data/databriefs/db74.pdf

[122] Center for Disease Control. (2007). *African-American women and their babies at a higher risk for pregnancy and birth complications*. Retrieved from http://www.cdc.gov/media/subtopic/matte/pdf/CDCMatteReleaseInfantMortality.pdf

White mothers.[123] A 2004 study found that two thirds of racial disparities in infant mortality are attributable to a rate for low birthweight in Blacks that is almost three times higher than that of non-Hispanic Whites.[124] As these studies clearly show, adverse birth outcomes are not distributed equally amongst racial and ethnic populations, but rather the Black population is at a much greater risk for preterm birth, low birthright, and infant mortality when compared to the non-Hispanic White population.

Adverse birth outcomes should be considered an issue of environmental justice as Black infants have been found to be significantly more likely than White infants to live in close proximity to highways, such as in public housing located along highways in New York City.[125] Those living in closer proximity to highways are exposed to greater concentrations of air pollution, which is positively associated with adverse birth outcomes.[126] An understanding of the location of public housing sheds light on the ways in which different races are exposed to various levels of air pollution given that in 2013, 46.2% of the families in New York City public housing were Black, but only 4.9% of the families were Non-Hispanic White[127].

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[123] Reichman, N. (2005). Disparities in low birth weight by race, ethnicity, and nativity. Retrieved November 12, 2014, from http://futureofchildren.org/publications/journals/article/index.xml?journalid=38&articleid=118

[124] Fiscella, K. (2004). Racial disparity in infant and maternal mortality: confluence of infection, and microvascular dysfunction. *Maternal and Child Health Journal*, *8*(2), 45–54.

[125] Currie, J., & Walker, R. (2011). Traffic Congestion and Infant Health: Evidence from E-ZPass. *American Economic Journal: Applied Economics*, *3*(1), 65–90. http://doi.org/10.1257/app.3.1.65

[126] Ghosh, J. K. C., Wilhelm, M., Su, J., Goldberg, D., Cockburn, M., Jerrett, M., & Ritz, B. (2012). Assessing the Influence of Traffic-related Air Pollution on Risk of Term Low

[127] New York City Housing Authority. (2014). Resident Data Summary Sheets. Retrieved from http://www.nyc.gov/html/nycha/html/resources/res_data.shtml

About Air Pollution

Air pollution is not only detrimental to the environment, but also to a person's health. The six criteria pollutants and most common air pollutants are particulate matter, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead.[128] The aforementioned pollutants are all associated with stroke, heart disease, lunch cancer, and acute and respiratory diseases, including asthma.[129,130] Accordingly, higher levels of air pollution are associated with poor cardiovascular and respiratory health.[131] Exposure to air pollution is also positively associated with preterm birth and low birthweight. Therefore, I argue that as was the case with health disparities generally, the positive correlation between air pollution and adverse birth outcomes leads to racial disparities, which is ultimately an issue of environmental justice.

Of the six criteria pollutants, particulate matter and ground-level ozone are the most widespread health threats.[132] The Clean Air Act, last amended in 1990, requires the Environmental Protection Agency (EPA) to set standards for the six criteria pollutants

[128] US EPA, O. (2014). Six Common Air Pollutants | Air & Radiation | US EPA. Retrieved January 28, 2015, from http://www.epa.gov/air/urbanair/

[129] Bernstein, J. A., Alexis, N., Barnes, C., Bernstein, I. L., Nel, A., Peden, D., … Bernstein, J. A. (2004). Health effects of air pollution. *Journal of Allergy and Clinical Immunology*, *114*(5), 1116–1123. http://doi.org/10.1016/j.jaci.2004.08.030

[130] Maantay, J. (2007). Asthma and air pollution in the Bronx: Methodological and data considerations in using GIS for environmental justice and health research. *Health & Place*, *13*(1), 32–56. http://doi.org/10.1016/j.healthplace.2005.09.009

[131] Pope, C. A., & Dockery, D. W. (2006). Health Effects of Fine Particulate Air Pollution: Lines that Connect. *Journal of the Air & Waste Management Association*, *56*(6), 709–742. http://doi.org/10.1080/10473289.2006.10464485

[132] Pope, C. A., & Dockery, D. W. (2006). Health Effects of Fine Particulate Air Pollution: Lines that Connect. *Journal of the Air & Waste Management Association*, *56*(6), 709–742. http://doi.org/10.1080/10473289.2006.10464485

that are considered harmful to health.[133] The EPA has found 12-μg/m^3 particle pollution concentration to be the annual allowable mean of primary particulate matter, 0.0075 ppm to be the annual allowable mean for ozone, 53 ppb for nitrogen dioxide, 0.15μg/m^3 for lead for a three month average, 9 ppm for carbon monoxide, and 75 ppb for sulfur dioxide.[134] The EPA is concerned with particulate matter that is 10 micrometers in diameter or smaller because that size particle can pass through the throat and nose, thereby entering the lungs and causing negative health effects.[135] Course particles can be inhaled because they are less than 10 micrometers in diameter and are found near roadways and industry locations that produce dust. Fine particles can also be inhaled as they are less than 2.5 micrometers in diameter and are "generally found in smoke and haze, [as they are] emitted from natural sources like forest fires and industrial combustion sources, [which are] formed when gases react in the air."[136] Ultrafine particles are particles less than 0.1 micrometers.[137] The particles that can be inhaled due to their small size are a major public health concern.

Starting in 2008, New York City began the New York City Community Air Survey (NYCCAS), which is a comprehensive survey of street-level air quality across the City. Pollutants such as particulate matter (PM2.5), nitrogen dioxide (NO_2), sulfur

[133] National Ambient Air Quality Standards (NAAQS) | Air and Radiation | US EPA. (2015). Retrieved May 4, 2014, from http://www.epa.gov/air/criteria.html

[134] National Ambient Air Quality Standards (NAAQS) | Air and Radiation | US EPA. (2015). Retrieved May 4, 2014, from http://www.epa.gov/air/criteria.html

[135] US EPA, O. (2014). Particulate Matter | AirTrends | Air & Radiation | EPA. Retrieved January 31, 2015, from http://www.epa.gov/airtrends/pm.html#pmreg

[136] US EPA, O. (2015). Particulate Matter | AirTrends | Air & Radiation | EPA. Retrieved January 31, 2015, from http://www.epa.gov/airtrends/pm.html#pmreg

[137] US EPA, O. (2015). Particulate Matter | AirTrends | Air & Radiation | EPA. Retrieved January 31, 2015, from http://www.epa.gov/airtrends/pm.html#pmreg

dioxide (SO_2), ozone (O_3), black carbon (BC), nitrogen oxide (NO), and metal constituents of PM2.5 were measured at 150 locations for two weeks during each each season. Figure 1 below shows where the air monitoring sites were located as part of NYCCAS. The results from NYCCAS monitoring show that levels of pollution were highest in Manhattan, Brooklyn, and The Bronx for nitrogen oxide (NO), nitrogen dioxide (NO_2), particulate matter 2.5, sulfur dioxide (SO_2), and nickel (Ni). Ozone (O_3) was found in extremely high quantities of 26.7 to 30.6 parts per million across New York City.[138] These toxins are found in motor vehicle exhausts, and occur in elevated levels near major roadways[139].

Air Pollution and Adverse Birth Outcomes

I conducted a literature review in which I researched articles that examined any one or a combination of the following: adverse birth outcomes, air pollution exposure, proximity to roads, and race. There was a significant amount of research that indicated a positive association exists between air pollution exposure and adverse birth outcomes. More specifically, one study that also used GIS found that pregnant women had an increased risk of adverse birth outcomes when exposed to NO_2 levels >46.2 $\mu g/m^3$ during the second and third trimesters as well as throughout the entire pregnancy and to benzene levels

[138] New York City Health. (2013). *New York City Trends in Air Pollution and its Health Consequences*. Retrieved from http://www.nyc.gov/html/doh/downloads/pdf/environmental/air-quality-report-2013.pdf

[139] Ghosh, J. K. C., Wilhelm, M., Su, J., Goldberg, D., Cockburn, M., Jerrett, M., & Ritz, B. (2012). Assessing the Influence of Traffic-related Air Pollution on Risk of Term Low Birth Weight on the Basis of Land-Use-based Regression Models and Measures of Air Toxics. *American Journal of Epidemiology*, kwr469. http://doi.org/10.1093/aje/kwr469

>2.7 μg/m^3 throughout the entire pregnancy.[140] A few studies relied on residential history to assess which participants lived closer to highways and were exposed to greater levels of air pollution.[141,142] These studies used birth certificate data for birth outcomes and mapped the addresses of over 56,000 participants to assess air pollution exposure. The study used a model based on the Gaussian probability distribution, which assumes that 96% of all motor vehicle exhaust pollutants disperse at 500ft (152.4m) from the roadway.[143]

Due to the number of studies that used residential history to assess air pollution exposure, I am examining the location and racial composition of public housing developments, as these data are known. A systematic review of air pollution and birth outcomes indicates that many studies found an association between preterm birth and low birthweight with particulate matter 2.5 (PM2.5).[144] A second systematic review found that the majority of studies reported reduced birth weight and increased odds of low birth weight in relation to exposure to carbon monoxide (CO), nitrogen dioxide (NO_2) and particulate matter less than 10 and 2.5 microns (PM10 and PM2.5).[145] A review of the literature on the effects of

[140] Llop, S., Ballester, F., Estarlich, M., Esplugues, A., Rebagliato, M., & Iñiguez, C. (2010). Preterm birth and exposure to air pollutants during pregnancy. *Environmental Research*, *110*(8), 778–785. http://doi.org/10.1016/j.envres.2010.09.009

[141] Brauer, M., Lencar, C., Tamburic, L., Koehoorn, M., Demers, P., & Karr, C. (2008). A Cohort Study of Traffic-Related Air Pollution Impacts on Birth Outcomes. *Environmental Health Perspectives*, *116*(5), 680–686. http://doi.org/10.1289/ehp.10952

[142] Wilhelm, M., & Ritz, B. (2003). Residential proximity to traffic and adverse birth outcomes in Los Angeles county, California, 1994-1996. *Environmental Health Perspectives*, *111*(2), 207–216.

[143] Wilhelm, M., & Ritz, B. (2003). Residential proximity to traffic and adverse birth outcomes in Los Angeles county, California, 1994-1996. *Environmental Health Perspectives*, *111*(2), 207–216.

[144] Shah, P. S., & Balkhair, T. (2011). Air pollution and birth outcomes: A systematic review. *Environment International*, *37*(2), 498–516. http://doi.org/10.1016/j.envint.2010.10.009

[145] Stieb, D. M., Chen, L., Eshoul, M., & Judek, S. (2012). Ambient air pollution, birth weight and preterm birth: A systematic review and meta-analysis. *Environmental Research*, *117*, 100–111. http://doi.org/10.1016/j.envres.2012.05.007

ambient air pollution on fetal growth that used traffic density to assess air pollution exposure also found a positive association with preterm birth.[146] Additionally, a 2005 review of the literature found that "for air pollution and birth weight the evidence suggests causality, but further studies are needed to confirm an effect and its size and to clarify the most vulnerable period of pregnancy and the role of different pollutants."[147] Only one paper did not find an association between air pollution and adverse birth outcomes.[148] However, the overwhelming majority of relevant and credible literature indicates that there is a clear positive association between air pollution and adverse birth outcomes, particularly preterm birth.[149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,166,167,168,169]

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[146] Maisonet, M., Correa, A., Misra, D., & Jaakkola, J. J. K. (2004). A review of the literature on the effects of ambient air pollution on fetal growth. *Environmental Research*, *95*(1), 106–115. http://doi.org/10.1016/j.envres.2004.01.001

[147] Šrám, R. J., Binková, B., Dejmek, J., & Bobak, M. (2005). Ambient Air Pollution and Pregnancy Outcomes: A Review of the Literature. *Environmental Health Perspectives*, *113*(4), 375–382. http://doi.org/10.1289/ehp.6362

[148] Glinianaia, S. V., Rankin, J., Bell, R., Pless-Mulloli, T., & Howel, D. (2004). Particulate Air Pollution and Fetal Health: A Systematic Review of the Epidemiologic Evidence. *Epidemiology*, *15*(1), 36–45. http://doi.org/10.1097/01.ede.0000101023.41844.ac

[149] Havard, S., Deguen, S., Zmirou-Navier, D., Schillinger, C., & Bard, D. (2009). Traffic-Related Air Pollution and Socioeconomic Status: A Spatial Autocorrelation Study to Assess Environmental Equity on a Small-Area Scale. *Epidemiology*, *20*(2), 223–230. http://doi.org/10.1097/EDE.0b013e31819464e1

[150] Gehring, U., Wijga, A. H., Fischer, P., de Jongste, J. C., Kerkhof, M., Koppelman, G. H., … Brunekreef, B. (2011). Traffic-related air pollution, preterm birth and term birth weight in the PIAMA birth cohort study. *Environmental Research*, *111*(1), 125–135. http://doi.org/10.1016/j.envres.2010.10.004

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[155] Chang, H. H., Reich, B. J., & Miranda, M. L. (2012). Time-to-event analysis of fine particle air pollution and preterm birth: results from North Carolina, 2001-2005. *American Journal of Epidemiology*, *175*(2), 91–98. http://doi.org/10.1093/aje/kwr403

[156] Currie, J., & Walker, R. (2011). Traffic Congestion and Infant Health: Evidence from E-ZPass. *American Economic Journal: Applied Economics*, *3*(1), 65–90. http://doi.org/10.1257/app.3.1.65

[157] Slama, R., Morgenstern, V., Cyrys, J., Zutavern, A., Herbarth, O., Wichmann, H.-E., & Heinrich, J. (2007). Traffic-Related Atmospheric Pollutants Levels during Pregnancy and Offspring's Term Birth Weight: A Study Relying on a Land-Use Regression Exposure Model. *Environmental Health Perspectives*, *115*(9), 1283–1292. http://doi.org/10.1289/ehp.10047

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[163] Bosetti, C., Nieuwenhuijsen, M. J., Gallus, S., Cipriani, S., La Vecchia, C., & Parazzini, F. (2010). Ambient particulate matter and preterm birth or birth weight: a review of the literature. *Archives of Toxicology*, *84*(6), 447–460. http://doi.org/http://dx.doi.org/10.1007/s00204-010-0514-z

[164] Chang, H. H., Reich, B. J., & Miranda, M. L. (2012). Time-to-event analysis of fine particle air pollution and preterm birth: results from North Carolina, 2001-2005. *American Journal of Epidemiology*, *175*(2), 91–98. http://doi.org/10.1093/aje/kwr403

[165] Chang, S.-C., O'Brien, K. O., Nathanson, M. S., Mancini, J., & Witter, F. R. (2003). Characteristics and risk factors for adverse birth outcomes in pregnant black adolescents. *The Journal of Pediatrics*, *143*(2), 250–257. http://doi.org/10.1067/S0022-3476(03)00363-9

[166] Ito, K., Mathes, R., Ross, Z., Nádas, A., Thurston, G., & Matte, T. (2010). Fine Particulate Matter Constituents Associated with Cardiovascular Hospitalizations and Mortality in New York City. *Environmental Health Perspectives*, *119*(4), 467–473. http://doi.org/10.1289/ehp.1002667

While an extensive literature search suggests a positive association exists between air pollution exposure from traffic and adverse birth outcomes, few papers examined the relationship between *race*, air pollution and traffic, and adverse birth outcomes.[170,171] A 2003 study found that Black mothers, as well as mothers of non-White racial groups, experienced "higher mean levels of air pollution and were more than twice as likely to live in the most polluted counties compared with White mothers after controlling for maternal risk factors, region, and educational status."[172] The same study also found an increase in the odds of preterm delivery in a county with high air pollution.[173]

A relevant 2013 study used census data to determine the size and distribution of the population living near high volume roads in the United States. The study sought to examine the racial and income disparities in populations residing in close proximity to roadways through the lens of environmental justice. It found that 19.3% of the American population

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[167] Salam, M. T., Millstein, J., Li, Y.-F., Lurmann, F. W., Margolis, H. G., & Gilliland, F. D. (2005). Birth Outcomes and Prenatal Exposure to Ozone, Carbon Monoxide, and Particulate Matter: Results from the Children's Health Study. *Environmental Health Perspectives*, *113*(11), 1638–1644.

[168] Sapkota, A., Chelikowsky, A. P., Nachman, K. E., Cohen, A. J., & Ritz, B. (2010). Exposure to particulate matter and adverse birth outcomes: a comprehensive review and meta-analysis. *Air Quality, Atmosphere & Health*, *5*(4), 369–381. http://doi.org/10.1007/s11869-010-0106-3

[169] Savitz, D. A., Bobb, J. F., Carr, J. L., Clougherty, J. E., Dominici, F., Elston, B., … Matte, T. D. (2014). Ambient Fine Particulate Matter, Nitrogen Dioxide, and Term Birth Weight in New York, New York. *American Journal of Epidemiology*, *179*(4), 457–466. http://doi.org/10.1093/aje/kwt268

[170] Habermann, M., & Gouveia, N. (2014). Socioeconomic Position and Low Birth Weight among Mothers Exposed to Traffic-Related Air Pollution. *PLoS ONE*, *9*(11), e113900. http://doi.org/10.1371/journal.pone.0113900

[171] Woodruff, T. J., Parker, J. D., Kyle, A. D., & Schoendorf, K. C. (2003). Disparities in exposure to air pollution during pregnancy. *Environmental Health Perspectives*, *111*(7), 942–946.

[172] Woodruff, T. J., Parker, J. D., Kyle, A. D., & Schoendorf, K. C. (2003). Disparities in exposure to air pollution during pregnancy. *Environmental Health Perspectives*, *111*(7), 942–946.

[173] Woodruff, T. J., Grillo, J., & Schoendorf, K. C. (1997). The relationship between selected causes of postneonatal infant mortality and particulate air pollution in the United States. *Environmental Health Perspectives*, *105*(6), 608–612.

lives in areas close to a high volume road as per traffic density and proximity to roads categorizations. What is most notable, however, is that the study indicates that people of color and people with low income are over represented in the population that lives in areas near roads. The study also found that there is a strong association between race, income, and traffic volume.[174]

From these studies, it is clear that exposure to air pollution, particularly to PM2.5 and NO_2 is positively associated with adverse birth outcomes. There is a gap, however, in examining the effects that air pollution exposure has on the racial disparities in adverse birth outcomes. Without using a statistical analysis, the rest of this thesis explores and generates hypotheses of the effects that air pollution may have on racial disparities in adverse birth outcomes in New York City.

[174] Rowangould, G. M. (2013). A census of the US near-roadway population: Public health and environmental justice considerations. *Transportation Research Part D: Transport and Environment*, *25*, 59–67. http://doi.org/10.1016/j.trd.2013.08.003

CHAPTER 5: Methods

Methods Used

I will use tools and maps created from ArcGIS to examine evidence for links between a number of datasets including race, public housing, air pollution, traffic, and adverse birth outcomes. The maps I have produced look at public housing developments in the five boroughs of New York City. For the purpose of my project, public housing includes conventional public housing and subsidized housing. I have chosen to focus on public housing because Black infants have been found to be significantly more likely than White infants to live in close proximity to highways, such as in public housing located along highways in New York City.[175] I am using public housing to explore how different races are exposed to different levels of air pollution, given that, for example, in 2013, 46.2% of the families in New York City public housing were Black, but only 4.9% of the families were Non-Hispanic White.[176]

I used various sets of data from which I created a set of maps using ArcMap 10.2 and ArcGIS software to explore correlations and questions that could feasibly generate hypotheses exploring the links between race, highways, and adverse birth outcomes. I focused on creating maps of New York City that depict community districts in the four

[175] Currie, J., & Walker, R. (2011). Traffic Congestion and Infant Health: Evidence from E-ZPass. *American Economic Journal: Applied Economics*, *3*(1), 65–90. http://doi.org/10.1257/app.3.1.65

[176] New York City Housing Authority. (2014). Resident Data Summary Sheets. Retrieved from http://www.nyc.gov/html/nycha/html/resources/res_data.shtml

boroughs of Queens, Brooklyn, Manhattan and The Bronx. Within these boroughs I mapped major roadways, roadways by traffic volume, public housing developments, community districts, race/ethnicity by community district, preterm birth by community district, and air pollution exposure by community district. I excluded Staten Island from my analysis because the data pertaining to that area are dissimilar to that of The Bronx, Brooklyn, Queens, and Manhattan due to Staten Island's proximity to New Jersey, particularly when discussing air pollution.

I collaborated with the New York City Department of Public Health to acquire data for adverse birth outcomes in New York City by community district. I also used data from the United States Census, Environmental Protection Agency (EPA), New York City Department of Health and Mental Hygiene (NYCDHMH), and New York City Housing Authority (NYCHA). Below is a detailed outline of the processes that I followed to prepare my data sets.

Data Sources

Data for the major roads of New York City originated from NYC Open Data (2013) and they included information about parkways, interstates, state routes, and U.S. routes. Data for community districts were provided by Tufts GIS Data Server and contained polygons of all community districts in Manhattan, The Bronx, Queens, Brooklyn, and Staten Island. I obtained data from the New York City Housing Authority that provides polygons of all housing developments in NYC (per borough) that are

considered public housing.[177] As aforementioned, for the purpose of my thesis, public housing includes conventional public housing and subsidized housing. There were several data layers that came from the New York City Department of Health and Mental Hygiene. Preterm birth data, which compares the percent of total live births with that of preterm births (<37 weeks) by community district, is from NYCHA. Air pollution data provides data for NO2, SO2, NO, and PM2.5 by community district, which are the types of data that have been found to be positively associated with adverse birth outcomes such as preterm birth and low birthweight[178][179]All data for race and income were provided by the United States 2010 Decennial Census[180]. Traffic Analysis Zones data were provided as shapefiles of New York State Average Annualized Daily Traffic, which showed traffic volumes on roads in New York State. The traffic data are from 2012, and they were provided by New York State GIS Clearinghouse[181]

[177] NYC Planning. (2015). Bytes of the Big Apple. Retrieved October 12, 2014, from http://www.nyc.gov/html/dcp/html/bytes/applbyte.shtml

[178] New York City Health. (2015). Environmental & Health Data Portal. Retrieved January 20, 2015, from http://a816-dohbesp.nyc.gov/IndicatorPublic/publictracking.aspx

[179] Gehring, U., Wijga, A. H., Fischer, P., de Jongste, J. C., Kerkhof, M., Koppelman, G. H., … Brunekreef, B. (2011). Traffic-related air pollution, preterm birth and term birth weight in the PIAMA birth cohort study. *Environmental Research*, *111*(1), 125–135. doi:10.1016/j.envres.2010.10.004

[180] Bureau, U. S. C. (2010). American FactFinder - Search. Retrieved January 28, 2015, from http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

[181] New York State Department of Transportation. (2015). New York State GIS Clearinghouse. Retrieved October 15, 2014, from http://gis.ny.gov/gisdata/inventories/member.cfm?organizationID=539

Dataset	Description	Source	Key Attributes
Major Roads	This layer contains all major Roads in New York. The roads have been divided by type to include highways, parkways, interstates, state routes, and U.S. routes	NYC Open Data, 2013	Parkway, interstate, state route, and US route
ESRI Basemap	This layer provides background of water bodies including ponds, lakes, reservoirs, rivers, and oceans. It will provide context.	Tufts GIS Data Server ESRI Data, 2010	Ponds, lakes, reservoirs, rivers, and oceans.
Community Districts	This layer provides polygons of all community districts in Manhattan, The Bronx, Queens, Brooklyn, and Staten Island.	Tufts GIS Data Server ESRI Data, 2010	
Borough Boundaries	This layer provides the boundaries of all of the boroughs, so it is clear to the viewer which borough is Manhattan, which is The Bronx, etc.	Tufts GIS Data Server ESRI Data, 2010	
Parks	This layer provides polygons of the all parks within New York City. It will provide context about the location of green and open space in relation to public housing developments.	Tufts GIS Data Server ESRI Data, 2010	
NYCHA Public Housing Developments	This layer provides polygons of all housing developments in NYC (per borough) that are considered public housing. For the purpose of my project, public housing includes conventional public housing and subsidized housing.	New York City Housing Authority Data, 2011.	
Air pollution exposure by community district	This layer provides air pollution exposure by community district. It provides data for NO2, SO2, NO, and PM2.5, which are the types of data that have been found to be positively associated with adverse birth outcomes such as preterm birth and low birthweight. http://a816-dohbesp.nyc.gov/IndicatorPublic/BuildATable.aspx	New York City Department of Health and Mental Hygiene, 2013	NO_2, SO_2, NO, and PM2.5
Percent of total live births with preterm birth (<37 weeks) by community district	This layer provides percent of total live births with preterm birth (<37 weeks) by community district. https://a816-healthpsi.nyc.gov/SASStoredProcess/guest?_PROGRAM=/EpiQuery/birth/birth2_v2&pop=kmage4&row=preterm&qtype=cd&mapvar=brate&year=2012	New York City Department of Health and Mental Hygiene, 2012	
Race	This layer provides the total population for each census tract and the number of the total population who are Black or African American by census tract for each borough and the number of the total population who are White by census tract for each borough.	2010 Decennial Census; US census bureau, American fact finder, SF 2010, census tracts by county	White and Black races
Traffic Analysis Zones	Traffic Analysis Zones data were provided as shapefiles of New York State Average Annualized Daily Traffic as showing traffic volumes on roads in New York State.	New York State GIS Clearinghouse, 2012[182]	

[182] New York State Department of Transportation. (2015). New York State GIS Clearinghouse. Retrieved October 15, 2014, from http://gis.ny.gov/gisdata/inventories/member.cfm?organizationID=539

Data Processes

ArcGIS Software was used to process all of the data and make GIS maps. All of the data were clipped to New York borough boundaries for Manhattan, Queens, Brooklyn and The Bronx. All layers were projected to NAD_1983_StatePlane_New_York_Long_Island_FIPS_3104_Feet. I used two different data sets for roadways, one that had road categories (NYC Open Data) and another that had road volume (NYS GIS Clearinghouse). Road data from NYC Open Data for the boroughs of Manhattan, The Bronx, Brooklyn, and Queens that were classified as highways, interstates, parkways, U.S. routes, and State Routes were processed to show areas that were within 1000, 2000, 3000 and 4000 feet of the nearest highway using Euclidian Distance. These data were also classified by community district (via the mean) using zonal statistics and reclassified in order to give each district a score of 1-4, where 1 was the farthest away from highways (3000-4000 feet) and 4 was the nearest to highways (477-1000 feet). Using Kernel Density, areas that had 0-0.68 road density were classified as low, and areas that had 2-2.72 road density were classified as high. This data was also classified by community district (via the mean) using zonal statistics and reclassified in order to give each district a score of 1–4, where 1 was the lowest road density (0 – 0.458) and 4 was the highest road density (1.512-2.716).

Public housing data from the New York City Housing Authority for the boroughs of Manhattan, The Bronx, Brooklyn, and Queens were processed by community district (via the mean) using zonal statistics and reclassified to show which community districts had the highest number of public housing residents where 1 indicated the fewest residents

and 4 the most residents. A score of 1 was 59-1000 residents, 2 was 500-1500 residents, 3 was 1500-3000 residents, and 4 was 3000-5000 residents.

Public housing data from the New York City Housing Authority for the same boroughs were processed by community district (via the mean) using zonal statistics and reclassified to show which community districts had the highest number of public housing units where 1 indicated the fewest units and 4 was the most residents. A score of 1 was 1-24 units, 2 was 24-150 units, 3 was 150-1000 units, and 4 was 1000-2500 units.

Reclassified data for road distance by community district, road density by community district, public housing population by community district, and public housing units by community district were added together using raster calculator to create an overall score for each community district on a scale of 4-16, where a score of 4 meant the community district scored 1 on each of the four factors and a score of 16 meant the community district scored 4 on each of the four factors. A score of 4 signified a community district that was *not* likely to have many public housing residents located in an area with many highways, and a score of 16 signified a community district that *was* likely to have many public housing residents located in an area with many highways.

Technical Difficulties and Limitations

There are several technical difficulties associated with air pollution measurements including distance relative to prevailing winds and continuous air pollution monitoring versus point monitoring.

The most notable technical difficulty that I encountered with ArcGIS was when I attempted to complete a spatial join between the Euclidian distance results and the

community districts. When I ran the spatial join, various fields appeared in my attribute table such as max_zona_3. I recognize now that some of the fields were originally named the same thing, so ArcMap assigned numbers to those fields. Given that I had to find another method to get distance by community district, I switched to using zonal statistics since it is equally as valid as spatial join.

Conceptual Difficulties and Limitations

I recognize that although my thesis discusses the Black/White racial disparities, racial disparities occur beyond Black and White racial groups. However, Black and White racial disparities have been studied extensively. Therefore, copious data exist on this disparity. Furthermore, over 40% of the residents in New York City housing developments are Black. Since housing developments are one of the focal points of my thesis, it made sense to focus on the Black community in New York City.

Another limitation is that the air pollution data is averaged by community district, and some parts of each community district have higher exposure than others. Therefore, the averaging masks the heterogeneity in community districts. The following chapter discusses the results that can be seen in the maps.

CHAPTER 6: Results

An Overview of New York City Geography

New York City is composed of five boroughs: Manhattan, Staten Island, Brooklyn, Queens, and The Bronx. As mentioned, Staten Island was excluded from my analysis due to its geography. New York City is broken up into 59 community districts across the boroughs, which attribute names and numbers to neighborhoods. Community districts are not all broken up evenly as they range from 900 acres to almost 15,000 and have populations from fewer than 35,000 residents to more than 200,000.[183] Figure 1 labels each borough and some of the neighborhoods I discuss throughout this chapter such as Harlem and Bedford Stuyvesant. Figures 4-11 include Black polygons throughout the boroughs, which are New York City Housing Authority (NYCHA) public housing developments, including conventional public housing and subsidized housing. As of March 1 2014, the NYCHA had 2,565 residential buildings providing housing for 403,120 residents.[184]

[183] NYC Planning. (2015). DCP Community Portal. Retrieved from http://www.nyc.gov/html/dcp/html/neigh_info/nhmap.shtml

[184] About NYCHA. (2015). Retrieved from http://www.nyc.gov/html/nycha/html/about/nycha70.shtml.

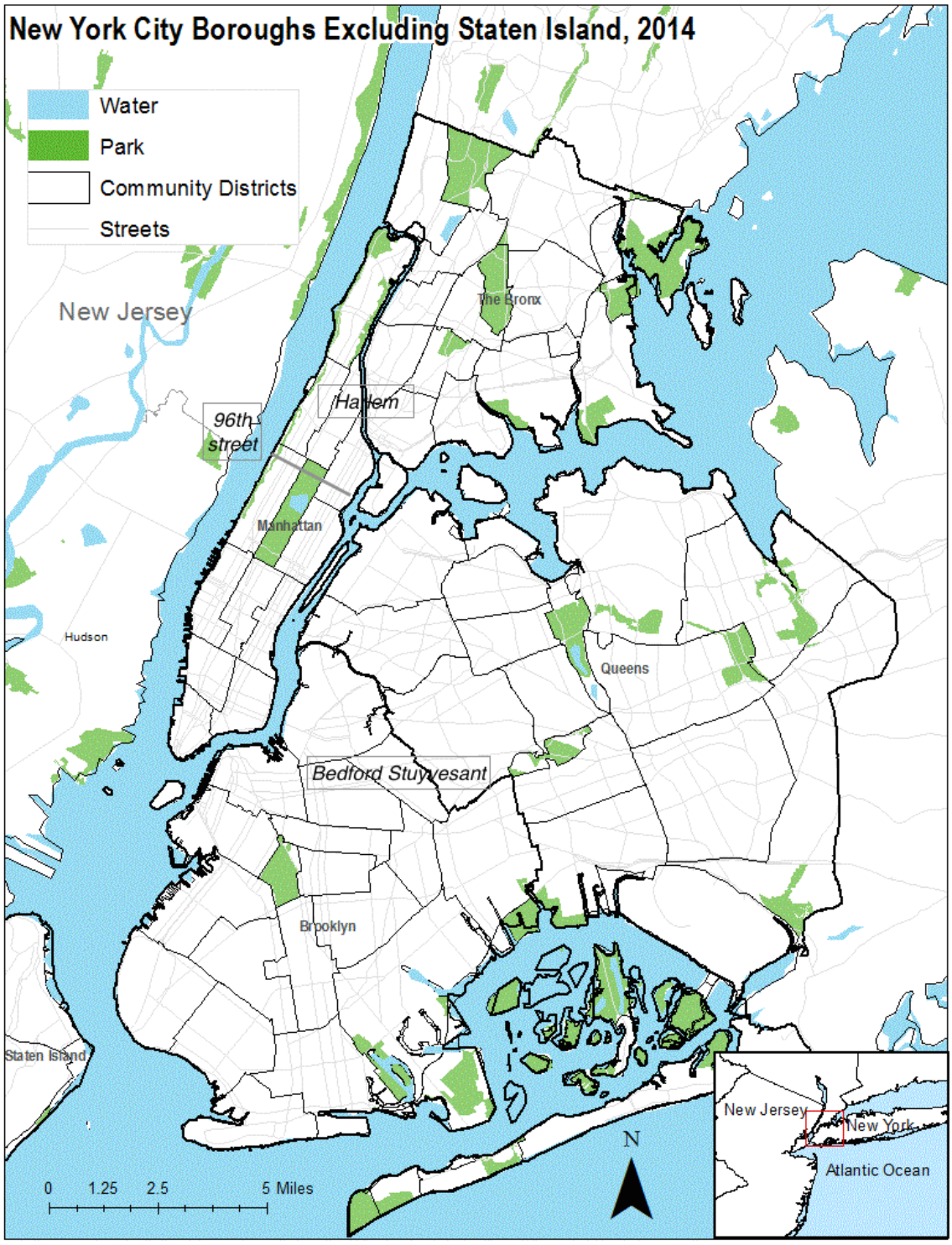

Figure 1. New York City Boroughs Excluding Staten Island, 2014.

Race in New York City

Maps of the current racial composition of New York City demonstrate the importance of the historical segregation in New York City. As discussed in Chapter 2, White flight and urban renewal contributed to how New York City looks today. Throughout the era of White flight, property valuations were based on the racial composition of the surrounding area; therefore, Whites reaped financial benefits from excluding Blacks from predominantly White neighborhoods. When slum clearance began during the 1930s and '40s, site evacuees were comprised of disproportionately poor Blacks and Puerto Ricans.

In 1941, the New York City Housing Authority (NYCHA) built the East River Houses (also known as the Harlem River Houses) located in East Harlem that were occupied by Blacks and Puerto Ricans who were displaced by urban renewal [185] Once the population of the East River Houses become predominantly Black and brown bodies, more and more Blacks and Puerto Ricans began to settle in Harlem, as there was no place where they were welcomed below 110th street.

Stuyvesant Town, built in 1943, became a Whites-only housing project on the Lower East Side of Manhattan, segregating Whites and Blacks not only from within housing developments, but also from areas in the City.

Stuyvesant Town and the East River Houses were the beginning of racial segregation in areas of New York City and in public housing. Around the same time that the East River Houses were built in Harlem, the newly-constructed A train ran from

[185] Zipp, Samuel. (2010). *Manhattan Projects: The Rise and Fall of Urban Renewal in Cold War New York*. New York, New York: Oxford University Press.

Harlem to Bedford Stuyvesant in Brooklyn. Blacks then dispersed themselves mainly between Harlem and Brooklyn, whereas White stayed mainly in Manhattan. We still see the patterns of racial segregation that began in the 1930s and '40s today. Figure 2, which is a map of the White population in New York City according to the 2013 census, indicates that the majority of Whites live in Manhattan, specifically below 96th street, and farther down in the wealthier areas of Brooklyn such as Park Slope, Dumbo, Prospect Park and Williamsburg. Figure 3, which is a map of the Black or African American population in New York City according to the 2013 census, demonstrates that the majority of Blacks still live in Bedford Stuyvesant and Harlem. The latter remains the densest Black community in the United States, while the largest most concentrated Black population in the U.S. resides in Brooklyn.[186] These maps clearly indicate that the white and Black populations in New York City remain segregated according to the same patterns that were created in the 1930s and '40s by the institutional racism of red lining, White flight, and urban renewal.

[186] BlackDemographics.com | New York City. (2015). Retrieved from http://Blackdemographics.com/cities-2/new-york-nj-ny/

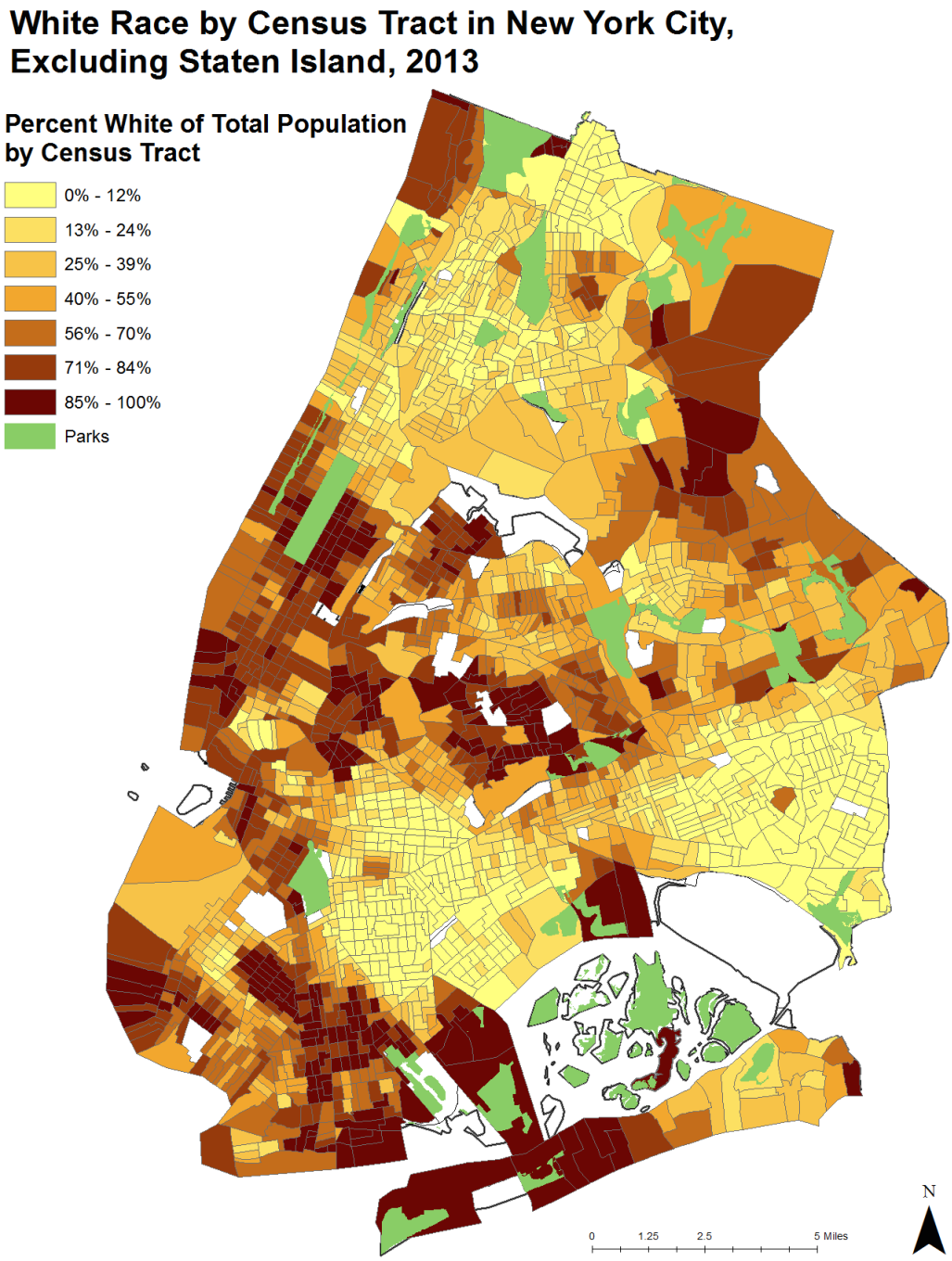

Figure 2. White Race by Census Tract in New York City, Excluding Staten Island, 2013. The color gradient on this map is counterintuitive because of the way census data works in ArcGIS. This map shows White race so it would make more sense if the color gradient were flipped so that the areas with the highest percentage of White population were lighter, but the gradient works such that the higher percentages are darker. When looking at the next map, Figure 3, it is clear that the lighter areas in this map are darker on the next map, which shows the Black population.

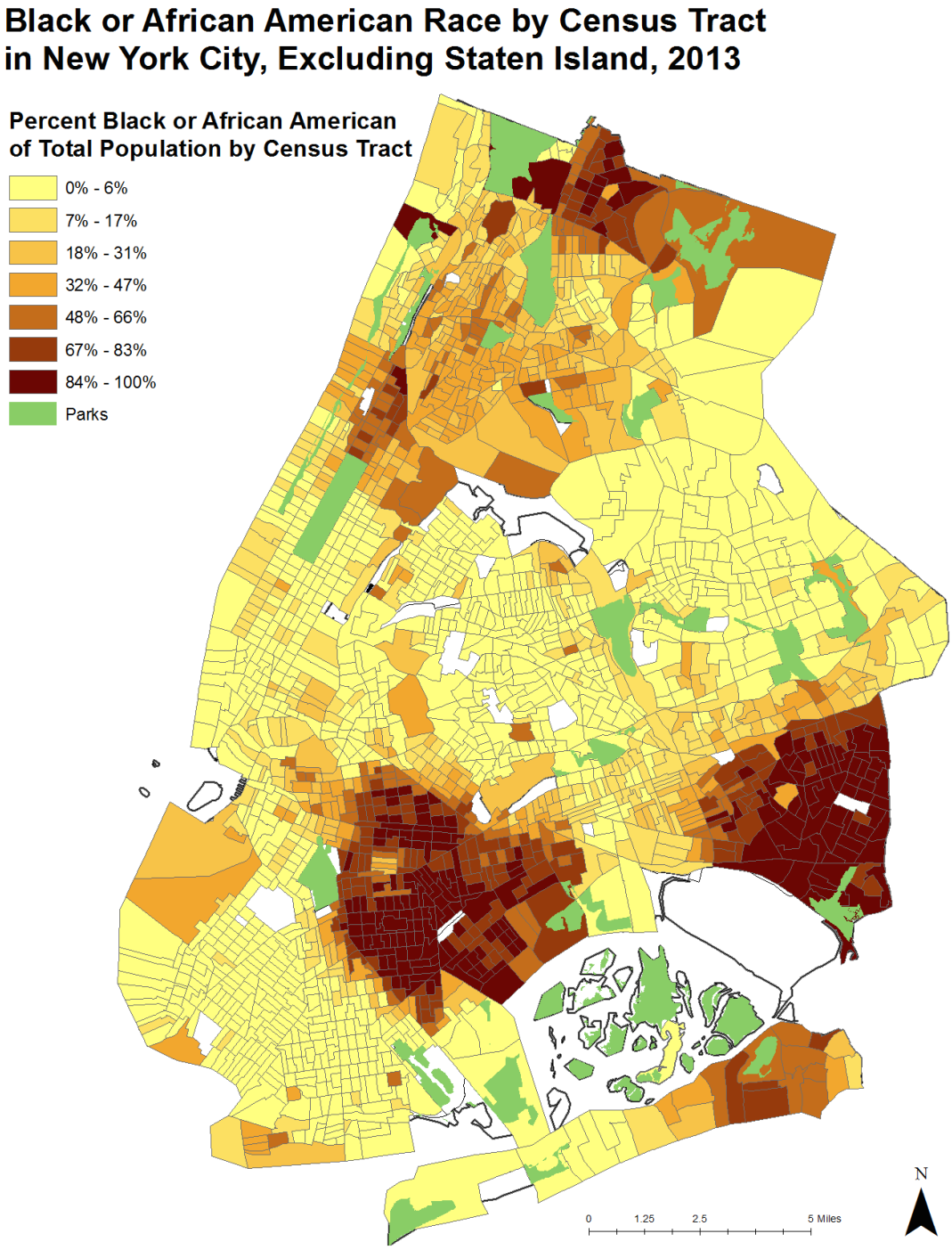

Figure 3. Black or African American Race by Census Tract in New York City, Excluding Staten Island, 2013.

Race and Adverse Birth Outcomes

The research and statistics included in this thesis clearly establish the association between race and adverse birth outcomes. More specifically, the infant mortality rate for Blacks is 2.4 times the rate of non-Hispanic Whites.[187] In 2007, non-Hispanic Blacks had an infant mortality rate of 13.31 per 1,000 live births, whereas non-Hispanic Whites had an infant mortality rate of 5.63.[188] Furthermore, the risk of preterm birth in the U.S. for Non-Hispanic Black women is 1.5 times the rate of their White counterparts.[189] And in 2013, the percent of low birthweight babies was 13% for Black mothers but 6.5% for White mothers.[190] Almost one in five infants of Black women were born preterm in 2007.[191] A 2004 study found that two thirds of racial disparities in infant mortality are attributable to a rate for low birth weight in Blacks that is almost three times higher than that of non-Hispanic Whites.[192] As these studies clearly show, adverse birth outcomes are not distributed equally amongst racial and ethnic populations, but rather the Black

[187] MacDorman, M., & Mathews, T. J. (2011). *Understanding Racial and Ethnic Disparities in U.S. Infant Mortality Rates*. Center for Disease Control. Retrieved from http://www.cdc.gov/nchs/data/databriefs/db74.pdf

[188] MacDorman, M., & Mathews, T. J. (2011). *Understanding Racial and Ethnic Disparities in U.S. Infant Mortality Rates*. Center for Disease Control. Retrieved from http://www.cdc.gov/nchs/data/databriefs/db74.pdf

[189] Center for Disease Control. (2007). *African-American women and their babies at a higher risk for pregnancy and birth complications*. Retrieved from http://www.cdc.gov/media/subtopic/matte/pdf/CDCMatteReleaseInfantMortality.pdf

[190] Reichman, N. (2005). Disparities in low birth weight by race, ethnicity, and nativity. Retrieved November 12, 2014, from http://futureofchildren.org/publications/journals/article/index.xml?journalid=38&articleid=118

[191] Center for Disease Control. (2011). Preterm Births --- United States, 2007. Retrieved January 28, 2015, from http://www.cdc.gov/mmwr/preview/mmwrhtml/su6001a16.htm

[192] Fiscella, K. (2004). Racial disparity in infant and maternal mortality: confluence of infection, and microvascular dysfunction. *Maternal and Child Health Journal*, *8*(2), 45–54.

population is at a much greater risk for preterm birth and infant mortality when compared to the non-Hispanic White population.

Data from New York City clearly depict this inequity further. In 2009, "The Bronx had the highest infant mortality rate (6.7), followed by Brooklyn (4.9), Queens (4.5), Manhattan (4.1) and Staten Island (3.7)."[193] Unsurprisingly, the infant mortality rate was highest among Blacks at 9.5, compared to Whites at 3.4 in New York City.[194] Additionally, Blacks were 1.8 times more likely than Whites to have preterm birth in New York City, and The Bronx had the highest preterm birth rate (9.7), followed by Brooklyn (8.3).[195] According to the 2010 Census, Blacks represented the majority of residents in The Bronx.[196]

Figures 4 and 5, which show low birth weight by community district and preterm birth by community district, respectively, demonstrate these disparities. In these maps, the Black polygons indicate public housing developments, and gray lines indicate major highways. In Figure 4, it is clear that there is a higher incidence of low birth weight in Harlem, The Bronx, Bedford Stuyvesant, and parts of Queens. A similar pattern can be seen in Figure 5, which shows a higher incidence of preterm birth in Harlem, The Bronx, and Bedford Stuyvesant. These are the same areas that are most heavily populated by Blacks, as The Bronx and Brooklyn are the boroughs with the highest Black population:

[193] New York City Health. (2012). *Infant Deaths in New York City, 2000-2009*. Retrieved from http://www.nyc.gov/html/doh/downloads/pdf/ms/bimt-infant-mortality-overview.pdf

[194] New York City Health. (2012). *Infant Deaths in New York City, 2000-2009*. Retrieved from http://www.nyc.gov/html/doh/downloads/pdf/ms/bimt-infant-mortality-overview.pdf

[195] New York City Health. (2015). Neighborhood Statistics: Maternal & Child Health. Retrieved November 12, 2014, from http://www.nyc.gov/html/doh/html/data/stats-mch.shtml

[196] New York City Health. (2011). *NYC 2010 Results from the 2010 Census: Population Growth and Race/Hispanic Composition*. Retrieved from http://www.nyc.gov/html/dcp/pdf/census/census2010/pgrhc.pdf

31.2% of the population in The Bronx is Black and 34.4% of the population in Brooklyn is Black.[197]

As discussed in Chapter 3 on racial disparities, the disparities that are observed in preterm birth and low birth weight are due to social determinants such as housing, education, and access to health care. The racial disparities in preterm birth and low birth weight are due to the institutional racism that still occurs today. The maps indicate that the incidence of low birth weight and preterm birth in areas inhabited predominantly by Blacks is double that of the incidence of low birth weight and preterm birth in areas inhabited predominantly by Whites.

[197] New York City Health. (2001). *Total population by mutually exclusive race and Hispanic origin new york city and boroughs, 1990 and 2000*. Retrieved from http://www.nyc.gov/html/dcp/pdf/census/pl3a.pdf

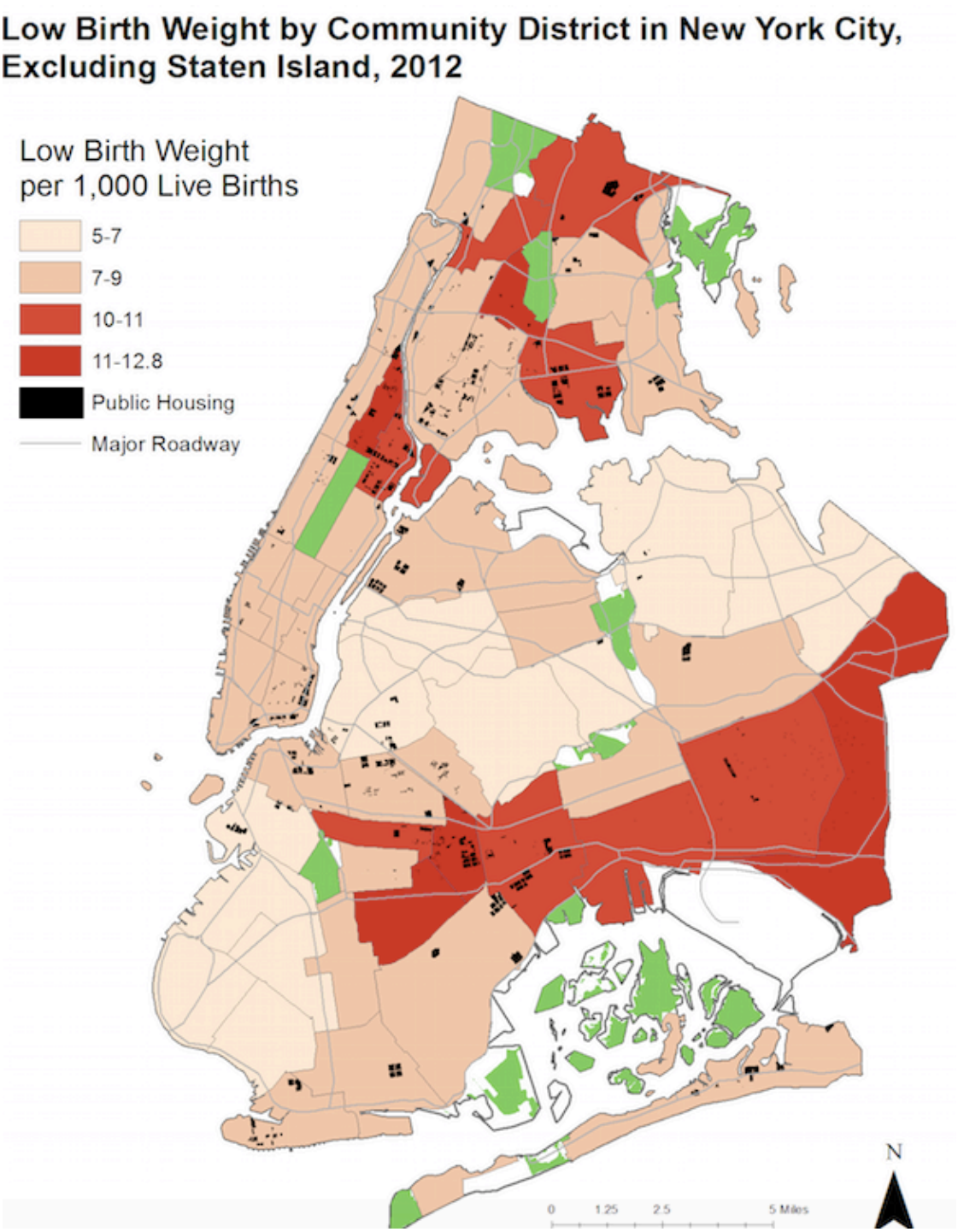

Figure 4. Low Birth Weight by Community District in New York City, Excluding Staten Island, 2012.

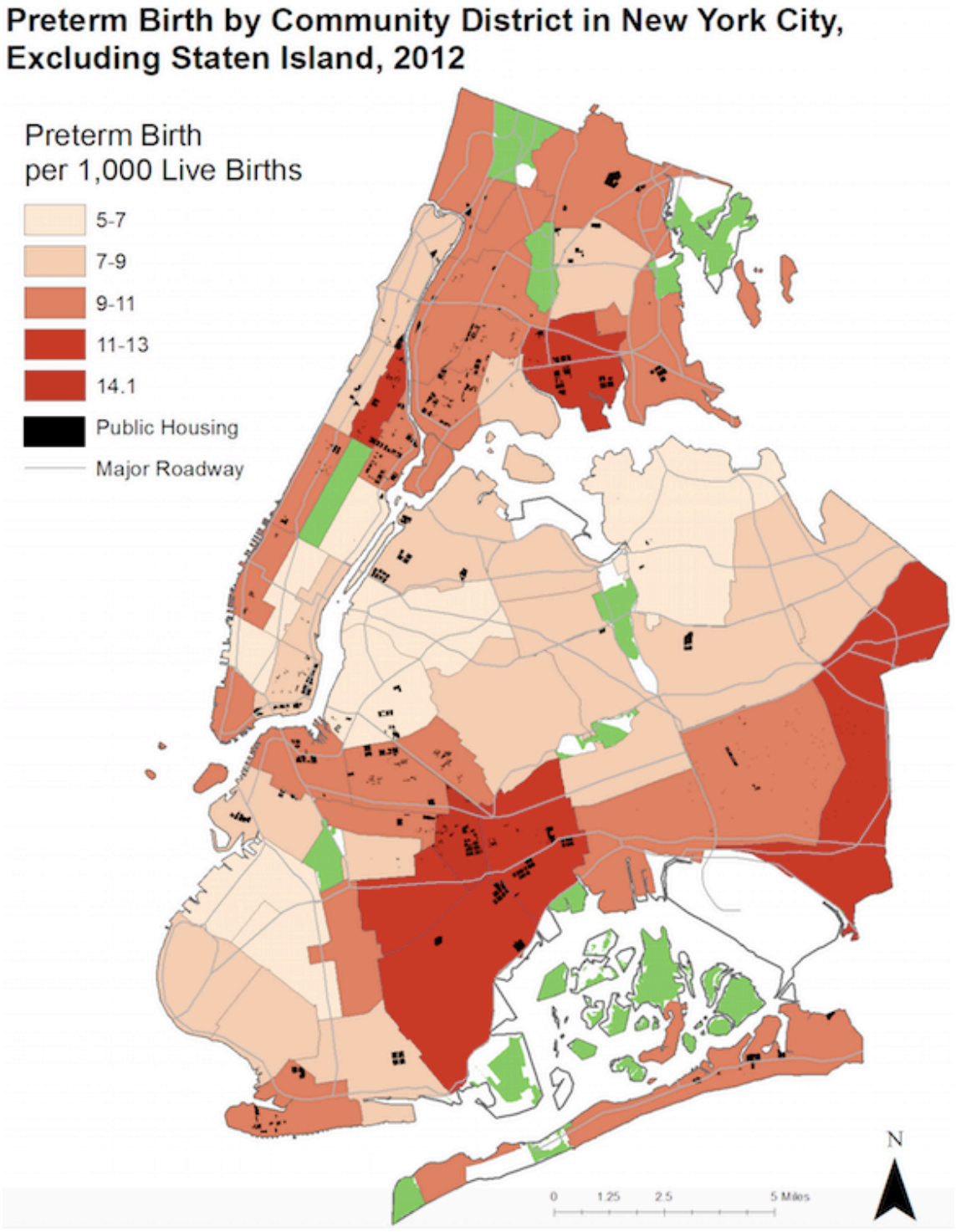

Figure 5. Preterm Birth by Community District in New York City, Excluding Staten Island, 2012.

Air Pollution and Preterm Birth

As discussed in Chapter 4 on air pollution and adverse birth outcomes, the literature establishes that there is a positive association between traffic-related air pollution exposure and adverse birth outcomes. A 2007 study in Munich, Germany found that the prevalence of low birthweight babies, which in this study was considered to be babies weighing <3000grams, increased by 13% for each increment of 1 $\mu g/m^3$ in PM2.5. The same study also found that 11.4% of the babies exposed to the lowest level of PM2.5 at 7.2–13.5 $\mu g/m^3$ and 16.5% of the babies exposed to the highest level of PM2.5 at 15.41-17.5 $\mu g/m^3$ were born low birthweight. It was also found that the prevalence of low birthweight births increased by 21% for each increment of 10 $\mu g/m^3$ of NO_2 levels.[198] A cohort study in Vancouver, British Columbia, Canada found that residence within 50 meters of a highway or freeway was associated with an 11% increase in low birthweight and a 26% increase in small gestational age. There was also a positive association between PM2.5 and preterm birth.[199] Furthermore, a study in Southern California found that the risk of very preterm delivery increased 128% for women exposed to the highest levels of NO_2 and 81% for women exposed to the highest levels of PM2.5.[200] A 2001-

[198] Slama, R., Morgenstern, V., Cyrys, J., Zutavern, A., Herbarth, O., Wichmann, H.-E., & Heinrich, J. (2007). Traffic-Related Atmospheric Pollutants Levels during Pregnancy and Offspring's Term Birth Weight: A Study Relying on a Land-Use Regression Exposure Model. *Environmental Health Perspectives*, *115*(9), 1283–1292. http://doi.org/10.1289/ehp.10047

[199] Brauer, M., Lencar, C., Tamburic, L., Koehoorn, M., Demers, P., & Karr, C. (2008). A Cohort Study of Traffic-Related Air Pollution Impacts on Birth Outcomes. *Environmental Health Perspectives*, *116*(5), 680–686. http://doi.org/10.1289/ehp.10952

[200] Wu, J., Ren, C., Delfino, R. J., Chung, J., Wilhelm, M., & Ritz, B. (2009). Association between Local Traffic-Generated Air Pollution and Preeclampsia and Preterm Delivery in the South Coast Air Basin of California. *Environmental Health Perspectives*, *117*(11), 1773–1779. http://doi.org/10.1289/ehp.0800334

2005 study in North Carolina found that "exposure to ambient PM2.5 during pregnancy is associated with increased risk of preterm birth, even in a region characterized by relatively good air quality."[201] Lastly, a 2012 prospective cohort study also found that maternal exposure to PM2.5 and NO_2 was inversely associated with weight at birth.[202]

These studies indicate that exposure to air pollution, particularly to PM2.5 and NO_2 is positively associated with adverse birth outcomes. There is a gap, however, in examining the effects that air pollution exposure has on racial disparities and in examining exposure to air pollution as an issue of environmental justice. Figures 6 and 7 show which areas of New York City are exposed to greater levels of NO_2 and PM2.5, respectively. Nitrogen Dioxide (NO_2) and particulate matter 2.5 are the two types of traffic-generated air pollution that have been shown to be positively associated with preterm birth and low birthweight. These maps demonstrate that those areas that are exposed to high levels of NO_2 and PM2.5 are Harlem and Bedford Stuyvesant in Brooklyn.

Surprisingly, however, the southernmost tip of Manhattan all the way up to 96th street (Manhattan proper, excluding Harlem) is exposed to the highest levels of both NO_2 and PM2.5. What is important to note, however, is that below 96th street, the average annual income is much higher than the average annual income in Harlem and Brooklyn. The median income for Manhattan below 96th street according to the 2013 census was

[201] Chang, H. H., Reich, B. J., & Miranda, M. L. (2012). Time-to-event analysis of fine particle air pollution and preterm birth: results from North Carolina, 2001-2005. *American Journal of Epidemiology*, *175*(2), 91–98. http://doi.org/10.1093/aje/kwr403

[202] Van den Hooven, E. H., Pierik, F. H., de Kluizenaar, Y., Willemsen, S. P., Hofman, A., van Ratingen, S. W., … Jaddoe, V. W. V. (2012). Air Pollution Exposure During Pregnancy, Ultrasound Measures of Fetal Growth, and Adverse Birth Outcomes: A Prospective Cohort Study. *Environmental Health Perspectives*, *120*(1), 150–156. http://doi.org/10.1289/ehp.1003316

$118,787. Yet the median household income in Harlem was $39,138 according to the same census, and the median income in Bedford Stuyvesant was $33,265. These maps reflect that Manhattan below 96th street also has fewer public housing developments than Harlem and Brooklyn. The difference in median income is important because those living in an area with a higher median income are more likely to have effective air ventilation systems or central air conditioning, thus decreasing exposure to air pollution. Conversely, individuals in areas with lower median income are less likely to have effective air ventilation systems.[203] New York City building code requires a ventilation system in any space greater than $500ft^2$, however, the type of ventilation system is not specified, and the cheapest systems are generally ineffective.[204] Despite these building codes, public housing developments are unlikely to have effective ventilation, if any.[205,206]

[203] Spengler, J. D., & Sexton, K. (1983). Indoor air pollution: a public health perspective. *Science*, *221*(4605), 9–17. http://doi.org/10.1126/science.6857273

[204] New York City Mechanical Code. (2008). *Ventilation*. Retrieved from http://www2.iccsafe.org/states/newyorkcity/Mechanical/PDFs/Chapter%204_Ventilation.pdf

[205] Krieger, J., & Higgins, D. L. (2002). Housing and health: time again for public health action. *American Journal of Public Health*, *92*(5), 758–768.

[206] Thomson, H., Petticrew, M., & Douglas, M. (2003). Health impact assessment of housing improvements: incorporating research evidence. *Journal of Epidemiology and Community Health*, *57*(1), 11–16. http://doi.org/10.1136/jech.57.1.11

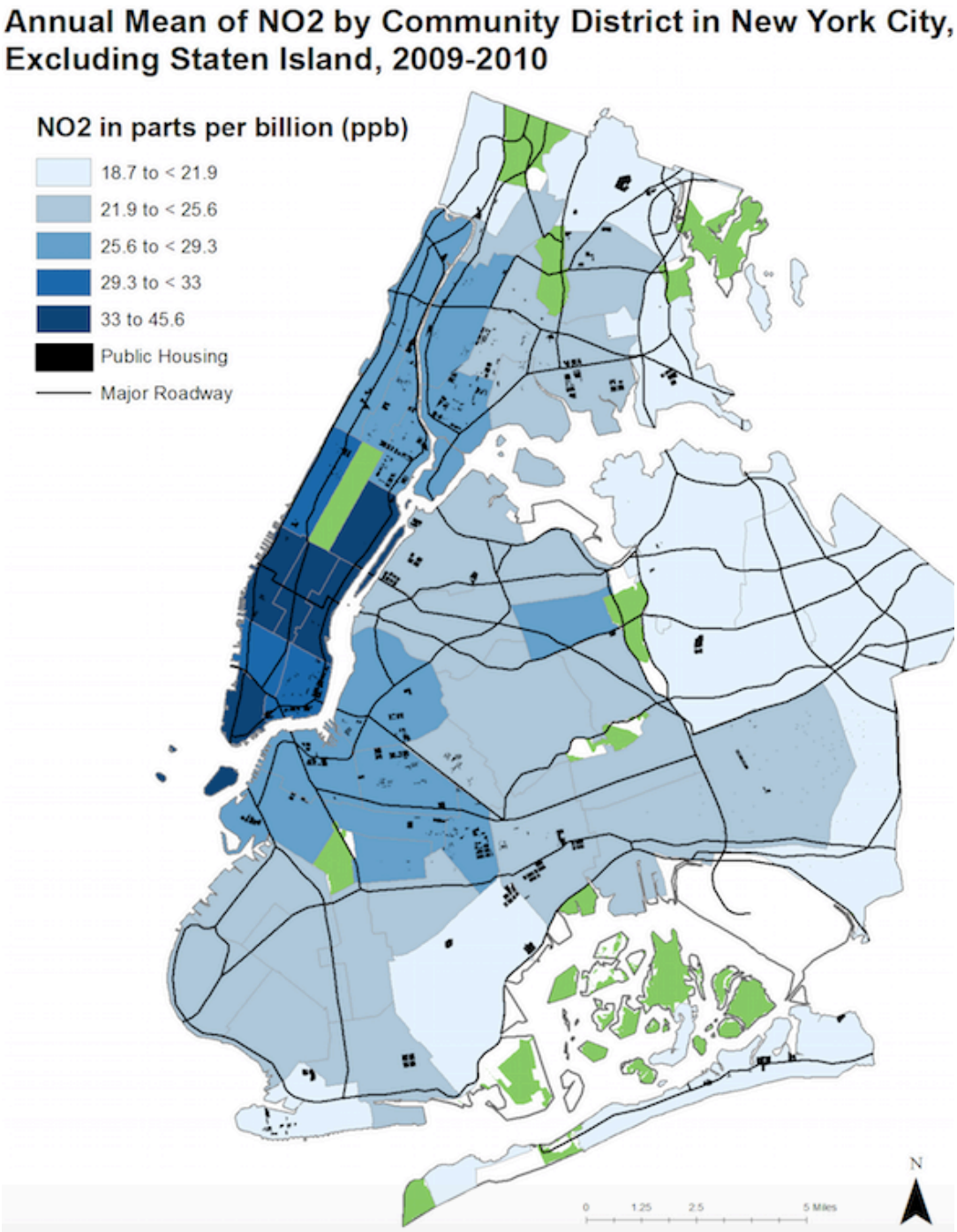

Figure 6. Annual Mean of NO_2 in parts per billion (ppb) by Community District in New York City, Excluding Staten Island, 2009-2010.

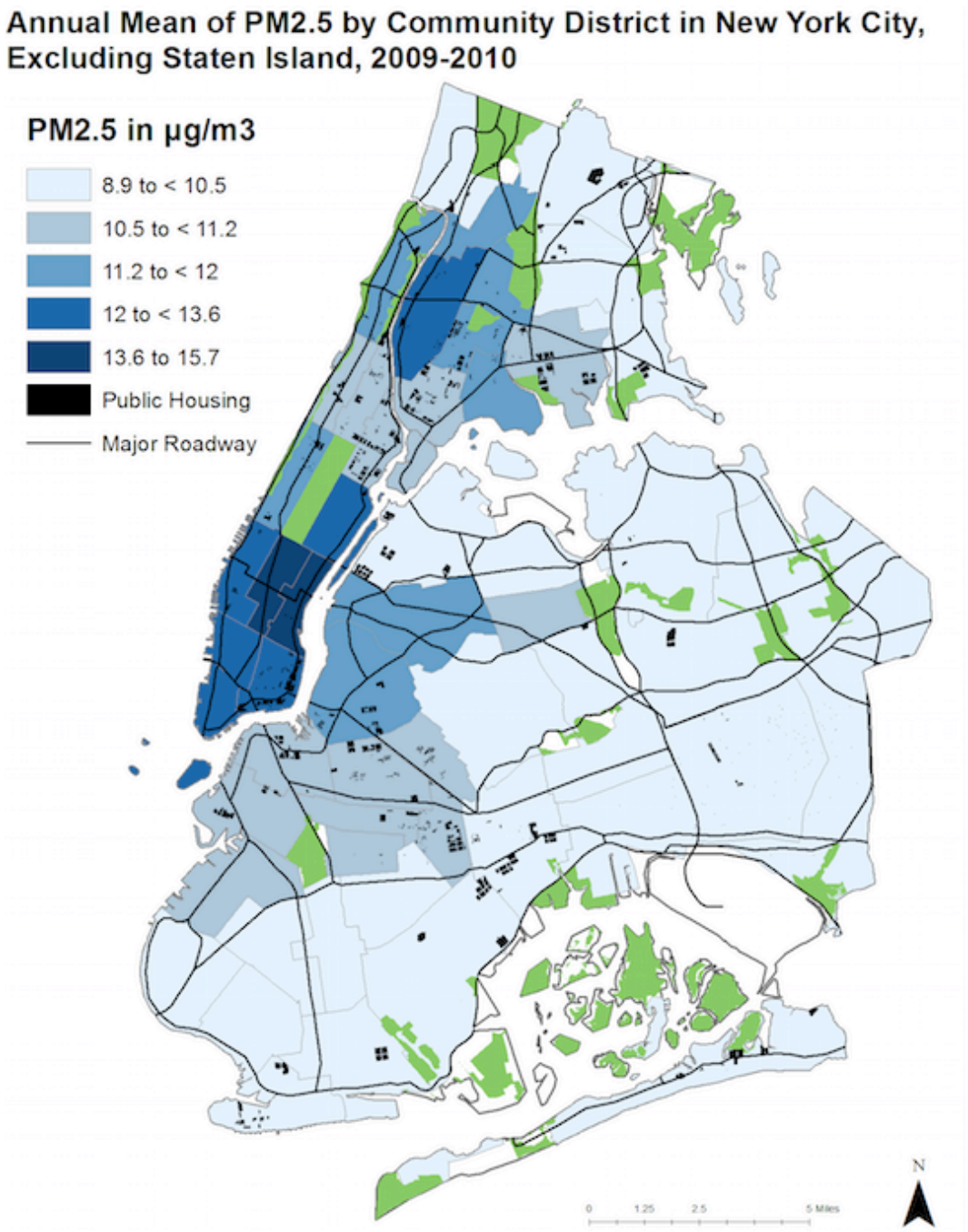

Figure 7. Annual Mean of PM2.5 in µg/m^3 by Community District in New York City, Excluding Staten Island, 2009-2010.

CHAPTER 7: Discussion

Housing and Air Pollution

Housing is a component of the built environment and is a social determinant of health that contributes to adverse birth outcomes.[207,208] The built environment encompasses any of the anthropogenic surroundings that provide the setting for human activity. Accordingly, public housing is included in the built environment. As mentioned, Black residents constitute the leading racial group living in New York City public housing developments.[209] In 2013, 46.2% of the families in New York City public housing were Black, but only 4.9% of the families were Non Hispanic White. Hispanics constituted 43.6% of residents, Asians constituted 4.5%, and 0.8% were other.[210] Prevalence of Black preterm birth increase in areas with a denser Black population, which include various public housing developments, Harlem, and Bedford Stuyvesant.[211] It has also been found that chronic lung disease, which is positively associated with air

[207] Matte, T. D., & Jacobs, D. E. (2000). Housing and health—Current issues and implications for research and programs. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, *77*(1), 7–25. http://doi.org/10.1007/BF02350959

[208] Rauh, V. A., Landrigan, P. J., & Claudio, L. (2008). Housing and health: intersection of poverty and environmental exposures. *Annals of the New York Academy of Sciences*, *1136*, 276–288. http://doi.org/10.1196/annals.1425.032

[209] New York City Housing Authority. (2013). *Comprehensive annual financial report for the year ended December 31, 2012.* Retrieved from http://www.nyc.gov/html/nycha/downloads/pdf/CAFR%202012.pdf

[210] New York City Housing Authority. (2013). *Comprehensive annual financial report for the year ended December 31, 2012.* Retrieved from http://www.nyc.gov/html/nycha/downloads/pdf/CAFR%202012.pdf

[211] Mason, S. M., Kaufman, J. S., Emch, M. E., Hogan, V. K., & Savitz, D. A. (2010). Ethnic Density and Preterm Birth in African-, Caribbean-, and US-Born Non-Hispanic Black Populations in New York City. *American Journal of Epidemiology*, *172*(7), 800–808. http://doi.org/10.1093/aje/kwq209

pollution exposure, increased from 1991-2001 in public housing in NYC.[212] Countless studies have recognized that housing influences health conditions given that poor housing can affect health both indirectly (e.g. by contributing to psychosocial stress that exacerbates illness) and directly (e.g. due to environmental hazards such as air pollution).[213] As discussed in Chapter 4 on air pollution and adverse birth outcomes, air pollution includes combustion by-products, which are found at elevated levels near highways and major roadways.

Race and Exposure to Air Pollution

The association between race and adverse birth outcomes has been established as a clear racial inequity. The causes of these racial disparities are embedded in social determinants of health such as education, income, and housing, and in institutional racism such as the lack of access to healthcare providers in poorer and mostly Black neighborhoods.[214] By referencing the maps included in the "Results" chapter of this thesis, it is clear that there is a higher prevalence of preterm birth and low birthweight in predominantly Black neighborhoods, which are the same neighborhoods that have low median household income. It can also be seen from Figure 8 that these are the areas that

[212] Althoff, K. N., Karpati, A., Hero, J., & Matte, T. D. (2009). Secular Changes in Mortality Disparities in New York City: A Reexamination. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, *86*(5), 729–744. http://doi.org/10.1007/s11524-009-9350-y

[213] Saegert, S. C., Klitzman, S., Freudenberg, N., Cooperman-Mroczek, J., & Nassar, S. (2003). Healthy Housing: A Structured Review of Published Evaluations of US Interventions to Improve Health by Modifying Housing in the United States, 1990–2001. *American Journal of Public Health*, *93*(9), 1471–1477.

[214] Winkleby, M. A., Jatulis, D. E., Frank, E., & Fortmann, S. P. (1992). Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. *American Journal of Public Health*, *82*(6), 816–820.

have the greatest number of public housing units, and from Figure 9 that these are the areas with the highest number of public housing residents.

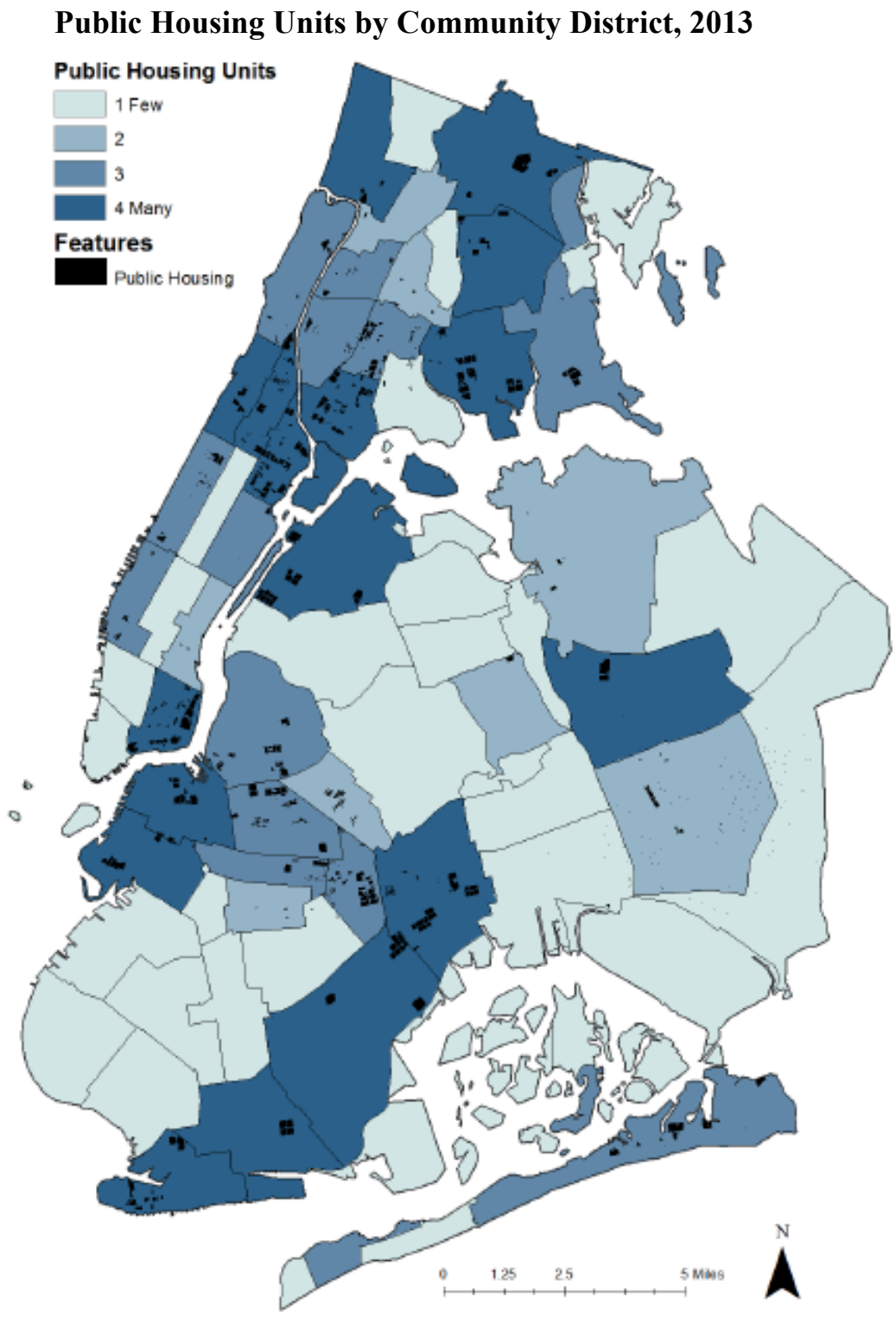

Figure 8. Public Housing Units by Community District in New York City, 2013.

Public Housing Population by Community District, 2013

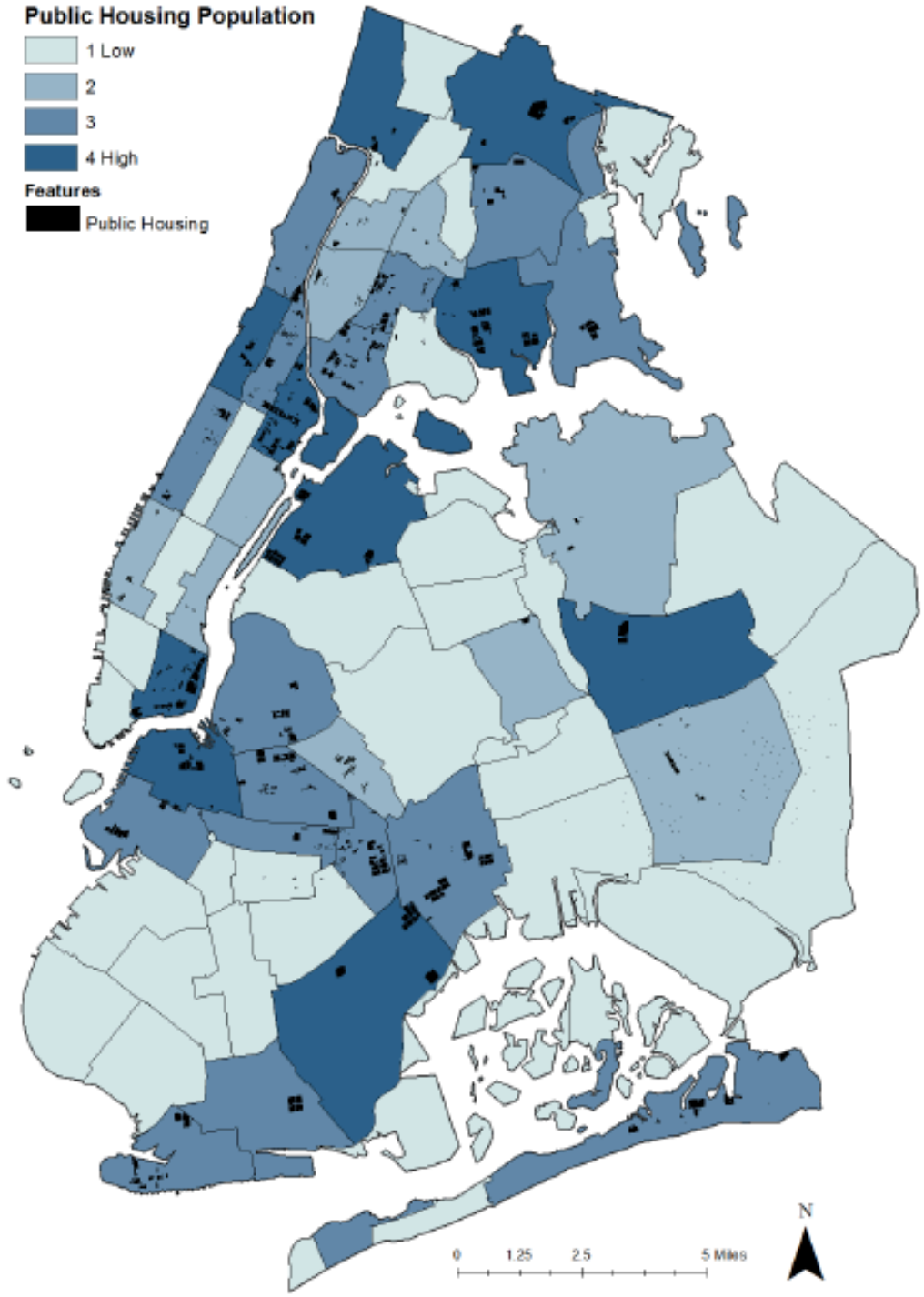

Figure 9. Public Housing Population by Community District in New York City, 2013.

The issue of preterm birth and low birthweight in New York City has yet to be considered an issue of environmental justice, but I argue that it must be. The areas where these adverse birth outcomes are most prevalent are those areas with some of the highest populations of Blacks in New York City; they are the areas that are exposed to greater levels of air pollution, with some of the highest numbers of public housing residents, and, as I will show through maps of traffic analysis zones, they are also some of the areas that have the highest highway density and vehicle traffic in New York City.

I am using the experience of public housing residents in New York City to explore the need for the issue of preterm birth and low birthweight to be considered one of environmental justice because the addresses of public housing developments are readily available, as are the demographics. The latter indicates that 46.2% of the families in New York City public housing were Black in 2013.[215]

The issue of racial disparities in preterm birth and low birth weight is an issue of environmental racism specifically due to the fact that those who are experiencing the highest incidences of these adverse birth outcomes are Black. As established in Chapter 2 on the history of New York City, Blacks established communities in Harlem and Brooklyn, particularly Bedford Stuyvesant, because the first New York City Housing Authority (NYCHA) public housing developments that allowed Blacks were built in Harlem. Shortly thereafter, the A train was built, which connected Harlem to Bedford Stuyvesant.

As part of urban renewal process of the 1930s and ‘40s, and under the Federal Aid Highway Act of 1956, however, highways were built near, around, and in these

[215] New York City Housing Authority. (2013). *Comprehensive annual financial report for the year ended December 31, 2012.* Retrieved from http://www.nyc.gov/html/nycha/downloads/pdf/CAFR%202012.pdf

neighborhoods, since they were neighborhoods populated by people of color without social capital.[216] The consequences of the construction of various highways that were built through these areas was considerable and greater than the fracturing of communities that took place, as they have likely contributed to the racial disparities we see in preterm birth and adverse birth outcomes today. Figure 10 shows where the major highways are in New York City, and the distance from the nearest highway ranging from 4000 feet (far) to 1000 feet (near).

Further Considerations and Environmental Justice

While the data must be further explored in order to draw accurate conclusions, the visualizations of the data remain compelling. Although race is often controlled for or not part of the central argument in many studies, this thesis argues that the racial disparities apparent in exposure to air pollution and the prevalence of adverse birth outcomes is due to institutional and environmental racism that persists today. Housing developments for Blacks were intentionally built in undesirable locations where Whites did not want to live. Similarly, highways purposefully disrupted Black and Brown neighborhoods so that these communities would lack cohesion and so that White neighborhoods remained united.

It can be hypothesized that the current location of NYCHA housing developments and the placement of high-volume highways is actually contributing to the racial disparities we see in preterm birth and low birthweight today. I urge public health

[216] Mohl, R. (2002). *The Interstates and the Cities: Highways, Housing, and the Freeway Revolt* (Research Report). University of Alabama at Birmingham. Retrieved from http://www.prrac.org/pdf/mohl.pdf

professionals who are studying air pollution exposure and/or adverse birth outcomes to further examine the possibility that a percentage of the racial disparities in preterm birth and low birthweight in New York City might actually be attributable to the location of public housing developments, where more than 40% of the residents are Black, and the location of highways near those housing developments. Race is the central component to this argument, and it must be considered more seriously when examining the association between air pollution exposure and adverse birth outcomes.

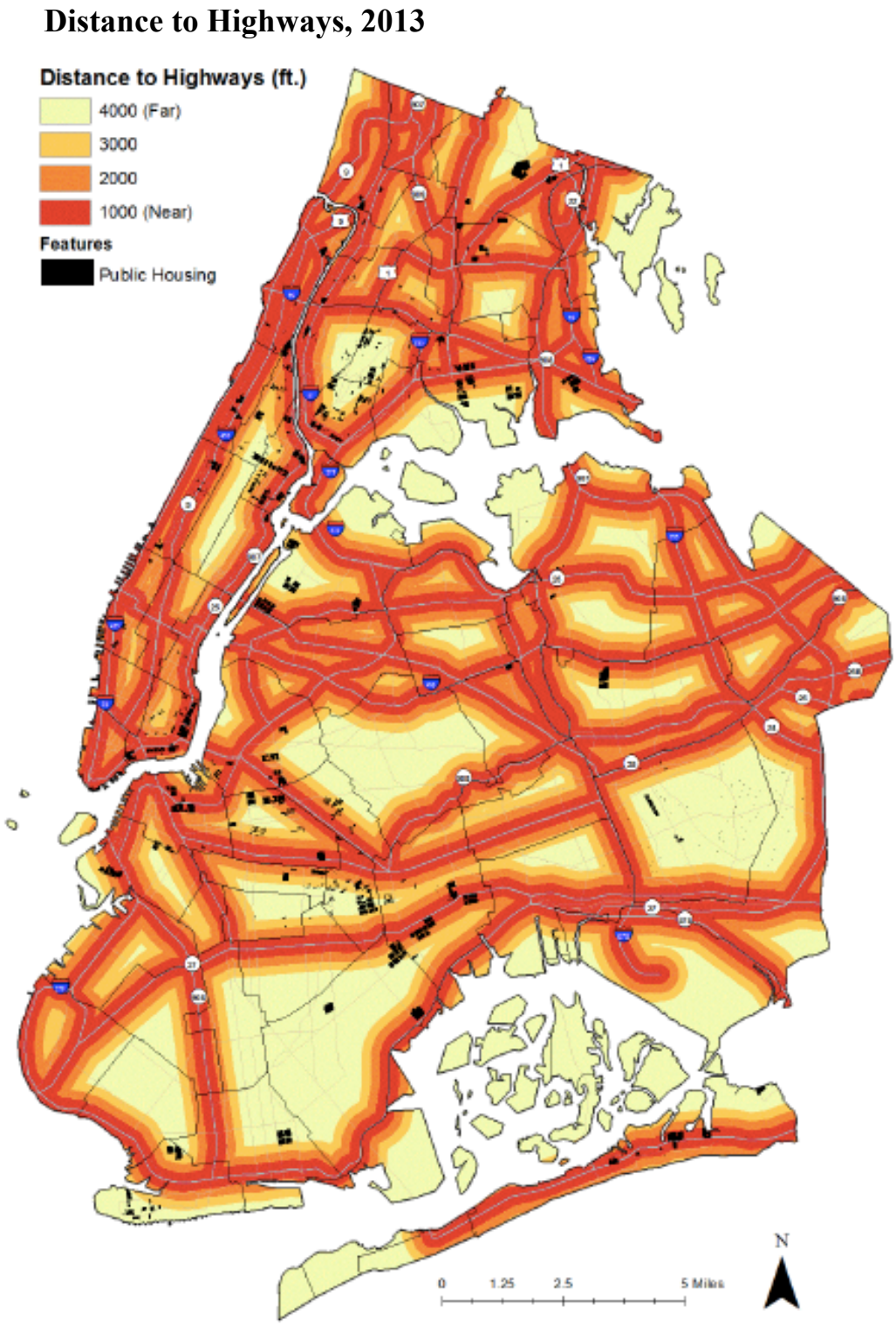

Figure 10. Distance to Highways in New York City, 2013.

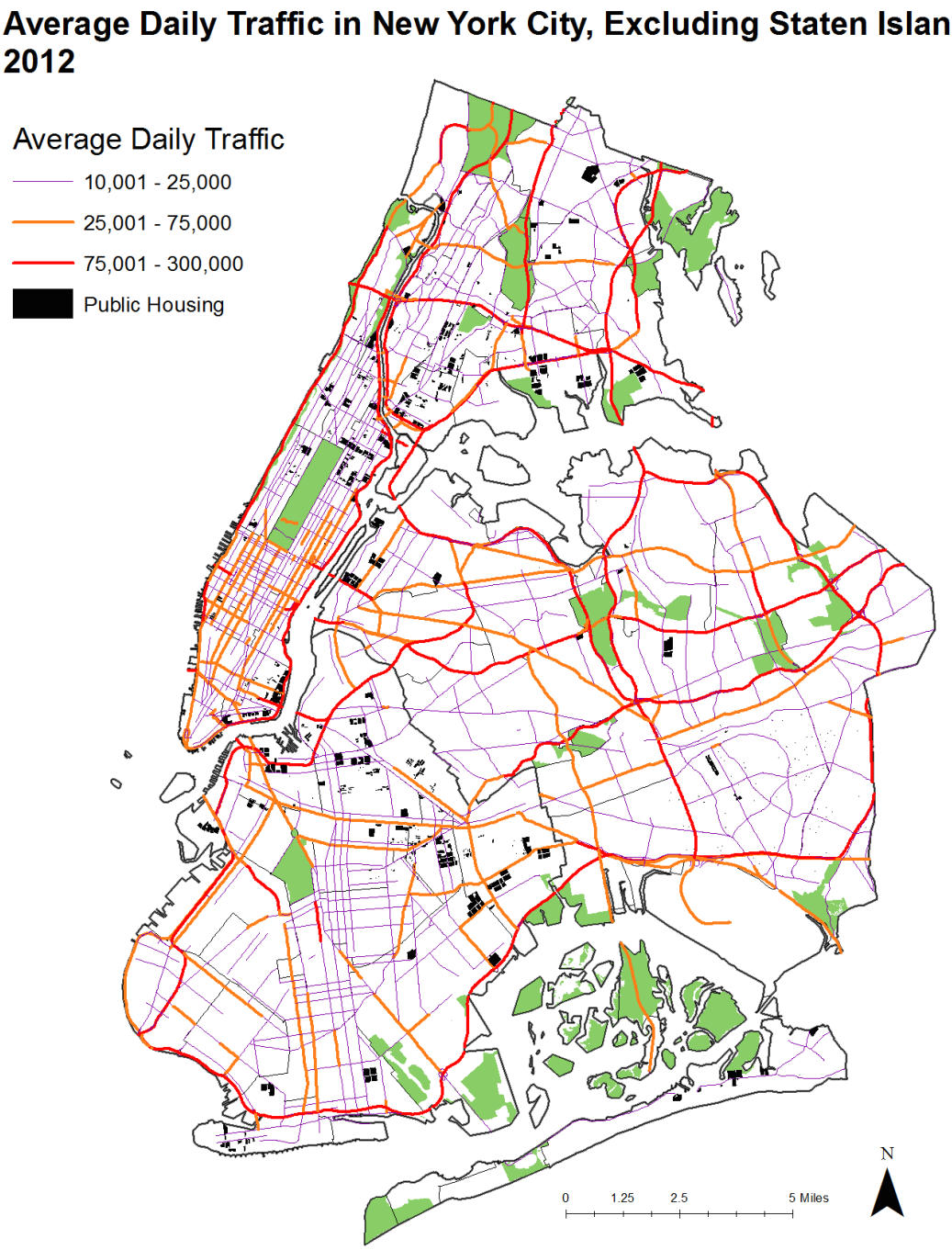

Figure 11. Average Daily Traffic in New York City, Excluding Staten Island, 2012.

Figure 10 indicates that the areas with the highest number of public housing residents in Harlem and Brooklyn are located near highways. Many studies have used residential proximity to highways to examine the association between air pollution exposure and adverse birth outcomes, and this thesis expands on that by using public housing development proximity to highways.[217,218,219] Figure 10 shows residential proximity to highways for public housing development residents. Figure 11 depicts the average daily traffic that passes through New York City's major highways. Studies have found that highways with 20,000 vehicles per day or more emit a significant amount of air pollution.[220]According to the data I am using, approximately 65% of New York Housing Authority developments are located within 1000 feet from major roadways or are located near highways that have more than 20,000 vehicles per day. The literature establishes that air pollution is positively associated with preterm birth and low birth weight, and also indicates that there are racial disparities in adverse birth outcomes. Yet there is not enough consideration for the fact that Black people in New York City are being exposed to higher levels of air pollution than White people, particularly in public housing developments. As a result, this difference in air pollution exposure should be

[217] Wilhelm, M., & Ritz, B. (2003). Residential proximity to traffic and adverse birth outcomes in Los Angeles county, California, 1994-1996. *Environmental Health Perspectives*, *111*(2), 207–216.

[218] Pedersen, M., Giorgis-Allemand, L., Bernard, C., Aguilera, I., Andersen, A.-M. N., Ballester, F., … Slama, R. (2013). Ambient air pollution and low birthweight: a European cohort study (ESCAPE). *The Lancet Respiratory Medicine*, *1*(9), 695–704. http://doi.org/10.1016/S2213-2600(13)70192-9

[219] Brauer, M., Lencar, C., Tamburic, L., Koehoorn, M., Demers, P., & Karr, C. (2008). A Cohort Study of Traffic-Related Air Pollution Impacts on Birth Outcomes. *Environmental Health Perspectives*, *116*(5), 680–686. http://doi.org/10.1289/ehp.10952

[220] Rioux, C. L., Gute, D. M., Brugge, D., Peterson, S., & Parmenter, B. (2010). Characterizing urban traffic exposures using transportation planning tools: an illustrated methodology for health researchers. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, *87*(2), 167–188. http://doi.org/10.1007/s11524-009-9419-7

considered an issue of environmental justice since Black people are disproportionately represented among the population of people living near highways in the United States.[221,222] Studies indicate that the exposure to NO_2 and PM2.5 of people who live near highways is drastically increased.[223] Blacks are disproportionately bearing the burden, because they are the majority of people living near highways and their options with regards to housing need to be greatly improved. This is an issue of environmental justice and must be treated as such.

Within the movement of environmental justice, there exists the concept of environmental racism, which describes the disproportionate effects of environmental pollution on people of color. Environmental racism "describes the disproportionate balance between high levels of pollution exposure for people of color and the low level of environmental benefits they enjoy."[224] Furthermore, environmental racism is the unequal distribution of environmental benefits and pollution burdens based on race.[225] The specific importance of environmental racism with respect to this thesis is the integration of public health with racial politics. This thesis sheds light upon the integral role that history plays in the creation of racial disparities in health outcomes due to environmental

[221] Rowangould, G. M. (2013). A census of the US near-roadway population: Public health and environmental justice considerations. *Transportation Research Part D: Transport and Environment*, *25*, 59–67. http://doi.org/10.1016/j.trd.2013.08.003

[222] Patton, A. P., Perkins, J., Zamore, W., Levy, J. I., Brugge, D., & Durant, J. L. (2014). Spatial and temporal differences in traffic-related air pollution in three urban neighborhoods near an interstate highway. *Atmospheric Environment (Oxford, England: 1994)*, *99*, 309–321. http://doi.org/10.1016/j.atmosenv.2014.09.072

[223] Llop, S., Ferran Ballester, Estarlich, M., Esplugues, A., Rebagliato, M., & Iñiguez, C. (2010). Preterm birth and exposure to air pollutants during pregnancy. *Environmental Research*, *110*(8), 778–785. http://doi.org/10.1016/j.envres.2010.09.009

[224] Sze, Julie. (2007). *Noxious New York*. Cambridge, Massachusetts: Massachusetts Institute of Technology.

[225] Sze, Julie. (2007). *Noxious New York*. Cambridge, Massachusetts: Massachusetts Institute of Technology.

burdens that are stratified by race. Researchers, policy makers, urban planners, and public health professionals too often ignore or fail to recognize that socially marginalized communities, which are predominantly communities of color, have lived experiences that differ from the perspectives of those in power today. These communities have experienced environmental inequities through their lived experiences, which have contributed to the racial disparities that occur in adverse birth outcomes in New York City.

Conclusion

My contribution to this overarching discussion is to bring forth an argument that compels professionals to conduct more research into the importance of race and environmental racism with respect to adverse birth outcomes in New York City. According to author Julie Sze, "there is a surprising dearth in writings about the historical impact of urban planning on communities of color in New York City."[226] Accordingly, this thesis aims to contribute to the aforementioned body of writing. Urban planning and public health are more connected than they might seem, and the racial disparities in adverse birth outcomes are due to the malfunctioning dynamics that plague these two institutions. I also argue that the institution of the New York City Housing Authority also contributes to the environmental racism present in New York City, and thereby, potentially also to the racial disparities in adverse birth outcomes in New York City as well. Newer housing developments built by NYCHA have been erected in

[226] Sze, Julie. (2007). *Noxious New York*. Cambridge, Massachusetts: Massachusetts Institute of Technology.

environmentally undesirable areas that are close to highways, thus disproportionately affecting the Black population, which constitutes the largest non-White racial group in public housing in New York City.

The possibility of differential burden by race must be more strongly considered with regards to urban planning, public housing, adverse birth outcomes, and air pollution exposure. This thesis shows that there are structural and systematic connections between history and geography that create and influence the differences between the lived experiences of Black people living in the U.S. and those of White people living in the U.S. The patterns of residency that occur in the U.S. have a historical context, and it is vital to understand this context in order to understand the distribution of demographics that we see today: race, socioeconomic status, health outcomes, etc. The history of Black people is at the root of how racism formed and took shape in America. I argue that the racial disparities we see in exposure to air pollution and incidence of adverse birth outcomes are due to institutional and environmental racism that persist today.

The idea for this thesis started during the fall semester of my sophomore year at Tufts. I wrote a paper on infant mortality in New York City, and quickly learned about the inequities that occur within various health outcomes, but particularly in adverse birth outcomes. Shortly thereafter I declared a double major in Community Health and American Studies to find the intersection between public health and social justice. This thesis is the culmination of years of finding my passion within this intersection, and it speaks to the ineffable racial inequities that exist today.

APPENDIX A: Timeline

Parallel timelines: events affecting the racial segregation in present day New York City

People and Immigration	**Transportation**	**Buildings**
1619: First African slaves were brought to the Jamestown, Virginia, to aid in the production of tobacco.		1653: A wall was built across Manhattan Island to protect the little town of New Amsterdam. The street next to it was called Wall Street.
1624: Dutch settled at the southern tip of now Manhattan.		
1700: New York had a population of almost 5,000, growing rapidly.		
1760: Population 18,000. It included immigrants from the Netherlands, England, France and Germany; indentured servants; And African slaves.		
1780: Approximately 10,000 Blacks lived in New York City	1811: The "Commissioner's Plan" established an orderly grid of streets and avenues for the undeveloped parts of Manhattan north of Houston	
1790: Naturalization Act of 1790 which restricted naturalization to free White persons with good moral character. 500,000 slaves in America.	1815: Colonel John Stevens created the first railroad charter in North America to build the New Jersey Railroad Company	
1820: By 1820 New York had become the country's largest city with a population		

123,000.[227] 1827: New York outlaws slavery	1832: First horse drawn streetcars ran through New York. 1832: First railroad constructed, and eventually became part of the Pennsylvania Railroad 1837: Harlem connected to New York by railway and grew rapidly	1842: A gas storage tank was built on the Lower East Side of Manhattan. Shortly after, many more gas storage tanks were built, nick-naming the area GasHouse District, which made the area largely undesirable.
1850: Influx of Germans and Irish to NY. Irish fled the potato famine of 1849. 1857: Dred scott v Sanford. The court found that no Black, free or slave, could claim U.S. citizenship, and therefore Blacks were unable to petition the court for their freedom. The Dred Scott decision incensed abolitionists and heightened North-South tensions, which would erupted in war just three years later.[228] 1860: 4 million slaves in America.		1857: Central Park was built by Frederick Law Olmstead

[227] Zinn, Howard. (1999). *A People's History of the United States* (Twentieth). New York, New York: HarperCollins Publishers Inc.

[228] Zinn, Howard. (1999). *A People's History of the United States* (Twentieth). New York, New York: HarperCollins Publishers Inc.

1861: Emancipation Proclamation Issued		
1865: Reconstruction Era began. Each state was required to accept the Thirteenth and Fourteenth Amendments to the Constitution, which granted freedom and political rights of Blacks.	1868: First elevated railway in New York began carrying passengers. 1869: The first coast-to-coast railroad was completed	
1875: Civil Rights act of 1875, which guaranteed African Americans equal treatment in public accommodations		
1880: Italians arrived and many Eastern European Jews came to New York.		1880: In NYC, 100,000 people lived in the cellars of the slums. [233]
1890: The Great Migration began, which was the relocation of more than 5 million African American from the southern states of the U.S. Around five million moved north		1892: Ellis island opened. Between 1892 and its closure in 1954 almost 17 million immigrants passed through Ellis Island.
1892: Blacks move to Harlem. At that time many poor New Yorkers lived in tenements. They were overcrowded, poorly ventilated and rooms often lacked windows.		1892: Five points slum was demolished. Throughout the 1800s Five points was home to Irish immigrants thought to be criminals. Throughout the 1850s, Five points slum was home to Blacks and the Irish.
1896 *Plessy v. Ferguson*: Supreme Court supports segregation via "Jim Crow" laws that specify 'separate but equal.'	1902: The American Road & Transportation Builders Association was established.	1895: Residents of Queens, The Bronx, Staten Island and

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	Later changes name to American Road Builders Association	Brooklyn–all independent cities at that time–voted to "consolidate" with Manhattan to form a five-borough "Greater New York."
1907: The Gentleman's agreement of 1907 was enacted to regulate Japanese immigration. The number of Japanese in California grew rapidly. The Gentlemen's agreement denied passports to laborers intending to enter the United States and recognized the U.S. right to exclude Japanese immigrants holding passports originally issued for other countries.	1908: Henry Ford introduced the first automobile, the model T. The incredible popularity of the car pressured the government to become directly involved in road development.	1902: Flat Iron Building was built 1904: Times Square is named after the New York Times, which moves to Times Square in 1904
1910: The total population of New York City was 4,766,883; The "Negro" population was 91,709, 1.9% of total population, and the White population was 40.4% of the population.[229] Most immigrants were working in sweatshops.[230]		1911: New York Public Library was built 1913: Grand Central was built
1916: From 1916 through the 1960s, more than 6 million Black people moved north.[231]	1916: American Road Builders Association successfully pushes the first Federal-Aid Road Act	

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1917: Immigration Act of 191 enacted. This act added to the number undesirables banned from ent U.S. 1921: Emergency Quota Act was enacted, which estab national immigration quotas. The quotas were based on the number of foreign-born residents of each nationality who were living in the United States as of the 1910 census. 1923: United States vs. Thind created the official stance to classify Indians as non-White, which at the time retroactively stripped Indians of citizenship 1924: Immigration act of 1924 (Johnson-Reed Act). The law was primarily aimed at further restricting immigration of Southern Europeans, Eastern Europeans. In addition, it severely restricted the immigration of Africans and prohibited the immigration of Arabs, East Asians, and Indians. 1930: Total U.S. population: 122,775,000 Negro U.S. population: 11,891,143, White U.S. population: 110,286,740,	1921: Bureau of Public Roads (BPR) was authorized by Federal Highway Act of 1921 to provide funding to help state highway agencies construct a paved system of two-lane interstate highways. 1930s: Bureau of Public Roads, along with state and local governments, created Depression-era road projects to employ as many workers as possible	1919: Governor Al Smith appointed Moses as chief of staff of New York state's reconstruction commission. 1925: Moses was made the chairman of the State Council of Parks. 1930: Chrysler Building was built 1930s: Slum clearance begins as part of urban renewal 1933: the Homeowner's Act of 1933, part of the New Deal, was passed.

1933: The New Deal, which was a series of Legislative acts, was to alleviate the worst effects of the Depression.	1936: The A train was built that ran from Harlem to Bedford Stuyvesant in Brooklyn.	1934: National Housing Act of 1934, which was part of the New Deal, was passed in order to make housing and home mortgages more affordable. It created the Federal Housing Authority (FHA) and the Federal Savings and Loan Insurance Corporation. 1934: Mayor Fiorello La Guardia, mayor of New York City, established the New York City Housing Authority (NYCHA)
1943: Chinese Exclusion Acts were repealed		1936: The first public housing development part of the NYCHA known as the First Houses opened on the Lower East Side on Manhattan.
1946: Luce-Cellar Act of 1946 ended discrimination against Indian Americans and Filipinos, who were accorded the right to naturalization and allowed a quota of 100 immigrants per year. 1952: The Immigration and Nationality Act of 1952 (the McCarran-Walter Act) revised the immigration quotas again, basing them on the 1920 census. For the first time in American history, racial distinctions were omitted from the U.S. Code.	1944: There was immense traffic congestion in cities. President Franklin D. Roosevelt had signed legislation authorizing a network of rural and urban express highways called the "National System of Interstate Highways."	1941: East River Houses in Harlem built as a Blacks-only development 1947: Stuyvesant Town was built in what once was the Gashouse District. This NYCHA housing development gave priority to veterans. 1949: The Housing Act of 1949 provided funding for slum clearance, increased funding for the Federal Housing Administration (FHA) mortgage insurance, extended federal money to build housing developments, and permitted the FHA to provide funding for rural homeowners.
1960: U.S. population: 179,977,000. "Negro" U.S. population:	1956: The Federal Aid Highway Act was enacted and signed by President Eisenhower in order to aid the development of the	

18,871,831. NY population: 10,627,000. White NY population: 15,287,071. Negro NY population: 1,417,511.[232] 1990: The Black population totaled 30 million, which was an increase of 3.5 million since 1980. The total population was 248,709,873. 80.3% was White, 12.1% of the population was Black.	Interstate Highway System		

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