ENVIRONMENTAL INJUSTICE:

HEALTH AND INEQUALITY IN MOBILE COUNTY, ALABAMA

by

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B.S., University of South Alabama, 1988
B.A., University of South Alabama, 1988
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AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Geography
College of Arts and Sciences

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2010

Abstract

This research set out to better understand the impact of socioeconomic characteristics, environmental risk, and the built environment on health in Mobile County, Alabama. A multilevel statistical analysis was used to identify those characteristics that had the greatest impact on health. The variables determined to be the most significant in defining health in Mobile County were used in the development of a health inequity index (HIQ). The index was used to identify the zip code tabulation areas (ZCTAs) in Mobile County that were likely to exhibit greater health inequality, and as a result, a higher potential for health inequity.

In this study, a mailed survey on the built environment and health was conducted to gain a better understanding of the characteristics of individual residences, perceptions of individuals in regards to neighborhood health, citizen activism, and the environmental justice movement. Because there was a low response rate for the mailed surveys, fieldwork with face-to-face interviews was conducted in July, 2009. In conjunction with the survey data, mortality data obtained from the Alabama Department of Public Health was incorporated into the multilevel analysis. Using crude death rate, cause-specific death rate for cancer, and cause-specific death rate for heart disease as dependent variables and factors associated with socioeconomic status, environmental risk, and the built environment as independent variables, multiple linear regression was performed.

The results of the multiple linear regression identified factors of socioeconomic status, environmental risk, and the built environment that had the greatest impact on health in Mobile County. Geographically weighted regression was performed to test local model strength by

ZCTA in Mobile County. It was determined that the health inequity index developed as a result of the multilevel analysis was a reasonable measure of population health. Calculations of HIQ for each ZCTA in Mobile County helped to identify those ZCTAs most in need of intervention. The ZCTAs with high HIQ values were also those where the built environment was extremely poor, indicating that health is impacted by the places where people live.

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Acknowledgements

There are so many individuals that have helped me finally reach my lifelong goal. I was fortunate to have a committee that allowed me the freedom to do things my way. Though I think he wondered at times if I would complete my dissertation, my major professor, Dr. Bimal Kanti Paul, has always been there to provide assistance. He has greatly influenced my knowledge of research technique, particularly when it comes to the use of statistics and surveys. Dr. Lisa Harrington (Geography) provided me with a sound understanding of rural resources and she has always been available to answer questions when needed. Dr. Shawn Hutchinson (Geography) was instrumental in my GIS education at Kansas State University and could always be relied on when I had technical questions. Dr. Robert Schaeffer (Sociology) has been an inspiration through his work – much of the motivation for this dissertation came as a result of a course I took with him on the environment and society.

Though not on my committee, a number of professors provided opportunities for graduate research or offered their expert knowledge on topics of interest to me. Dr. John Harrington recommended me to work on a GIS project in Mexico and Dr. Peter Herlihy at the University of Kansas gave me the opportunity to do so. My summer in San Luis Potosi was wonderful. I was able to use my GIS skills in a working environment and to experience a culture that was new to me. Dr. Herlihy offered new perspectives on research and sparked my interest in cultural geography. Dr. Kevin Blake furthered that interest through his course on Western Landscapes and allowed me the opportunity to gain a basic knowledge of cultural geography through an independent study. Dr. Jeffrey Smith was always available to discuss Latin America or to provide insight and advice on my research interests.

I owe a great deal of my success to undergraduate faculty at the University of South Alabama. Dr. Glenn Sebastian is the single most influential geographer in my life. Through his field courses in Big Bend National Park, I gained an appreciation not only for geography, but the desert as well. Dr. Victoria Rivizzigno (Geography) and Dr. Betty Brandon (History) were role models for me as I completed degrees in geography and history. They were always available to give advice and extremely supportive of my endeavors. From the standpoint of research and an appreciation for national parks, I will be forever grateful to Dr. Lary Dilsaver.

I would like to thank Anne Donovan, Scott Deaner, F. Rowan Wilcox and Dr. John Patrick Harty for being great office mates and for offering insight and assistance when needed. I would also like to thank Chris Tee, Joseph and Kai Weixelman for helping me make it through my first two years at Wayne State College in Nebraska. I am very grateful to Dr. Larry Lawhon. His friendship, guidance, and support have pulled me through some trying times.

I owe a special thanks to Andrea Kohutek and my sister, Julie Tinnon. Their assistance in conducting surveys in Mobile County, Alabama was crucial in the completion of this dissertation. I would also like to thank Dr. Joe Blankenau at Wayne State College for his assistance with the statistical analysis. To my brother, Kevin Tinnon, my nephews, Kevin Tinnon, Jr. and Robert Tinnon, my niece, Taylor Inez Tinnon, and my dog and faithful companion, Katrina – I finally did it! I would never have made it this far without the love and support of my parents, Gerald and JoAnn Tinnon.

Dedication

Throughout my life, I have met many people. Many of those individuals are still with us today, but one that shared my love of the desert passed away on October 15th, 2007. Jan Bolton lived her life to the fullest and her friendship helped me make it through the worst periods of my life. As I sat in front of the computer one afternoon trying to figure out what to write and how I was going to finish, her words came to me. She had faith in my ability and was convinced that I would be successful. She helped me start my journey at Kansas State University and she helped me finish it. Without her assistance, I would not have been able to move to Manhattan, Kansas and pursue a dream.

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CHAPTER 1 - Introduction

> "Given the importance of moral interests in health inequality, it is surprising that a comprehensive theoretical and analytical framework for measuring health inequality that acknowledges moral concerns has yet to be developed."
>
> (Asada 2007, 10)

Attention to environmental justice arose as a result of the merging of the environmental movement with the civil rights movement. Traditionally, definitions of environmental justice have specifically incorporated the notion that "race matters" when it comes to the distribution of hazardous waste facilities and industries that produce toxic chemicals. According to Corburn (2004), environmental justice "…outlines a democratic research and decision-making agenda that is attentive to the distributive, procedural, and corrective justice concerns of people of color" (p. 541). The problem, however, is that the unequal distribution of hazardous waste locations is hard to prove. Bowen (2001) contends that a precise definition of environmental justice is not yet available, and without standardized data sources and a clear geographic unit of study, researchers cannot prove environmental inequity actually exists.

Work on environmental justice has largely been confined to studies that attempt to determine if minority and low income communities are burdened with an unequal distribution of hazardous facilities. Research has focused on the placement of facilities and the potential environmental risks associated with those industries. While this research has provided a better understanding of issues of environmental inequity, the paradigm itself has failed to recognize the importance and potential usefulness of adding the issue of health inequality to its equation. Though Jerrett et al. (2001) include the unequal health effects of environmental risk in their conceptual model of environmental justice, most research to date does not key in on this important idea, and particularly does not include significant attention to the concept of health inequality. Jerrett et al. (2001) noted that related research emphasizes the study of health determinants and complementary research stresses environmental health inequality.

The environmental justice movement, in its current orientation, has not been successful in producing the evidence necessary to persuade individuals, planners, and policymakers that there is a need for healthier communities. Though health is an essential component of the movement, the focus has been on the location of toxic facilities. As a result, it has created a racial barrier and has also disenfranchised a number of people who could benefit from representation in their quest for environmental improvement. Thus, it is time for a change in the movement – one that envelopes the idea that a community's health surpasses the necessity to prove whether or not hazardous facilities were located in the "neighborhood" prior to the arrival of minority populations and that injustice goes well beyond the scope of exposure.

1.1 Research Background

Health/medical geography can play a key role in environmental justice research by contributing through studies on health inequality and inequity. Traditionally, health and medical geography have focused on two approaches, often with sub-categories: disease ecology and health care (Paul 1985; Jones and Moon 1993; Mayer 1994; Kearns 1997; Del Casino and Dorn 1998; Kearns and Moon 2002; Meade and Earickson 2005). Research in disease ecology tends to focus on understanding the dynamics of disease in relation to characteristics of the natural environment (Paul 1985). Since the 1960s, some health/medical geographers have emphasized issues related to health care, including health-seeking behavior and accessibility to health care services (Paul 1985). In recent years, the idea of a new health geography, focusing on topics such as therapeutic landscapes and health perception, has been put forward (Kearns 1997; Kearns and Moon 2002). Environmental health professionals and epidemiologists are recognizing the importance of geography in their fields (Parvis 2002; Kreiger 2003). Though there is a great deal of debate surrounding future trends in health/medical geography, the concept of studying the health of a population in regards to place can potentially be a significant contribution to epidemiology and environmental health, as well as a key factor in promoting environmental justice.

One aspect of inequality research today focuses on environmental equity. Frazier, Margai, and Tettey-Fio (2003) presented a conceptual model of environmental equity research based on three dimensions of environmental equity: process equity, outcome equity, and response equity. Process equity involves urban processes such as industrialization, suburbanization, and public housing development. Outcome equity looks at environmental indicators, such as water pollution, toxic release inventory sites, and waste treatment facilities. Response equity considers policies and actions taken as a result of findings, including grassroots activism and litigation. Though this research incorporates a number of these ideas, it also differs from the perspective that environmental inequity is an urban phenomenon and that it is always racial. In fact, one of the underlying assumptions of this research is that too much of the focus was initially placed on the location of toxic release facilities and not enough on the populations that could be impacted.

Another area of concern in health research is the difference between urban and rural areas (Curtis and Jones 1998; Curtis 2007). Studies conducted in the United Kingdom suggest that those in urban areas suffer higher mortality than those in rural locations (Fox and Goldblatt 1982; Britton et al. 1990). Other studies indicate that those in rural areas may suffer some health disadvantage and have even worse outcomes than people in metropolitan areas (Bentham 1984; Eberhardt and Pamuk 2004; Thomson, Mitchell, and Williams 2006). "Over a quarter of the population in the United States lives in rurally classified areas according to Rural Urban Commuting Area codes (RUCAs), and the health care needs of rural Americans are unique and challenging" (Lafronza and Ingoglia 2005, 179). Higher rates of chronic disease and injuries from occupational hazards are particularly significant in rural areas. In the literature, the causes of these outcomes are related to poverty, isolation and restricted mobility, limited resources and an aging population (Taylor, Hughes, and Garrison 2002; Lafronza and Ingoglia 2005; Curtis 2007).

Geographic literature on population health and inequality tends to focus on health variation by looking at the relative importance of compositional and contextual effects (Curtis and Jones 1998; Smyth 2008). There is a debate in the discipline as to which is more important – the significance of place (contextual) or the characteristics of individuals within that place (compositional). Studies of aggregated regional populations are often questioned because assumptions made about individuals in the population may not be accurate. This concept, the ecological fallacy, has typically led many researchers to place less value on ecological studies than those based on individual data. However, an over-emphasis on individuals can produce an atomistic fallacy, whereby a researcher may disregard or misinterpret effects better understood at a larger scale (Curtis and Jones 1998; Curtis 2007).

According to many health/medical geographers, place definitely matters when it comes to health. "Place has been seen as an operational 'living' construct which 'matters' as opposed to being a passive 'container' in which things are simply recorded" (Kearns and Moon 2002, 609). Many of the recent studies providing the evidence for the relationship between health outcomes and place have come from the United States (Smyth 2008). With the exception of Great Britain, many studies on health inequality focus on developing countries (Curtis and Jones 1998; Smyth 2008). However, health inequality exists in developed countries, and though the solutions to some of the problems may be different than those in developing countries, it is important to question why these inequalities exist.

Curtis and Jones (1998) contend that, "There is also empirical evidence, derived by using several different research strategies, to suggest that contextual effects operating at the level of places, seem to have some power to explain health inequalities, independently of the strong effects of individual attributes" (p. 666). Health and medical geographers are also using a wide variety of approaches, from epidemiological surveys to interviews and focus groups, to better understand health across populations (Jones and Moon 1993). Geographical research has the potential to bring justice to the forefront of health studies and to assist policy analysts in tackling health inequalities (Kearns 1997; Smyth 2008).

1.2 Research Questions and Objectives

The goal of this research is to answer the following primary questions: Is a health inequity index based on socioeconomic status (SES), environmental risk, and the built environment a feasible measurement of population health? Can it be used to pursue environmental justice? Is health in the city of Mobile significantly worse than in rural areas of the county? Does the built environment have a significant impact on population health in Mobile County, Alabama? In conjunction with the primary research questions, secondary questions will also be explored: If health inequalities are to be tackled in developed countries, are improvements in the built environment the way to move forward? Is it possible to identify health inequalities that are unfair and unjust? In order to answer the above questions, this research aims to accomplish the following objectives:

1. To create a health inequity index for Mobile County through a multilevel statistical analysis.
2. To determine if there is a significant difference between rural and urban health in the county.
3. To look over the findings of the multilevel analysis and determine the impact of the built environment on health.

1.3 Study Rationale

The environmental justice movement was instrumental in the signing of Executive Order 12898 in 1994, which required "…federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on people of color in the United States…" (Northridge et al. 2003, 209), but it has been relatively unsuccessful in addressing the problems of communities in need (Brulle and Pellow 2006). With the exception of health research on lead poisoning, very few studies have been conducted on environmental equity as it relates to health (Northridge et al. 2003). Srinivasan, O'Fallon and Dearry (2003) note that environmental health is no longer just a study of the direct effects of toxic agents on human health, it now encompasses "the broad physical and social environment, which includes housing, urban development, land-use and transportation, industry and agriculture" (p. 1446).

One of the major purposes of this dissertation is to consider that research in environmental justice, through contributions from health and medical geographers should shift its focus from looking solely at environmental inequity to inclusion of studies that incorporate an analysis of health inequality from the standpoint of the built environment. "The built environment encompasses all buildings, spaces, and products that are created or modified by people" (Srinivasan, O'Fallon, and Dearry 2003, 1446). Quantitative methods in this research include the use of statistical analysis to identify significant variables that are important in defining the general health of Mobile County, Alabama. Though the quantitative methods provide for the majority of the analysis in this study, observations of neighborhoods, mailed surveys, and face-to-face interviews are important in determining the characteristics of the built environment of the study area.

This research considers the importance of health, particularly in the context of improvements in the built environment, as an important focal point in the future of environmental justice. Though a majority of the data for Mobile County can be obtained at the census tract level, health data throughout Alabama are recorded at the zip code level. As a result, this analysis defines a community's health based on zip code tabulation areas (ZCTAs). The community's overall health is determined by a health inequity index designed to incorporate not only environmental risk and socioeconomic variables, but also the built environment. The primary objectives of this research are to develop a health inequity index that identifies environmental characteristics that lead to poor health and to bring a new conceptual framework to the study of health inequality in developed countries. While other studies have considered variables in each of these categories, none have attempted to create a health inequity index that would benefit researchers and citizen activists in their pursuit of environmental justice.

In order to identify important variables in defining the general health of Mobile County, multiple linear regression was used. Upon completion of this process, variables that were significant in defining the general health of county residents were determined. Based on those variables, a health inequity index was developed. Using this index and geographic information systems (GIS), the health status of the county was mapped and the neighborhoods most in need of intervention were identified. Though this research depends on data obtained through the Alabama Department of Public Health - Center for Health Statistics, the United States Census Bureau and the United States Environmental Protection Agency's Toxic Release Inventory (TRI), observations of ZCTAs and a random sample of mailed surveys were used to gain a better understanding of variables in the built environment that are potentially immeasurable.

1.4 Significance of Study

From a theoretical perspective, this dissertation takes the perspective that in order for environmental justice to successfully contribute to improving living conditions and influence policy, it must incorporate the importance of health – particularly, the relationship between health and the built environment. There is a need for more research that identifies the mechanisms "…by which the built environment adversely and positively impacts health and to develop appropriate interventions to reduce or eliminate harmful health effects" (Srinivasan, O'Fallon and Dearry 2003, 1446). The identification of factors that significantly affect health is beneficial to those who are concerned about unhealthy communities and seek to improve them, particularly epidemiologists, environmental health professionals and planners. Places where mortality rates are high may face a greater number of adverse impacts. With an understanding of the factors that lead to poor health, citizens will be better prepared to pursue community improvements.

The desire to create "healthy places" currently plays an important role in community planning. However, it is still relatively unknown as to which aspects of the social, economic and physical environment have the greatest impact on health (Weich et al. 2001). According to Weich et al. 2001 (p. 283),

> This is partly because most previous research on the geographies of health has been based on studies of the aggregated socio-economic characteristics of people living in particular areas (measures of ‘social composition’), rather than ‘contextual’ characteristics of the places where people live.

This research does consider the ‘social composition’ of the community, but it is enhanced by identifying those characteristics related to issues of health in the places where people live. Though many aspects of the built environment can be observed through fieldwork and obtained from databases of city and county planning offices, acquiring specific data on individual residences is difficult. Through a mail survey on the built environment and health, this study identifies some characteristics that are less evident and are not likely to be discussed in the current literature.

Research on the built environment usually focuses on one characteristic of the particular place, and often, looks solely at the urban setting (e.g., Cohen et al. 2000; Morland, Wing and Diez Roux 2002; Krieger and Higgins 2002; Bashir 2002; Srinivasan, O’Fallon and Dearry 2003; Schweitzer and Valenzuela 2004; Horowitz et al. 2004; Hood 2005; Moore and Diez Roux 2006). This research will consider more than one characteristic of the study area and will identify significant health factors in neighborhoods classified as urban, suburban, and rural. Though there is evidence that those living in urban areas experience worse physical health than those in rural areas, many rural residents in the United States do suffer from poor health and very little research has been conducted to determine the potential causes (Weich et al. 2001; Lafronza and Ingoglia 2005). Mobile County offers a rare opportunity to study health across a diverse population; a population that lives in a number of different settings.

1.5 Chapter Outlines

This research postulates that poor health is not randomly distributed in Mobile County, Alabama, and that health is worse in low income and minority neighborhoods where environmental risk is greater and the built environment is not conducive to creating a healthy place. Chapter 2 focuses on the current literature in health inequalities and health inequities. Definitions of health inequality and inequity are not codified and this has created some debate in research circles. Some countries prefer to use alternative terms such as health disparity (Carter-Pokras 2002; Graham 2007). This only adds to the 'fuzziness' of the concept. Of course, if we cannot define health inequality, then how can we determine inequity? This question leads to the other major debate in health inequality research – what is fair and what is unjust?

Chapter 3 describes the study county with a focus on the socio-economic characteristics of the population and the built environment, particularly housing. Research on the built environment is becoming more abundant and Chapter 4 discusses the concept of the built environment, research on the built environment and health, and the environmental justice movement. Recent studies on the built environment and health have primarily focused on one characteristic of the built environment such as housing, transportation or access to green space. Current research is also attempting to find the best ways to measure the built environment's impact on health.

Chapter 5 describes the techniques used to measure health inequality. The research methods, including the qualitative means of obtaining information from mail surveys and interviews, the quantitative techniques used to develop the health inequity index, and the applied technique for testing model effectiveness, are detailed. In Chapter 6, the results of the analysis, the health inequity index, and the differences between rural and urban health in the county are discussed. Chapter 7 focuses on perception of neighborhood health in Mobile County and the impact of the built environment on health. Other topics addressed in this chapter are whether or not health inequalities can be identified as unfair and unjust and the ineffectiveness of the environmental justice movement on addressing issues of health inequality. What actions can the movement take to enhance grassroots activism, policymaking, and planning to improve community health? The summary, conclusions, and recommendations are presented in Chapter 8.

CHAPTER 2 - Health, Health Inequality, and Health Inequity

The history of the study of health and health inequalities in developed countries reveals progress and setbacks and provides the evidence as to why countries stand where they do in regards to research. Though studies of health and health inequality are being conducted in many developed countries, this section will focus on research in the United Kingdom (UK) and the United States (US). From the perspective of progress in health research, more has been done in the UK than in the US. One of the main reasons for this lies in the ability of the UK to collect data in a manner that allows for studies of health from a cross-sectional perspective, and through longitudinal analyses.

The study of social inequalities of health is not anything new in the US. Documentation of health issues goes back to the 1600s when successive smallpox epidemics killed many settlers and devastated the Native American population (Krieger and Fee 2005). However, unlike the UK and several other European countries, the US has not incorporated death rates by socio-economic status (associated with occupation) into its databases. Age, sex and race are the characteristics recorded for death statistics (Navarro 1990; Krieger and Fee 2005). One of the reasons given for missing social class data revolves around the notion that the government likes to relay the impression that the US is a "classless" society. Therefore, data on social class is irrelevant to US population health (Krieger and Fee 2005).

Though data in the US is collected this way today, there was a movement to collect mortality information by social class in the past. In the early 1900s, the Bureau of the Census was interested in gathering information on occupation of the decedent. At this time, there were a number of social and political concerns about rapid industrialization and its impacts on health. However, the Bureau never published any reports on the socio-economic data collected because it was not comfortable with the accuracy of the information. The British, on the other hand, created a system of social classes which was, and still is, officially used in government reports on health (Krieger and Fee 2005; Galobardes et al. 2006).

By 1924, when Charles V. Chapin released his study on the relationship of socioeconomic differences and death rates, the necessity for accurate data on mortality was further revealed. Chapin did not have the luxury of contemporary data on income and US adult mortality. In order to conduct his research, he had to match 60-year-old death records to tax information from the 1865 census. His conclusion was that the death rate of those who were wealthy enough to pay taxes was less than half that of the poorer, non-tax-paying citizens. From his study, Chapin concluded that, with the realization that poorer citizens suffered greater health inequality, it was relevant to study their behaviors and the environments in which they lived (Chapin 1924; Krieger and Fee 2005).

In 1930, the Census Bureau and the National Tuberculosis Association, under the leadership of Jessamine S. Whitney, decided to work on a project whereby information on death certificates would include occupational data. Whitney was convinced that mortality rates were affected by two factors – the specific hazards associated with an occupation and the standard of living allowed by wages. The issue of dividing occupations into a few economic groups is not an easy task – even in the 1930s, job mobility in the US was much more pronounced than in the UK. However, with the assistance of Alba M. Edwards of the Bureau of the Census, Whitney was able to divide the US workforce into six groups. Based on information from 10 of the 48 states, Whitney concluded that those in the lowest socioeconomic group had a higher mortality rate and that to understand patterns of mortality, both occupation and standard of living had to be considered (Whitney 1934; Krieger and Fee 2005).

During the period of the Great Depression, research began to focus on economic inequality and disease, not mortality. The Public Health Service was able to conduct a ten-city study of the effects of the Depression on illness. The study included 12,000 white families that were broken up into three economic groups and found that the disabling illness rate was highest amongst the poor (Perrott and Collins 1935; Krieger and Fee 2005). In 1935, the Public Health Service began an even larger project. The project included the first National Health Survey where 2.5 million people in 83 cities were surveyed. Though there were issues with data collection and classification, the reports released as a result of the survey revealed the importance of socioeconomic factors on health (Goddard 1939; Hailman 1941; Kiser 1942; US Public Health Service 1945; US Public Health Service 1951).

Much of the work and progress that was accomplished in the 1930s was derailed by World War II and eventually, the Cold War. By 1938, the political climate was changing and a more conservative Congress was elected. The Bureau of the Census prepared a report on US vital statistics that stated that the following should be tabulated: geographic area, cause of death, age, race, sex, nativity, and month of death. They noted that special studies could consider other factors, such as occupation, duration of disease and extent of hospitalization (Linder and Grove 1943). The 30-year effort to develop a system to better understand the health of the population was basically erased and the essential characteristics became age, race and gender (Kreiger and Fee 2005).

Mortality data today, in Alabama, are still tabulated by those three characteristics. As Kreiger and Fee (2005) acknowledge, we must "…avoid becoming entangled in the older debates about the relative importance of mortality versus morbidity data, vital statistics versus health surveys, income versus occupation, and social class versus race/ethnicity" (p. 72). They stress the need to push for the routine collection and reporting of US health data by social class and race/ethnicity along with age and gender. In the meantime, researchers must continue to study population health in the hopes of uncovering vital links that will allow for the elimination of health inequalities.

2.1 Defining Health

Definitions of health are varied and while everyone has a basic idea of what it means, a precise definition is difficult to formulate (Meade and Earickson 2005). Since definitions of health are abundant, there are likely to be many inconsistencies in health research theory and design. One of the reasons given for the inability to pin down a concrete definition is that researchers who study health also study disease (Meade and Earickson 2005). Health, however, is much more than disease – this idea is particularly important in the context of this research. In the following paragraphs, definitions of health that pertain to this research are presented.

The first major, and one of the most recognized definitions of health was provided in 1948 when the World Health Organization (WHO) stated in the preamble to their constitution that "Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." Though this definition provides a broad scope of what health entails, many researchers do not find it effective in assisting with the framework of research design (Meade and Earickson 2005). The WHO definition is often criticized as being too ideal, or even utopian (Meade and Earickson 2005; Gatrell and Elliot 2009).

Dubos' (1965) definition seems to fit fairly well when considering the study of health. "States of health or disease are the expressions of the success or failure experienced by the organism in its efforts to respond adaptively to environmental challenges" (p. xvii). Meade and Earickson (2005) contended that this definition focuses on what health results from and not what health is. Dubos (1960) had other ideas on health as well. He argued that medicine had a relatively small impact on the health of a population. Dubos also believed that living conditions, associated with different levels of social and economic development, were more significant in determining whether people were healthy or unhealthy (Curtis 2007).

In their book, *Medical Geography*, Meade and Earickson (2005) asserted that J. Ralph Audy's definition is the most complete. "Health is a continuing property that can be measured by the individual's ability to rally from a whole range and considerable amplitude of insults, the insults being chemical, physical, infectious, psychological, and social" (Audy 1971, 142). They note that health is a 'dynamic quality' and must continuously cope with changing environments. The idea that Audy believes health can be measured is also significant. Meade and Earickson (2005) acknowledged, however, that researchers have attempted to measure health through various indices; indices which are usually narrow in scope and never widely adopted. Gatrell and Elliot (2009) add that health could easily incorporate the availability of personal and societal resources that allow individuals to achieve optimal health.

From this brief discussion on defining health, it is easy to see why there are so many different approaches used today to study health and why it is so difficult to devise a universal measurement for health. It may be that measurements of health are dependent on place (i.e., developed or developing, rural or urban, industrial or technological). For this reason, I contend that health should be defined in the following manner: health is a continuous property that can be measured by an individual's ability to cope with the chemical, physical, infectious, psychological, and social environments of a specific place in a given time.

Though it is important to understand health variation between and within countries, it is much more practical to understand differences in health in a specific place (Macintyre, Ellaway and Cummins; 2002). Researchers are concerned with the life course of an individual's health, but why limit research to people? Tunstall, Dorling and Shaw (2004) stated that, "…few studies consider the life course of places and how place histories influence life course" (p. 8). Changes in the environment of a specific place will influence health – making improvements to that place and studying the health of the population over time will allow researchers to better understand health and move toward the goal of "…complete physical, mental, and social well-being…" (WHO 2009).

2.2 Health Inequality and Health Inequity

Gatrell and Elliot (2009) assert that researchers are prone to study issues for which the data is easily attainable. From this perspective, it makes sense for health/medical geographers to study disease and illness because incidence can be measured. Understanding general population health is more difficult, however, because there is more subjectivity in trying to define why a person feels unhealthy in a particular place. If the ideas of health inequality and inequity are added to that, the puzzle becomes even more complex. In research on health, 'inequality' and 'inequity' are often used interchangeably. From a theoretical context, however, equality and equity have distinct definitions (Margai 2006; Resnik and Roman 2007).

Graham (2007) notes that 'health inequality' and 'health inequalities' are often used interchangeably in the literature, but the pluralized form is more common. Researchers also use the term 'health inequality' in different ways – difference, disparity, inequity and injustice are just a few words that substitute for inequality (Carter-Pokras 2002; Asada 2007). Definitions of health inequality vary as well. According to Murray, Gakidou, and Frenk (1999), "Health inequality should be defined in terms of inequality across individuals. By moving towards the measurement of the distribution of health across individuals, the study of inequality will be put on firmer scientific footing" (p. 541).

On another note, the definition of health inequality can vary between countries. In the United States, for example, the term has not fared well – researchers and policymakers prefer to use 'health disparities' (Carter-Pokras 2002; Graham 2007). Health disparity is also the preferred nomenclature in the definition provided by Thomson, Mitchell, and Williams (2006): "Racial and ethnic minorities, poor people, and other groups experience worse health in a variety of circumstances. Called health disparities, these differences are reflected by indices such as excess mortality and morbidity and shorter life expectancy" (p. 15).

The committee assigned to examine the *Health Disparities Research Plan* of the National Institutes of Health (NIH) noted that health disparities are not solely defined as differences in health (Thomson, Mitchell, and Williams 2006). The committee contended that the term *disparity* includes differences that are inequitable, unjust, or unacceptable, but acknowledge the fact that the term "*health disparities"* is also used to describe differences in health not associated with inequity (Thomson, Mitchell, and Williams 2006). The meaning and significance of the term can also change over time, and though the term health inequality is important in the UK today, it did fall out of favor in the 1980s and early 1990s (Graham 2007).

There are also those who make an attempt at 'political correctness' in their definition of health inequality. As Braveman (2006, 167) put it,

> Health disparities/inequalities do not refer to all differences in health. A health disparity/inequality is a particular type of difference in health…it is a difference in which disadvantaged social groups – such as the poor, racial/ethnic minorities, women, or other groups who have persistently experienced social disadvantage or discrimination – systematically experience worse health or greater health risks than more advantaged social groups.

Braveman’s definition actually straddles the fence in another manner – it paves the way for making the connection between health inequality and health inequity. Whitehead (1992) defined health inequities as differences in health that are unnecessary, avoidable, unfair, and unjust. This idea of health inequity stimulated debate in Europe and has since been useful in many other places (Braveman, Starfield, and Geiger 2001; Braveman and Gruskin 2003). As a result of continued debate, researchers desire a more precise definition of equity in health because not all health inequalities reflect inequity (Braveman and Gruskin 2003). “Equity means social justice or fairness; it is an ethical concept, grounded in the principles of distributive justice” (Braveman and Gruskin 2003, 254). Graham (2007) acknowledges that “Understanding what is unfair and unjust about health inequities takes us beyond health research into moral and political philosophy…” (p. 3).

Preference in this research is to use the term health inequality; the term health inequality expresses a stronger desire to impact change. “Health disparity” does not emphasize that inequality exists – “health inequality” does. Research can then focus on health inequalities that are unfair or unjust in a specific place and develop solutions for those inequities. Though there are many disciplines that can contribute to studies of health, health/medical geographers are particularly well suited to the tasks of identifying spatial distributions and patterns in a place and figuring out why they exist.

2.3 Geographical Perspectives on Health and Health Inequality

Understanding geographical perspectives on health inequality ultimately lies in realizing the importance of place in relation to health. Geographers must consider how individuals interact with their environment and must attempt to develop theories to explain the relationships (Curtis 2007). Health/medical geographers typically examine *spaces of risk*. In order to understand these spaces of risk, we must consider different combinations of health determinants to explain the variation in health for a given place (Curtis 2007).

Geographers are fascinated with location. As they study locations on the earth's surface and give them meaning, they become places (Gatrell and Elliot 2009). Places can vary in scale. Health/medical geographers' conceptions of study area size can vary as well. Some prefer to look at health from a global standpoint, some from a national perspective and others from a local angle. Geographical research can lead one to label a place as unhealthy or healthy. It is likely that one's perception of the place in which they live can also have a significant influence on their health.

Often, health and medical geographers will study health in a particular place, such as Mobile County, Alabama or will compare health between places (Gatrell and Elliot 2009). Though research on health across time and place has been accomplished in countries like the UK, it is relatively difficult to do in most regions of the world because health data is not designed to contribute to longitudinal studies. This is a challenging dilemma for those that study health. The dilemma can only be solved if researchers determine health inequalities that are unjust, compensate for those inequities, and then study that place over time to see if health improves.

In regards to the study of health from a health/medical geography perspective, Meade and Earickson (2005) presented their idea of the "state of health" through the triangle of human ecology (Figure 2.1). This model focuses on three components of human ecology that impact individual health: population characteristics, behavioral characteristics and habitat. Population includes the ability of humans to contend with issues of health and considers factors such as age, gender, and genetics. Behavior entails observations of culture, including mobility, cultural practices, and technological interventions. Habitat is the environment in which people live; human ecology focuses on human interaction with the natural environment, the social environment, and the built environment.

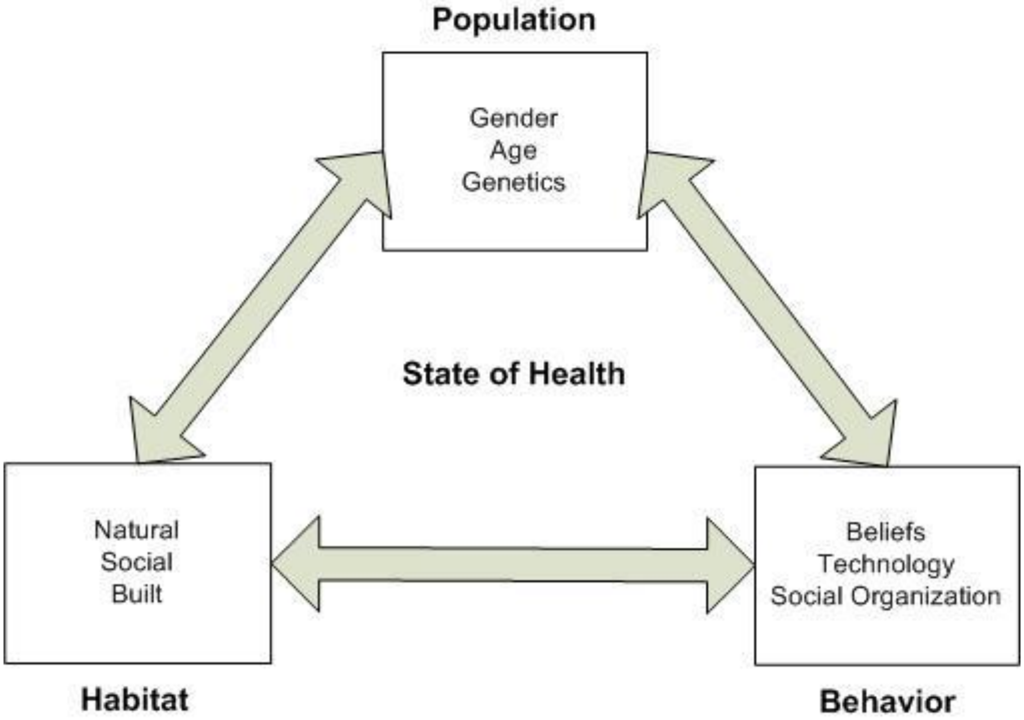


Figure 2.1 The triangle of human ecology. After Meade and Earickson (2005, 25).

Population characteristics like age and gender can be significant from a health inequality perspective and there does appear to be an interest in studies on age and gender in relation to health (Tang, Petrie, and Prasada Rao 2007). Genetics may play a role in health inequality, but are not necessarily associated with health inequity. Behavior is similar to genetics in that certain actions may lead to health inequality, but that does not mean that an inequity exists. In terms of the triangle of health ecology, the most likely component associated with inequity would be habitat.

Though there may be many areas classified in the social environment as being inequitable, it is the built environment where inequity is visibly noticeable. In the past, consideration of the built environment typically dealt with the characteristics of the places people inhabited – their homes. Humans play a major role in defining the built environment on health (Meade and Earickson 2005). Many health issues associated with housing can be avoided and are dependent on construction materials, architectural design, and landscape development. Today, research on the built environment encompasses much more; this topic will be dealt with in detail later.

According to Gatrell and Elliott (2009), there are five approaches to the geography of health: positivist, social interactionist, structuralist, structurationist, and post-structuralist (Figure 2.2). They note that there is no single correct philosophical perspective or type of explanation in studying the geographies of health. Different approaches may be used to conduct research on a given problem.

The positivist approach to studying health relies on accurate measurement and recording, and uses statistical methods to find strong associations between health and given variables. Traditionally, medical geographers have mapped disease data and then attempted to describe and give reasons for the spatial distribution. The end goal for positivist research is to search for laws – typically, however, the end results are classified as generalizations. With a heavy reliance on statistical methods, positivists generally sample from a wider population and attempt to use the sample to predict characteristics of the population. An effort is often made to have a large sample in order to strengthen the conclusions (Gatrell and Elliott 2009).

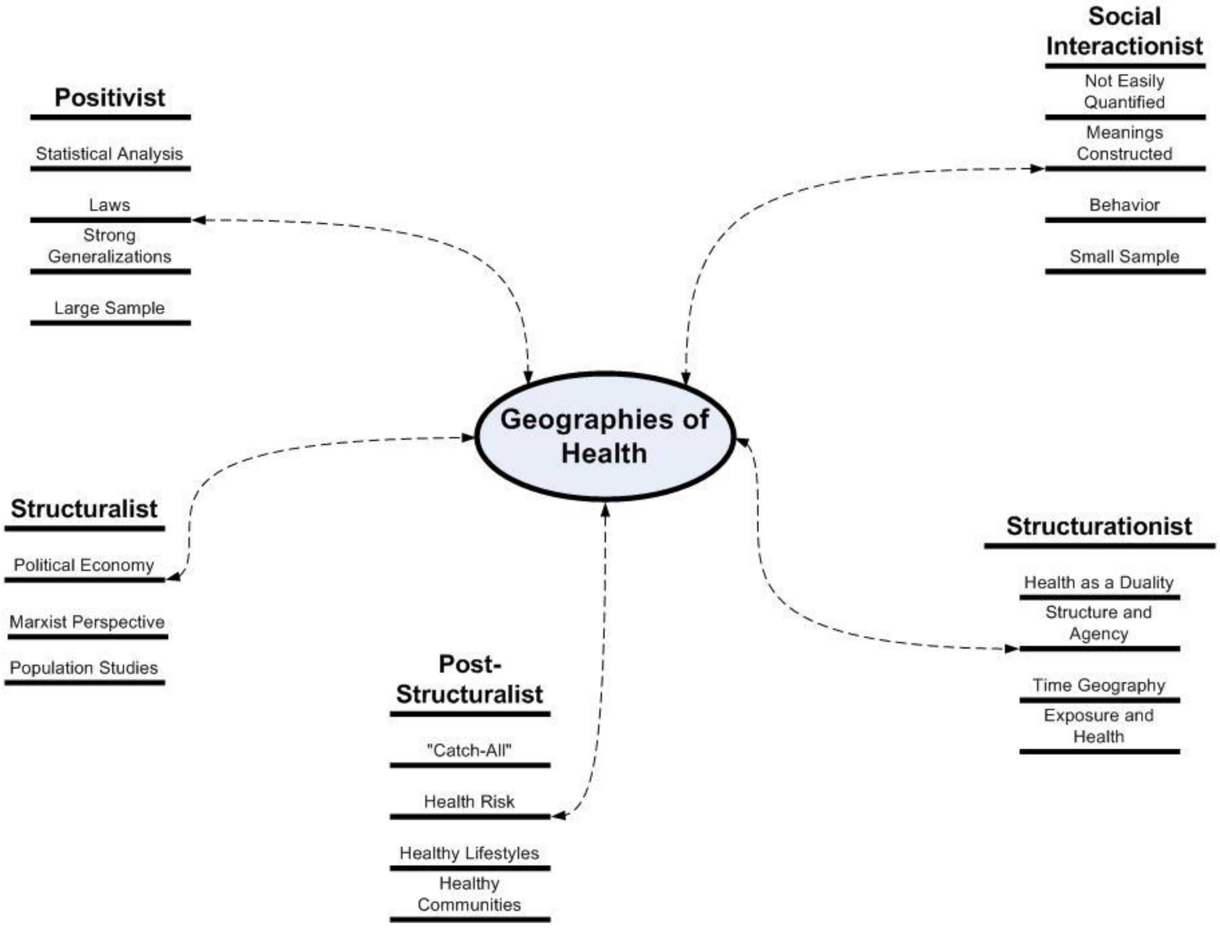


Figure 2.2 Approaches to geographies of health. Source: Gatrell and Elliot 2009.

From the social interactionist or social constructionist perspective, researchers seek to find individual meaning in health issues. “They are so called, because meanings are *constructed* out of the interactions (which may be conversations or encounters) that we have with each other in everyday life” (Gatrell and Elliot 2009, 30). The social interactionist approach tends to look at factors that are not easily measured or quantified; the subjective experience of health and illness is valued in this type of research. It is important to look at the meaning of the disease or illness from the perspective of the individual, and to figure out these meanings in order to understand why people behave the way they do. Whereas the positivist approach likes to sample from large populations, researchers studying from the “humanist” approach prefer to look at small numbers of people such as communities and neighborhoods (Gatrell and Elliott 2009).

The structuralist approach implies that the underlying causes of disease are the result of political and economic systems. This approach does not emphasize the study of individuals; it contends that research should be conducted from a broader social context. It is assumed in the structuralist approach that health is not related to the body, but to the body politic. This is also known as the political economy perspective and has been emphasized in recent years as a key method to understanding health inequality in health/medical geography (Mayer 1996). Most of the theory for this approach can be attributed to Marxist ideas of oppression, domination, and class conflict. From this perspective, medicine is not seen in a favorable context. Medicine is seen as adding to social inequality, widening the gap between the rich and the poor and not promoting any type of agenda to reduce health inequality. Recent studies from this approach have also focused on issues of health from a gender perspective (Gatrell and Elliott 2009).

The structurationist approach emphasizes that the study of health is a duality of structure and agency. “That is to say, it acknowledges that structures shape social practices and actions, but that, in turn, such practices and actions can create and recreate social structures” (Gatrell and Elliott 2009, 40). This has typically been associated with epidemiological and time geography research. This idea has been put forth to show that exposure to an environmental problem or to social stress over a given period of time can impact health (Gatrell and Elliott 2009).

According to Gatrell and Elliott (2009), the post-structuralist, or post-modern, approach is a “catch-all” for researchers that have begun to take on other theoretical developments. Some of the work conducted from this approach centers on health “risk” and adopting healthy lifestyles. In developed countries, the problems of infectious disease have typically been solved and the focus is now on chronic diseases like cancer.

This research focuses on chronic disease in Mobile County, Alabama, and attempts to find connections between socioeconomic status and the built environment in regards to health. The ultimate goal is to understand the underlying causes of poor health in the county. This research could potentially make a significant impact on reducing health inequality by commanding the attention of those in the environmental justice movement.

As far as perspectives on the geography of health inequality, Curtis (2007) has developed a concept that considers the landscapes of health inequality (Table 2.1). She defines five types of landscapes associated with health inequality: therapeutic landscapes, landscapes of power and resistance, landscapes of poverty and wealth, landscapes of consumption, and ecological landscapes. Curtis contends that geography is well suited to thinking holistically. Geographers study people and their interaction with the environment; health and medical geographers concentrate on the health of populations and explore the reasons why health varies between places. The idea of landscapes of inequality is based on the concept that a system of factors and processes act together to create differences between places (Curtis 2007).

Table 2.1 Landscapes of health inequality.

Theoretical Framework	**Landscape Focus**
Theories of Sense of Place and Identity	Therapeutic Landscapes
Theories of Social and Political Control	Landscapes of Power and Resistance
Theories of Production and Structuration	Landscapes of Poverty and Wealth
Theories of Consumption and Lifestyle	Landscapes of Consumption
Theories of Ecological Processes	Ecological Landscapes

After Curtis (2007, 23-24).

Theories of sense of place and identity are significant in studies of therapeutic landscapes. Research in this theoretical framework varies from looking at therapies of complementary and alternative medicines to considering places that are 'therapeutic' for health and those that are harmful. Therapeutic landscapes do not require an attachment to medical spaces like hospitals or clinics; the home, natural spaces, and places associated with healing can also be therapeutic (Curtis 2007).

The theoretical perspective behind studies on the landscapes of power and resistance are similar to Gatrell and Elliott's (2009) structurationist approach. The agency of individual action and choice interacts with the power structure of society, resulting in health differences between social groups. The controlling of resources, territoriality, and surveillance are components of the landscapes of power. Health inequalities are created because certain groups in society do not have the power to fight for legislation that will protect them. The idea goes beyond high and low income groups and research today is investigating health inequalities between different minority and ethnic groups, as well as differences between men and women (Curtis 2007).

Landscapes of poverty and wealth consider the idea of uneven development and its relation to health inequality. In her discussion on research in this area, Curtis (2007) noted that there is much debate today on the possible limits of health gains as societies become wealthier. This is not only associated with individuals, but is particularly of interest in looking at places or communities where there are conditions of material poverty. Though many environmental issues in regards to health are related to the idea of ecological landscapes, the built environment is technically an important visual component in the landscapes of poverty and wealth.

Geographically varying patterns of health care services and other important resources for health are the primary focus in landscapes of consumption research. Curtis (2007) contended that economic inequalities contribute to the explanation of differences in consumption, but there are other factors that are important. Political, administrative, and social structures are crucial to understanding consumption as well. Curtis also pointed out that the spatial organization of infrastructure, or the methods available for the delivery of goods and services, is a critical component to understanding why health inequalities exist. These structures change over time, and depending on geographic location, can vary as well. From this standpoint, it would benefit geographers with an interest in health inequality to study the health of a place in a given time or to consider the concept of place histories and their impact on population health over time.

One of the most studied areas of health inequality is the ecological landscape. This usually involves the study of risk factors associated with the environment, and their impact on human health. Typically, research focuses on the biological and chemical risk of medically recognized diseases – in developing countries, these are often infectious diseases, while in developed countries, the focus is usually on chronic ailments. One major direction for health inequality research within this framework is exposure. Through new GIS and modeling approaches, current studies in medical geography allow us to better visualize the patterns and distributions of disease (Curtis 2007).

There are many theoretical components to the research in this dissertation. For the most part, it would be considered to take a post-modern approach in looking at health inequality, but this research does have a strong positivist approach as well. Though most of this dissertation is highly quantitative and applied, it does take into account social interactions, particularly through questions on perception of neighborhood health, activism, and the environmental justice movement. The research does consider the ecological landscape, but brings in concepts from the landscapes of power and from ideas on poverty and wealth. Dealing heavily with the built environment, it can be associated with the triangle of human ecology, focusing on ‘habitat’ and implying that the built environment in some places can be identified as an inequity (Figure 2.1).

2.4 Research on Health Inequality

In 1916, Benjamin S. Warren and Edgar Sydenstricker prepared two reports; one report detailed the health of garment workers in relation to their socio-economic status and the other looked at health insurance in relation to public health (Warren and Sydenstricker 1916a; Warren and Sydenstricker 1916b). These studies, along with those that Sydenstricker subsequently completed "…clearly established poverty as the main axis of analysis of socioeconomic differences in health in the United States…" (Krieger and Fee 2005, 55). Warren and Sydenstricker summarized differences in health that resulted from the workplace and those that were the result of inadequate wages and irregular employment, including poor diet and unhealthy living conditions (Warren and Sydenstricker 1916a).

In recent decades, the research that put health inequality based on social class to the forefront once again was a study completed in the UK entitled *The 1980 Report of the Working Group on Inequalities in Health* (Macintyre 1997; Bartley 2004). This document is commonly known as *The Black Report* and set the standard for future health inequality research in the UK. In 1998, *The Acheson Report* summarized evidence on health inequality in the UK and was used to create a three-year plan to improve health (Asada 2007).

Research reports on health inequality appear in journals from many disciplines. Environmental health, public health, and epidemiology contribute significantly to research on health inequality. Recently, planning has become more involved in promoting healthier communities. Health and medical geographers contribute research on health inequality in journals like *Health and Place*. Research on health inequalities or disparities has provided society with a large amount of information on the magnitude of the problem and has also initiated investigation into the causes of poor health (Thomson, Mitchell, and Williams 2006).

In academic circles, health inequality research has focused on the impact of income and other socio-economic variables. Though research in developing countries has focused on a number of socio-economic variables, research in developed countries has centered on income inequality. It is often assumed that industrialized countries do not need to worry about health issues, but recent literature suggests there should be concerns and attention to health variability in wealthier countries, as well as less-developed regions. Industrialized nations may not suffer from the same health inequalities as developing regions, but health inequalities do exist and it is important to understand why. In the following sections, current literature relevant to this research is presented. Though housing is an important factor in understanding health inequality, it is discussed in a later chapter on the built environment.

Income Inequality and Health

Research on income and its impact on health inequality have been the focus of much interest in recent decades (Wagstaff and van Doorslaer 2000; Subramanian and Kawachi 2004; Subramanian and Kawachi 2006). Numerous studies incorporating different data sources, sample populations, and methods have been completed to determine the relationship between income inequality and health in the United States (Fiscella and Franks 1997; Kennedy, Kawachi, and Glass 1998; Soobader and LeClere 1999; Diez-Roux, Link, and Northridge 2000; Kahn, Wise, and Kennedy 200l; Lochner, Pamuk, and Makuc 2001; Subramanian, Kawachi, and Kennedy 2001; Mellor and Milyo 2003). Other studies have focused on income and inequality outside the United States (Lynch et al. 2000; Shibuya et al. 2002; Asafu-Adjaye 2004; Jones et al. 2004; Cantarero, Pascual, and Sarabia 2005; Tunstall et al. 2007; Bockerman et al. 2009).

The studies have varying conclusions on the relationship between income inequality and health. In the following section, a number of these will be discussed.

New data from the European Community Household Panel (ECHP) was used by Cantarero, Pascual, and Sarabia (2005) to examine the relationship between income inequality and health in European Union countries. Through statistical analysis, they concluded that there is a relationship between income inequality and health in the European Union. Greater inequality is associated with higher mortality, and higher life expectancy is related to lower inequality. The authors also note that environmental and social variables are important in looking at health, but the relationship between income and health is extremely important in creating appropriate health care policies.

Asafu-Adjaye (2004) investigated the effect of income level, income inequality, the level of savings and the level of education on health status. He used a data set for 44 countries over six time periods. The results indicated that income inequality measured by the Gini coefficient has a significant effect on health status when the levels of income, savings, and education are controlled. Thus, this study provides results that reveal some empirical support for the income inequality hypothesis.

Bockerman et al. (2009) used individual micro-data from Finland over the period 1993 – 2005 to examine a variety of individual health indicators to income inequality as measured by local Gini coefficients. They found no overall association between income inequality and several measures of health status. As a result, they concluded that income inequality is not always harmful for health. These findings are similar to other results that indicate that income inequality in small populations is often irrelevant for health outcomes (Wilkinson 1997; Franzini, Ribble, and Spears 2001; De Vogli et al. 2005, Wilkinson and Pickett 2006).

Tunstall et al. (2007) conducted a longitudinal mortality study of all residents in Britain during the period 1971-2001. They identified a group of areas where economic adversity had been experienced for a long time. From those areas, they identified members with relatively low age specific mortality rates. They concluded that economic adversity is not always a killer because areas with similar economic histories do not all have high mortality rates. The areas studied were quite diverse in types of illness and the authors do contend that future research is necessary to identify reasons for this.

Using data from the Behavioral Risk Factor Surveillance System (BRFSS), Diez Roux, Link, and Northridge (2000) investigated whether inequality in the distribution of income in the US was related to the prevalence of four cardiovascular disease risk factors. The four risk factors were body mass index (BMI), history of hypertension, sedentarism, and smoking. They used multilevel models to examine the relationship between state inequality and risk factors before and after adjustment for individual income level. State inequality was associated with three of the four risk factors (BMI, hypertension, and sedentarism), particularly at low income levels. These associations were statistically significant in women, but not in men. The authors noted that their findings were not conclusive, but they are suggestive of the effect of income inequality at the lower income level.

Current research on income inequality and its relationship to health is mixed. This is evident in a study conducted by Subramanian and Kawachi (2006). They examined the multilevel interactions between state income inequality, self-rated health, and a number of demographic and socioeconomic markers in the US. Pooled data from the 1995 and 1997 Current Population Surveys and US Census data on state income inequality from 1990, 1980, and 1970 was used in the research. Through the use of a cross-sectional multilevel modeling procedure of 201,221 adults in the US, they concluded that there was not strong statistical support for the effects of state income inequality across different population groups. In fact, the relationship between state income inequality and poor health was steeper for whites than for blacks.

Studies dealing with self-rated health have come to the foreground over the last decade and Subramanian, Kawachi, and Kennedy (2001) used multilevel statistical procedures to investigate the sources of variation between states in the US. Data for their analysis came from the 1993-94 Behavioral Risk Factor Surveillance System and the 1986-90 General Social Surveys. The results from the analysis revealed that individual level factors such as low income, being black, and smoking were strongly associated with self-rated poor health.

Though much of the work on health inequality is highly quantitative and revolves around income, research today is moving toward a more holistic approach. Studies on income inequality and its relationship to health now incorporate other variables into the equation and use more complex statistical methods and models to better understand the underlying causes of poor health. In conjunction with this, many researchers are now realizing the importance of "lay epidemiology" and how a person's perception of the place in which they live impacts their health.

Qualitative Studies in Health Inequality

One of the newer research interests in health inequality focuses on the individual's perception of the place in which they live and the impact this has on their well-being. The notion here is that it is not only the physical space that affects health, but also the way people feel about their place of residence and their communities. This type of research has paved the way for an offshoot of health/medical geography that resembles health psychology (House 2001; Bolam, Murphy, and Gleeson 2006). It has pressed the need for broader definitions of health in order to understand inequalities and has allowed for spirited debate in research circles (Bolam, Murphy, and Gleeson 2006).

One of the earliest attempts at understanding the relationship between place and health involved a study of four socially contrasting neighborhoods in Glasgow in the late 1990s (Ellaway, Macintyre, and Kearns 2001). The authors analyzed the perceptions of individuals on their residential environment and self-reported health. They concluded that one's neighborhood of residence is significantly related to the incidence of social and environmental problems. The most affluent neighborhoods tended to have the lowest level of problems and the highest level of cohesion while poorer areas had the lowest cohesion and greatest number of social and environmental problems. The neighborhood itself was not the only factor that impacted health – housing tenure and employment were also noted as being major influences.

Typically, studies on the relationship between health and income inequalities use mortality measures as the dependent variable. Ellaway, Macintyre, and Kearns (2001) used self-reported health measures which were likely to be more susceptible to neighborhood influences. Another significant finding of the research was the potential positive impact of neighborhood involvement in formulating public policies. The 'psychological sense of community' provides citizens with positive attitudes and previous studies have shown that this is important for people's health (Ellaway and Macintyre 2000).

Popay et al. (2003) noted that very little had been done with lay perspectives on health inequalities prior to their research. Their data were collected through postal self-completion surveys and in-depth interviews. During the interviews, respondents living in advantaged and disadvantaged areas were asked to explain why people living in different locations have different health experiences. Most people in the survey sample made an attempt to answer the question. Place-based factors were considered more important in determining inequality when compared with aspects of individual behavior. Also, people in disadvantaged areas were more likely to suggest place-based causes for inequalities in health, while those in more affluent circumstances were likely to use individual explanations (behavior). However, the authors noted that in many instances, respondents offered multiple causes for inequality in health.

Bolam, Murphy, and Gleeson (2006) used accounts of place identity in relationship to geographical inequalities in health to determine the significance of place and social characteristics on health. They noted that health research has documented everyday experiences and perceptions of health since the 1970s, but their study was "…the first empirical investigation of place-identity in health psychology…" (p. 404). They conducted their research in a southern English city with a population of approximately 380,000. They looked at two communities within the city where most of the people lived – 'North city' and 'East city.' The participants were purposively selected based on their geographical area of residence.

After initial contact with the participants, the researchers relied on the snowball technique to survey a number of individuals. They conducted 30 semi-structured interviews using open-ended prompt questions in order to get the participants to expound on the issues that were most significant to them. The respondents provided three key themes to the environments in which they lived: pollution, space (i.e., feelings of being cramped), and community. The authors concluded that these dimensions impact places differently. East city residents had higher levels of material and psychological deprivation, but a strong sense of community. On the other hand, the residents of North city had the material and psychological advantage, but lacked in their sense of a shared local identity. There are some issues in contemporary urban life, like migration, that could potentially impact the results of studies like this. However, the authors also note that the concept of place-identity as it relates to health can have important implications in health psychology and further research is needed to pursue its applicability (Bolam, Murphy, and Gleeson 2006).

Research on the perception of place as it relates to health is a significant part of this dissertation. This subject is becoming more important in studies dealing with health because it allows researchers to understand how individuals view their place of residence and their community. An awareness of what concerns citizens helps to bring critical issues to the forefront. Though this will be discussed in a later chapter, information from surveys conducted in Mobile County alludes to the fact that many individuals are willing to pursue activism if it benefits their communities. This leads one to believe that if people in a given place realize the potential threat of the environment on their health, they would be prepared to fight for policies to enhance the quality of their surroundings.

CHAPTER 3 - Mobile County, Alabama

Mobile County is Alabama's fourth largest county, covering 1,233 square miles (Figure 3.1). The city of Mobile lies within the county and is important in its economy. There is also a large suburban ring, and rural areas in the northern and southern portions of the county. To the south lies the Gulf of Mexico and to the east, Mobile Bay. There are also a number of other significant water features including the Mobile River, which runs through the northern part of the county and the Theodore Industrial Canal to the south.

With access to major bodies of water, Mobile is home to the Port of Alabama which handles a variety of cargos, including containers, forest products, metals, and bulk cargo. The Alabama State Docks were dedicated in 1923 and the port serves as a gateway between the southeastern United States and the rest of the world. In 2005, the Alabama State Port Authority began the process of expanding the state docks facilities by building a container terminal that cost approximately $300 million (Mobile Area Chamber of Commerce 2007; US Department of Housing and Urban Development 2009).

Mobile County is also home to a number of chemical producing industries that are mostly located in the northern part of the county and along the Theodore Industrial Canal. In terms of Superfund sites in 2002, Mobile County was the highest in the state, but in comparison to other counties in the United States, it ranked with the cleaner counties. In terms of toxic chemical release, its ranking was in the top ten percent of counties in the United States for total environmental release, cancer risk score, non-cancer risk score, and air releases of recognized carcinogens, developmental toxicants, and reproductive toxicants (Scorecard 2002).

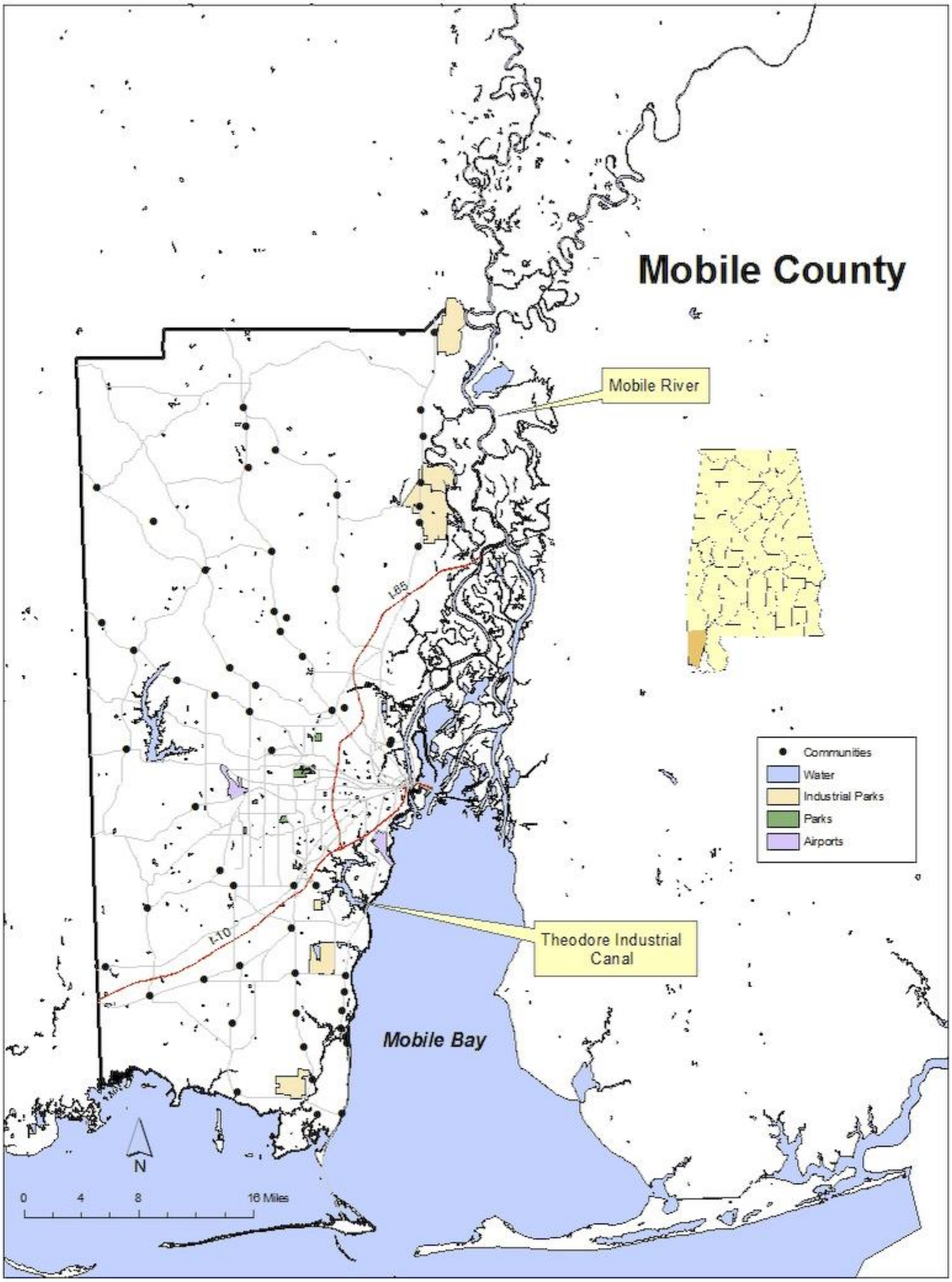


Figure 3.1 Study area: Mobile County, Alabama. Map by author. Source: City of Mobile.

The study of health in Mobile County requires an understanding of the socio-economic characteristics of residents, factors that potentially are a risk for poor health, and the built environment. This dissertation aims to recognize the importance of place on health. Mobile County is an ideal location to conduct a study such as this because it is home to numerous facilities that conduct on-site release of toxic substances; its population is still highly segregated, racially and by income; and it contains an urban core, a suburban ring, and rural areas. Health inequality researchers are now pursuing various methods to identify the characteristics most likely to have an impact on health. In this context, it is critical to understand the place being studied and how it might differ from other localities in a region. An economic overview is provided in the next section, followed by a detailed look at socioeconomic characteristics, housing, and mortality by zip code tabulation area (ZCTA) in Mobile County.

3.1 Economic Overview

Mobile, Alabama and its surrounding area benefit from abundant natural resources. The county also boasts a prime location, particularly in the context of its climate. Mobile County enjoyed steady economic growth throughout the twentieth century. That growth has continued into the first decade of this century, but the county has suffered a slight economic slump in the last few years. The unemployment rate from 2001-2008 was around 5 percent, but in July of 2009, the unemployment rate in Mobile hit 10.8 percent, the highest since 1987 (US Department of Agriculture 2008; Amy 2009).

As a right-to-work state, Alabama ranks below half the states in its percentage of union membership and it still maintains one of the lowest corporate income tax rates in the nation. This has been a critical factor in Mobile County’s ability to attract firms from around the world, including many large chemical companies (Table 3.1). As a result of Mobile’s Foreign-Trade

Zone (FTZ), the city has been able to enhance its focus on international trade. Firms can use the FTZ procedures to reduce costs associated with duties and tariffs. In 2006, more than $1.5 billion was generated through Zone-related activity (Mobile Area Chamber of Commerce 2007).

The diversity of economic activity in the region is evident in Table 3.2. Retail trade and other services top the list for business enterprises in the county, but there are a number of other types of businesses that are significant, including construction, manufacturing, and wholesale trade. In fact, retail and wholesale trade make up a large percentage of the local economy; approximately 18 percent of the total workforce is employed in retail and wholesale trade. The chemical industry, the shipbuilding industry, and the aviation/aerospace industry are all important sectors of the economy, and there is continued growth in each of these (Table 3.3). High-technology businesses have blossomed in the county over the last decade (Mobile Area Chamber of Commerce 2007; US Department of Housing and Urban Development 2009).

Though manufacturing is a major component of the economy in Mobile County, the service sector employs 83 percent of the workforce (Table 3.4). Topping the list in service sector employment is the Mobile County Public School System. Colleges and universities, financial institutions, utilities, government organizations, and health care services also provide employment (Mobile Area Chamber of Commerce 2007; US Department of Housing and Urban Development 2009). Wal-Mart, a company that is often perceived not to have the best wages and benefits, is a major employer in Mobile County.

Table 3.1 Foreign investment in Mobile County.

Country of Ownership	Enterprise Name
Australia	Austal USA
Austria	Lenzing Fibers, Inc.
Canada	IB Nitrogen Inc. Masonite International Yellowhammer Homes, Inc.
England	Ineos Phenol Shell Chemical LP/Shell Mobile Site Tate & Lyle Sucralose Inc.
France	Arkema Inc. Technip USA EADS Airbus
Germany	Evonik Degussa Corporation ThyssenKrupp Steel & Stainless USA, LLC
Holland	Akzo Nobel Functional Chemicals LLC Shell Offshore Inc.
Japan	Mitsubishi Polysilicon Plasmine Technology, Inc. Lanier Worldwide Master Halco Konica Minolta Printing Solutions USA, Inc.
Korea	Glovis America, Inc.
Norway	Aker Solutions
Scotland	Energy Cranes LLC
Singapore	ST Mobile Aerospace Engineering Inc.
South Africa	Barloworld Handling
Spain	EADS CASA North America Inc.
Sweden	SSAB Alabama Inc.
Switzerland	Ciba Specialty Corporation Holcim (US) Inc. Syngenta

Source: Mobile Area Chamber of Commerce (2007).

Table 3.2 Type and number of businesses in Mobile County.

Type of Business	Number in Mobile County
Forestry, Fishing, Hunting and Agriculture Support	45
Mining	21
Utilities	36
Construction	975
Manufacturing	419
Wholesale Trade	690
Retail Trade	1,645
Transportation and Warehousing	339
Information	134
Finance and Insurance	521
Real Estate	407
Professional Services	882
Management of Companies, Enterprises	56
Admin, Support, Waste Management	484
Educational Services	84
Health Care, Social Services	684
Arts & Entertainment, Recreation	102
Accommodation and Food Service	657
Other Services (except Public Administration)	1,136
Auxiliaries	16
Unclassified Establishments	101

Source: Mobile Area Chamber of Commerce (2007).

Table 3.3 Top manufacturing companies in Mobile County.

Company	Products	Total Employees
ST Mobile Aerospace Engineering, Inc.	Aircraft Refurbishing	1,300
Austal USA	Shipbuilding	1,014
Atlantic Marine Alabama LLC	Ship Repair	868
Bender Shipbuilding & Repair Co., Inc.	Shipbuilding & Repair	746
Kimberly Clark Corporation	Paper Products	725
Evonik Degussa Corporation	Chemicals	700
CPSI	Software	653
Press-Register	Newspaper Publishing	548
Teledyne Continental Motors	Aircraft Piston Engines	475
SSAB Alabama Inc.	Steel Mill	370
UOP, LLC A Honeywell Co.	Chemicals	334
Barnett Millworks, Inc.	Wood Products	300
Coca-Cola Bottling Company Consolidated	Soft Drinks	300
Olin Corporation	Chemicals	275
Masland Carpets LLC	Carpet Mfg.	256
Gulf Lumber Company, Inc.	Wood Products	200
Shell Chemical LP/Shell Mobile site	Petroleum refining	181
Armstrong World Industries, Inc.	Acoustic Ceiling Tile	170
Arkema, Inc.	Chemicals	170
Tate & Lyle Sucralose, Inc.	Sucralose	160
Holcim (US) Inc.	Dry Cement	158
Mitsubishi Polysilicon	Chemicals	155
DuPont Agricultural Products	Chemicals	150

Source: Mobile Area Chamber of Commerce (2007).

Table 3.4 Service sector employment in Mobile County.

Company	Total Employees
Mobile County Public School System	8,134
Mobile Infirmary Medical Center	6,450
University of South Alabama & USA Health System	5,000
Wal-Mart	3,000
City of Mobile	2,410
Mobile County	1,588
Providence Hospital	1,570
Springhill Medical Center	1,375
Regions Bank	950
U.S. Coast Guard	949
U.S. Postal Service	765
U.S. Army Corps of Engineers	600
Alabama State Port Authority	650
Hertz Corporation	560
Saad Healthcare	510
Sears Home Central	420
NCO Financial	390
World Omni Financial Corp.	385
The SSI Group, Inc.	370
Mobile Gas Service Corporation	255
Global Tel*Link Corporation	200
Bishop State Community College	200

Source: Mobile Area Chamber of Commerce (2007).

Mobile has always welcomed tourists and it is home to the second largest Mardi Gras celebration in the United States. Carnival Cruise Lines began sailing from its homeport of Mobile in 2004 and plans are now in the works to expand Mobile’s waterfront (Mobile Area Chamber of Commerce 2007). From an economic standpoint, future prospects for the county appear to be positive. How has the growing economy in the county in recent decades impacted residents from a socioeconomic perspective? In the following section, this question will be investigated.

3.2 Socioeconomic Characteristics

In order to understand the socioeconomic makeup of the county in the context of this study, a number of characteristics are examined. The areal unit of study for this research is the zip code tabulation area (ZCTA) and the socioeconomic characteristics of the county discussed in this section are based on that unit. Zip code tabulation areas are geographic units that approximate the delivery area for a US Postal Service five-digit zip code. They are the aggregation of census blocks that have the same predominant zip code associated with the addresses in the US Census Bureau's address file. The ZCTAs are not precise depictions of zip code delivery areas and do not include all the zip codes for mail delivery. Though the US Census Bureau tabulated data for zip codes in the 1990 census and before, in 2000, they created ZCTAs as a new areal unit (US Census Bureau 2001).

The county consists of thirty-one zip code tabulation areas (ZCTAs). In recent years, the county has continued to grow and a few new ZCTAs are showing up. However, for the purposes of this research, those available from the US Census in 2000 are being used. Health data from the Alabama Department of Health, Center for Health Statistics, are tabulated by zip code and this information is closely tied to ZCTAs from the 2000 census (Figure 3.2). There are a few post offices in Mobile County that are not represented by ZCTAs in this study. Generally, these are associated with very small locations within larger ZCTAs and do not have an impact on the approach taken in this research.

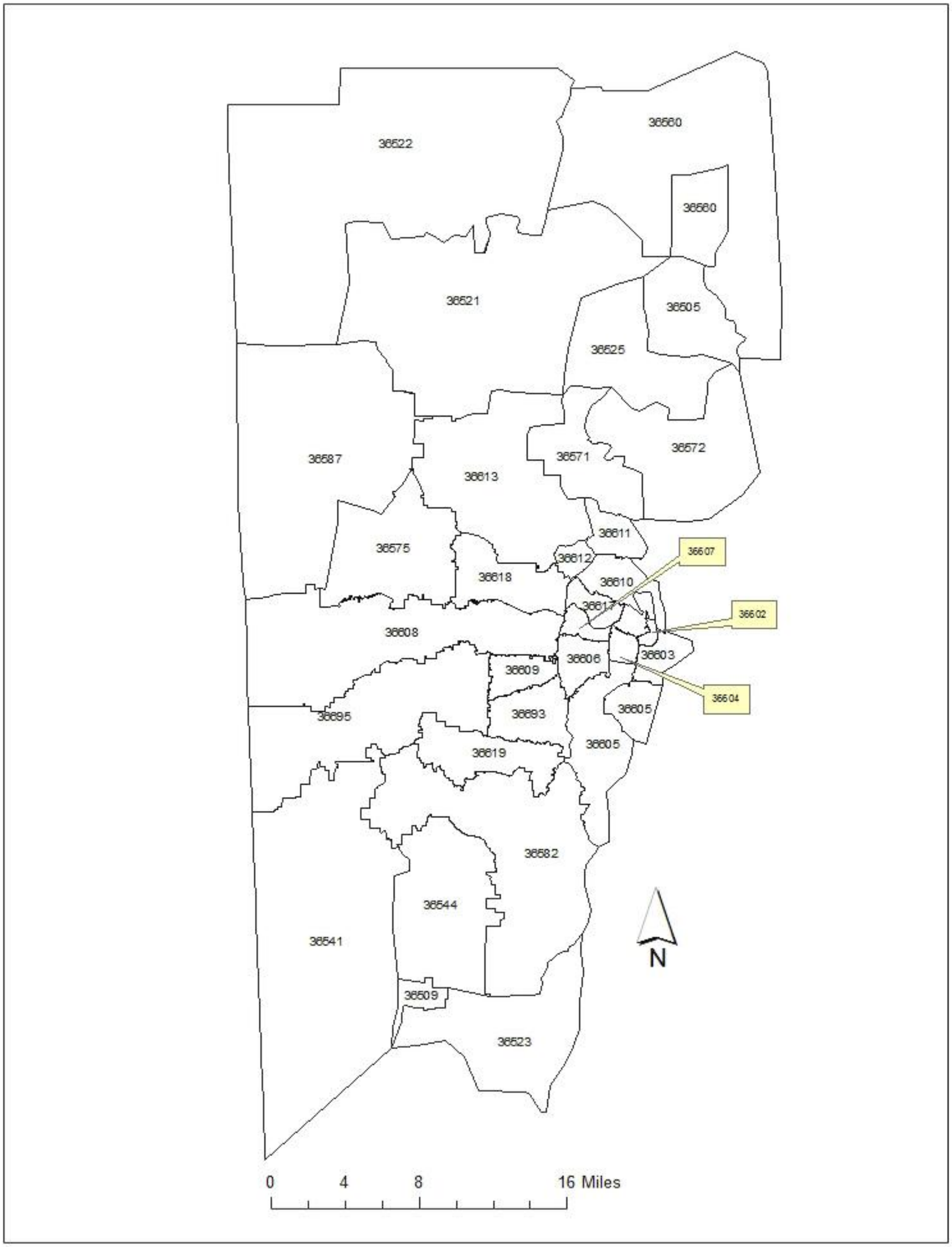


Figure 3.2 Zip code tabulation areas. Map by author. Source: US Census Bureau (2001).

Demographic Variation

In order to fully understand the impact of the built environment on health in Mobile County, it is important to be knowledgeable about a number of demographic characteristics. Mobile's overall population did increase during the period 1990 – 2008 (Table 3.5). From 1990 to 2000, population change in Mobile County was calculated at 5.6 percent. Estimates from 2000 to 2008 show the approximate population change to be 1.6 percent which is much lower than the previous decade (US Department of Agriculture 2009).

From a racial perspective, there have also been some noticeable trends in the percent white and percent African-American residents. The percent white population in 1990 was 67.3 percent and the estimated 2008 proportion white is 61.9 percent. African-Americans have seen an increase of approximately 3 percent in the county from 1990 to 2008 (US Census Bureau 2000; US Department of Agriculture 2009). Though other populations are present in Mobile County, they only contribute minimal numbers to the overall population and are not dealt with in this study.

Table 3.5 Population statistics for Mobile County.

	Total Population	Percent White	Percent African-American
1990	378,643	67.3	31.1
2000	399,843	63.1	33.4
Estimated 2008	406,309	61.9	34.4

Source: US Census Bureau (2001, 2007).

The map depicting racial composition provides some insight into the amount of racial segregation that still exists in the county (Figure 3.3). Higher African-American populations tend to be located in the northeast rural corner of the county and in the urban core. The white population tends to reside in the suburban ZCTAs, particularly in the central corridor, and in many rural ZCTAs within the county. Over the past two decades, migration within the city has occurred along the central corridor to the west - a movement that continues today. African-American pockets of low-income neighborhoods and public housing are located primarily in the urban core just north of the central business district (CBD). Racial segregation within Mobile County does correspond with socioeconomic segregation in the three ZCTAs where the poverty rate was the highest (US Census Bureau 2001).

The percentage for all people in poverty in Mobile County in 2007 was approximately 20.8 percent, compared to the national average of 12.3 percent (US Census Bureau 2007). For children ages 0 – 17, the poverty rate was 30.7 percent (US Department of Agriculture 2009). Poverty by ZCTA in Mobile County reveals that most poverty occurs just north of the CBD and extending to the northwest (Figure 3.4). There is also a pocket of higher poverty in the northeast corner of Mobile County (US Census Bureau 2001). The median income for the county in 2009 was $37,575; this is relatively high in comparison to other counties in the state (US Department of Agriculture 2009). The areas of the lowest median income in Mobile County are found in the urban core, the northeast corner of the county, and a small ZCTA in the southern part of the county (Figure 3.5).

Another characteristic typically associated with health inequality is that of education. Mobile County has seen an increase in individuals 25 years and over who have earned a high school diploma. In 1970, 57.4 percent of all persons 25 years and over in Mobile County had completed high school. By 2000, that percentage dropped to 23.3 percent (US Department of Agriculture 2009). Examination of high school dropout rates in Mobile County reveals a number of ZCTAs where the percentage exceeds 30. Many of these are associated with ZCTAs in the urban core and are predominantly African-American. There are, however, numerous rural, predominantly white ZCTAs, where this occurs, as well. Rates in many of the suburban ZCTAs tend to be lower (US Census Bureau 2001).

The population density for Mobile County is shown in Figure 3.4. It is not surprising that the most densely populated area of the county is the urban core. The central corridor that extends out from the urban core is the primary area of suburban growth. To the north and south of the central corridor lie some moderately populated ZCTAs that exhibit characteristics of suburban areas. Though it is likely that population change did occur between 1990 and 2000 in each of the ZCTAs, this is difficult to show in the context of this study - without data based on ZCTAs prior to 2000, it is not easy to determine the change by zip code.

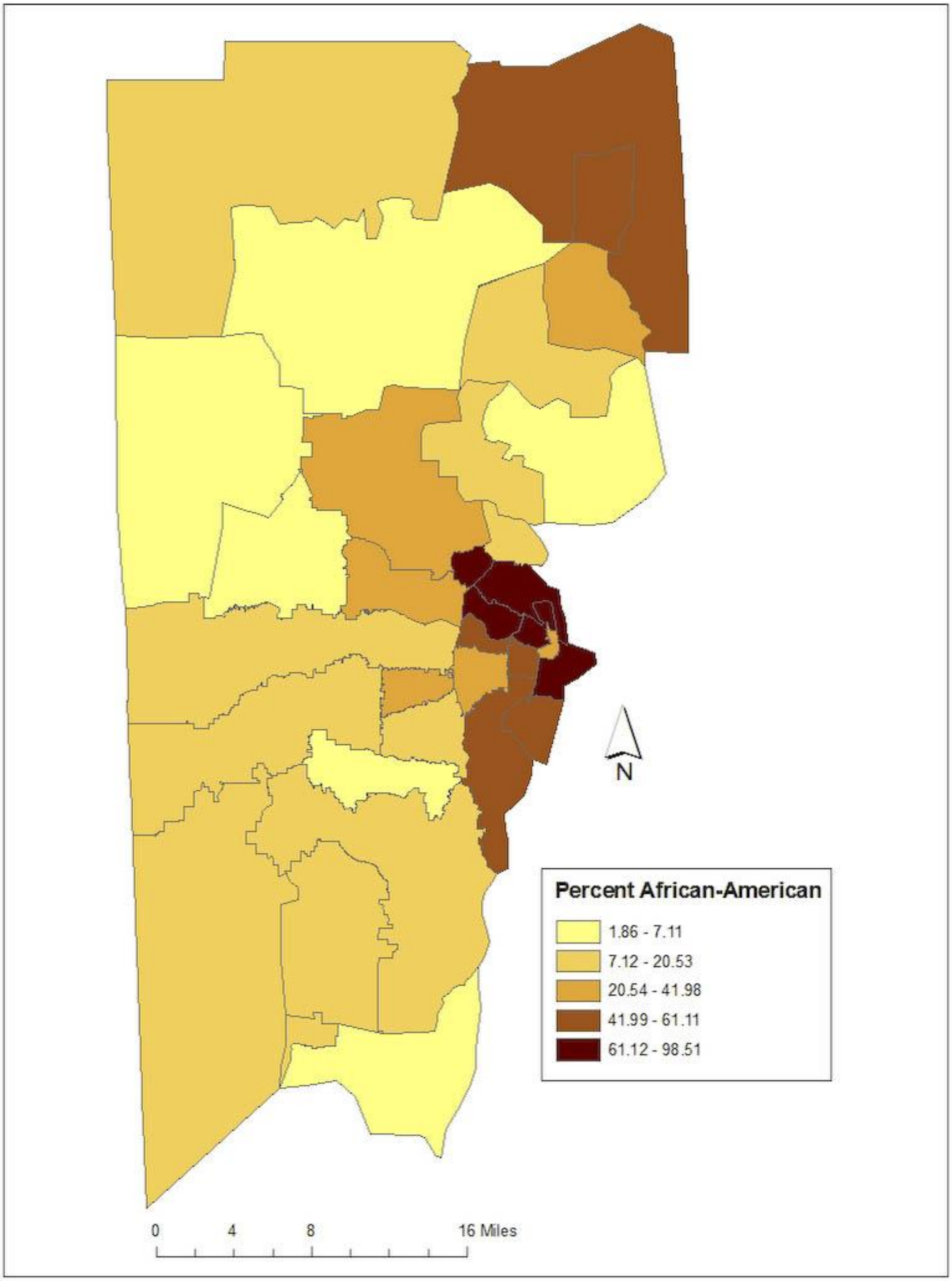


Figure 3.3 Percent African-American population. Map by author. Data source: US Census Bureau (2001).

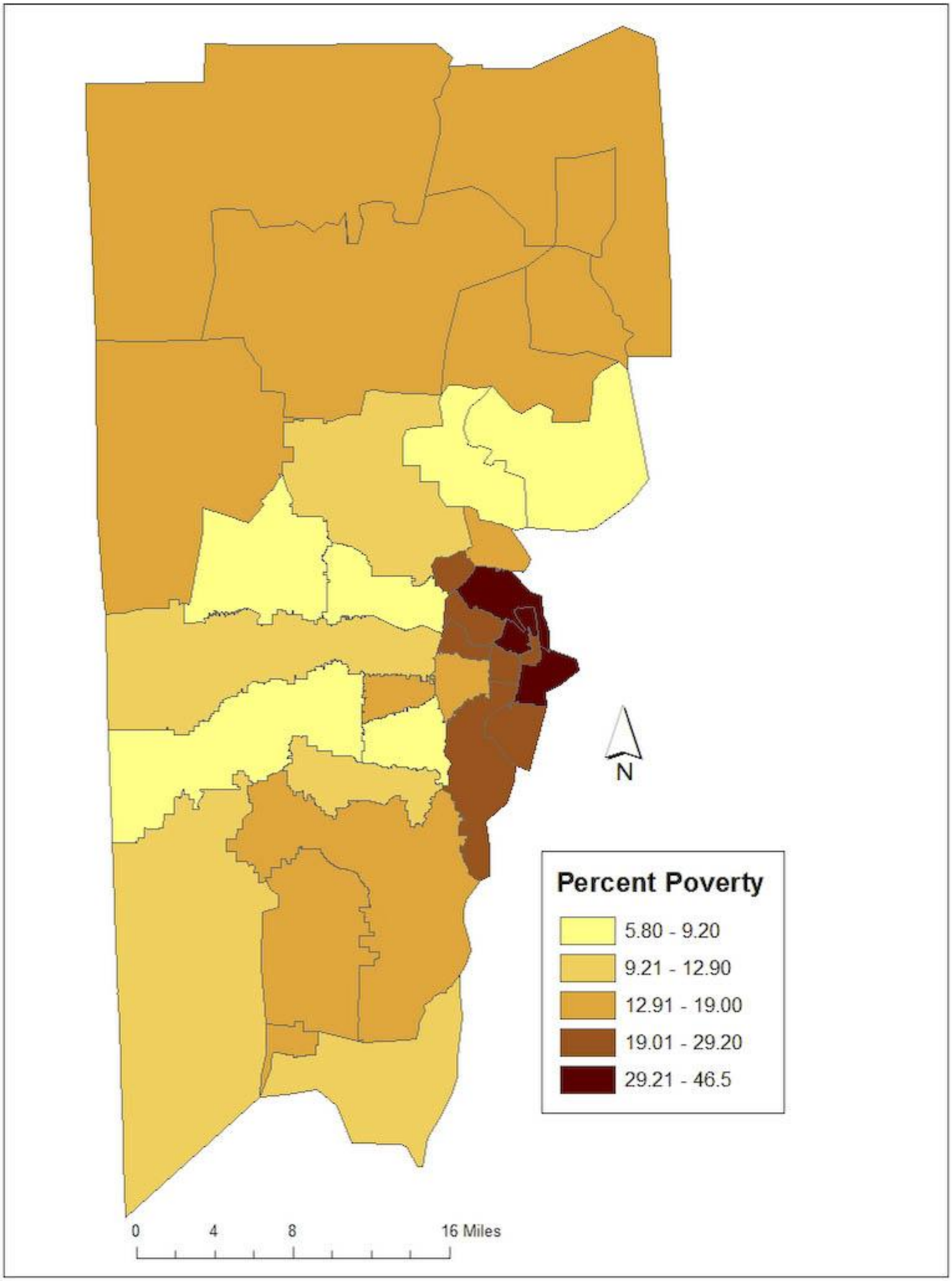


Figure 3.4 Percent poverty by ZCTA. Map by author. Data source: US Census Bureau (2001).

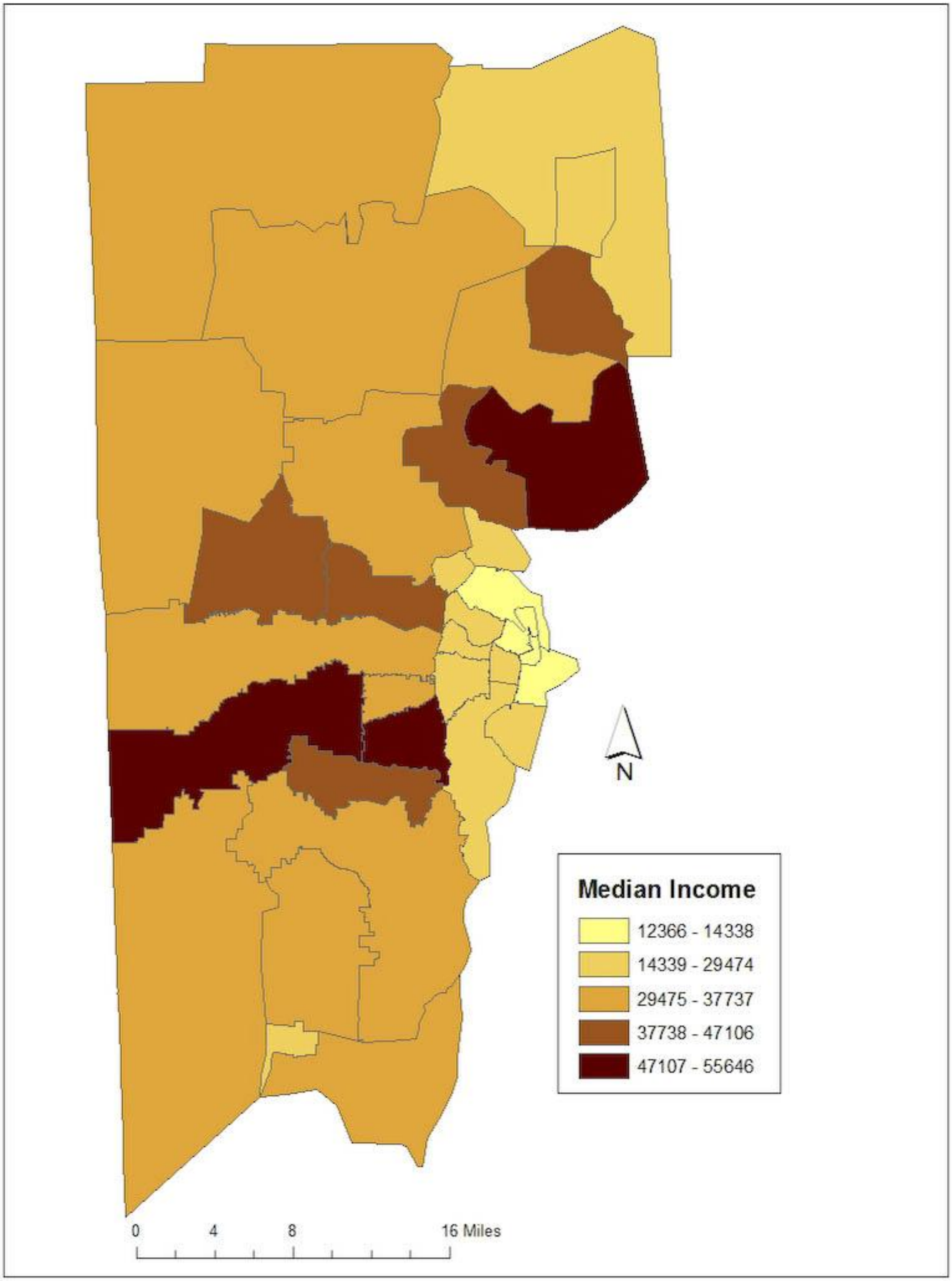


Figure 3.5 Median income by ZCTA. Map by author. Data source: US Census Bureau (2001).

Figure 3.6 Population density by ZCTA. Map by author. Data source: US Census Bureau (2001).

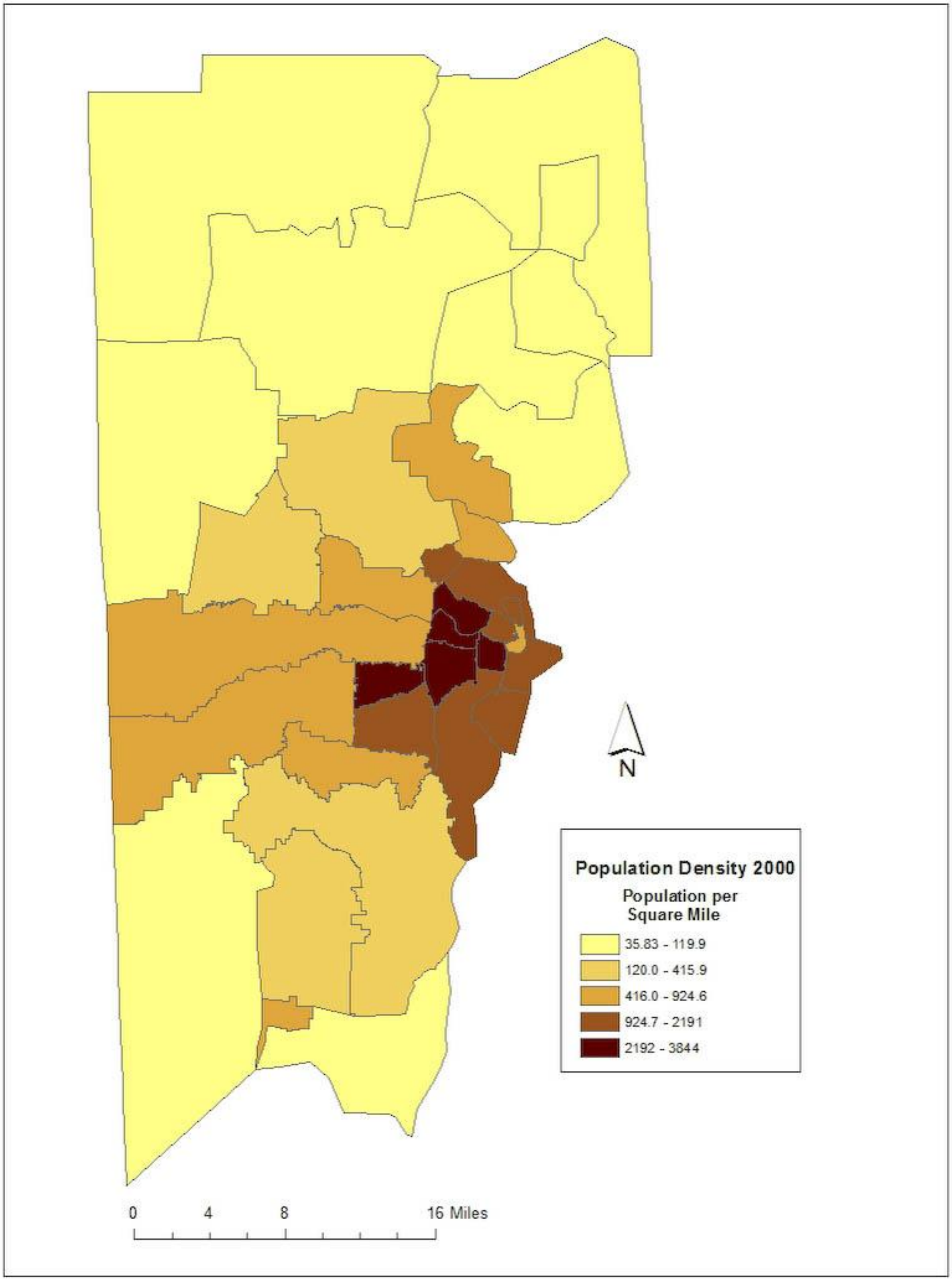


Figure 3.6 Population density by ZCTA. Map by author. Data source: US Census Bureau (2001).

Housing in Mobile County

Housing plays a critical role in this study due to the fact that it is a significant part of the built environment. Research focusing on a single aspect of the built environment and its relationship to health has often considered varying characteristics of housing. Housing characteristics are used to identify likely causes of poor health from the perspective of the built environment. Though this research will consider various components of the built environment and its relationship to health, housing is a critical part of the analysis.

One of the critiques of health research is the inability to account for migration to and from the given study area (Boyle 2004; Connolly, O'Reilly, and Rosato 2007; van Lenthe, Martikainen, and Mackenbach 2007). Though this is likely to have an impact on results, one approach to potentially lessen the criticism would be to focus research on the health of a place rather than putting so much emphasis on individuals within that place. Studying the health of a place, and monitoring that place over time, is a major argument in this research. It is recognized, however, that individual characteristics within a place can provide insight to understanding why poor health occurs in one place and not in another.

One way to gain insight into migration within a county is to analyze residential stability over a given time period. The census can assist with this because data is provided showing the percentage of the population still residing in the same house five years previous. Once again, it would be relevant to look at residential stability over a longer period, but the use of ZCTAs in this study only allows for information provided in 2000. The highest residential stability between 1995 and 2000 was found within rural ZCTAs of Mobile County and also in ZCTAs that exhibit higher pockets of poverty (US Census Bureau 2001). The least stability appears in ZCTAs classified as suburban and typically associated with rapid growth. One interesting case is ZCTA 36602. This ZCTA is associated with extreme poverty and wealth. Many of the old homes in this ZCTA are being purchased and renovated by wealthier citizens – a good example of gentrification where the median value of a home is $122,200.

According to a recent comprehensive housing market analysis for Mobile, the sales housing market and the rental housing market have softened in recent years. The sales market has declined as a result of slower job growth and tighter lending standards. The rental market appears to be a bit more balanced. The vacancy rate for rentals in Mobile is approximately eight percent (US Department of Housing and Urban Development 2009). Immediately following Hurricane Katrina, the rental market tightened significantly, causing an increase in rental property construction. Eventually, as construction increased and as Katrina victims returned to their homes in the coastal communities of Alabama and Mississippi, a significant amount of rental housing was left vacant (US Department of Housing and Urban Development 2009).

Figure 3.8 reveals the vacancy rates for all housing in each ZCTA of Mobile County. Vacancy rates are highest in the rural ZCTAs and in those associated with the urban core. Higher vacancy rates are also associated with ZCTAS that are primarily composed of lower income and minority populations. With the exception of one ZCTA, the lowest vacancy rates are associated with areas where the median value of owner-occupied housing exceeds $90,000. Another characteristic that stands out in regards to housing is the rental occupation ratio. The highest renter-occupied ratios are found in the urban core. One of the highest for renter occupied is ZCTA 36602 – the ZCTA that also boasts the highest median house value at $122,200 (US Census Bureau 2001).

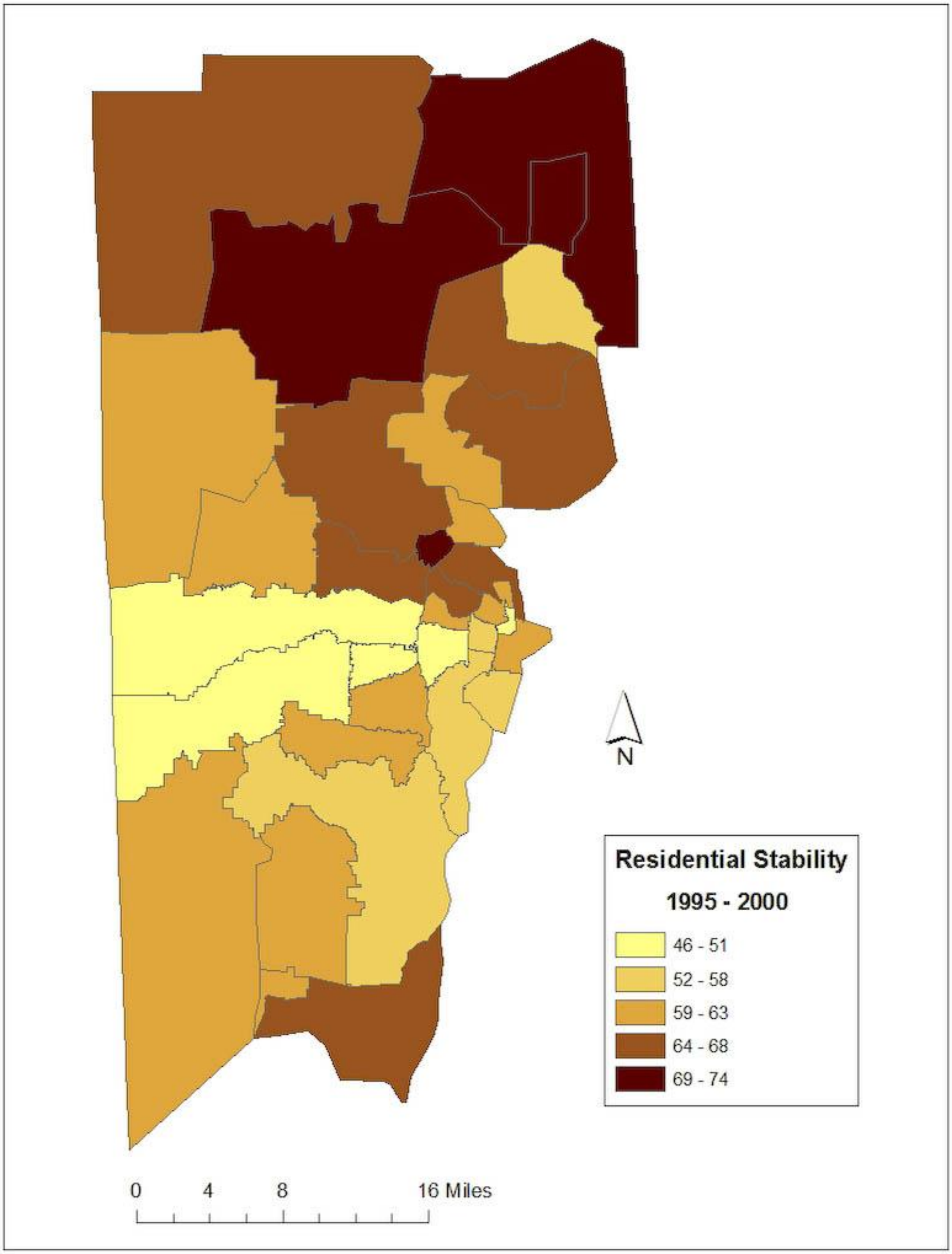


Figure 3.7 Residential stability in Mobile County. Map by author. Data source: US Census Bureau (2001).

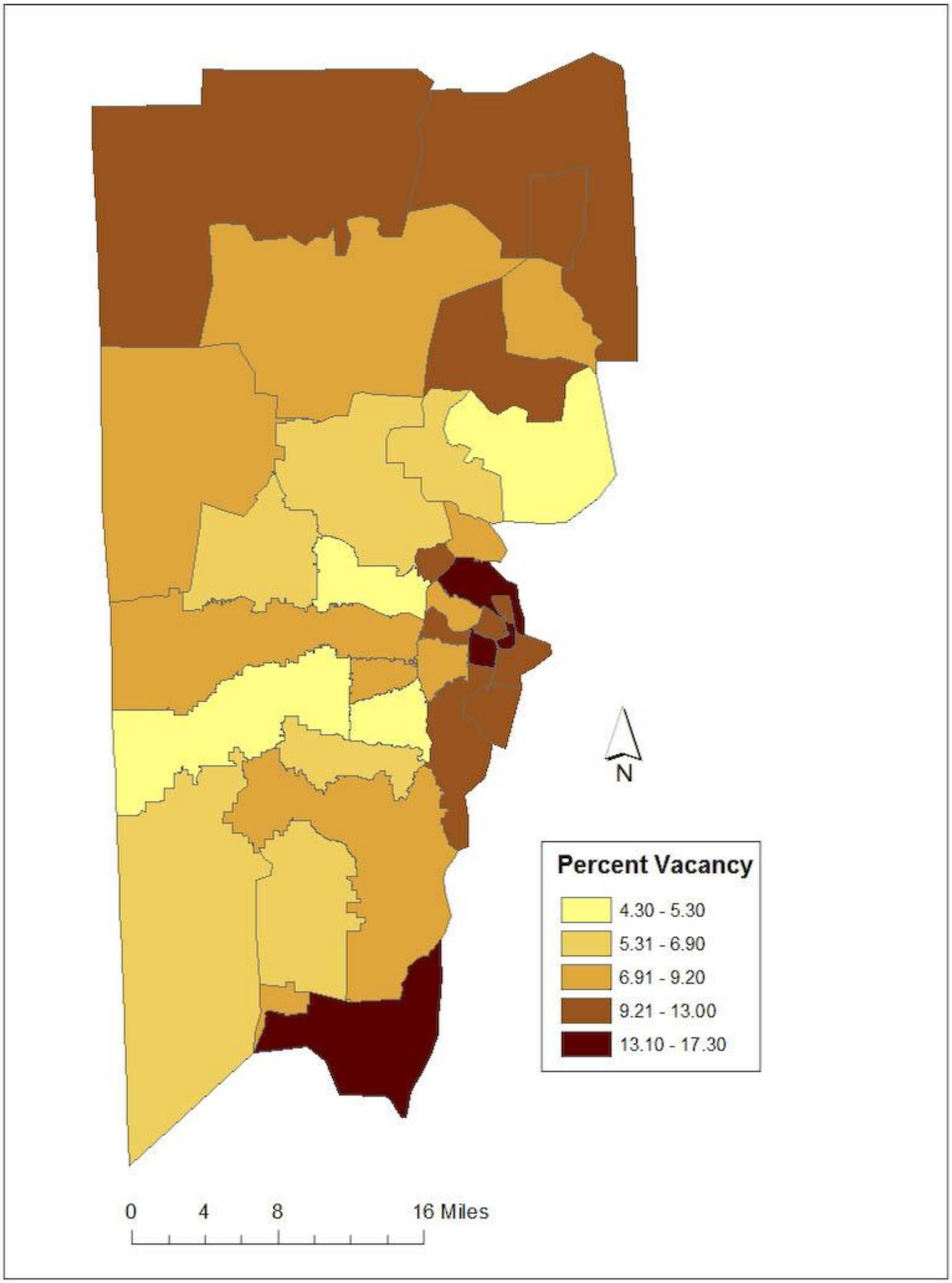


Figure 3.8 Housing vacancy rates in Mobile County. Map by author. Data source: US Census Bureau (2001).

Housing density for each ZCTA in the county is shown in Figure 3.9. In this study, population density and housing density are key factors of environmental risk. It is not surprising that the greatest housing density is associated with the urban core. Moderate density is associated with most of the ZCTAs in the suburban region. As one would expect, the rural ZCTAs exhibit the lowest housing density (US Census Bureau 2001). Socioeconomic and housing characteristics play a major role in this dissertation, as independent variables explored for significance in defining the population health of Mobile County. Through data collected for this research and mortality data from the Alabama Department of Public Health, significant variables are identified and used to develop a health inequity index.

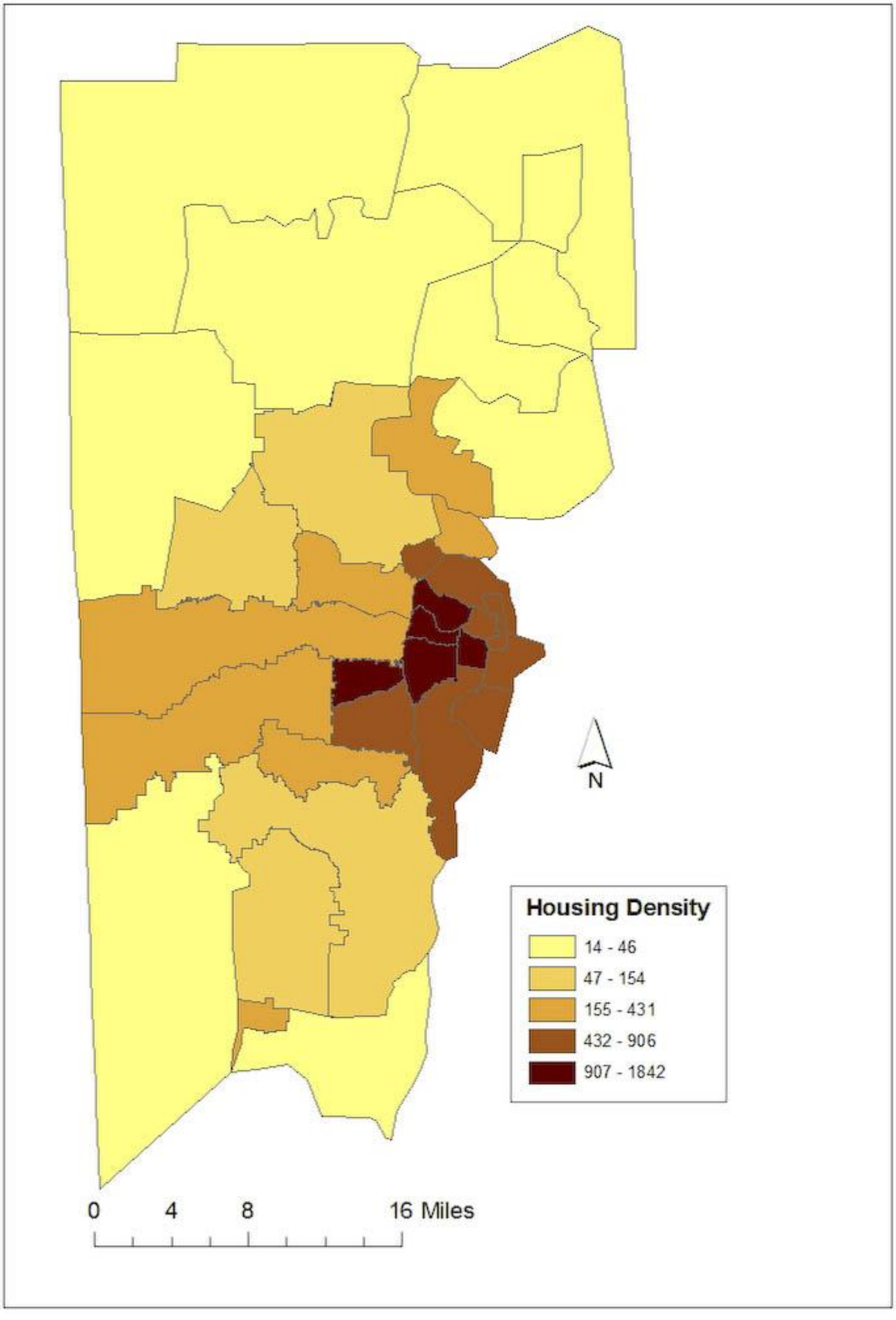


Figure 3.9 Housing density in Mobile County. Map by author. Data source: US Census Bureau (2001).

Mortality in Mobile County

Data for mortality in Mobile County is tabulated by the Center for Health Statistics of the Alabama Department of Health. For this research, data for the top ten causes of death in each ZCTA in the county for the period 1997 – 2007 were requested. The 2000 dataset provided the information necessary to identify the determinants of health in Mobile County. In this section, a brief overview of mortality in the county is presented.

Figure 3.10 shows the leading causes of death in the county for 2000. An examination of data from 1997 to 2007, inclusive, reveals minimal changes in the top causes of death during the period. Alzheimer's enters the fold in 1999 and is present through 2007. For the purposes of this study, however, heart disease, cancer, stroke, respiratory illness, diabetes, and influenza were used to calculate the crude death rate due to health factors (Accidental deaths, e.g., were not included). Other causes of mortality in 2000 are identified, but are not significant in number of cases and will not add to the issues addressed in this dissertation.

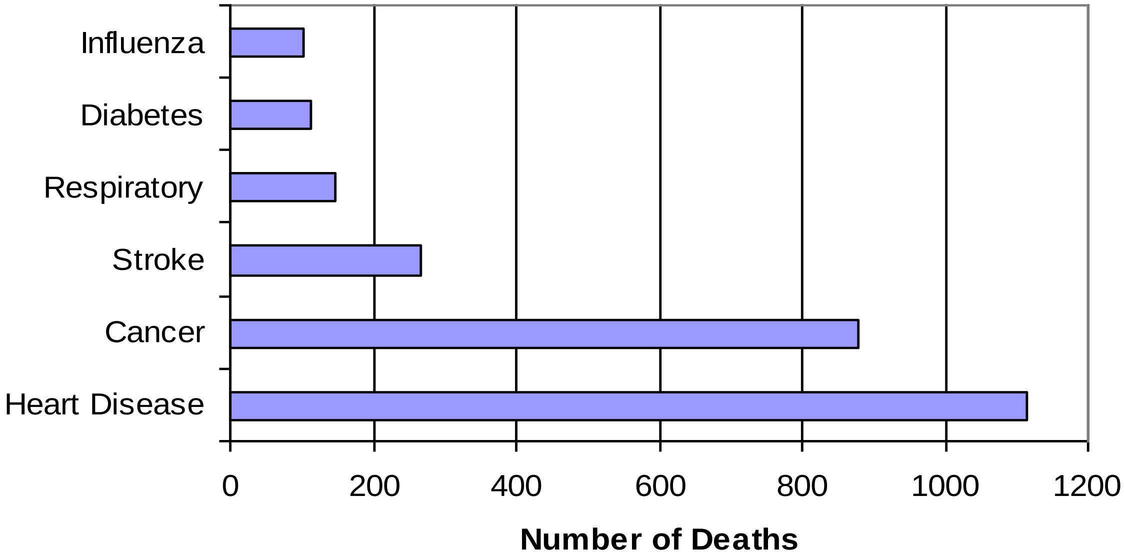
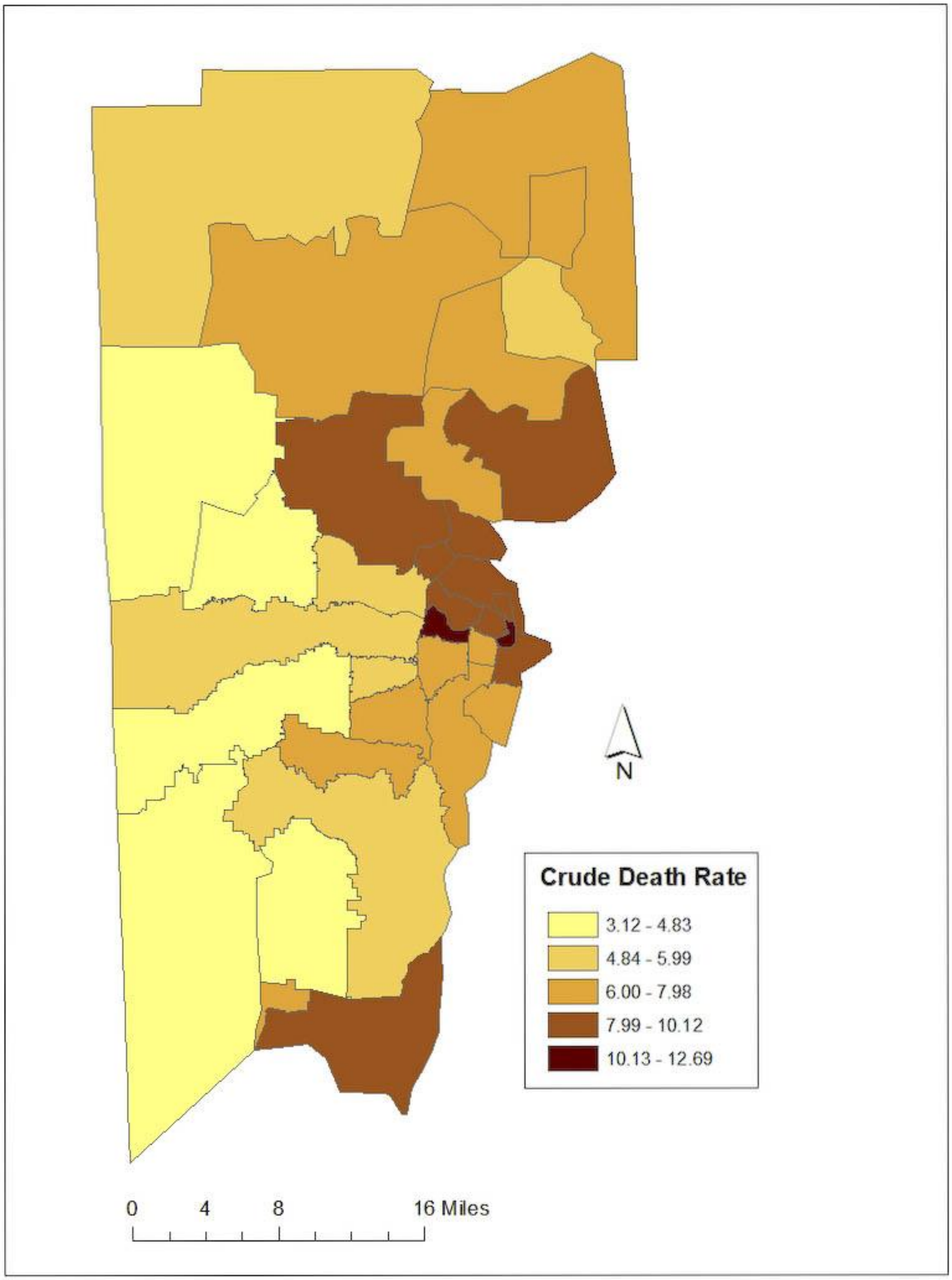


Figure 3.10 Leading causes of death in 2000. Data source: Alabama Department of Public Health (2000).

Figure 3.11 shows the crude death rate by ZCTA for Mobile County in 2000. Crude death rate is highest in the urban core and in rural areas to the north and south. These are ZCTAs that are associated with lower income and minority populations. One ZCTA, 36608, stretches from the urban core west to the Mississippi border. Though the western part of this ZCTA is very suburban with many new subdivisions, the eastern portion is more densely populated, contains older housing, and has a more diverse population. Adjacent to ZCTA 36608, and also stretching to the Mississippi border, is ZCTA 36695. This ZCTA has grown in recent years, attracting middle- and upper-class individuals from zones closer to the urban core. Socioeconomic characteristics in this ZCTA are typically highest in the county and the crude death rate is one of the lowest.

The two leading causes of death in Mobile County in 2000 were cancer and heart disease. In order to examine the spatial distribution of cancer and heart disease, the cause-specific death rates for both were calculated and mapped (Figure 3.12 and Figure 3.13). The highest cause-specific death rates for cancer are associated with the urban core and three northern rural ZCTAs. One of these ZCTAs, 36560, has the greatest number of county facilities on the Toxic Release Inventory (TRI).

Figure 3.11 Crude death rate for major causes of death in 2000. Map by author. Data source: Alabama Department of Public Health (2000).



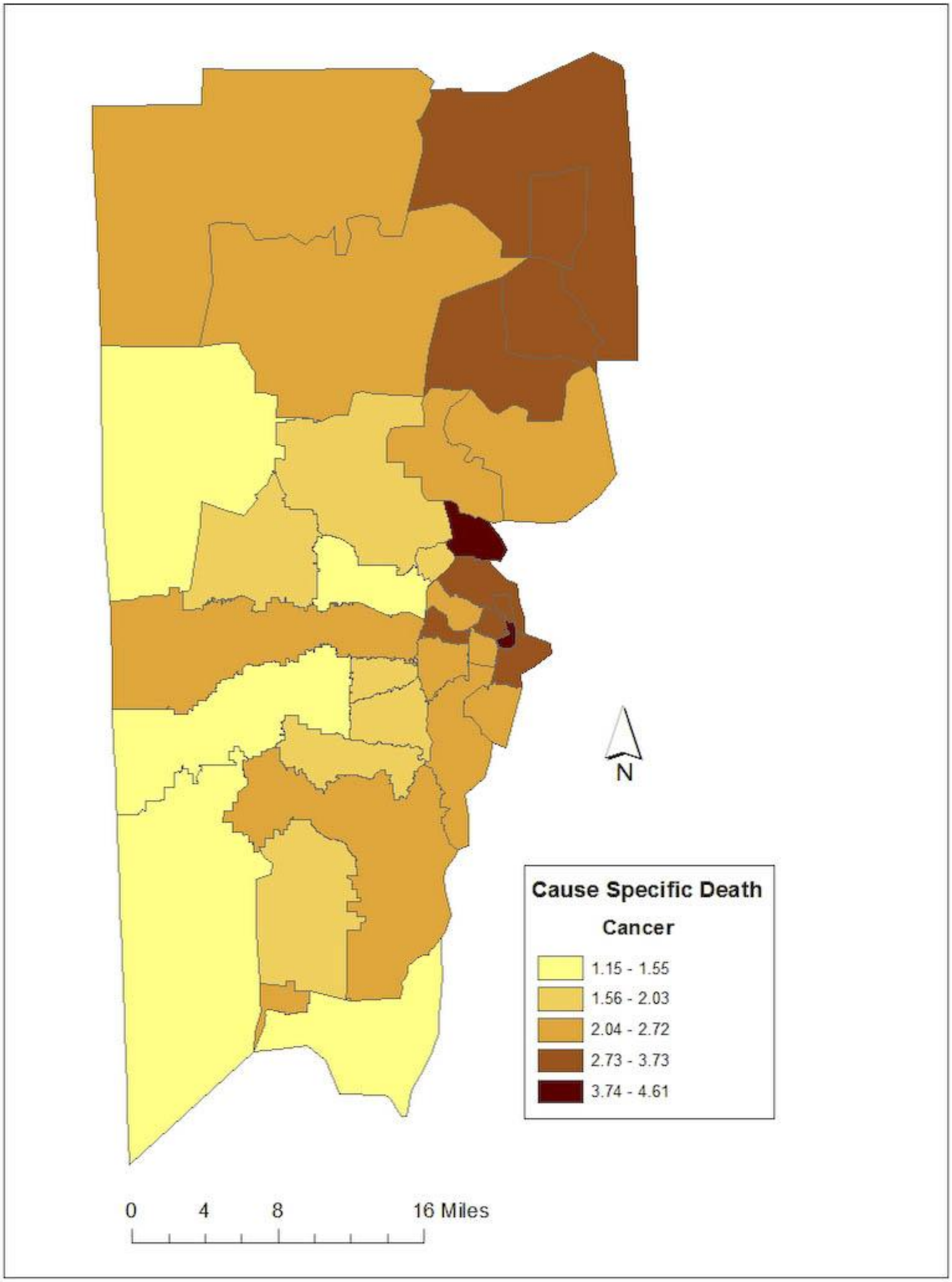


Figure 3.12 Cause-specific death rate for cancer in 2000. Map by author. Data source: Alabama Department of Public Health (2000).

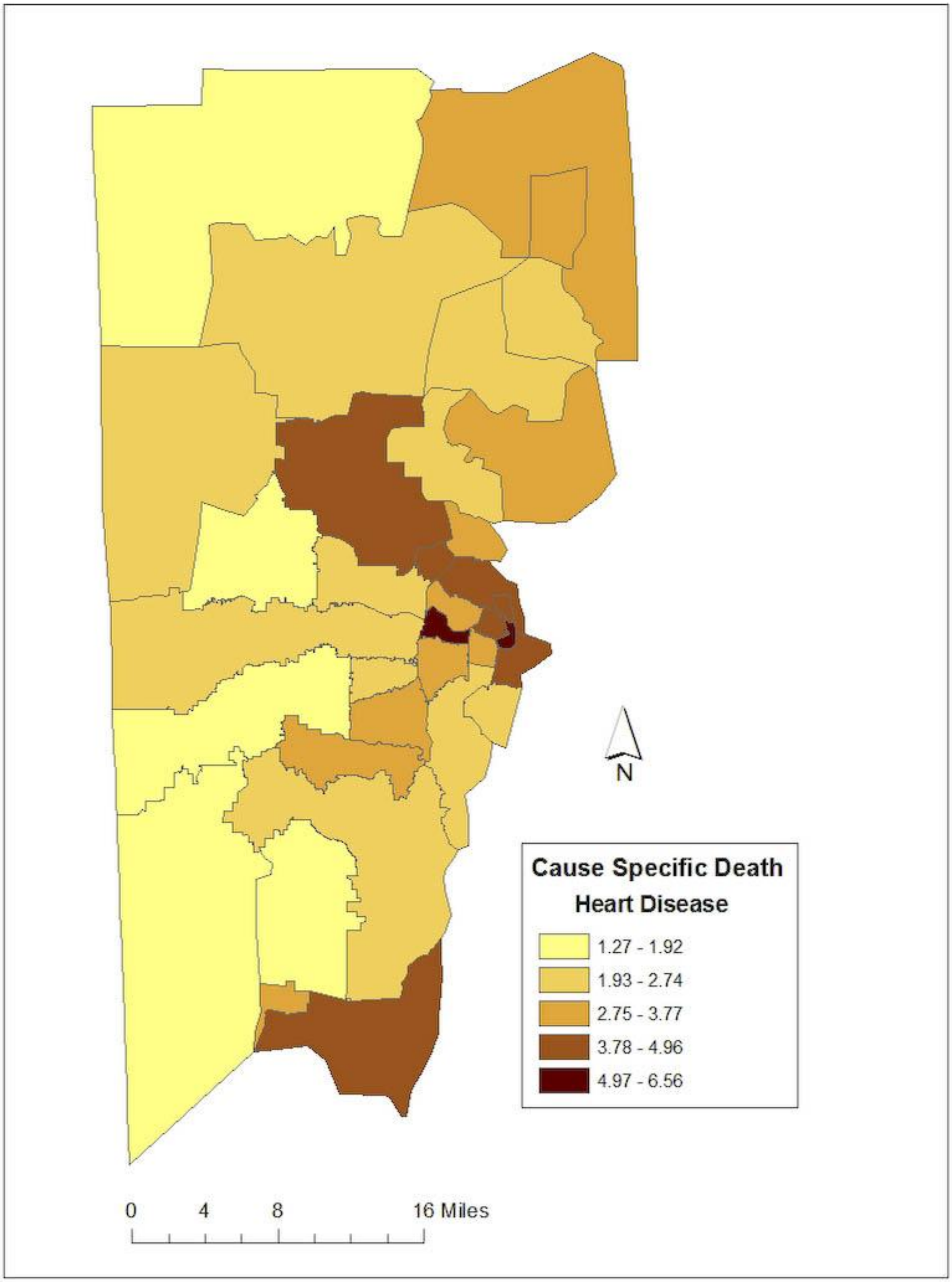


Figure 3.13 Cause-specific death rate for heart disease in 2000. Map by author. Data source: Alabama Department of Public Health (2000).

3.3 Regions of the County

The county was divided into three regions for the purposes of this dissertation: rural, suburban, and urban (Figure 3.14). Zip code tabulation area populations are identified by the US Census Bureau as rural or urban. The population information, combined with my knowledge of the county, provided the basis for designating the ZCTAS as rural, suburban, or urban. The urban core consists of the CBD and high density land use ZCTAs surrounding it. They are classified as such by the US Census Bureau (Table 3.6). The suburban ZCTAs contain numerous subdivisions and do consist of populations classified by the US Census as rural and urban. The ZCTAs classified as urban, however, are those where the population is identified as primarily urban. Suburban ZCTAs were incorporated with the urban ZCTAs when the comparison was made between rural and urban health. The ZCTAs designated as rural have substantially lower populations away from the urban core and were classified by the US Census Bureau as such (US Census Bureau 2001).

Table 3.6 Regions of Mobile County by ZCTA.

Regions of the County	Zip Codes			
Urban	36602	36603	36604	36605
	36606	36607	36610	36611
	36612	36617		
Suburban	36509	36544	36571	36572
	36575	36582	36608	36609
	36613	36618	36619	36693
	36695			
Rural	36505	36521	36522	36523
	36525	36541	36560	36587

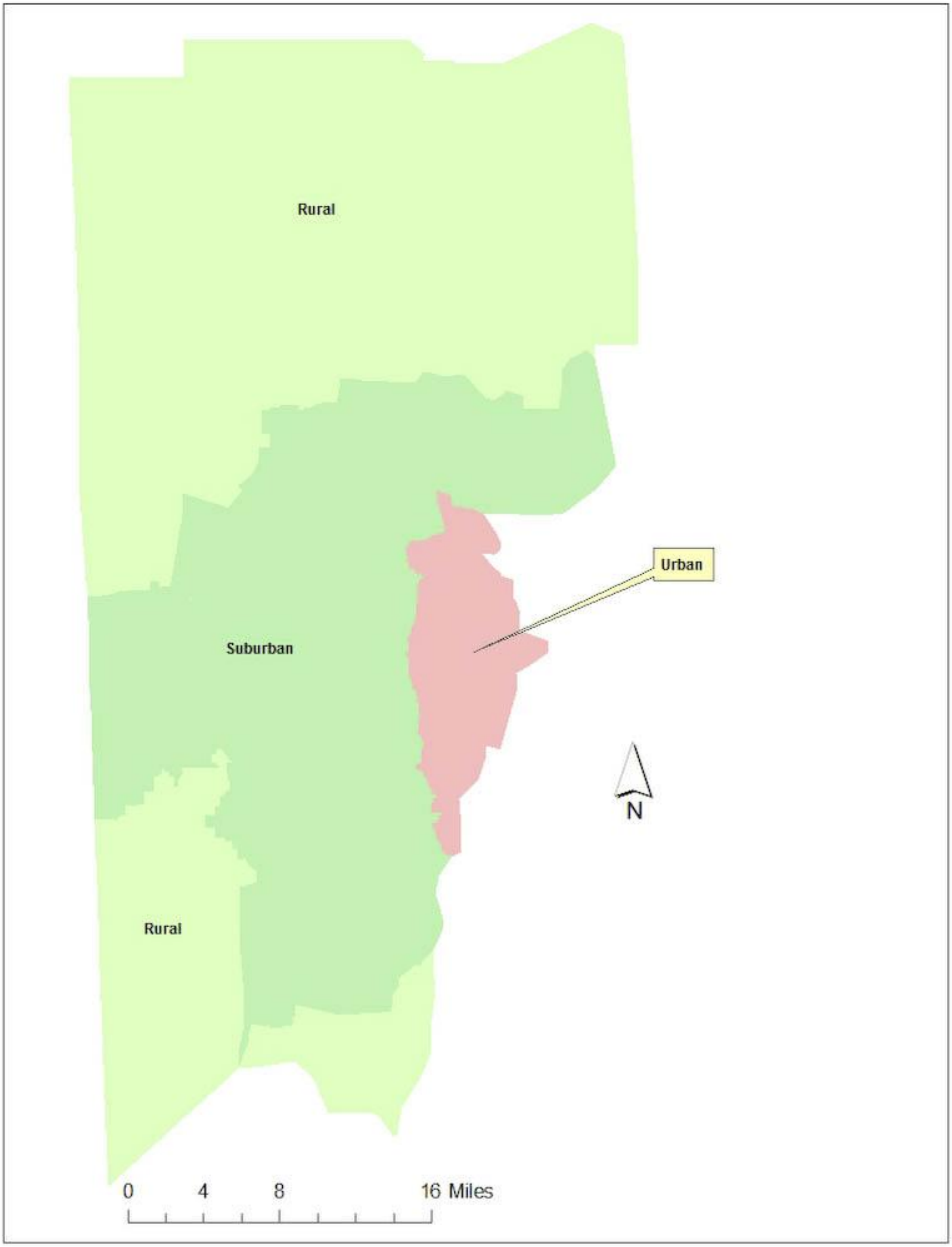


Figure 3.14 Regions of Mobile County. Map by author.

The rural region to the north is home to many of the chemical facilities in the county, a large steam plant, and a steel production facility. In the south, parts of the rural region are adjacent to the ZCTA that contains the Theodore Industrial Canal where a number of chemical facilities are also located. Rural ZCTAs account for approximately 11 percent of the total county population. The African-American population varies in the rural region from a high of 46.6 percent in ZCTA 36560 to 4.3 percent in 36587. The average median income for the rural area is $35,054 and approximately 15 percent of the population falls below poverty. The number of individuals not completing high school is somewhat high in the region as all ZCTAs are close to or over 30 percent (US Census Bureau 2001).

The urban core consists of approximately 33 percent of the county's population. Poverty, as expected, is highest in this region. Below poverty levels range from 46.5 percent in ZCTA 36610 to 16.1 percent in 36611 and the average median income for the urban core is $21, 633. The county's African-American population is concentrated in this region with ZCTAs 36603, 36610, and 36617 close to 100 percent African-American. High school graduation rates for persons over 25 are similar to those in rural areas with the exception of two ZCTAs, 36603 and 36610, where the rate exceeds 40 percent (US Census Bureau 2001).

Over 50 percent of the population resides in ZCTAs classified as suburban. The two largest suburban ZCTAs by population are also those that have seen strong growth in recent years – 36608 and 36695. The African-American population is much lower in the suburban region, but higher clusters (around 30 percent) occur in ZCTAs near the urban core. The median income in this region is $39,768 and poverty levels are substantially lower. The highest levels of poverty occur in ZCTAs that exhibit some rural characteristics (United States Census Bureau 2001).

There is a great deal of variation in the socioeconomic characteristics within each ZCTA. It should also be noted that there are many rundown neighborhoods adjacent to others that are well maintained. This creates a limitation to this study because data for each ZCTA does not provide a true picture of the intra-ZCTA variation. In order to examine neighborhoods thoroughly, it would likely be more useful to look at socioeconomic characteristics and the built environment at the block level. Health data in Mobile County, however, is collected at the zip code level and for the purposes of this study, socioeconomic characteristics at that level were also used. Through the use of a survey, an attempt was made to gain a better understanding of intra-ZCTA variation, particularly variation in the built environment. The built environment plays a major role in this research and, for that reason, is covered in detail in the next chapter.

CHAPTER 4 - The Built Environment and Environmental Justice

Good examples of underlying causes of inequality that are avoidable include unsafe and unhealthy working and living environments (Carter-Pokras 2002). The major focus of this dissertation is the built environment, its impact on population health, and the potential of the environmental justice movement to enhance awareness of health inequality in relation to the built environment. For this reason, this section is devoted to discussion on the built environment, ideas about how the built environment can be measured, research on the built environment and health, and the environmental justice movement.

Sallis and Glanz (2006) defined the built environment as consisting "…of the neighborhoods, roads, buildings, food sources, and recreational facilities in which people live, work, are educated, eat, and play" (p. 89). Another perspective on the built environment is provided by Weich et al. (2001). They note that "…the built environment includes many characteristics of places that cannot be reduced to the characteristics of the people who live there, such as housing form, roads and footpaths, transport networks, shops, markets, parks and other public amenities, and the disposition of public space" (p. 284).

Assessing relationships between the built environment and health is highly challenging. The built environment can impact the lives of individuals in many ways, including the effects of traffic, noise, and air pollution. It can also influence the 'social capital' of an area and the sense of community (Weich et al. 2001). There is a limited amount of research on how to measure the built environment in regards to health. In the following section, studies relevant to this research are presented.

4.1 Measuring the Built Environment

Articles discussing how researchers might want to design studies on the built environment and health are rather limited. It is an issue that has resurfaced in recent years, particularly in the fields of planning and environmental health (Perdue et al. 2003; Blake 2008; Blake 2008a; Heishman and Dannenberg 2008). The conditions in which people lived were at one time a major concern of planners, environmental and public health professionals, civil engineers, and urban geographers (Corburn 2004). Eventually, as communities were assumed to be healthier in places like the UK and the U.S., many in the field felt it was no longer necessary to focus on health and the built environment. Instead, researchers began to pursue studies on the growth and development of urban areas. Within the past decade, urban planners and environmental health professionals have made a concerted effort to once again make the public aware of the importance of healthy communities.

Weich et al. (2001) have produced the only available article on measuring the built environment. They note that there are limited reliable measures of place with which to study the effects of socioeconomic variables on health. Their study on measuring the built environment was conducted prior to an examination of the effects of an urban renewal program on the mental health of local residents in north London. The renewal program was initiated to improve the quality of the built environment. Weich et al. (2001) hypothesized that improvements in the built environment would cause a decrease in the incidence of depression.

The respondents were chosen using random probability sampling methods. Once the respondents were chosen, no substitutions were allowed. The two study wards were sub-divided into housing units. The housing units were defined through observation by one of the authors and areas were designated based on similar form and character of structures. In order to evaluate the built environment, Weich et al. (2001) created a built environment site survey checklist (BESSC). It contained a number of items to be rated, including housing form, height, and age; the number of dwellings and type of access; gardens and public space; the number of dilapidated structures; security; and accessibility to a number of services.

Respondents were asked to rate their satisfaction with the place in which they lived and the results were assessed using kappa and kappa weighted statistics. This is the most widely used measure of inter-rater reliability and allows one to notice the difference between the level of agreement of two raters and that expected by chance. The authors did find evidence of statistically significant associations between five measures of the built environment and occurrence of depression. Cases of depression were more likely to be where the individual was living in housing on newer properties with deck access but fewer gardens. They were also likely to share recreational spaces and patches of graffiti were common in their neighborhoods.

The authors note that their approach may be criticized for not incorporating the residents' views about the boundaries of their neighborhoods. They also state, however, that relationships were found between researcher-defined neighborhoods and residents' satisfaction with their housing areas. A major limitation to their study is the applicability of the survey to other urban areas, and to suburban and rural settings as well. The authors recommended for further research to validate the measure for other urban areas.

From more of a policy perspective, Douglas et al. (2001) present the idea of health impact assessment (HIA). The idea behind HIA is to predict health impacts so recommendations can be made to advance policy, and ultimately, to improve health. In order to work on the development of the HIA, the authors conducted two case studies. The first case study compared three scenarios for the future development of the transportation network in Edinburgh. Using different grids, they were able to determine the impacts of the network on different population groups. In the second case study, they assessed the health impacts of investment in housing in disadvantaged areas of Edinburgh.

In their HIA of the urban transport strategy, the authors found that the scenario with the most funding would produce the greatest health gain. They also noted that the lower funding scenario would have effects on health, particularly those classified in the most disadvantaged groups. In the second case study, a number of physical and mental health impacts were identified. The housing strategy had the greatest impact on mental health, specifically stress and depression. Redevelopment also created greater self-esteem among residents. Like Weich et al. (2001), the authors concluded that there is no single blueprint for HIA and different approaches and methods will be required for different situations.

In this dissertation, the goal is to begin the process of determining aspects of the built environment that are most relevant to poor health. Though an extensive amount of research has been conducted on the built environment and health, a great deal focuses on just one aspect of the built environment. In the next section, a number of studies are presented to show the diversity of work that has been accomplished. Many researchers concerned with the built environment and health are now acknowledging that future studies need to consider multiple aspects (Srinivasan, O’Fallon and Dearry 2003; Dearry 2004). In order to influence future policy and promote better health, those aspects of the built environment that are detrimental to a person’s well-being must be identified.

4.2 Research on the Built Environment and Health

Hood (2005) noted that scientific evidence has proven that aspects of the built environment have measurable effects on both physical and mental health. Spatial analysis is now one of the tools being applied to determine the relationship between the built environment and health. One tool in particular, GIS, allows researchers to look at community resources such as parks, fast food restaurants, convenience stores and other factors that can have positive or negative impacts on health.

According to Hood (2005) and others (Easterlow, Smith, and Mallinson 2000; Krieger and Higgins 2002; Srinivasan, O'Fallon, and Dearry 2003), housing is likely to be the most significant issue when it comes to health and the built environment. Recent research has focused on housing (Allen 2000), resulting in intervention activity and attempting to find new methods to solve old problems. The literature on substandard housing and its relationship to poor physical and mental health is extensive (Wilkinson 1996; Dunn 2000). Most studies to date have relied on the cross-sectional approach. Research on the effects of housing on health has traditionally been concerned with tenure, individual homes, the effects of structural problems and residents' satisfaction (Weich et al. 2001).

Allen (2000) used in-depth narrative interviews conducted before and after renewal work on a local authority peripheral estate in the United Kingdom to determine if the elements of *renewal* affected resident's health positively or negatively. He found that most individuals looked at the renewal favorably from a physical health perspective, but were somewhat annoyed at not having any power in the decision-making process which appeared to cause some mental health issues. Previous to Allen's study, Halpern (1995) and Dalgard and Tambs (1997) looked into the effects of urban renewal on mental health. Both studies relied on residents' perceptions and both found that improvements in the built environment were associated with lower levels of anxiety and depression.

Howden-Chapman et al. (2007) performed a cluster randomized study in low-income communities in New Zealand where 1,350 homes were randomly allocated to an intervention group with free insulation or to a control group. Data were collected from 86 percent of the households through interviewer administered questionnaires and occupant self reports. Since insulation was associated with an increase in temperature and decreased relative humidity, self reported health improved significantly in those households that were insulated. This group was less likely to wheeze and did not take as many days off from school or work. Visitations to health practitioners and hospital admissions were not significantly reduced.

Sharfstein et al. (2001) surveyed families due to receive Section 8 vouchers at the Boston Housing Authority in the summer of 1999. They approached 158 eligible families, of which 74 participated. Participants reported that 44.8 percent of children had suffered health consequences as a result of housing conditions. The health consequences included emotional disorders and asthma.

Cohen et al. (2000) examined the relationships between neighborhood conditions and gonorrhea. They assessed 55 block groups by rating housing and street conditions and mapped all cases of gonorrhea between 1994 and 1996. The study resulted in the creation of a ‘broken windows index’ that measured housing quality, abandoned cars, graffiti, trash, and public school deterioration. Their results indicated that the broken windows index was associated more with the variance in gonorrhea rates than the poverty index, which measures income, unemployment, and low education.

As a follow-up to the research conducted in 2000, Cohen et al. (2003) investigated the relationship between boarded up housing and rates of gonorrhea and premature mortality. They conducted an ecological study of 107 U.S. cities and developed several models predicting rates of gonorrhea and premature death (before age 65). Race, poverty, education, population change, and health insurance were controlled. Boarded up housing remained a predictor of gonorrhea rates and premature mortality (from numerous causes) after control for socioeconomic variables. The authors concluded that neighborhood physical conditions require further consideration as potential factors influencing health and well-being.

Marsh et al. (2000) attempted to create a housing deprivation index that included variables strongly associated with ill health. They concluded that housing deprivation emerged as a significant explanatory variable in affecting health even when controlled for other factors such as social, economic, standard of living and behavioral. They did note, however, that their index would be more reliable if data on housing circumstances and conditions in Britain at the end of the 1990s were incorporated into the longitudinal study.

Thomson, Petticrew, and Morrison (2001) completed a systematic review of intervention studies in housing. Many of the studies were of poor quality, but they did note that improvements as the result of housing intervention have been reported in physical and mental health. Other significant improvements were reductions in the use of health services, increased neighborly contact, and less fear of crime. However, they contend that the small sample sizes used in a number of studies may overestimate the effects of housing improvements.

In a similar article, Saegart et al. (2003) sought to evaluate successful public health interventions related to housing. They used content analysis on 72 articles on U.S. interventions from 1990 through 2001. Ninety-two percent of the studies focused on one factor (e.g., lead poisoning or asthma) and over half targeted children. Most interventions consisted of a single action to improve the environment or to change behavior or attitude. Though most studies indicated significant improvements, only a few were viewed as extremely successful.

Studies looking at the associations of the effects of the wider environment outside the home are rather limited, but research in this direction appears to be on the increase. A study often cited as significant from this perspective was conducted by Kearns et al. (2000). The authors distributed a random postal survey in eight local authority districts in West Central Scotland to measure psycho-social benefits of the home. Through multivariate analysis, they concluded that housing tenure is less important to psycho-social benefits from the home than the neighborhood context and the incidence of problems with the home.

A recent trend of research on the built environment and health focuses on the concentration of food markets and convenience stores in specific neighborhoods. Horowitz et al. (2004) compared the availability and cost of diabetes healthy foods in a minority neighborhood in East Harlem with those in an adjacent largely white neighborhood in the Upper East Side. They concluded that East Harlem does not have a shortage of food markets, but the neighborhood did have fewer large stores and a smaller number of stores carrying food items for diabetes.

Morland, Wing, and Diez Roux (2002) studied the association between the local food environment and residents' recommended dietary intake. They used participants from the Atherosclerosis Risk in Communities program and analyzed a semi-quantitative food frequency questionnaire administered from 1993 through 1995. Through the research, it was determined that African-Americans' fruit and vegetable intake increased 32 percent for each additional grocery store in a census tract. They concluded that their findings suggest that the local environment is associated with diet.

Gordon-Larsen et al. (2006) sought to assess the geographic and social distribution of physical activity (PA) facilities. They determined how disparity in access might underlie population physical activity and overweight patterns. Residential locations of US adolescents in the National Longitudinal Study of Adolescent Health (1994-1995) were geocoded and an 8.05 kilometer buffer was placed around each residence. Logistic regression analyses were used to test the relationship of PA-related facilities with block-group socio-economic status and the association of facilities with overweight and PA at the individual level.

The research indicated that higher-SES block groups had significantly greater odds of having one or more facilities and low-SES and high-minority block groups were less likely to have facilities. As a result, lower-SES and higher minority block groups had less access to facilities which was associated with decreased PA and increased problems with weight. Though their results were not conclusive, the authors contend that inequality in the availability of PA facilities likely contributes to ethnic and SES disparities in PA patterns, and ultimately, problems with weight.

Many of the results of the above studies indicate that the built environment does indeed impact health. However, it is also evident that much of the research today centers on one element of the built environment and how that specific characteristic affects health. It is important to continue research on the built environment and determine the factors within communities that are the most significant in creating health problems. Therefore, future studies on the health of communities needs to be all encompassing. The built environment, environmental risk, and socioeconomic variables need to be evaluated in specific places to determine what approach will work best in creating a healthy environment. The environmental justice movement has the potential to assist communities and influence policy decisions that will improve the environments in which people live.

4.3 The Environmental Justice Movement

The environmental justice movement arose out of the concept of "environmental racism" which can be defined as "…racial discrimination in environmental policymaking and the unequal enforcement of environmental laws and regulations…" (Hines 2001, 779). The general assumption regarding environmental racism is that it is associated with the proliferation of hazardous facilities in minority neighborhoods (Meyer 1992; Mitchell 1993). Meyer (1992) suggests, however, that the definition should also include the indifference of mainstream environmental groups to the issue because "their agendas ignored the life-and-death environmental issues that only infrequently afflicted the white middle class" (p. 30).

Studies on environmental racism assert that the main factor that determines the extent to which an individual will be negatively affected by their environment is race (Colquette and Robertson 1992; Mohai and Bryant 1992; Hines 2001). As early as 1971, a study conducted by the U.S. Council on Environmental Quality recognized that exposure to environmental pollutants was not distributed equally. African-American and other minority communities have experienced disproportionately high levels of environmental risk (Ringquist 2000; Mohai and Bryant 1992; Hines 2001). In fact, Mohai and Bryant (1992) found that the proportion of minorities in communities that have a commercial hazardous waste facility is about double that in communities without facilities.

Though there was evidence of environmental racism as early as 1971, it took a major incident to spark national interest in the inequity of hazardous waste facility siting. In North

Carolina in 1982, outlaw dumpers deposited carcinogenic polychlorinated biphenyls (PCBs) along state roads. The state scraped up some 32,000 cubic yards of contaminated soil and needed to find a place to bury it. The state decided on Afton, North Carolina – a small town in Warren County consisting of a population that was more that 84 percent African-American (Meyer 1992; Mohai and Bryant 1992; Colquette and Robertson 1994; Ringquist 2000). The decision to locate this highly dangerous PCB landfill in Warren County ignited protest from local residents and civil rights and political leaders who supported the community in its opposition to the construction of the landfill (Colquette and Robertson 1994; Cole and Foster 2001).

The community failed in its attempt to persuade the state to reverse its decision, but it sparked a series of studies that would bring the issue of environmental racism into the national spotlight. As a result of the North Carolina incident, Congressional Delegate Fauntroy requested that the Government Accountability Office (GAO) determine the correlation between the location of hazardous waste landfills and the racial and economic status of the surrounding communities (Colquette and Robertson 1994; Anderton et al. 1994; Been 1994). The 1983 report found that three of the four largest hazardous waste sites in the southeastern United States were located in predominantly black areas (Bullard 1992; Coughlin 1996).

On the heels of the 1983 GAO study, Robert Bullard investigated the siting of hazardous waste facilities in the city of Houston, Texas. Bullard determined that twenty-one of the twenty-five incinerators and landfills in Houston were predominantly located in African-American neighborhoods (Been 1994; Szasz and Meuser 1997). There have been many criticisms of the Bullard study because of the areal unit used and because many of the twenty-five incinerators and landfills were placed in the city back in the 1920s; many of these facilities are no longer in operation (Been 1994). Bullard used “neighborhoods” and not well-defined boundaries in his analysis. The importance of areal unit has now become a major issue, with many suggesting that the ideal unit for studies in environmental inequity may be found at the census tract level (Been 1994; Sheeley 1997).

In an attempt to look at more defined areas to determine the siting of hazardous waste facilities, the United Church of Christ commissioned a study in 1987 that compared zip codes that had no hazardous facilities to those that did (Szasz and Meuser 1997). The study concluded that race was a primary factor in the location of hazardous facilities and it also contended that uncontrolled toxic waste sites were much more likely to be found in African-American and Hispanic neighborhoods (Colquette and Robertson 1992; Szasz and Meuser 1997). The same report revealed that 50 percent of all Americans live in communities with uncontrolled hazardous waste sites (Mitchell 1993). It was concluded that the probability of these results occurring purely by chance was less than one in 10,000 (Colquette and Robertson 1994).

With mounting evidence that race was the most significant factor differentiating communities with hazardous facilities from those without, a group of academics convened at the University of Michigan for a conference on *Race and the Incidence of Environmental Hazards* (Mohai and Bryant 1992a; Coughlin 1996; Szasz and Meuser 1997; Cole and Foster 2001). The significance of this meeting was not necessarily viewed in terms of the papers presented and discussions that ensued. It was, however, important in a social context because nine of the twelve scholarly papers presented at the conference were given by people of color (Mohai and Bryant 1992a). This was the first time that a conference on race and the incidence of environmental hazards was held where a majority of the participants were people of color (Mohai and Bryant 1992a). As a result of the conference, the Environmental Protection Agency's (EPA) Administrator, William K. Reilly, stated in a speech at the National Minority

Career Conference that the "…review pointed out significantly disproportionate health impacts on minorities due to higher rates of exposure to pollution" (Mohai and Bryant 1992a, 10).

According to Mohai and Bryant (1992a), this was the first public recognition by the EPA that environmental hazards disproportionately impact people of color and it was also the first time an "Administrator had agreed to meet with any group made up primarily of people of color to discuss environmental equity issues" (p. 10). In response to the Michigan Conference, the EPA initiated a study to review and evaluate the evidence that racial minorities and low income persons bear a disproportionate burden of environmental risk (Coughlin 1996). In 1992, in a report entitled *Environmental Equity: Reducing Risk for All Communities*, the EPA acknowledged that African-Americans and Hispanics were more likely to live in urban areas that did not meet federal air quality standards and that commercial hazardous waste facilities were more likely to be located in African-American communities (Coughlin 1996).

As the idea of environmental racism spread into the mainstream and people realized the potential impacts of toxic hazardous release, they began to fight the placement of treatment, storage, and disposal facilities (TSDFs) in their communities. Though the road has been tough, some communities have been able to stave off the powerful corporations that are looking for the cheapest possible land to maximize profit without concern for the health of those who live adjacent to their facilities. "A central purpose of the Equal Protection Clause of the Fourteenth Amendment is to prevent official conduct that discriminates on the basis of race" (Colquette and Robertson 1994, 199). Though it is realized that a large portion of the TSDF burden has been placed on the shoulders of African-Americans, it is difficult to prove discrimination based on race in the placement of hazardous facilities. "In showing discriminatory intent, a person must establish a clear pattern, unexplainable on grounds other than race" (Colquette and Robertson

1994, 199). In an era when corporations have unlimited power, the time is ripe for an invasion of TSDFs into low income and minority neighborhoods – it is now up to grassroots activists and mainstream environmentalists to come together in the all-encompassing quest for environmental equity.

The concept of environmental racism has resulted in the desire for many to seek environmental equity. Environmental equity is defined as "the extent to which the physical and economic burdens of pollution are evenly distributed across society" (Pollock and Vittas 1995, 294). The idea of "out of sight and out of mind" in terms of hazardous waste has left an irreparable scar on many communities. The consensus among those fighting for environmental justice is that it is now time for society as a whole to equally shoulder the burden of hazardous toxic release.

Colquette and Robinson (1994) acknowledge that hazardous waste disposal facilities are a necessity to protect both human health and the environment. However, they also note that the burden of housing hazardous waste facilities is not equally shared (Colquette and Robertson 1994). "Pollution, poverty, and worker insecurity reflect three different ways that American corporations express themselves as they exploit people and resources for maximum profits" (Austin and Schill 1991, 73). This is all the more evident when it comes to facilities that emit hazardous toxic release. Like a broken record, politicians tend to argue that these facilities benefit the community by generating tax revenues and increasing employment (Colquette and Robertson 1994). Though elected officials have the power to block the placement of hazardous facilities in their districts, the real power for issues of environmental justice will largely have to evolve out of grassroots activism.

It was through grassroots organizations opposing TSDFs that the environmental justice movement blossomed. This movement, like that of civil rights, brought together people of diverse backgrounds to fight against inequity. These groups, however, rarely have the financial resources to mount productive opposition to corporate polluters. Implementing strategies to fight the powerful "...requires vast amounts of time, money, political influence, and access to a variety of resources, including meeting places, publications, public and private records, funding for technical assistance, and the ability to research possible health impacts" (Colquette and Robertson 1994, 168).

In essence, a powerful bond could be established between those in the environmental justice movement and those involved with health inequality. Grassroots environmental groups, particularly those dealing with toxic release issues, have begun to broaden their base to cover social justice – it is these issues of fairness and justice that could potentially build a solid coalition to fight environmental inequity, and ultimately, health inequality and inequity (Bullard and Wright 1990; Taylor 1992). As a result of the events that took place in the 1980s, the environmental justice movement came to the forefront in dealing with the spatial inequality of exposure to toxic substances, particularly in the context of minority and low income neighborhoods. The framework for social change that emerged included the following ideas:

1. incorporates the principle of the right of all individuals to be protected from environmental degradation,

2. adopts a public health model of prevention (elimination of the threat before harm occurs) as the preferred strategy,

3. shifts the burden of proof to polluters and dischargers who do harm or discriminate or who do not give equal protection to racial and ethnic minorities and other "protected" classes,

4. allows disparate impact and statistical weight, as opposed to “intent” to infer discrimination, and
5. redresses disproportionate risk burdens through targeted action and resources. (Brulle and Pellow 2006, p. 110)

Using the EBSCO Host on the library website at Wayne State College, “environmental justice” was typed in the search bar and journal articles that have appeared over the last fifteen years were listed. The goal of the analysis was to browse through the different topics covered with in an interest in those dealing specifically with health. Many of the articles discussed the theory, history, and politics associated with the environmental justice movement (Table 4.1). It was not surprising that the next two largest categories focused on exposure/risk and race. According to Jerrett et al. (2001), the focus of environmental justice research is the spatial inequality of exposure (as illustrated in Figure 4.1). There were a number of articles that were not specifically about health, but research dealing with exposure/risk often considered issues of health. While articles specifically about health were rather limited, it was not surprising to see research being conducted on environmental management, waste, and urban issues.

Brulle and Pellow (2006), note that environmental justice literature has produced many methodological advances in the context of race versus class. They contend, however, that research has missed the bigger picture - that the distribution of environmental harm affects all people and focusing on a single form of inequality without regards to others lessens the explanatory power of the approach. In this research, inequality in socioeconomic status, environmental risk, and the built environment in regards to health is evaluated. The following chapter details the methods used to determine the variables that influence health in Mobile County, Alabama.

Table 4.1 Keywords in environmental justice literature over the past fifteen years.

Keywords	**Total Number**
Theory, History and Politics	194
Economic	22
Social Deprivation	4
Race	63
Climate Change	15
Agriculture	15
Disabled Persons	1
Peace	4
Children	3
Tourism	1
Rural	1
Dams	2
Sports	1
Human Rights	11
Feminist/Gendered	20
Sustainability	23
Psychosocial	1
Health	25
Native American	18
Environmental Management/Waste	47
Exposure or Risk	86
Environmental Equity	11
Urban Issues	37
Outdoor Recreation	7
Livable Communities	3
Water	7
Energy	16

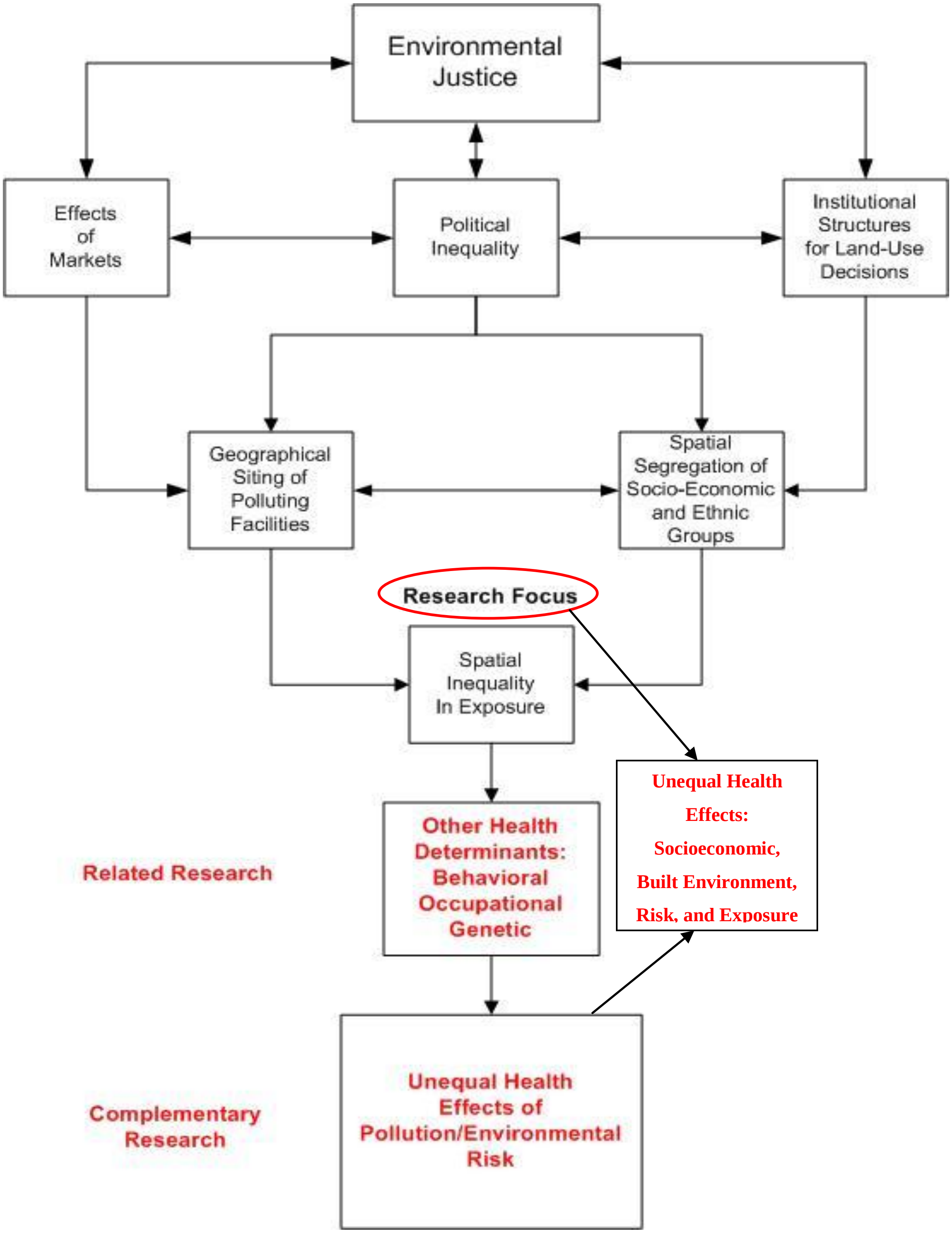


Figure 4.1 Theoretical model of environmental justice. After Jerrett et al. (2001, 957).

CHAPTER 5 - Multilevel Analysis Approach to Health Inequality

The underlying purpose of this research is to identify those determinants of health that impact residents in Mobile County to evaluate whether the environments in which people live are unfair and unjust, and to determine whether the environmental justice movement should focus its research agenda to concentrate on community health and the inequalities associated with it. Research on health inequality is constantly evolving and studies continually attempt to decipher the significant reasons for health inequality. Many different methods have been used to measure population health and some of those will be discussed in the first section of this chapter.

This chapter is devoted to discussing the choice of statistical methods used in the research, including a discussion of the dependent and independent variables. Though this analysis is substantially quantitative, it is difficult to truly understand the built environment and health issues within a neighborhood without firsthand knowledge. Familiarity with the area has been beneficial and allowed for the designation of regions within the county. However, to gain a better understanding of neighborhoods and the people that live in them, a survey of the built environment, health, and perception was conducted. The survey process and purpose are discussed in Section 5.2.

Attempting to construct a health equity index is quite challenging and also very complex. As a result, different statistical methods were used in this research to gain the necessary knowledge required to analyze the health situation in Mobile County. The survey data was most appropriate through the use of contingency table analysis. Multiple linear regression was used to determine the significant variables associated with crude death rate, cause-specific death rate for cancer and cause-specific death rate for heart disease. The models were tested for each ZCTA through the use of geographically weighted regression (GWR). The variables found to be significant were used to develop the health inequity index. The statistical methods used in this research are detailed in Section 5.3.

5.1 Measuring Health Inequality

Pickett and Pearl (2001) contended that population inequalities in disease are not typically accounted for by any known combination of individual genetic and environmental risk factors. Therefore, they must be the result of other unmeasured factors, some of which are likely to be found at the aggregate level. In fact, the most important determinants of health may center on ecological factors. The places in which people live may contribute significantly to health. The availability and accessibility of health services, the lack of parks, deterioration of infrastructure in neighborhoods, the amount of grocery stores within a given distance, stress, and inadequate social support are all possible determinants (Pickett and Pearl 2001). In recent years, research has started to focus on these ideas and a number of the methods used are presented in the following paragraphs.

Though factors such as educational attainment, employment, and income have been researched extensively, health variation within communities has received less attention (Pickett and Pearl 2001). One of main reasons for this is the continued debate over the value of ecological perspectives (Pickett and Pearl 2001; Curtis 2007). Critics of the ecological approach contend that results may wrongly attribute the characteristics of the aggregated population to individuals within the population – a concept known as the ecological fallacy. Associations observed at the population group level may not be indicative of individuals within the group (Curtis 2007). Improved statistical techniques now provide researchers with methods to combine group level and individual level factors in various types of regression models (Pickett and Pearl 2001).

Another concern in health-related studies is associated with the researcher’s ability to define and measure a “neighborhood.” The choice of boundaries can play a critical role in the final results and the use of varying units of scale can reveal different factors of significance. There has been debate over the best choice of area size when conducting studies at the individual level, and more recently, questions have arisen as to the best area size to use in contextual studies (Pickett and Pearl 2001). The modifiable areal unit problem (MAUP) does not only pertain to univariate and bivariate statistical analysis, but with the advent of modern technology and the use of GIS, researchers are now concerned with the possible unreliability of multivariate analysis based on areal units (Fotheringham and Wong 1991).

In 1991, Fotheringham and Wong realized that the lack of individual-level data, the use of census figures, and the increasing capability of GIS to conduct multivariate analyses of areal data could produce highly unreliable results. Of concern to the authors was the fact that many studies using multivariate analyses were providing the framework for policy decisions. They were also bothered by the insensitivity of researchers who did not consider the problems of MAUP in their studies. Today, geographers are well aware of the situation.

However, there are still limitations on data, particularly in regard to studies on health. Due to privacy issues in the United States, it is difficult to obtain sanctioned data of individual residences. The mortality data for the state of Alabama is based on zip code; therefore, cross-sectional studies on health that require this type of data are limited. This is one reason why research on health inequality is moving toward the use of individual data collected through interviews and surveys.

Researchers in public health have increasingly turned to the use of qualitative studies to investigate the relationship between individuals, communities, and health. Qualitative methods are important to community health research because they allow for a deeper understanding of community complexity (Brown 2003; Etches et al. 2006). Quantitative data are needed to determine the potential impacts of the environment and socioeconomic status on health, but qualitative data allow researchers to relate to the experiences of individuals and communities (Brown 2003; Etches et al. 2006).

Large-scale household surveys are typically designed to obtain information on demographics and socioeconomic issues. Surveys that are representative of the population as a whole can provide more detail than a comprehensive census (Yazbeck 2009). Survey data can be of considerable importance in health equity analysis, but it does have some limitations. Large-scale surveys can be expensive to conduct. The scope, focus, and measurement approaches can vary over time, and as a result, it is difficult to make comparisons across surveys (Yazbeck 2009). Also, it is important to consider and reflect on the method in which the potential respondents are chosen. This becomes a concern when analysts make inferences from the data. It is important to recognize that survey data provides a representation of a population and researchers should be aware of this when drawing conclusions (Yazbeck 2009).

Though qualitative methods are forging into health research, there are a number of quantitative models associated with health inequality. In the past, the Standardized Mortality Ratio (SMR) contributed significantly to our understanding of health inequality. It is a ratio because it compares the death rate in any social class to what the rate would have been if the group had exactly the same age structure as the whole population (Bartley 2004). The average is designated as 100, so a SMR of 50 would indicate that the group has only half the average death rate. Researchers must be careful when using the SMR because it only shows the mortality in each class relative to the average for all persons in a given year (Bartley 2004).

Today, the standardized form that is used more commonly is direct standardization. It provides a standardized percentage that tells us what proportion of people would have died in the population if that population had the same age structure as the social class in question (can also be used for illness, etc.). In order to calculate direct standardization, a standard population is required (Bartley 2004). One common way to do this is to determine the population at one of the time points you want to compare. It does not matter what areal unit or what time point is included in the standard population, but all other groups at all other times must be compared to the same one.

Typically, the outcome measure in health inequality research is a qualitative or categorical measure that reflects the risk or probability of illness of each individual member of the group (Bartley 2004). This is accomplished in statistical models through a measure called the odds ratio (OR). Models that incorporate the OR are called logistic models. This method is used when a researcher is looking for results that are represented as categories, such as "ill' and "healthy" (Bartley 2004).

When using OR and other statistical measures, researchers must investigate the possibility of whether or not the apparent relationship has been biased by factors other than those used in the study. In regards to health inequality studies, a proposed variable that is found not to be the result of social disadvantage is called a confounder (spuriousness). In order to check for confounding, a statistical adjustment is made. An adjustment is made to see if the relationship discovered in the model is still there when other factors are taken into account. If the relationship disappears with use of other factors while variables are held constant, then the original relationship has been explained (Bartley 2004).

The ratios discussed above only consider examples of the measure of health that involve two values. In some studies of health inequality, researchers want to consider the relationship of a number of independent variables on an outcome variable. In this instance, a linear regression model is used. The equation for a simple linear regression is:

$$y = a + bX + e$$

In the equation, “a” represents the starting point or the intercept. The “b” refers to the amount of change per unit change in the independent variable and is called the regression coefficient. The “e” is the error term and, as in any study, measures are subject to different types of error (Bartley 2004).

In research on health inequality, the multiple regression analysis is more useful because it considers the influence of several independent variables on a dependent variable:

$$y = a + b_1X_1 + b_2X_2 + \ldots + b_kX_k + e$$

Of course, the letters in the multiple linear regression equation represent the same characteristics as they do in the simple linear regression, with the exception of the “k” which is equal to the total number of independent variables in the equation. Variables in the equation should bear on the research problem and should not be added to the equation for the sake of it (Welch and Comer 2001).

Many studies of health inequality include multiple linear regressions and attempt to explain a health or disease measure through variables of socioeconomic status. In this dissertation, multiple regression was performed using the crude death rate for zip code tabulation areas (ZCTAs) in Mobile County as the dependent variable. The independent variables were associated with socioeconomic status (percent poverty, median household income, educational attainment, and percent African-American), environmental risk (housing density, population density, toxic release inventory rank, rural, and urban), and the built environment (percent vacancy, median value of owner-occupied housing, percent renter occupied, median year built, grocery store ratio, and convenience store ratio).

Multiple linear regression was also performed on cause-specific death for heart disease and cause-specific death rate for cancer – the two leading causes of death in Mobile County. A number of regressions were run in order to determine the variables of significance. The variables of significance were also run using geographically weighted regression (GWR). The GWR was of particular interest in this dissertation because the spatial perspective provided a better understanding of the factors that impacted health in the county. Traditional multiple linear regression models assume that the processes being examined are constant over space, while GWR runs a regression for each individual ZCTA (Fotheringham, Brunsdon, and Charlton 2002). Geographically weighted regression will be presented in a later section.

Statistical analysis through the use of crosstabs (contingency analysis) was the preferred method to find relationships between health and the built environment from the survey data. Other statistical methods were considered for this dataset, but due to the limited response from residents in Mobile County, it was determined that survey data could best be examined through bivariate analysis. Though limited in its contribution to the dissertation, the survey did provide potential avenues of approach in future studies and did produce some significant relationships between health and the built environment.

5.2 Qualitative Methods

Though the majority of this dissertation is quantitative, it was necessary to explore qualitative measures as well. In order to gain a better understanding of individual residences in relation to the built environment in different zip code areas of the county, a survey was conducted (Appendix B). The survey also incorporated questions that revealed respondent's perceptions of health in their neighborhood, familiarity with the environmental justice movement and willingness to become involved in community activism. The information from the survey was used for both contextual purposes and statistical analysis (Appendix C).

The survey consisted of twenty questions that were primarily close-ended, with the exception of the last question. This question asked the respondents how long they had lived at their current residences. It was a mailed survey and designed to be simplistic in order to increase the potential response rate (Salant and Dillman 1994). Due to the fact that the ZCTAs vary in population (unlike census tracts and blocks), the mailed surveys were weighted in regards to population size (Table 5.1). The current population of the Mobile Metropolitan Statistical Area (Mobile County) is approximately 400,000; 400 surveys were mailed to addresses throughout the county. The recipients were selected randomly based on an address within a ZCTA from available public listings (Figure 5.1). The initial mail surveys were sent out in late May, 2009. In mid-June, a second mailing was conducted. Due to budget limitations, no other attempts were made to obtain information through mailed surveys.

Though only one survey was returned as undeliverable, the response rate for the mailed survey was extremely low. Fifty-four surveys were returned resulting in a response rate of approximately 14 percent. Most of the returned surveys came from ZCTAs in the areas of Mobile County designated as urban or suburban (Figure 5.2). Survey response in rural areas and ZCTAs where the population was significantly minority or low income was minimal.

Table 5.1 Mailed survey distribution by zip code.

Zip Code	Population	Surveys
36505	976	2
36509	2646	3
36521	4515	5
36522	6875	7
36523	3229	4
36525	2270	2
36541	13042	13
36544	11039	11
36560	4761	5
36571	15797	14
36572	5634	6
36575	15389	16
36582	20436	12
36587	8591	9
36602	867	2
36603	12526	12
36604	11533	12
36605	33475	34
36606	19007	19
36607	7776	8
36608	37251	37
36609	23882	24
36610	19717	20
36611	6364	7
36612	5074	5
36613	11816	12
36617	16158	17
36618	15718	16
36619	13389	13
36693	18099	18
36695	33010	35

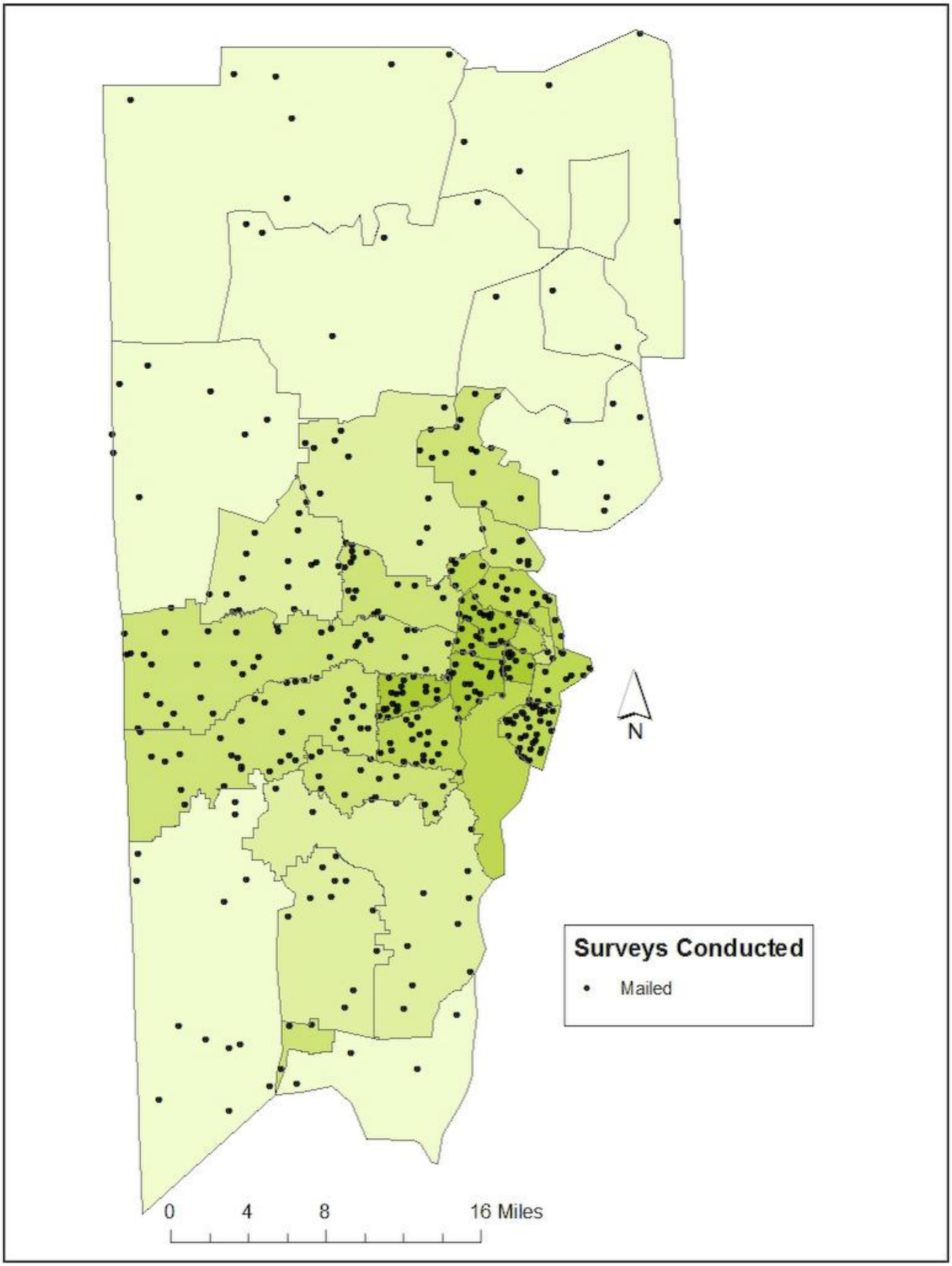


Figure 5.1 Mailed surveys. Map by author.

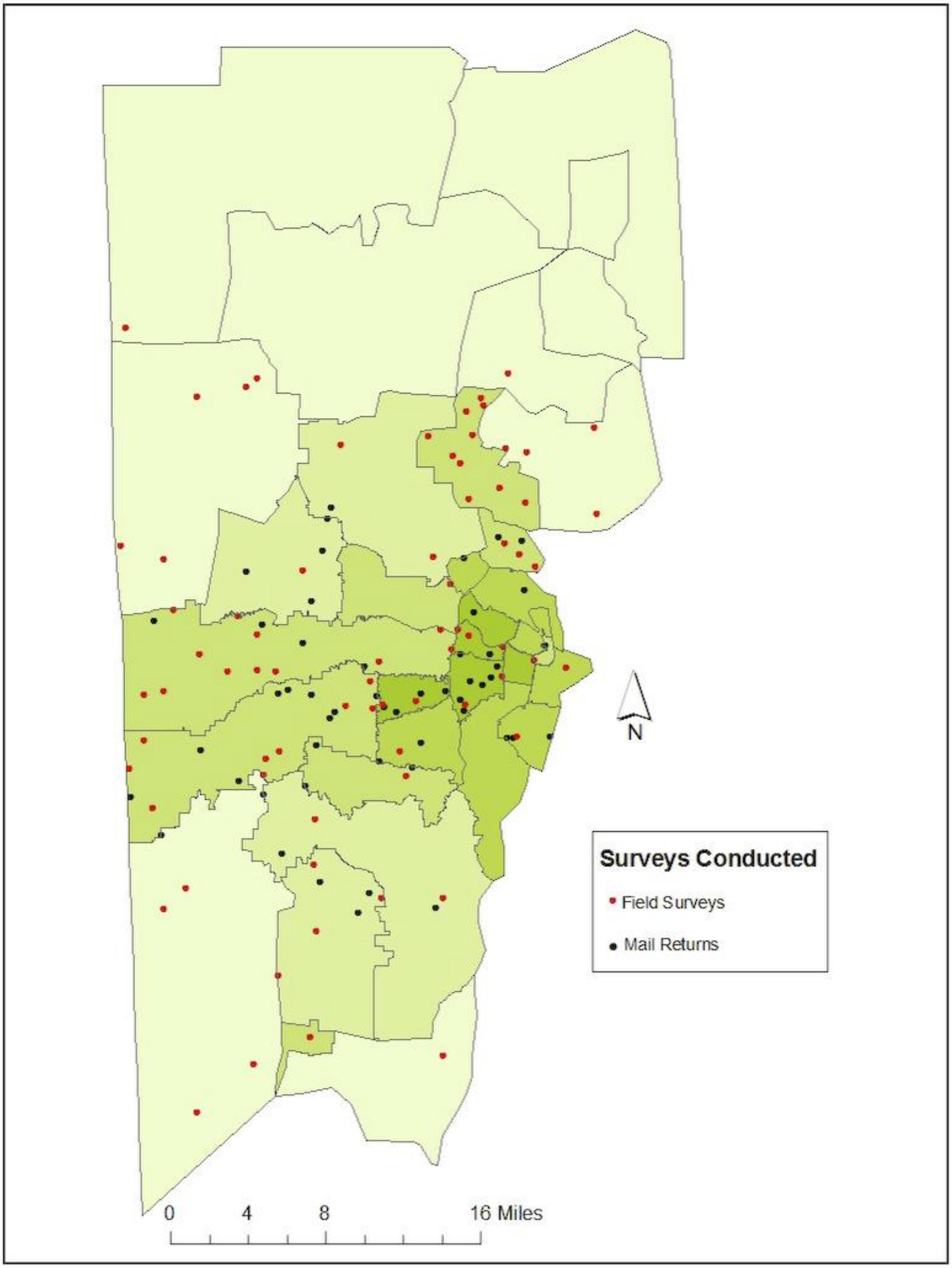


Figure 5.2 Surveys returned and conducted in the field. Map by author.

In order to substantiate the response, fieldwork was conducted in Mobile County during the final week of July, 2009. Surveys on the built environment and health were conducted by the author, a graduate student from the University of South Alabama and an undergraduate student from the University of Alabama. The intent was to focus on those ZCTAs where there was minimal or no response. There were a number of ZCTAs in all designated regions of Mobile County where survey response was still needed. One student concentrated on ZCTAs in the suburban ring and the other assisted the author in the urban core and the rural areas of southern and northern Mobile County.

Many potential respondents were hesitant to complete the survey when the word "health" was introduced into the conversation. Even though the survey was anonymous and based on zip code, a number of individuals feared discussing the issue because of possible job implications. It was also difficult to survey in the rural areas due to the increase in meth labs throughout the county and associated safety issues. While conducting surveys in the southern part of the county, a bust was made in an adjacent ZCTA. Apparently, meth has become a major problem in the county; last year alone, according to the nightly news, 70 raids took place. The survey team members, however, were able to complete 76 surveys throughout the county (Figure 5.2). As a result, survey response rose from 14 percent to approximately 33 percent.

Fieldwork proved to be much more successful, but this method would definitely take more time and would likely be more expensive. Due to potential issues associated with conducting surveys house-to-house, it would also be more efficient to organize neighborhood meetings to discuss health concerns. Establishing communication with community leaders and organizations and familiarizing them with the objectives of the research would also be beneficial.

Health issues do appear to be a sensitive topic and having an “insider” connection would likely produce even more significant results.

An increase in the response rate from the county would have allowed for a more detailed look at the impact of the built environment on health. Continued research on health in Mobile County will focus on enhancing the survey and obtaining a higher response rate. Though the survey was limited in scope, it did provide information as to the variables that should be included in the regression analyses. Outside of the information in the survey, built environment data had to be obtained from the US Census Bureau. Though information available from the US Census Bureau does not specifically identify characteristics of the built environment, variables such as vacant housing and renter occupied, do allow for educated assumptions on the quality of living conditions in a given areal unit.

5.3 Quantitative Methods

In order to assess the determinants of health in Mobile County, Alabama, a number of statistical analyses were performed. Studies on health inequality in the past often used one method to examine socioeconomic characteristics and their impact on health. Today, there is a growing movement to conduct research on health inequality through multilevel analysis (Curtis and Rees Jones 1998; Pickett and Pearl 2001; Srinivasan, O’Fallon, and Dearry 2003; Subramanian, Acevedo-Garcia, and Osypuk 2005). This typically involves a number of bivariate and multivariate statistical methods. Often, data from organizations such as the U.S. Census Bureau and mortality data from regional, national, and local offices are used to investigate possible relationships between the socioeconomic characteristics of the population and health. In this dissertation, multilevel analysis is accomplished through contingency table analysis, multiple linear regression, and GWR.

Surveys can play a major role in obtaining data for multilevel analysis. Whether at the regional, national, or local scale, individual perceptions of a place can provide the researcher with information that is not found in most standard sources. In regards to health, this is particularly important at the local level because surveys often reveal specific information about how individuals relate to their environment and their community. Their answers to questions of personal and neighborhood health provide insight into the possible psycho-social elements of health inequality.

Properly designed surveys can provide a large amount of data that can be statistically analyzed. Typically, surveys are designed to provide data for specific tests, but occasionally issues arise that may not be conducive to a given statistical method. In the case of this dissertation, the initial intent was to use the survey results in a regression analysis. However, with the limited survey response and reluctance of many to agree to the completion of the survey, chi-square analysis was used to examine the possibilities of relationships between the built environment and health. After a number of trial runs, it was determined that contingency table analysis (crosstabs) provided the most relevant information.

Contingency Table Analysis

The survey for this research was designed to examine the possible relationships between certain health problems and the built environment. Respondents were asked to provide information about their physical environment and whether or not any family members had been diagnosed with cancer, respiratory illness, or depression. The goal of the survey was to determine if certain characteristics in the built environment were related to the diagnosis of cancer, respiratory illness or depression. Since the survey was based on zip code, it had the potential to evaluate specific areas within Mobile County, and, through statistical analysis, aid in the determination of “healthy and “unhealthy” neighborhoods.

Contingency or cross-classification tables allow researchers to examine the link between two variables. In order to construct a contingency table, researchers must have a clear notion of the variables. The ‘illness diagnosed’ variables in this analysis were based on the diagnosis of cancer, respiratory illness, or depression in a given residence. The ‘built environment’ variables stemmed from questions on the built environment in places where the respondents lived (Table 5.2)

Table 5.2 Built environment and illness diagnosed variables for cross-tabulation.

Built Environment	Illness Diagnosed
Type of House Year Built Children's Play Areas Presence of Vacant Buildings Presence of Graffiti Presence of Vandalism Proximity to a Four-Lane Road Proximity to a Bus Stop Proximity to a Park or Green Space	Diagnosed with Cancer Diagnosed with Respiratory Illness Diagnosed with Depression

Though one can construct large contingency tables (those with more than two values of the independent and dependent variable), interpretation is more difficult. It is recommended that contingency tables be limited in size so that they are manageable (Welch and Comer 2001). One possibility for looking at a number of variables, but minimizing table size, is to collapse values of variables into a single category. It is important, however, that the collapsed categories make sense (Welch and Comer 2001). The use of collapsed categories was considered for this study, but it was determined that collapsing the diagnosis of cancer, respiratory illness, and depression into a single category would not allow for any meaningful conclusion. It was also considered for use with the built environment variables, but once again, it was determined that more relevant information would come from variable on variable analysis. The collapsed category for overall health, however, was used in the analysis on urban and rural health.

Mortality Data

The mortality data used in this study are from the State of Alabama Department of Public Health's Center for Health Statistics. The data covers the period 1997 – 2007 and contains the zip code of residence, age cohort, sex, and race of each person that died in the county during that time. The primary year of focus in this research is 2000. The fact that it is difficult to get thorough population data in non-census years was the primary reason for focusing on 2000.

In this study, total deaths by ZCTA in 2000 (in which all deaths were tabulated to calculate the crude death rate for each ZCTA), the cause-specific death rate for cancer by ZCTA in 2000, and the cause-specific death rate for heart disease by ZCTA in 2000 were used. The crude death rate for each ZCTA was calculated by totaling the number of deaths in each ZCTA, dividing it by the population of the area (population of the ZCTA) and multiplying by 1,000. To calculate the cause-specific death rates for cancer and heart disease in each ZCTA, the total number of deaths for the specific cause were divided by the population of the ZCTA and then multiplied by 1,000 (Nebraska Health and Human Services System 2004).

The mortality data were grouped by age cohorts and by race. Though there are a number of minority groups in Mobile County, the majority of the population is either white or African-American. The data received from the Center of Health Statistics was broken down by white male, white female, black male, and black female. The focus of this study is to determine the impact of the built environment on health, so classifications of age and race were not a primary objective; age data were not recorded ideally for calculations of age-specific death rates.

Percentage African-American, however, is used as an independent variable in the multivariate regression analysis discussed in the next section.

As stated above, the purpose of this study was to determine the effects of the built environment on health. The data, however, is limited from the prospect of examining health over a number of decades. Since mortality data in Alabama is based on zip code, the use of smaller areal units like the census block or census tract are not feasible. The only reason this study can be performed today is because the U.S. Census Bureau tabulated population characteristics for ZCTAs beginning with the 2000 Census.

In addition to issues with defining a neighborhood/community based on ZCTA, there are other concerns. The data source for the regression and spatial analyses is based on aggregate data and questions often arise as to the reliability and validity of the data, the ecological fallacy dilemma, and the MAUP. Spatial autocorrelation and multicollinearity are also concerns that need to be considered in this analysis, but that will be addressed in the next section on regression.

Due to the fact that the data were tabulated and coded for each ZCTA in Mobile County by the Alabama Department of Public Health, it is likely that the mortality data are reliable. However, in research such as this, addresses of the decedent would have allowed for a more thorough study in regards to the built environment in specific neighborhoods. Also, the mortality data does not divulge years of residence in a given location for the decedent; years of residence in a specific house are of particular importance in this type of research because it allows for more validity when evaluating the impacts of the built environment on health. One of the questions on the survey asked respondents to provide the number of years lived at their current residence.

This question did provide some insight on length of residence and perception of neighborhood health.

Regression Analysis

The mortality data for Mobile County was used in a multiple linear regression to assist in identifying the variables that were significant in regards to mortality. Small area mortality analysis is still extremely important in a multivariate context for identifying health inequalities (Wolfson and Rowe 2001). With limited data available to examine health from other angles and for the purposes of this research, the mortality data also served an important role in deciding on the variables that would be used in the health inequity index. Studies on health inequality have traditionally attempted to make the connection between socioeconomic characteristics and health. Typically, the focus has been on income inequality, and to a lesser extent, education.

Many studies tend to focus on one characteristic (Cohen et al. 2000; Morland, Wing, and Diez Roux 2002; Krieger and Higgins 2002; Bashir 2002; Srinivasan, O'Fallon, and Dearry 2003; Schweitzer and Valenzuela 2004; Horowitz et al. 2004; Hood 2005; Moore and Roux 2006). In recent years, there has been a call for more research to examine health inequality from an approach that encompasses more than one factor. This dissertation attempts to move in that direction by not only focusing on income and education, but extending the possible causal factors to include environmental risk and the built environment.

The initial step in the creation of the health inequity index for Mobile County was to run multiple linear regressions containing variables believed to impact health. Three multiple linear regression models were run based on the independent variables and dependent variables in Table 5.3. It can be noted that median household income and educational attainment were included in the regression models. In past studies, income and education have typically proven to be factors in health inequality, but some studies have shown that those results are not conclusive. The independent variables are associated with socioeconomic status (percent poverty, median household income, educational attainment, percent African-American), environmental risk (housing density, population density, toxic release inventory index, rural, and urban), and the built environment (percent vacancy, median value of owner-occupied housing, percent renter occupied, median year built, grocery store ratio, and convenience store ratio).

Table 5.3 Independent and dependent variables for multiple linear regression models.

Independent Variables	Dependent Variables
Percent Vacancy Percent Renter Occupied Percent Poverty Median Value Owner-Occupied Housing Median Year Built Median Household Income Educational Attainment Percent African American Housing Density Population Density Grocery Store Ratio Convenience Store Ratio Rural Urban TRI Rank Percent Renter Occupied	ZCTA Crude Death Rate 2000 ZCTA Cause Specific Death - Cancer ZCTA Cause Specific Death - Heart Disease

Most of the independent variables are self-explanatory, but a few do need some clarification here. The convenience store and grocery store ratios were added to the built environment category because recent research has focused on this aspect of health inequality (Morland, Wing, and Diez Roux 2002; Horowitz et al. 2004). In order to calculate the convenience store ratio, the total number of establishments was tallied for each ZCTA. The number of stores was then divided by the area of the ZCTA to come up with the ratio. The grocery store ratio was calculated in a similar manner, but was based on large corporate stores, and not local markets.

The Toxic Release Inventory (TRI) data were obtained from a website maintained by the US Environmental Protection Agency. Each ZCTA was typed into the TRI for 2000 and a report outlining the company, types of chemicals, and amount of total toxic release was provided. The TRI rank was calculated by first ranking the ZCTAs in terms of total on-site toxic release. The ranks ranged from zero to three. The values for each rank were calculated by using the natural breaks (Jenks) method (Table 5.4). ArcMap identifies the break points by locating groups with similar values and maximizing the differences between classes. The features are divided into classes whose boundaries are set where there are large jumps in the data values.

Table 5.4 Toxic release rank for regression analysis.

On-Site Toxic Release in Pounds	Rank
0 - 7348	0
7349 - 51413	1
51414 - 167895	2
> 167896	3

Source: US Environmental Protection Agency (2000)

Attempting to identify the factors associated with health inequality is complex. It is likely that there are several factors that simultaneously affect health and a great deal of research is still needed to pinpoint these. It is also important from the standpoint of policy as to where finances and effort should be distributed to alleviate problems of health inequality. From this perspective, this dissertation is a starting point in determining those factors. The significance of the independent variables in relation to each of the three dependent variables (crude death rate, cause specific death rate for cancer, and cause specific death rate for heart disease) were determined through multiple linear regression analyses that were performed using SPSS (Yockey 2008).

Though multiple linear regression is a powerful tool, it does have some limitations. One major concern with the use of multiple linear regression involves specification error. This is the notion that the wrong variables are being included in the equation, resulting in estimates that will be distorted (Welch and Comer 2001). It is important for researchers to think through regression models and to identify and remove the variables that are not relevant. Missing data can also create problems. This is particularly an issue when using surveys as a base for the regression model. The data used in this dissertation did not involve any cases of missing data. However, it is necessary to correct for missing data by combining missing variables into a scale so a case is not lost, or by recoding missing data to the mean, median, or mode of the variable (Welch and Comer 2001).

Another potential issue involving data in multiple linear regression is that of multicollinearity. This occurs when two or more independent variables used in the regression are not independent, but are correlated. This is a common problem in social science research since many socioeconomic variables are likely to be related (Schroeder, Sjoquist, and Stephan 1986). When two or more independent variables are correlated, the statistical estimation techniques performed in the regression are unable to identify the independent effects of each on the dependent variable. Multicollinearity is likely to be present in all regression models, but it becomes a problem in the analysis when there are “high” correlation coefficients between the variables in the equation.

There are other potential problems that are not associated with data. Autocorrelation occurs when the residual error terms from different observations are correlated. It is more likely to pose problems with time series data and the problem is usually restricted to error terms associated with successive time periods. Autocorrelation can be the result of several factors, including the omission of an explanatory variable or the use of the wrong functional form. If autocorrelation is revealed in a model, it can influence the outcome of the hypothesis-testing procedure. Autocorrelation can be positive or negative; a positive autocorrelation causes an underestimation of the standard error of the estimated coefficient which inflates the t-ratio. Inflation of the t-ratio means that coefficients will be found to be significantly different from zero when in fact they are not (Schroeder, Sjoquist, and Stephan 1986).

In order to test the significance of health in the urban, suburban, and rural portions of Mobile County, it was necessary to create dummy variables. Most variables in a regression analyses are usually continuous. In some models, however, variables will take on only the values of zero or one. Using nominal variables in regression does pose some problems, but this is not insurmountable. In this case, there were three nominal variables: suburban, urban, and rural ZCTAs. The rule for creating dummy variables is to use one less than the number of values in the nominal variable. Due to the fact that the survey response was strongest in the suburban portion of the county, urban and rural were chosen for the dummy variables. Therefore, suburban was represented by zero in each of the dummy variables (Schroeder, Sjoquist, and Stephan 1986; Welch and Comer 2001).

Creating multiple linear regression models to test for the significance of variables that might impact health in the county was extremely important to this research. When multiple linear regression was conducted on the dependent variables of total crude death rate for each ZCTA, cause-specific death rate for cancer by ZCTA, and cause-specific death rate for heart disease by ZCTA, some patterns were recognized and some independent variables were found to be significant. The variables found to be significant were used to create a regression equation that was run through geographically weighted regression (GWR). Often, the strength of geographically influenced models increases when GWR is performed. The analysis can also provide information on where the model works best. Once the variable analyses were complete, variables that appeared to have the greatest influence on health were used to construct the health inequity index. In the following section, the value of GWR in studies of health inequality is presented. This is particularly important when dealing with areal units that vary in size across space.

Geographically Weighted Regression

Health in Mobile County involves processes that vary over space. In order to account for this, GWR was used to examine the nature of the processes being investigated. The equation is slightly different than the traditional model:

$$y(g) = a(g) + b_1(g)X_1 + b_2(g)X_2 + \ldots + b_k(g)X_k + e$$

The difference being the addition of "(g)," which represents the idea that the parameters are to be estimated at a location whose coordinates are given by the vector g (geographic location). In the case of this study, coordinates are the interpolated latitude and longitude for each ZCTA. The parameter estimates for GWR are solved using a weighting scheme based on the idea that those observations near the point in space where the parameter estimates are desired will have more influence on the result than observations further away (Fotheringham, Brunsdon, and Charlton 2002).

Geographically weighted regression research has been led by Stewart Fotheringham, Chris Brunsdon, and Martin Charlton who developed a statistical technique that allows for the modeling of processes that vary over space. As a result, this technique improves on traditional types of regression modeling by allowing the researcher to examine processes in relation to location, and in the process, enhances the understanding of patterns across geographic areas. The method works by allowing model coefficients to vary regionally and a regression is run for each location (Fotheringham, Brunsdon, and Charlton 2002).

Newer innovations in GIS allow for the mapping of GWR results. Once the R^2 values have been calculated for each location, the coefficients and R^2 can be mapped and researchers can gain a sense of the relationship between the dependent and independent variables (Mitchell 2005). Mapping the R^2 values reveals the locations in the study area where the model is working best (the higher the R^2, the better the fit). Mapping the values of the coefficients reveals how each coefficient varies across the region. Locations where the t-score exceeds the critical value for specific confidence levels can also be mapped, revealing where the dependence is statistically significant for each independent variable (Mitchell 2005).

The process of conducting GWR in this dissertation is shown in Figure 5.3. Ideas for the model are based on determining possible variables that explain mortality in Mobile County. The data for the model were obtained from the U.S. Census Bureau, Alabama Department of Public Health, and the U.S. Environmental Protection Agency. Once the variables for the GWR were chosen, a file was created for input into the model. The database file (.dbf) contained the pool of variables and the data for the 31 ZCTAs in Mobile County. The data table was added to the GIS for Mobile County. With the release of ArcGIS 9.3.1, GWR models can now be run in the GIS program. The results are stored in an output feature class attribute table and can be used immediately to map local R^2, standardized residuals, and local coefficient estimates (Charlton and Fotheringham 2007).

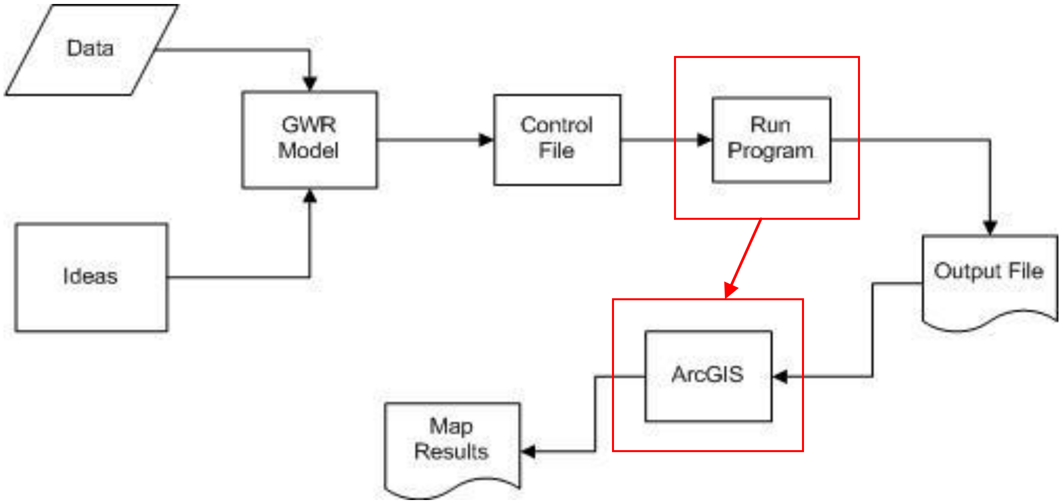


Figure 5.3 GWR process. After Charlton, Fotheringham, and Brunsdon (2007, 6).

There are a number of methods that can be employed to run the model. Based on the type of data being used, either a fixed or an adaptive kernel must be selected. Spatial kernels are used to provide the geographic weighting in a model (Charlton and Fotheringham 2007). If the observations are somewhat regularly positioned, then a fixed kernel will suffice. If the observations are clustered and distances vary, then an adaptive kernel will be more effective. The adaptive kernel was chosen for this research because of varying distances associated with the different sized ZCTAs. Users must also decide which bandwidth method to use. There are three possible choices, two of which use an automatic method for finding the bandwidth, and a third which allows the user to specify a bandwidth. The corrected Akaike Information Criterion (AICc) method, an automatic method, was the one chosen. This method has a correction for small sample sizes (Charlton and Fotheringham 2007). There are a number of other options available with GWR, but they were not considered for this research.

The Development of the Health Inequity Index

The multilevel analysis approach allowed for the selection of variables that have the greatest impact on health in Mobile County. As a result, five variables were deemed important for determining health inequity: percent poverty, educational attainment, toxic release rank, percent renter occupied, and percent housing vacancy. Further research may require the inclusion of new variables or modification in the current index. Figure 5.4 reveals the key factors associated with the health inequity index and the processes used to identify those variables. The factors included in the index were weighted based on appearance and significance in the multiple linear regression and GWR models. The index was calculated for each ZCTA and the results were mapped. The map revealed the spatial distribution of ZCTAs where the potential exists for health inequity.

As noted by Ellaway, Macintyre, and Kearns (2001), studies on features of the social and physical environment which might affect health are based on data that happens to be available at a given time. They emphasized the need for current health research to focus on the neighborhood. In order to do this, researchers need to combine qualitative and quantitative techniques and to study populations at the community and individual level (Brown 2003). Multilevel analysis allows for the examination of processes that link individual and community characteristics to health (Etches et al. 2006). This dissertation is a multilevel analysis that attempts to determine the location of neighborhoods (ZCTAs) of poor health by linking community and individual characteristics through statistical analysis. In the following chapter, the results of the multilevel analysis on health in Mobile County are presented.

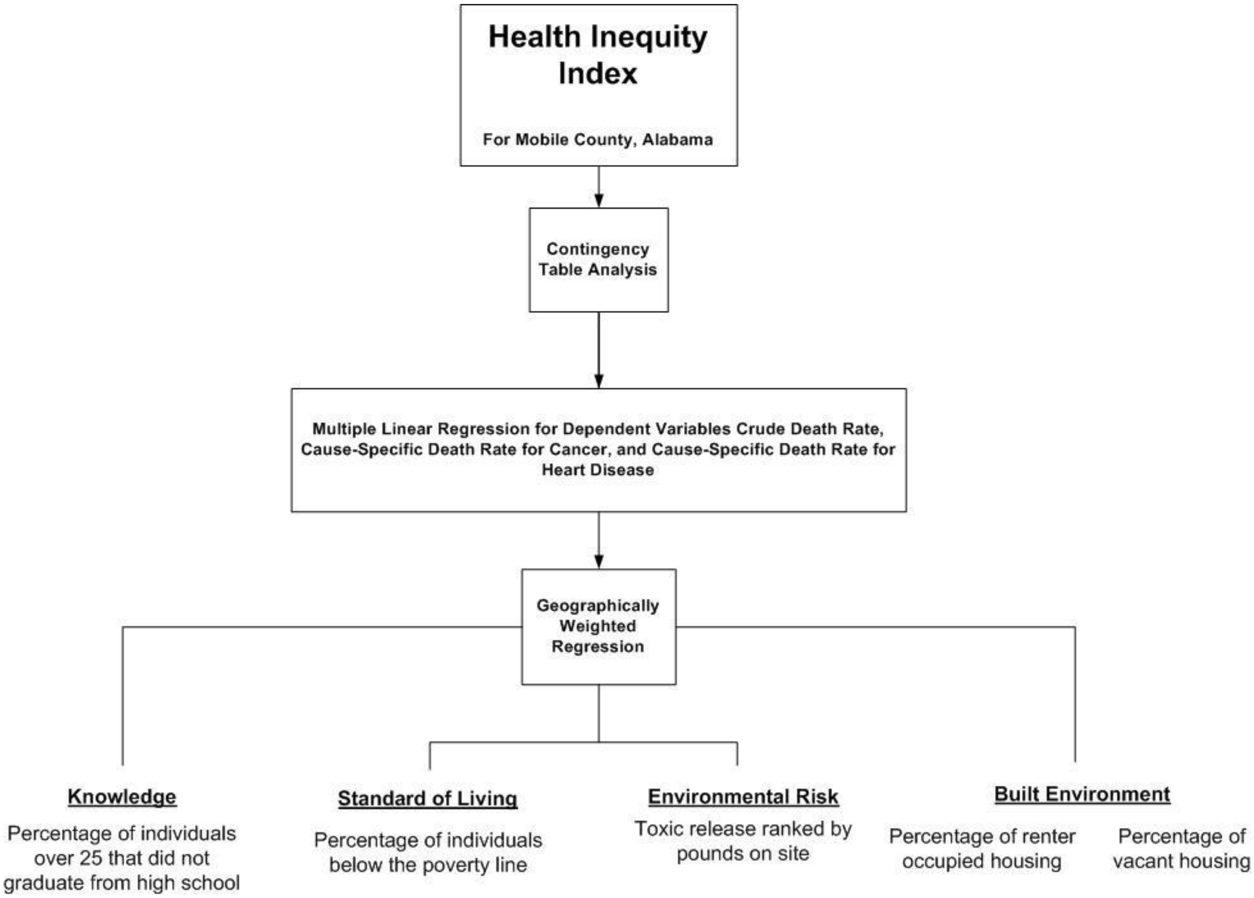


Figure 5.4 Methods used to develop health inequity index for Mobile County, Alabama.

CHAPTER 6 - Health and Inequality in Mobile County

Knowledge of risk factors at the individual level might help explain temporal trends in different aspects of population health and how social conditions affect the distribution of those risk factors in the population at a particular time (Lynch et al. 2004). An attempt was made through the use of data obtained from the survey to identify the risk factors associated with the built environment that impact health in Mobile County. Though some characteristics of the built environment can be obtained from information in the U.S. Census, detailed characteristics of a neighborhood are often missing. This is particularly true when using larger areal units such as ZCTAs where the built environment can vary quite substantially within a few blocks.

In a systematic review, Lynch et al. (2004) showed that links between income and inequality and population health are strongest in the United States. There is also evidence of a regional component in the link between mortality and income inequality. The southern states and U.S. metropolitan areas have lower average incomes, higher income inequality and generally higher mortality rates (Lynch et al. 2004).

In order to identify socioeconomic variables relevant to mortality, multiple linear regressions using the 2000 crude death rate, cause-specific death rate for cancer, and cause-specific death rate for heart disease as the dependent variables were performed. The survey data, the regression analysis, and the health inequity index were then used to determine if there was a significant difference between urban and rural areas in regards to health.

6.1 Results of the Multilevel Analysis

The multiple linear regression analysis provided the variables for the model to run in GWR. Using the crude death rate for 2000 as the dependent variable and percent poverty, educational attainment, percent housing vacancy, percent renter occupied, toxic release rank, and grocery store ratio as the independent variables, the model was run. Models were also run for cause-specific death rate for cancer and cause-specific death rate for heart disease. The results of the GWR revealed where the model was most successful. The intent was that the model would determine the areas where health inequality in the county was significant, and thus, where potential inequities exist. From the multilevel analysis, it was then determined what variables were critical in defining health in the county and those were used in the development of the health inequity index

Contingency Table Analysis Results

The initial intent was to use the data collected from the survey to run multiple linear regressions where the dependent variables were cancer, respiratory illness, and depression. The independent variables were to come from the survey data on the built environment. After early analysis, it was evident that the use of bivariate methods would be better suited for the data. Contingency table analysis completed through the *Crosstabs* function in SPSS was used. Each type of diagnosis was tested to determine any possible relationship with a single characteristic of the built environment. The complete analysis can be found in Appendix D, but for the purposes of this discussion, only strong relationships and some potentially important characteristics are presented. Typically, for each variable associated with a specific diagnosis of an illness, one aspect of the built environment was strongly related.

The first analyses involved identifying the relationships between characteristics of the built environment and the diagnosis of cancer. There were two variables dealing with the built environment that had a strong relationship with cancer diagnosis. The first was the year that the house was built. It is interesting to look at the cross-tabulation for this variable. Housing constructed during the period 1940 – 1969 had the highest percentage of individuals diagnosed with cancer (30.6 percent). This is definitely not a conclusive link to cancer and older housing, but it does present some potential avenues to approach in the future.

Table 6.1 Cross-tabulation for cancer diagnosed and year built.

			Year Built				**Total**
			Pre-1939	**1940 - 1969**	**1970 - 1989**	**1990 +**	
Cancer Diagnosed	Yes	Count	1	11	9	2	23
		% Cancer Diagnosed	4.3%	47.8%	39.1%	8.7%	100.0%
	No	Count	8	25	40	34	107
		% Cancer Diagnosed	7.5%	23.4%	37.4%	31.8%	100.0%
Total		Count	9	36	49	36	130
		% Cancer Diagnosed	6.9%	27.7%	37.7%	27.7%	100.0%

Chi-square = 8.015, df = 3, P = 0.046

Another variable that was significant in terms of the environment and cancer diagnosis was the number of years individuals resided in the same house (Table 6.2). This can be of particular interest when studying the potential impact of long-term exposure to toxic release. Due to the fact that Mobile County is in the top ten percent of all counties in the United States for total toxic environmental release, cancer risk score, and air releases of recognized carcinogens, this becomes even more significant. As a result, a cross-tabulation showing the relationship between zip code and years of residence was further analyzed to determine any potentially significant spatial patterns (Table 6.3). When considering ZCTAs where on-site toxic release is substantial, there are indications of spatial patterns (Figure 6.1). The inset map reveals the cause-specific cancer rate for the survey data in the ZCTAs (darker shades indicate higher rates). Comparing the ZCTAs does reveal a spatial relationship between on-site toxic release and cancer.

Table 6.2 Cross-tabulation for cancer diagnosed and years at current address.

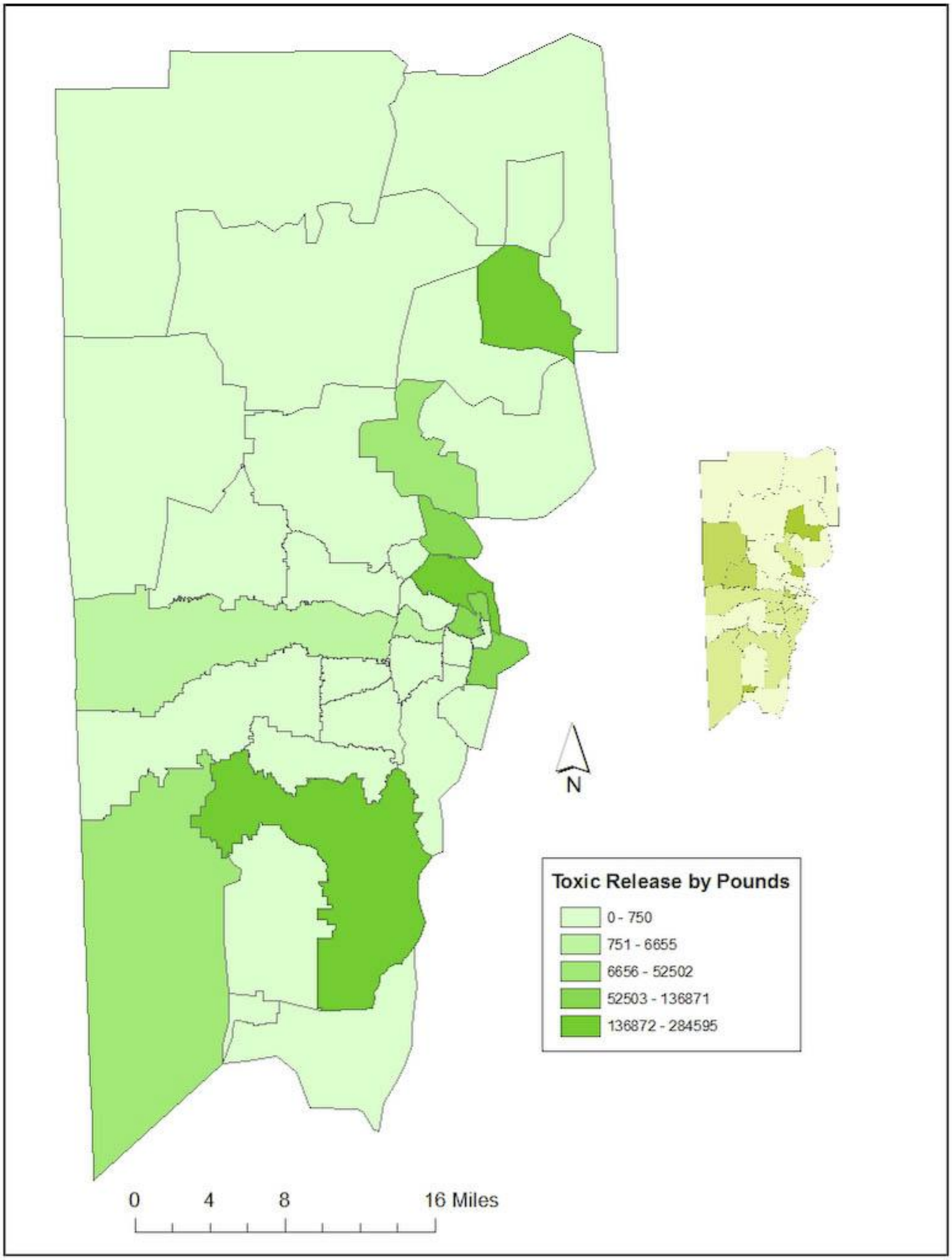
			Years at Address				**Total**
			0 - 10 Years	**11 - 20 Years**	**21 - 30 Years**	**> 30 Years**	
Cancer Diagnosed	Yes	Count	6	9	3	5	23
		% Cancer Diagnosed	26.1%	39.1%	13.0%	21.7%	100.0%
	No	Count	64	23	11	9	107
		% Cancer Diagnosed	59.8%	21.5%	10.3%	8.4%	100.0%
Total		Count	70	32	14	14	130
		% Cancer Diagnosed	53.8%	24.6%	10.8%	10.8%	100.0%

Chi-square = 9.647, df = 3, P = 0.022

Table 6.3 Cancer diagnosed cases by zip code.

Zip Code	Cancer Diagnosed		Total
	Yes	No	
36509	1	0	1
36522	0	1	1
36523	0	1	1
36525	1	0	1
36541	1	5	6
36544	0	7	7
36571	1	10	11
36572	0	4	4
36575	2	5	7
36582	1	3	4
36587	2	3	5
36602	0	1	1
36603	0	1	1
36604	0	4	4
36605	3	1	4
36606	2	8	10
36607	1	4	5
36608	3	12	15
36609	1	6	7
36610	0	1	1
36611	2	3	5
36612	0	2	2
36613	0	3	3
36617	0	1	1
36619	0	4	4
36693	2	1	3
36695	0	16	16

Figure 6.1 On-site toxic release in pounds, 2007. Map by author. Source: US Environmental Protection Agency (2009).



The impacts of the built environment on depression can be seen in regards to vacant buildings and proximity to a bus stop. The vacant building variable did reveal a strong relationship with depression (Table 6.4). Due to the fact that there was limited response in ZCTAs associated with minorities and low income groups, it would be interesting in future research to further investigate this variable. Latkin and Curry (2003) in their study considered the neighborhood environment and its impact on depression in their study of Baltimore, Maryland. They identified characteristics that influenced neighborhood disorder. Two of the most cited by respondents were vandalism and vacant housing. The variable that had a strong relationship in this study in regards to depression was proximity to a bus stop (Table 6.5). This is not totally surprising as many of the neighborhoods likely to be associated with bus stops are located within urban cores or in the more populated regions of the suburban ring. Rural respondents tended to note on the survey that they were not located near any bus stops.

Table 6.4 Cross-tabulation for depression diagnosed and vacant buildings.

			Vacant Buildings		**Total**
			Yes	**No**	
Depression Diagnosed	Yes	Count	8	29	37
		% Depression Diagnosed	21.6%	78.4%	100.0%
	No	Count	35	58	93
		% Depression Diagnosed	37.6%	62.4%	100.0%
Total		Count	43	87	130
		% Depression Diagnosed	33.1%	66.9%	100.0%

Chi-square = 3.066, df = 1, P = 0.080

Table 6.5 Cross-tabulation for depression diagnosed and proximity to a bus stop.

			Proximity to a Bus Stop				
			Less Than 1 Block	**1-2 Blocks Away**	**3-4 Blocks Away**	**> 5 Blocks Away**	**Total**
Depression Diagnosed	Yes	Count	16	1	4	16	37
		% Depression Diagnosed	43.2%	2.7%	10.8%	43.2%	100.0%
	No	Count	16	24	9	44	93
		% Depression Diagnosed	17.2%	25.8%	9.7%	47.3%	100.0%
Total		Count	32	25	13	60	130
		% Depression Diagnosed	24.6%	19.2%	10.0%	46.2%	100.0%

Chi-square = 14.767, df = 3, P = 0.002

Vandalism is the variable that was most strongly related for the diagnosis of respiratory illness (Table 6.6). Again, this is not surprising as it is likely that neighborhoods of high vandalism are associated with the urban core. It also tends to indicate that these neighborhoods are older and likely not as well maintained as other areas within the county. Even though vandalism was the variable found to have the strongest relationship with respondents in terms of respiratory illness, there are likely many other underlying factors in the built environment that impact respiratory illness and are simply correlated with vandalism. Vesper, et al. (2007) used a relative moldiness index to predict childhood respiratory illness in Cincinnati, Ohio and northern Kentucky. Obviously, in many neighborhoods where vandalism is reported, homes are likely to be in poor condition and often dealing with dampness. Thus, the prospect for mold in neighborhoods associated with vandalism is high.

Table 6.6 Cross-tabulation for respiratory illness diagnosed and vandalism.

			Vandalism		Total
			No Signs	Signs of Vandalism	
Respiratory Illness Diagnosed	Yes	Count	23	12	35
		% Respiratory Illness Diagnosed	65.7%	34.3%	100.0%
	No	Count	80	15	95
		% Respiratory Illness Diagnosed	84.2%	15.8%	100.0%
Total		Count	103	27	130
		% Respiratory Illness Diagnosed	79.2%	20.8%	100.0%

Chi-square = 5.317, df = 1, P = 0.021

The contingency table analysis was important for this research because it assisted in the development of the health inequity index and provided insight for future research that will help to improve the understanding of health inequality and why it exists where it does. A number of variables were identified in the analysis in relation to individual households and the diagnosis of cancer, respiratory illness, and depression. This was the first attempt by the author to obtain health information at the individual level and a great deal was learned as a result.

Multiple Regression Results

The multiple linear regressions played a critical role in this research because they aided in determining the variables most likely to impact health in Mobile County. Numerous models were developed for the dependent variables of crude death rate, cause-specific cancer death rate, and cause-specific heart disease death rate. The models incorporated a number of variables associated with socioeconomic status, environmental risk, and the built environment. These variables were discussed in the previous chapter. The statistical information in the following tables represents the most significant models developed as a result of the three dependent variables and the pool of independent variables chosen for this study.

The initial step in the design of the models was to run a multiple linear regression containing all of the independent variables against the dependent variable. The first run allowed for the identification of variables that could result in multicollinearity. Potential cases of multicollinearity were identified using the variance inflation factor (VIF). The VIF identifies variables with inflated variances. Inflated variances can be problematic in regression because some variables add very little information to the model. The general rule is that the VIF should not exceed 10 (Robinson and Schumacker 2009). The regression models for this study were run numerous times to ensure that multicollinearity was not present.

After the initial run of each model, the VIF was checked and variables that were over 10 were analyzed through comparison with other variables. If the analysis revealed that two variables provided similar information, then the one with the highest VIF was removed from the model. This process was continued until multicollinearity in the model no longer existed. Once the issue of multicollinearity was dealt with, the process then moved on to creating the most significant model based on the ability of the independent variables to explain the variance in the dependent variable.

The first model attempted to determine which independent variables would best describe the dependent variable, crude death rate. As seen in Table 6.7, the R^2 for this model is 0.659 indicating that 65.9 percent of the variance in the dependent variable can be explained by the independent variables. The adjusted R^2, however, is the preferred measure for goodness-of-fit because it contains some adjustment for the number of variables in the model (Charlton and Fotheringham 2009). If the adjusted R^2 is used, 55.5 percent of the variance in the dependent variable can be accounted for by the independent variables. Though the model is quite significant, there are likely other factors that would enhance it; this would be an objective of future research.

The significant variables in the model were urban zips, percent poverty, educational attainment, and percent renter occupied. The grocery store ratio and the percent vacancy were not significant, but when taken out of the model, the R^2 dropped, indicating that these variables are important factors for crude death rate. Dummy variables were used to look at crude death rate between urban, suburban, and rural. Suburban ZCTAs were recorded as zero in both the urban and rural values. The crude death rate is significantly higher in urban areas.

Table 6.7 Variables of significance for crude death rate.

	Unstandardized Coefficients		**Standardized Coefficients**		
Independent Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	2.775	1.431		1.940	.065
Rural Zip Codes	-.780	.887	-.153	-.880	.388
Urban Zip Codes	3.051	1.148	.639	2.657	.014
Poverty Percentage	-.206	.073	-.880	-2.812	.010
Educational Attainment	.143	.064	.594	2.226	.036
Renter Occupied Percentage	.087	.041	.652	2.093	.048
Grocery Store Ratio	-3.290	2.345	-.239	-1.403	.174
Vacant Housing Percentage	.131	.143	.204	.921	.367

R^2 = 0.555, F = 8.743, <0.001

The model for cause-specific cancer was not quite as strong as the crude death rate model, but it did provide a number of significant variables. The R^2 value indicates that 63 percent of the variance in the dependent variable is explained by the independent variables. The adjusted R^2 of 0.538 implies that 53.8 percent of the variance in the dependent variable is accounted for by the independent variables. The model shows that the cause-specific cancer death rate is significant for the urban variable indicating that there is a strong relationship between cancer and individuals living in the urban core (Table 6.8). Other significant variables for the cause-specific cancer model were percent renter occupied and the grocery store ratio. Though the TRI rank was not significant in the model, the model was weakened when this variable was removed. In comparison to the crude death rate model, many variables are the same.

Table 6.8 Variables of significance for cause-specific death rate for cancer.

	Unstandardized Coefficients		**Standardized Coefficients**		
Independent Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	1.355	.349		3.882	.001
Rural Zip Codes	.506	.280	.272	1.809	.083
Urban Zip Codes	1.110	.418	.637	2.656	.014
Poverty Percentage	-.034	.020	-.403	-1.743	.094
Renter Occupied Percentage	.030	.010	.615	2.955	.007
Grocery Store Ratio	-1.817	.820	-.362	-2.216	.036
TRI Release Rank	.288	.158	.283	1.821	.081

R^2 = 0.538, F = 6.815, <0.001

Another model of interest for cause-specific cancer is included in the analysis because it revealed the significance of some variables not present in the above model. The R^2 for the model is 0.615, indicating that 61.5 percent of the variance in the dependent variable is explained by the independent variables. The adjusted R^2 reveals that only 49.7 percent of the variance in the dependent variable can be accounted for by the independent variables. This model was not as strong as the above model, but it is interesting to examine the significant variables in the model (Table 6.9). Median income and the toxic release rank are significant, while median value of owner-occupied housing reveals a strong relationship. In previous research on cancer in Mobile County, median value of owner-occupied housing and median income were significant. However, in this research, more variables were considered and some of those actually made the overall model stronger. It is of interest that the toxic release rank is significant in this model, but the urban variable is not.

Table 6.9 Variables of significance for cause-specific death rate for cancer (2).

	Unstandardized Coefficients		Standardized Coefficients		
Independent variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	3.175	1.195		2.656	.014
TRI Release Rank	.422	.158	.415	2.673	.014
Value of Owner Occupied Housing	.000	.000	.325	2.057	.051
Median Household Income	.000	.000	-.700	-2.595	.016
Mobile Home Ratio	-.051	.042	-.310	-1.209	.239
Rural Zip Codes	.606	.385	.325	1.573	.129
Urban Zip Codes	.483	.490	.277	.985	.335
Poverty Percentage	-.036	.024	-.424	-1.480	.153

R^2 = 0.497, F = 5.243, 0.001

The cause-specific heart disease model was the least significant model in regards to the variables used for this study (Table 6.10). The R^2 value of 0.636 indicates that 63.6 percent of the variance in the dependent variable is explained by the dependent variables, while the adjusted R^2 shows that the independent variables account for 52.6 percent of the variance in the dependent variable. For heart disease, neither the urban zip variable nor the rural zip variable is significant. Other significant variables for cause-specific heart disease death rate are percent poverty and educational attainment. Percent vacancy is not significant in the model, but it does appear to have a strong relationship to heart disease. Though percent African-American was not significant, the model was weakened when it was not present.

Table 6.10 Variables of significance for cause-specific death rate for heart disease.

	Unstandardized Coefficients		Standardized Coefficients		
Cause-Specific Heart Disease	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	.032	.768		.041	.968
Poverty Percentage	-.169	.051	-1.266	-3.326	.003
Vacant Housing Percentage	.153	.082	.415	1.866	.075
Educational Attainment	.101	.035	.736	2.929	.008
Percent African American	.021	.011	.482	1.915	.068
Renter Occupied Ratio	.043	.024	.563	1.802	.085
Rural Zip Codes	-.739	.521	-.254	-1.418	.170
Urban Zip Codes	.715	.662	.262	1.080	.291

R^2 = 0.526, F = 5.747, 0.001

Research tends to indicate that the type of housing in which low-income families reside in adversely impacts their health (Bashir 2002). Do they live in an owner-occupied structure, rented housing, or public housing? The above models do show a relationship to health as renter occupied appears in every model and is significant in two. The models also indicate that factors associated with socioeconomic status, environmental risk, and the built environment all contribute to the health of individuals. Though many of these variables are good predictors of crude death rate, cause-specific cancer death rate, and cause-specific heart disease death rate, a great deal of research is still required. There are obviously many variables that can improve model strength, but the ones identified in this research are significant enough to develop an initial health inequity index; an index that can be improved over time through continued research and a better understanding of the complex nature of health.

Geographically Weighted Regression

The contingency table analysis and the multiple linear regressions provided the information necessary to create an equation for the GWR model. The significant variables in the regression analysis were used as the primary factors for determining overall health in Mobile

County. However, variables that were not necessarily significant, but impacted the overall model strength were used in the model as well. The contingency table analysis considered many factors of the built environment and did aid in gaining a better understanding of those factors that could potentially impact health. It also strengthened the validity of certain factors in the model, such as housing vacancy, and indicated that housing tenure might be important as well.

Based on the results of the multiple linear regression analysis, the following equation was developed:

$$CDR_i = \alpha_0 + \alpha_1 POV_i + \alpha_2 EDU_i + \alpha_3 RENT_i + \alpha_4 GRO_i + \alpha_5 VAC_i + \alpha_6 URB + \varepsilon_i$$

where CDR_i represents the crude death rate in each ZCTA; POV is the poverty percentage; EDU is a percentage representing the number of people over 25 who have not completed high school; RENT is the percentage of housing that is renter occupied; GRO is the grocery store ratio; VAC is the percentage of vacant housing; and URB is the variable for ZCTAs designated as urban.

Once the factors for the equation were determined, a new dataset was created consisting of the ZCTAs in Mobile County, the interpolated location in latitude and longitude for each ZCTA (required for input into GWR), and the above variables. The crude death rate model does include at least one variable from characteristics associated with socioeconomic status, environmental risk, and the built environment. This follows along with the notion that health is a complex issue and that in order to truly understand health inequality in a specific place, a holistic approach is required. Using the GWR tool in ArcGIS 9.3.1, the strength of the crude death rate model was tested from a spatial perspective.

The results of the GWR for crude death rate reveal a R^2 of 0.70 and an adjusted R^2 of 0.54 indicating that the independent variables accounted for 54 percent of the variance for crude death rate. The values for the observed and predicted cases of crude death rate can be seen in

Table 6.11. The output from the GWR also provides values for the local R^2, standardized residuals, and local coefficient estimates. The local R^2 value provides some indication of how well the crude death rate model fits in each ZCTA (Figure 6.2). Due to the fact that GWR runs a regression for each location, the local R^2 gives an idea of how well the model can replicate the data recorded in the vicinity of the regression point (Fotheringham, Brunsdon, and Charlton 2002). However, the R^2 must be interpreted carefully because it reflects a mixture of two issues: "…how well the model replicates the data and how stationary are the processes being modeled" (Fotheringham, Brunsdon, and Charlton 2002, 216).

In terms of the GWR analysis for crude death rate, the local R^2 values tended to indicate that the model works best in the northern half of the county. The urban core local R^2 values are right at 0.60 or greater. The values in the northern portion of the county all exceed 0.62. The lowest values (0.55) are found in ZCTAs 36541 (rural) and 36544 (suburban) in the southwestern part of the county. The multiple linear regression adjusted R^2 value (global) of 0.55 is close to the adjusted R^2 value of 0.54 for the spatial (local) model. In this case, the use of GWR did not improve model performance.

Table 6.11 Observed and predicted values for crude death rate, cancer, and heart disease.

	Crude Death Rate		Cancer		Heart Disease	
Zip	Observed	Predicted	Observed	Predicted	Observed	Predicted
36505	5.12	5.64	3.07	3.26	2.05	2.79
36509	6.42	9.06	2.27	2.41	3.02	3.66
36521	6.64	6.05	2.21	2.32	2.66	2.31
36522	5.82	6.19	2.47	2.47	1.75	2.7
36523	8.98	8.34	1.55	1.67	4.96	4.93
36525	6.61	5.82	3.08	2.8	2.2	2.47
36541	4.83	5.13	1.46	1.8	1.92	2.46
36544	4.71	6.23	1.72	1.74	1.54	2.07
36560	7.98	7.78	3.15	2.58	3.15	3.6
36571	7.1	8.46	2.34	2.71	2.34	3.14
36572	8.87	6.83	2.66	1.83	3.19	2.29
36575	4.03	6.09	1.69	1.51	1.69	2.17
36582	5.97	6.85	2.3	2.49	2.45	2.5
36587	4.42	5.24	1.51	1.89	2.1	2.13
36602	12.69	12.4	4.61	4.31	5.77	5.74
36603	10.12	11.03	3.51	3.84	4.31	4.64
36604	6.5	6.8	2.6	2.22	2.95	3.54
36605	6.6	6.84	2.33	2.25	2.27	2.8
36606	7.52	6.95	2.31	2.18	3.31	2.98
36607	12.47	9.44	3.73	2.65	6.56	4.44
36608	5.99	6.68	2.25	2.52	2.34	2.73
36609	5.36	6.95	1.8	2.55	2.09	2.91
36610	8.93	8.65	2.94	3.39	4.56	3.81
36611	9.9	10.38	4.24	3.4	3.77	3.73
36612	8.87	9.62	1.77	2.41	4.93	5.41
36613	8.89	7.3	2.03	1.86	4.74	3.15
36617	8.35	8.03	2.72	2.33	3.34	4.21
36618	5.6	5.31	1.53	1.89	2.74	2.62
36619	6.42	5.92	1.72	1.98	3.21	2.05
36693	7.4	5.55	1.99	2.06	3.15	2.29
36695	3.12	4.68	1.15	1.82	1.27	1.78

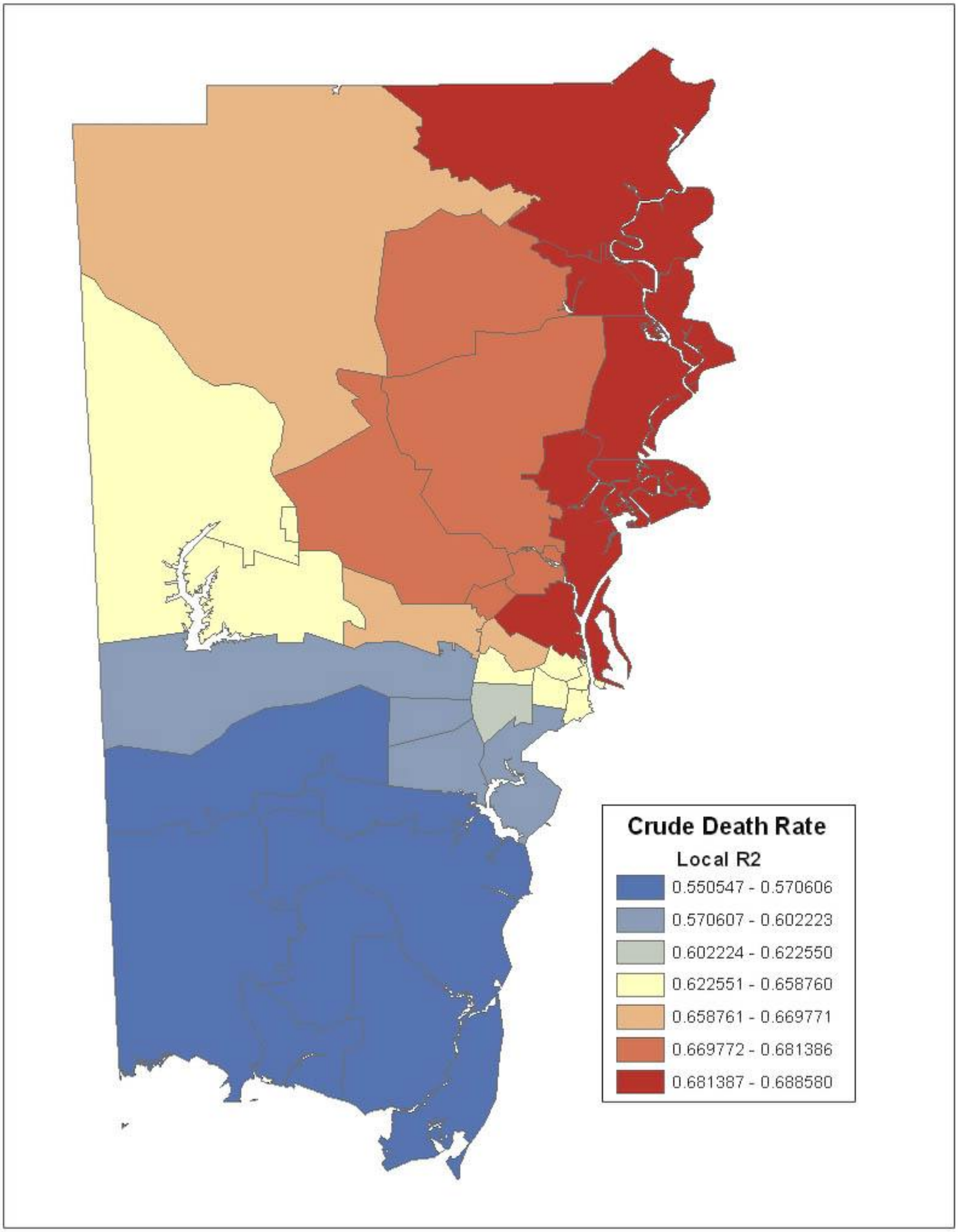


Figure 6.2 Local R^2 values for crude death rate. Map by author.

Mapping the values of the standardized residual allows for the determination of the location of unusually high or low residuals. The standardized residuals for crude death rate do not have any extremely high or low residuals (Figure 6.3). Generally, residuals that are larger than -3 or +3 are considered to be unusual. Researchers should examine unusually large observations in an attempt to discover possible reasons why (Fotheringham, Brunsdon, and Charlton 2002; Charlton and Fotheringham 2009). The two highest standardized residuals for crude death rate were found in ZCTAs 36509 (suburban) and 36607 (urban).

Based on the results of the multiple linear regression analysis, the following equation was developed:

$$\mathrm{CAN_i} = \alpha_0 + \alpha_1\mathrm{POV_i} + \alpha_2\mathrm{TRR_i} + \alpha_3\mathrm{RENT_i} + \alpha_4\mathrm{GRO_i} + \alpha_5\mathrm{URB} + \varepsilon_i$$

where $\mathrm{CAN_i}$ represents the cause-specific cancer death rate in each ZCTA; POV is the poverty percentage; TRR is the toxic release rank; RENT is the percentage of housing that is renter occupied; GRO is the grocery store ratio; and URB is the variable for ZCTAs designated as urban.

The results of the GWR for cause-specific cancer death rate reveal a R^2 of 0.71 and an adjusted R^2 of 0.58 indicating that the independent variables accounted for 58 percent of the variance for cause-specific cancer death rate. The values for the observed and predicted cases of cause-specific cancer death rate can be seen in Table 6.11. The local R^2 values for cause-specific cancer indicate that the best fit for the model is in the southern portion of the county. The urban ZCTAs hover around 0.60. The lowest local R^2 values are located in rural ZCTAs 36522 and 36587. The global R^2 value for this model was 0.538 and the local R^2 is 0.58 indicating a slight improvement in the model using GWR. The standardized residuals for cause-specific

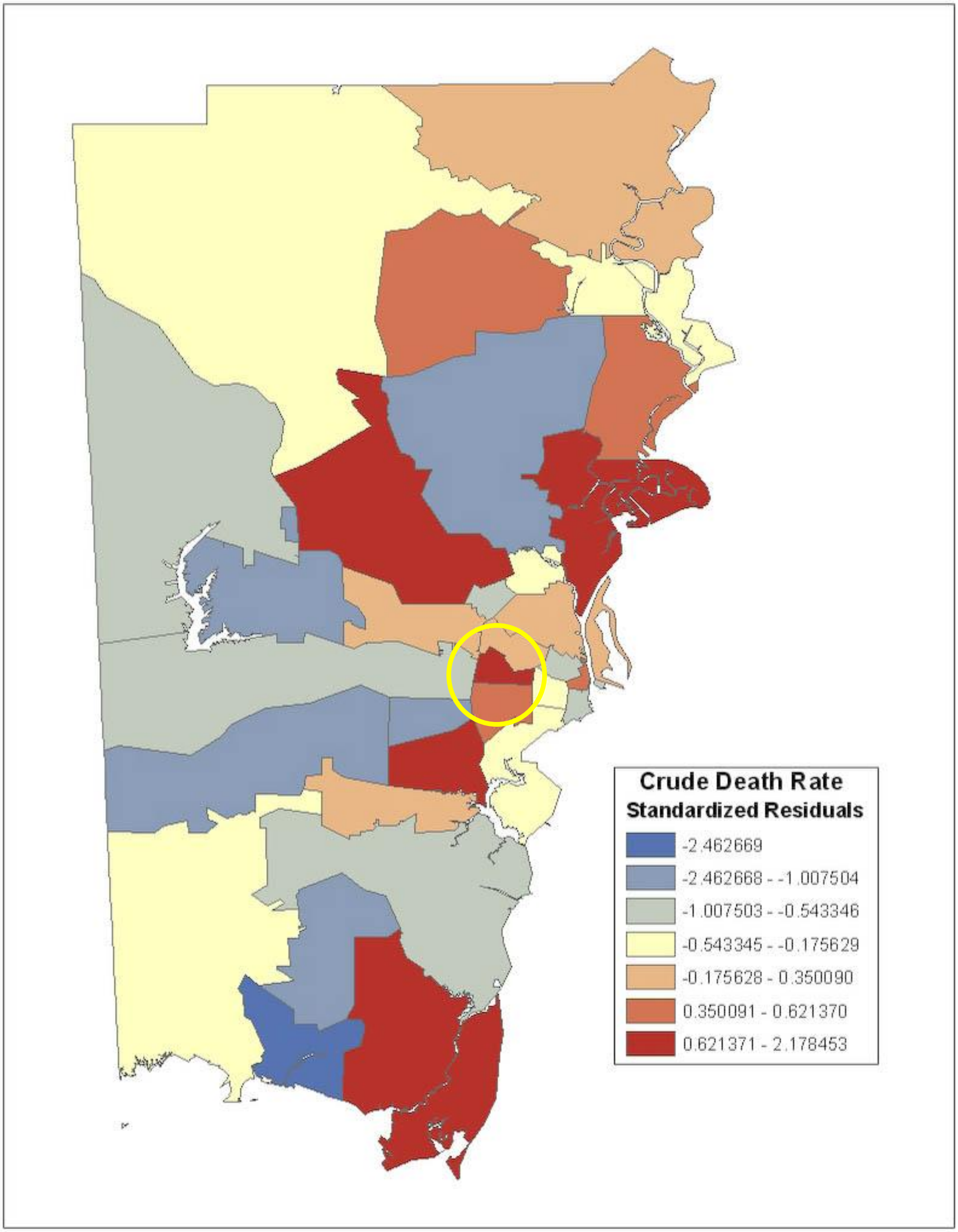


Figure 6.3 Standardized residuals for crude death rate. Map by author.

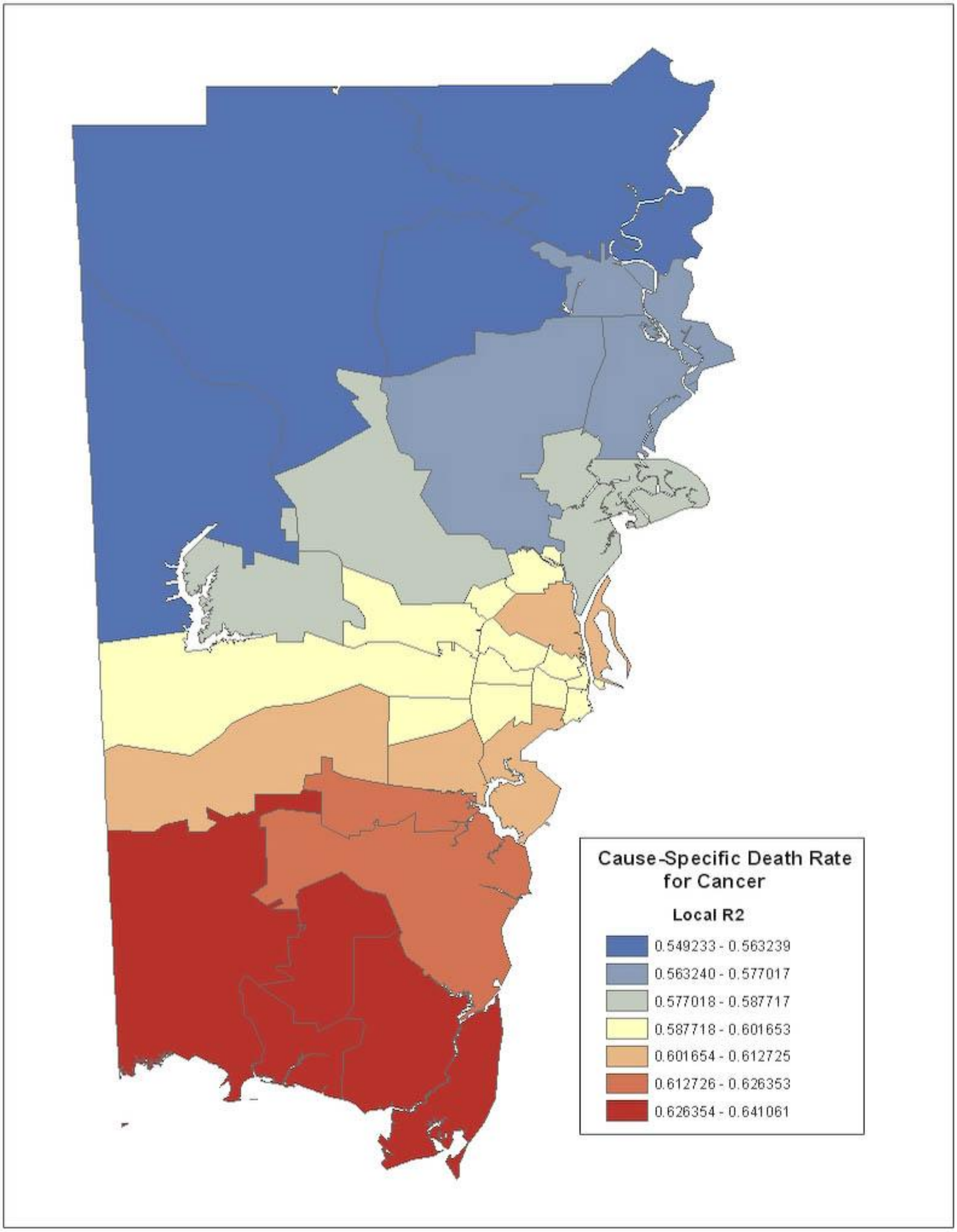


Figure 6.4 Local R^2 values for cause-specific death rate for cancer. Map by author.

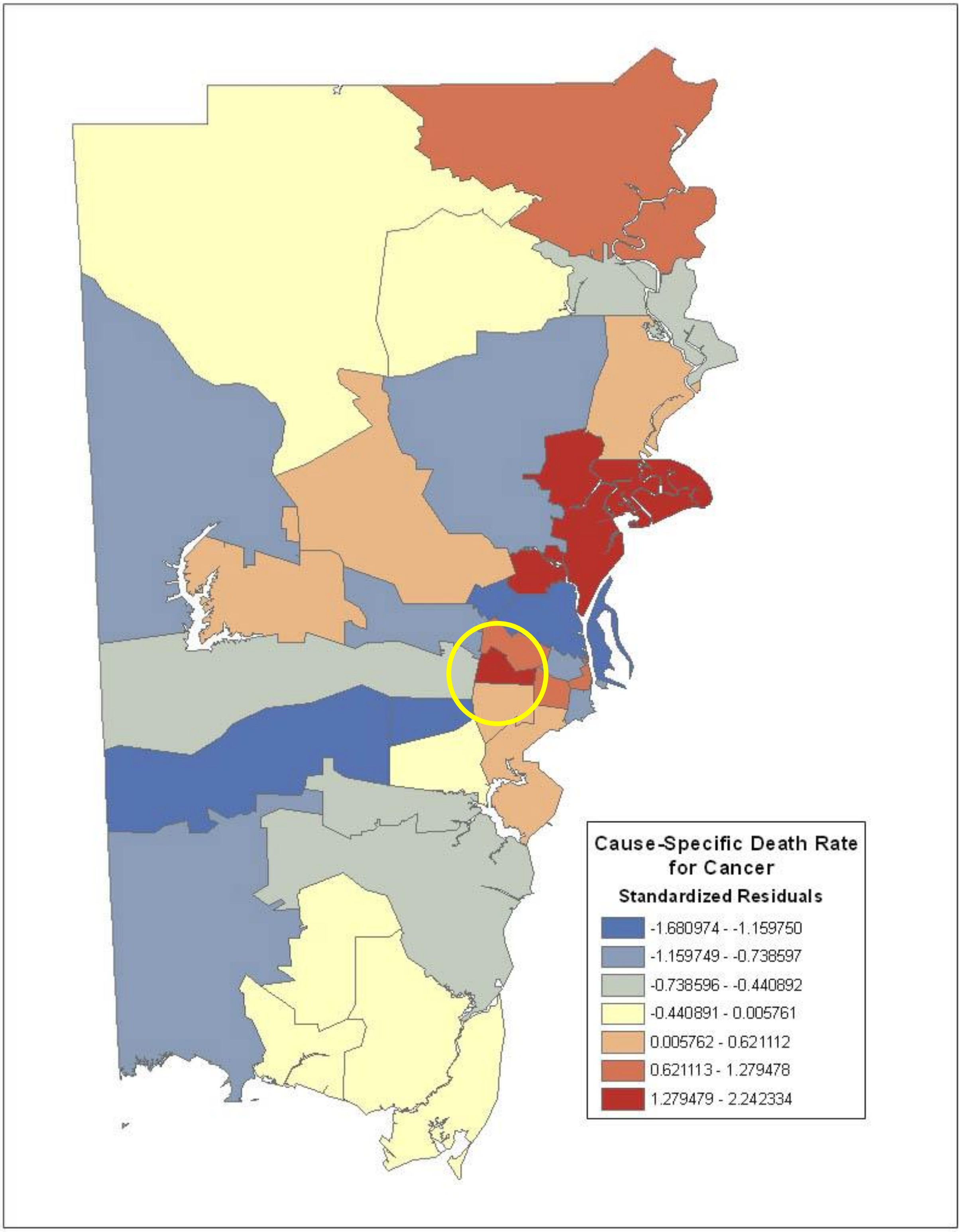


Figure 6.5 Standardized residuals for cause-specific death rate for cancer. Map by author.

death rate for cancer were mapped, revealing no unusually high or low values (Figure 6.5). The two highest residuals for cause-specific cancer death rate were associated with urban ZCTAs 36607 and 36611.

Based on the results of the multiple linear regression analysis, the following equation was developed:

$$HRT_i = \alpha_0 + \alpha_1 POV_i + \alpha_2 EDU_i + \alpha_3 RENT_i + \alpha_4 VAC_i + \alpha_5 AA + \varepsilon_i$$

where HRT_i represents the cause-specific heart disease death rate in each ZCTA; POV is the poverty percentage; EDU is a percentage representing the number of people over 25 who have not completed high school; RENT is the percentage of housing that is renter occupied; VAC is the percentage of vacant housing; and AA is the variable for percent African-American.

The results of the GWR for cause-specific heart disease death rate reveal a R^2 of 0.67 and an adjusted R^2 of 0.50 indicating that the independent variables accounted for 50 percent of the variance for cause-specific heart disease death rate. The values for the observed and predicted cases of cause-specific heart disease death rate can be seen in Table 6.16. The local R^2 values for cause-specific heart disease death rate indicate that the best fit for the model is in the southern part of the county (Figure 6.6). The central corridor and the urban core have R^2 values around 0.60. The global R^2 for this model was 0.526 and the local R^2 was 0.50. Using GWR did not improve this model.

The standardized residuals for cause-specific heart disease death rate were mapped and analyzed to determine if there were any unusually high or low residuals (Figure 6.7). There were not any residuals larger than -3 or +3. The two ZCTAs with the highest standardized residuals were 36607 (urban) and 36613 (suburban). One ZCTA that does stand out in regards to all three

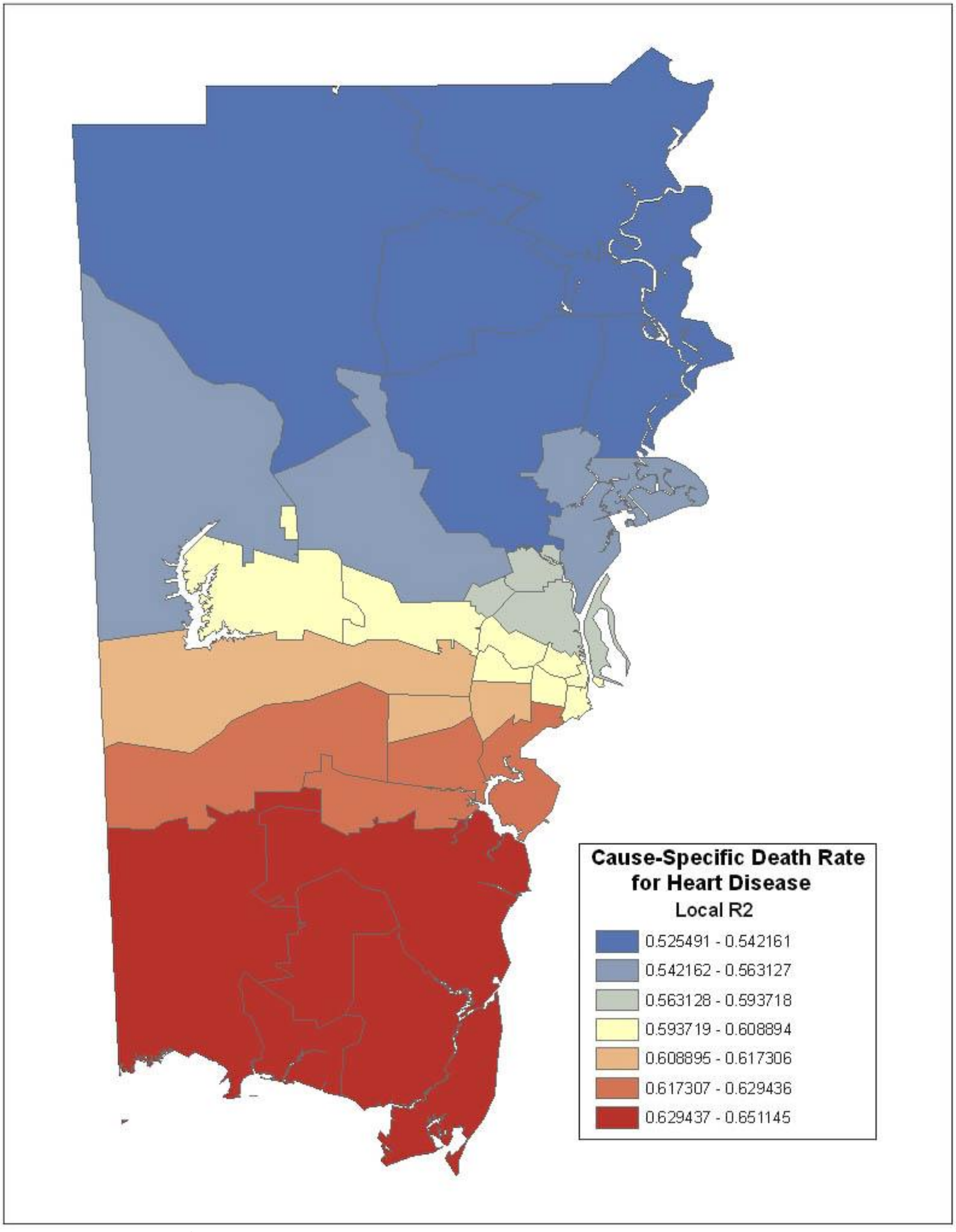


Figure 6.6 Local R^2 values for cause-specific death rate for heart disease. Map by author.

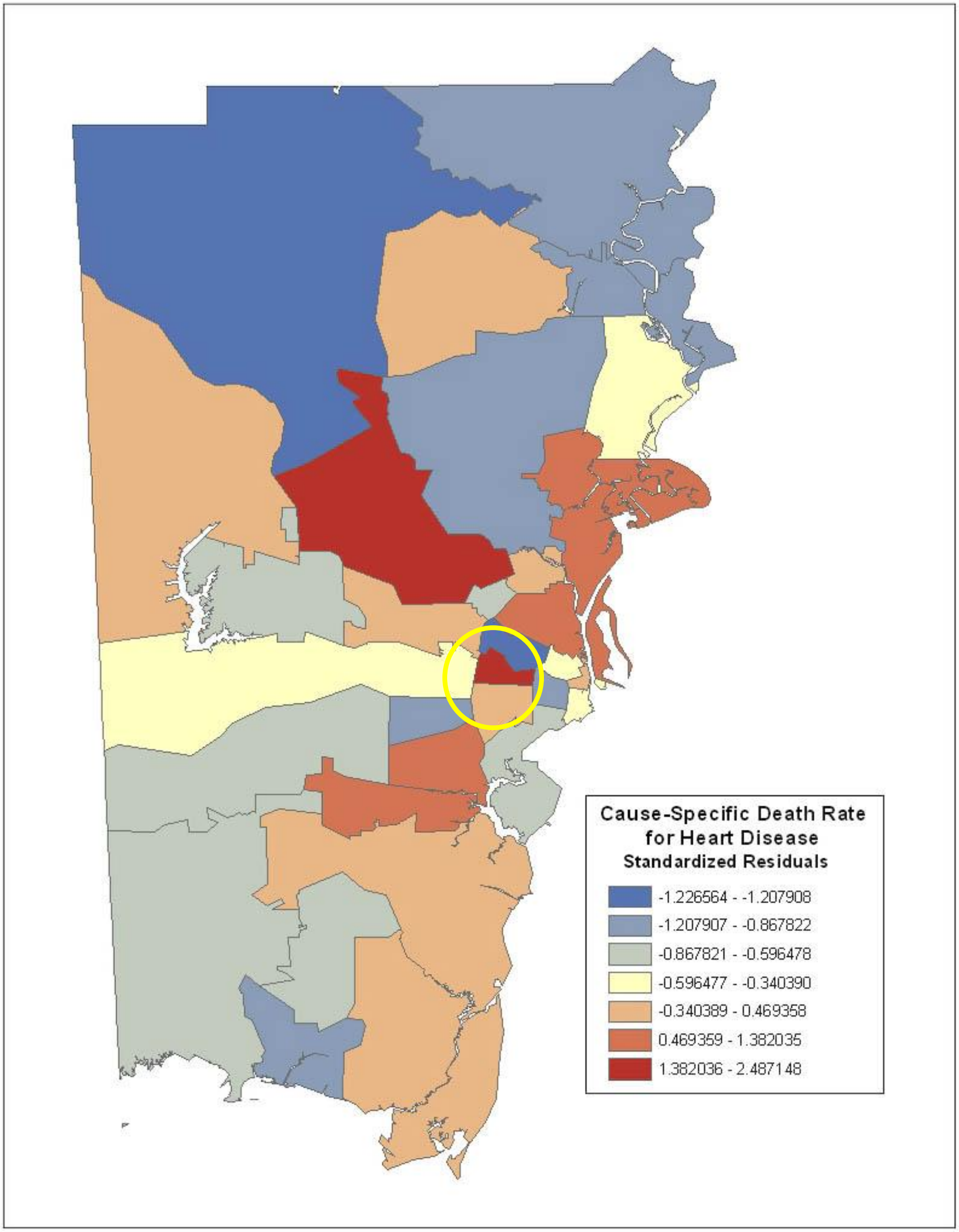


Figure 6.7 Standardized residuals for cause-specific death rate for heart disease. Map by author.

models as having the highest standardized residual is 36607 (circled in yellow in Figures 6.3, 6.5, and 6.7). This ZCTA is under-predicted in every model. It is an urban ZCTA, but it does not exhibit some of the characteristics associated with others in the urban core. This would be one ZCTA to look at further because there is obviously something causing the higher-than-predicted death rates. The ZCTA is surrounded by others that do have large amounts of on-site toxic release, and it is a ZCTA that has an inner urban-like area and an outer, more suburban type of environment.

Though the use of GWR did improve the R^2 for the cause-specific cancer death rate model, it did not reveal any significant differences with the global models in the previous section. Geographically weighted regression, however, does allow for an analysis of the ability of the independent variables to explain the variance of the dependent variable by ZCTA. The local R^2 allows researchers to visualize where the model works best and to consider other characteristics within an areal unit that might help to explain the variance in the dependent variable.

Calculations of the standardized residuals help to identify those areas that are unusually high or low. Mapping of the standardized residuals provides a visual analysis of the data and can help to recognize unusual patterns or distributions. The local coefficient estimates for each variable are also calculated in GWR, and when mapped, provide a visual representation of the ability of a given variable to explain the variance of the dependent variable in the chosen areal unit. Factors likely to impact health in Mobile County were examined through a multilevel analysis. Though more significant variables may be discovered in future research, the analysis of the variables in this study identified a number of characteristics that have a strong relationship to health. The objective of the multilevel analysis was to identify those variables and use them to create a health inequity index.

6.2 The Health Inequity Index

After completing all of the statistical analyses, the independent variables were analyzed to determine significance in defining health in Mobile County. The variables most significant were then used to create the health inequity index for the county. Variables were weighted based on their impact on health in the county. The multilevel analysis approach allowed for the selection of variables that have the greatest impact on health in Mobile County, Alabama. The index can be calculated using the following equation, where HIQ represents health inequity:

$$HIQ = 0.3(POV) + 0.2(EDU) + 0.2(RENT) + 0.2(VAC) + 0.1(TRR)$$

The most important variable in the index is poverty – this variable appeared in all three models and was significant for crude death rate and cause-specific death rate for heart disease. Percent renter occupied also appeared in all three models and was significant for crude death rate and cause-specific death rate for cancer. Educational attainment appeared in two models, crude death rate and cause-specific death rate for heart disease, and was significant in both. Percent vacancy appeared in both the crude death rate and cause-specific death rate for heart disease models. It was not significant in either model, but as a result of the contingency table analysis from the survey, it was identified as having a strong connection to the built environment and health. The toxic release rank was not significant in any of the three strongest models, but it was a key component of the cause-specific death rate for cancer model and was the most important variable of those representing environmental risk.

In order for the toxic release variable to work in the index, a ranking system was developed based on the amount of on-site toxic release in pounds (Table 6.12). The ranked classes were created through the use of GIS. The data for on-site release in pounds was placed into the GIS and then mapped. The natural breaks (Jenks) method was used to create the groupings. ArcMap identifies the break points by locating groups with similar values and maximizing the differences between classes. The features are divided into classes whose boundaries are set where there are large jumps in the data values.

Though percent renter occupied and percent poverty both appear in all three models, poverty was assigned the most weight. Poverty is associated with less education and is the reason why many live in rundown neighborhoods. Those in poverty tend to live in places where vacant buildings are abundant, where industries produce large amounts of on-site toxic release, and where the inability to own a home forces many to rent. For these reasons, and as a result of the regression analyses, poverty was chosen as the variable most likely to impact health. It was determined that percent vacancy, percent renter occupied and educational attainment are all associated with environments conducive to poor health and were weighted evenly in the HIQ.

Table 6.12 On-site toxic release in 2000 for ranking in health inequity index.

On-Site Toxic Release in Pounds Per ZCTA	Rank
0 - 1000	0
1001 - 7348	25
7349 - 51413	50
51414 - 167895	75
> 167896	100

Source: US Environmental Protection Agency (2009).

After completing the ranking for on-site toxic release, the index was calculated for each ZCTA in Mobile County. The health inequity index ranges on a scale from 1 to 100, where 1 would be the lowest and 100 the highest. A higher number denotes areas where health inequality is likely to exist, and as a result, an increased possibility for health inequity. Health inequity is divided into four categories ranging from low HIQ to high HIQ (Table 6.13). The HIQ ranges were calculated by the same method as that used for calculating the breaks for on-site toxic release (natural breaks).

Table 6.13 Index range and classification for health inequity.

Index Range	Classification
0 – 13.64	Low
13.65 – 18.37	Moderate Low
18.38 – 29.45	Moderate High
> 29.45	High

A low classification indicates that health inequality in a given place is likely to be low and intervention is probably not necessary. Locations that fall in the moderate low category may have to contend with some health inequality, but it is likely to be minimal. Health inequality starts to become more noticeable in the moderate high category and places that fall within this classification will typically deal with issues of health inequity. Places in the high category are denoted in red for a reason – they have reached a danger zone where health inequality is evident and health inequity is of greatest concern.

As stated in a previous chapter, health inequity is in many ways a moral dilemma. It must be decided as to what issues associated with health can be identified as unfair and unjust. The idea behind the HIQ is to determine locations that exhibit inequality from the perspective of socioeconomic status, environmental risk, and the built environment. Through the multilevel analysis, variables were selected that revealed a strong relationship between health and socioeconomic status, environmental risk, and the built environment. The end result was the creation of the HIQ index, presenting a possible method for identifying areas that exhibit characteristics conducive to unhealthy places. High HIQ values strongly suggest that a given location be further investigated for issues of health inequality, and potentially health inequity. Though a number of socioeconomic factors contribute to the prevalence of health inequality, many of these are difficult to improve upon without a major societal shift in the perception of equality.

The impetus for societal improvement often begins at the local level. It is at this level where individuals understand best the environments in which they live. If this notion holds true, then local improvements in regards to health should begin with the environments in which people live. From this perspective, the built environment is the key to initiating change and enhancing quality of life. Though it is not certain whether or not a community will revert back to its original state after improvements have been made, efforts must be undertaken to improve life situations.

Table 6.14 shows the results for HIQ in Mobile County and the mapped results are presented in Figure 6.9. The two highest HIQ values are associated with ZCTAs in the urban core. They also exhibit extremely high values in terms of poverty, educational attainment, and renter occupied housing. It is interesting to note that ZCTAs 36603 and 36610 are also associated with facilities whose on-site toxic release is over 100,000 pounds. They are also predominantly African-American (Table 6.15). From the perspective of the built environment, these areas are definitely not conducive to the idea of a healthy place. As far as Mobile County is concerned, these two ZCTAs would be the ones most in need of intervention at this time.

Table 6.14 Health inequity index by ZCTA for Mobile County, Alabama.

	Percent Poverty	Educational Attainment	Toxic Release	Percent Vacancy	Percent Rented		
Zip Code	***0.3**	***0.2**	***0.1**	***0.2**	***0.2**	**HIQ**	**Code**
36505	16.5	30.28	100	7.3	18.81	26.23	R
36509	18.7	38.84	0	9.2	32.45	21.71	S
36521	16	35.81	0	7.7	10.04	15.51	R
36522	14	29.32	0	9.6	20.45	16.07	R
36523	12.7	39.05	0	17.1	16.72	18.38	R
36525	14.9	27.99	0	9.8	19.98	16.02	R
36541	12	29.3	0	6.1	12.87	13.25	R
36544	16	33.14	0	6.1	14.16	15.48	S
36560	14.1	37	0	10.3	14.74	16.64	R
36571	7.8	22.94	50	6.3	23.07	17.8	S
36572	6.7	21.83	0	4.3	10.91	9.42	S
36575	8.5	23.1	0	5.7	12.33	10.78	S
36582	16.1	28.17	100	8.2	22.61	26.63	S
36587	16.8	33.68	0	7.7	12.98	15.91	R
36602	22.7	18.59	0	15.8	78.88	29.45	U
36603	44.5	42.57	100	13	63.7	47.2	U
36604	25.4	21.73	0	15.4	45.5	24.15	U
36605	27.7	26.54	0	9.7	37.72	23.1	U
36606	19	19	0	8.2	40.4	21.68	U
36607	24.7	29.03	25	10.7	47.6	27.38	U
36608	11.2	10.29	25	7.7	40.84	17.63	S
36609	14.7	9.16	0	8.7	49.64	17.91	S
36610	46.5	40.96	100	17.3	52.4	46.08	U
36611	16.2	31.09	75	8	33.1	26.8	U
36612	22.5	31.15	0	10.1	40.73	23.15	U
36613	12.9	28.27	0	6.9	13.67	13.64	S
36617	29.3	35.33	0	8.4	33.19	24.17	U
36618	9.21	17.3	0	4.9	17.07	10.61	S
36619	10	19.1	0	6.9	20.46	12.29	S
36693	5.8	11.1	0	4.4	23.62	9.56	S
36695	6	9.52	0	5.3	21.05	8.98	S

Figure 6.8 Health inequity in Mobile County, Alabama. Map by author.

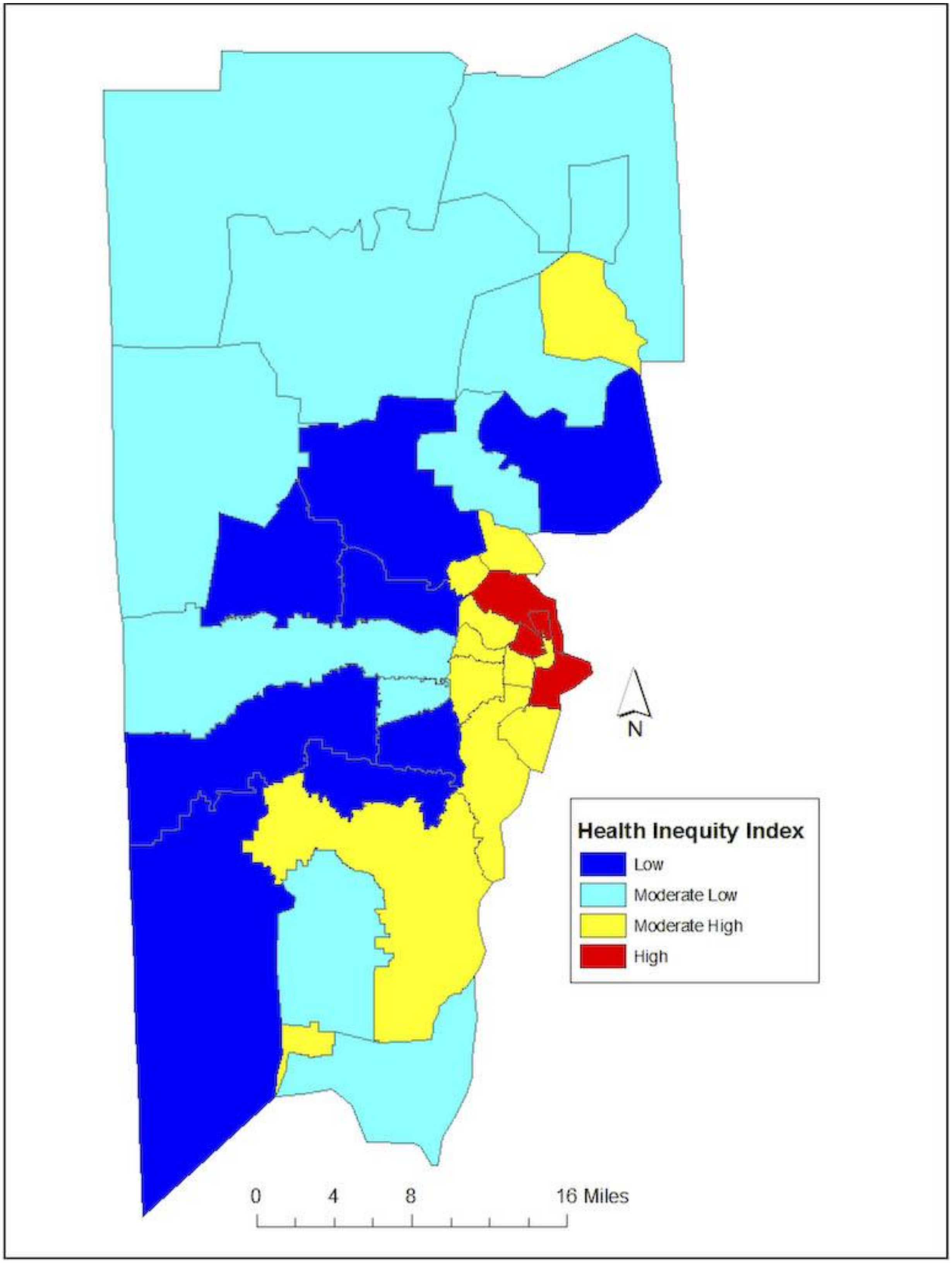


Table 6.15 Percent African-American in ZCTAs with moderate high and high HIQ.

Zip Code	Percent African-American
36505	27
36509	9.52
36523	4.43
36582	13.06
36602	41.98
36603	92.58
36604	53.02
36605	61.11
36606	40.49
36607	58.1
36610	96.26
36611	8.12
36612	87.94
36617	98.52

The moderately high HIQ values are primarily in urban ZCTAs as well. The ZCTAs that have a HIQ over 25 are 36505, 36582, 36602, 36607, and 36611. There are two ZCTAs that are not associated with ZCTAs in the urban core - the suburban ZCTA 36582 and the rural ZCTA 36505. The African-American population in 36582 is 13.06 percent. The population 25 and over that has not completed high school is close to 30 percent. Looking at the built environment variables, the percent vacancy is 8.2 and the percent renter occupied is 22.61. The other characteristic that stands out about this ZCTA is the amount of on-site toxic release. This ZCTA is associated with a number of facilities on the Toxic Release Inventory and their combined on-site release is over 200,000 pounds. In comparison to other suburban ZCTAs, this ZCTA is in the higher range for poverty and educational attainment.

The rural ZCTA of 36505 has an African-American population of 27 percent. The poverty level is 16.5 percent and approximately 30 percent of the population over 25 did not complete high school. Vacancy and renter occupied housing are low to moderate in relation to other ZCTAs in the county. Once again, however, on-site toxic release in this ZCTA exceeds

100,000 pounds. The crude death rates for 36505 and 36582 are on the lower end, but the cause-specific cancer death rate for each is moderate to high. The ZCTAs where HIQ exceeds 25 are generally those that have higher crude death rates. Most are in the higher categories for cause-specific cancer and heart disease death rates as well. There are a few ZCTAs in the low to moderate low range that do have slightly higher crude death rates and cause-specific cancer and heart disease death rates than might be expected. Many of those ZCTAs are located adjacent to ZCTAs with high on-site toxic release and this would be an interesting angle to pursue in future research.

6.3 Rural and Urban Health in Mobile County

One of the objectives of this research was to determine if there was a significant difference in health between the urban and rural regions of the county. The survey data and the mortality data were both used to find out if urban environments were less healthy than rural ones. The initial stage of the analysis involved the use of chi-square to establish possible relationships between urban and rural areas with cancer, respiratory illness, and depression. As stated earlier, the suburban and urban zip codes were combined for this particular analysis. The results revealed no significant difference between rural or urban areas in regards to cancer diagnosis, respiratory illness, or depression. Of the three, however, respiratory illness and the urban environment had the strongest relationship.

In order to gain more insight into this issue based on the survey data, an index was created to compare overall health in relation to urban and rural areas. The index was based on a scale of zero to two. For individuals that answered no to the questions on the diagnosis of cancer, respiratory illness, and depression, a zero was assigned. For those that answered yes to one diagnosis, a one was assigned and for those indicating the diagnosis of more than two illnesses, a two was assigned. Approximately 43 percent of rural respondents indicated that within their families two or more of the selected illnesses were diagnosed. Urban respondents had a much lower percentage for two or more illnesses diagnosed, but the result for one illness diagnosed was much higher (42 percent) than that for rural respondents (Table 6.16).

Table 6.16 Cross-tabulation for survey data for rural/urban comparison of health.

	Rural-Urban Comparison		
	Rural	**Urban**	**Total**
No Illnesses Diagnosed	7 11.7%	53 88.3%	60 100.0%
One Illness Diagnosed	1 2.0%	49 98.0%	50 100.0%
More Than Two Illnesses Diagnosed	6 30.0%	14 70.0%	20 100.0%
Total	14 10.8%	116 89.2%	130 100.0%

Chi-square = 11.749, df = 2, P = 0.003

The multiple linear regression analyses also revealed some significant differences in rural and urban/suburban health. Eberhardt and Pamuk (2004) contend that in order to accurately characterize health disparities across the rural-urban continuum, researchers need to consider measures of urbanization that include a suburban category. The regression models for crude death rate and cause-specific death rate for cancer show that there is a significant difference between urban and suburban ZCTAs (Table 6.7 and 6.8). The regression model for cause-specific death rate for heart disease does not reveal any significant difference between urban, suburban, and rural ZCTAs (Table 6.10).

In order to analyze health between rural and urban ZCTAs, the suburban and urban ZCTAs were collapsed together to represent urban. The urban ZCTAs were assigned a one and the rural ZCTAs were designated as zero. The first model (Table 6.17) shows crude death rate, with a R^2 value of 0.677 indicating that 67.7 percent of the variance in the dependent variable is explained by the independent variables. The adjusted R^2 for this model, 0.596, is actually stronger than the model that compared health between urban, suburban, and rural ZCTAs. The rural-urban zips variable is significant, revealing that crude death rate for urban ZCTAs are higher than rural ZCTAs. The significant variables are the same as in the original model, but they do exhibit a stronger significance.

Table 6.17 Rural-urban comparison for crude death rate.

Independent Variables	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	-2.246	1.592		-1.411	.171
Rural Urban Zips	2.792	.834	.585	3.349	.003
Poverty Percentage	-.222	.071	-.951	-3.142	.004
Educational Attainment	.254	.065	1.052	3.920	.001
Renter Occupied Percentage	.124	.035	.937	3.533	.002
Grocery Store Ratio Area	-1.348	2.053	-.098	-.657	.518
Vacant Housing Percentage	.123	.126	.191	.975	.339

R^2 = 0.596, F = 8.378, < 0.001

The model statistics for the rural-urban comparison of cause-specific death rate for cancer are found in Table 6.18. This model was not as strong as the model that compared urban, suburban, and rural ZCTAs. The adjusted R^2 for this model is 0.404 indicating that 40.4 percent of the variance in the dependent variable is accounted for by the independent variables. The rural-urban zips value is not significant in this model and the only significant variable is the percent renter occupied. In the model used to compare urban, rural, and suburban ZCTAs, the urban zip variable was significant. The toxic release variable does indicate that there is a strong relationship to cause-specific death rate for cancer.

The model for the rural-urban comparison of cause-specific death rate for heart disease is similar in strength to the model comparing urban, suburban, and rural ZCTAs (Table 6.19).

Whereas there was no indication of significance for heart disease in the comparison of urban, suburban and rural in the original regression analysis (Table 6.10), the model below indicates that individuals in urban ZCTAs are more likely to die from heart disease. The significant variables are poverty percentage, vacant housing percentage, and educational attainment. These are the same as those in the stronger model discussed earlier in the chapter.

Table 6.18 Rural-urban comparison of cause-specific death rate for cancer.

	Unstandardized Coefficients		Standardized Coefficients		
Independent Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	1.234	.324		3.813	.001
TRI Release Rank	.312	.182	.307	1.714	.099
Rural Urban Zips	-.218	.310	-.125	-.705	.487
Poverty Percentage	-.008	.020	-.098	-.413	.683
Renter Occupied Percentage	.036	.011	.749	3.282	.003
Grocery Store Ratio	-1.116	.910	-.222	-1.226	.231

R^2 = 0.404, F = 5.071, 0.002

Table 6.19 Rural-urban comparison of cause-specific death rate for heart disease.

	Unstandardized Coefficients		Standardized Coefficients		
Independent Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	-1.122	.949		-1.182	.248
Rural Urban Zips	1.625	.548	.596	2.968	.007
Poverty Percentage	-.098	.043	-.734	-2.288	.031
Vacant Housing Percentage	.243	.067	.662	3.635	.001
Educational Attainment	.081	.031	.586	2.635	.014
Percent African American	.016	.011	.369	1.445	.161

R^2 = 0.501, F = 7.012, < 0.001

The final analysis comparing health in Mobile County involved the use of a one-way between subjects analysis of variance (ANOVA). This test is used when the means of two or more independent groups are compared on a dependent variable of interest. In this case, the dependent variable of interest was the HIQ and the independent groups were rural, urban, and suburban. The *p*-value was less than 0.05, so the null hypothesis assuming the variances are not equal in the population was rejected, indicating that at least one of the comparisons between rural, urban, and suburban health was different from the others. Using the conservative Bonferroni post hoc procedure, it was concluded that there is a significant difference between rural-urban HIQ and between suburban-urban HIQ.

Table 6.20 Output for one-way between subjects ANOVA.

	N	Mean	Std. Deviation
Rural	8	17.2513	3.89171
Urban	10	28.3160	9.92427
Suburban	13	14.8031	5.37337
Total	31	19.7939	9.01980

F(2, 28) = 11.521, p < 0.001 Bonferroni post hoc procedure indicated that there was a significant difference between urban-rural and urban-suburban.

The statistical analysis of the comparison between rural and urban areas in regards to crude death rate, cause-specific death rate for cancer, and cause-specific death rate for heart disease does reveal a pattern that tends to indicate that those in the urban ZCTAs of Mobile County are likely to deal with more health issues than those in rural ZCTAs. Some research indicates that health in rural areas is worse than that in urban areas, but in the analysis of Mobile County, this is not the case (Levin and Leyland 2006). With the realization that income inequality is not likely to be solved in the near future, how should developed countries proceed in attempting to alleviate or eliminate health inequality and the inequities associated with it? This question is discussed in the following chapter.

CHAPTER 7 - Health Inequity, the Built Environment, and Environmental Justice

Engels (1872, 40) remarked that

> …the so-called 'poor districts' in which the workers are crowded together are the breeding places of all those epidemics which from time to time afflict our towns… Capitalist rule cannot allow itself the pleasure of generating epidemic diseases among the working class with impunity; the consequences must fall back on it and the angel of death rages in its ranks as ruthlessly as in the ranks of the workers.

Though Engels was making his observations in 1872, he understood the relationship between housing, and for that matter, the built environment and health in the cities of his time. Many of the diseases Engels wrote about have been virtually eliminated in urban centers of developed countries, but there still exists a gap in overall health between those in poorer communities and those in more affluent neighborhoods (Dunn 2000).

Attempting to make the association between health and the built environment has been around for a long time. It is definitely much easier to identify health problems and make connections between poor health and substandard environments than it is to fix them (Bashir 2002). In developed countries, there is still a major 'housing question' in regards to health (Dunn 2000). More than five million families and over four million children are living in substandard housing in the United States. This housing is often in horrible condition, and yet many Americans can barely afford it (Bashir 2002). In many of these houses and apartments there are a number of harmful biological and chemical contaminants. One of the negative consequences of substandard housing is the increasing incidence of asthma. Between 1982 and 1994, the number of children impacted increased 70 percent (Bashir 2002).

One of the goals of public health is to improve average health status in a given population and to attempt to reduce health inequalities and inequities between groups and individuals (Brulde 2008). Elected officials and community residents realize that substandard housing is an important issue of social justice – it is an inequity that influences health (Krieger and Higgins 2002). Thompson Fullilove (2000) stated, "…shelter is a fundamental necessity. Whether they find it in caves, teepees, igloos, straw huts, or mansions, people need a place to live" (p. 183). This shelter is significant for health from both a physical and psychosocial perspective. If housing is a significant factor in health, then so too are communities as a whole.

This research holds to the traditional focus on area of residence to explore geographical health inequalities. The results are likely to underestimate the migratory character of urban life. They do, however, highlight a number of potential associations between the built environment and health. This is important in the context of health/medical geography because it definitely indicates that geographers can contribute significantly to the understanding of where and why health inequality exists. Physical and emotional characteristics contribute to the quality of life, and together, both of these relate to the health-related quality of life (Torrance 1987).

The perception of residents in Mobile County, Alabama, in regards to health shows how the concept of place-identity can have importance in understanding the psychology of health. Do residents consider health issues to be a problem in their neighborhoods? This question is considered in the following section through survey results based on variables dealing with socioeconomic status, diagnosis of illness, and the built environment. An individual's perception of their community can positively or negatively impact their views on neighborhood health and a great deal of their impression is associated with the environment in which they live – the built environment.

For about three decades, the environmental justice movement has sought to reduce the unequal burden of toxic exposure in low income and minority neighborhoods. Though this is a worthy cause, it has had limited success in rallying individuals together to fight for healthier communities. Jerrett et al. (2001) noted that environmental justice research has tended to focus on the spatial inequality of exposure. The notion that minority and low income individuals bear the burden of exposure is generally accepted today. However, many in those communities affected do not realize the severity of the exposure and its potential impact on health. If health becomes the focus, and areas of poor health are identified, then the impact of the built environment on health is more likely to be realized. As a result, it may be logical for the environmental justice movement to focus on identifying areas of poor health and fighting for improvements in the built environments of those communities.

7.1 Health, Perception, and the Built Environment

This research does support the notion that poor physical environments impact health. Can an individual's perception of their environment also influence their health? Ellaway, Macintyre, and Kearns (2001) note that health inequalities are often the product of *perceptions*, particularly in regards to relative income. For those at the lower end of the economic scale, this can produce negative emotions that ultimately translate into poor health at the individual level (Ellaway, Macintyre, and Kearns 2001). Though this research does not go into great depth into the psychosocial impact of health, residents of Mobile County were asked if they believed health problems to be an issue in their neighborhood. In order to gain some insight on individual perception and health, a number of socioeconomic characteristics and components of the built environment were evaluated in the context of the above question.

The respondents that lived in the same house for over 30 years were more likely to agree with the statement that there were health issues in their neighborhood (35.7 percent). Those that lived in the same house for 11 to 30 years were much less likely to agree with the statement (Table 7.1). It was interesting that 15.7 percent of those that had been in their residence for less than 10 years believed that health issues were a problem.

Table 7.1 Perception of neighborhood health based on years at present address.

			Years at Address				**Total**
			0 - 10 Years	**11 - 20 Years**	**21 - 30 Years**	**> 30 Years**	
Health Issues are a Problem	Strongly Disagree	Count	20	11	8	1	40
		% Health Issues are a Problem	50.0%	27.5%	20.0%	2.5%	100.0%
	Mildly Disagree	Count	12	4	2	0	18
		% Health Issues are a Problem	66.7%	22.2%	11.1%	.0%	100.0%
	Neither Agree nor Disagree	Count	27	13	3	8	51
		% Health Issues are a Problem	52.9%	25.5%	5.9%	15.7%	100.0%
	Mildly Agree	Count	8	1	1	3	13
		% Health Issues are a Problem	61.5%	7.7%	7.7%	23.1%	100.0%
	Strongly Agree	Count	3	3	0	2	8
		% Health Issues are a Problem	37.5%	37.5%	.0%	25.0%	100.0%
Total		Count	70	32	14	14	130
		% Health Issues are a Problem	53.8%	24.6%	10.8%	10.8%	100.0%

Chi-square = 17.682, df = 12, P = 0.126

Income was another good indicator of how individuals felt about their neighborhoods in regards to health (Table 7.2). Approximately 46 percent of those with an income of less than $20,000 agreed to some extent that health issues were a problem. The other two income groups were much less likely to agree with the statement. In regards to age, 12.5 percent of the individuals under 45 mildly agreed with the statement and 18.3 percent of those over 45 agreed to some extent that health issues were evident (Table 7.3). Though there was a strong indication that those with incomes less than $20,000 tended to agree that health issues were a problem in their neighborhood, researchers do need to take into consideration the fact that people dealing with poor health are more likely to be negative about the areas in which they live (Ellaway, Macintyre, and Kearns 2001). Further investigation of self-assessed neighborhoods of poor health will allow for the determination of whether or not health inequality exists.

Table 7.2 Perception of neighborhood health based on income.

			Household Income			Total
			Less than $20,000	**$20,000 - $75,000**	**More than $75,000**	
Health Issues are a Problem	Strongly Disagree	Count	1	27	12	40
		% Health Issues are a Problem	2.5%	67.5%	30.0%	100.0%
	Mildly Disagree	Count	0	15	3	18
		% Health Issues are a Problem	.0%	83.3%	16.7%	100.0%
	Neither Agree nor Disagree	Count	6	33	12	51
		% Health Issues are a Problem	11.8%	64.7%	23.5%	100.0%
	Mildly Agree	Count	2	8	3	13
		% Health Issues are a Problem	15.4%	61.5%	23.1%	100.0%
	Strongly Agree	Count	4	3	1	8
		% Health Issues are a Problem	50.0%	37.5%	12.5%	100.0%
Total		Count	13	86	31	130
		% Health Issues are a Problem	10.0%	66.2%	23.8%	100.0%

Chi-square = 20.71, df = 8, P = 0.008

Table 7.3 Perception of neighborhood health based on age.

			Age		Total
			Under 45	Over 45	
Health Issues are a Problem	Strongly Disagree	Count	15	25	40
		% Health Issues are a Problem	37.5%	62.5%	100.0%
	Mildly Disagree	Count	5	13	18
		% Health Issues are a Problem	27.8%	72.2%	100.0%
	Neither Agree nor Disagree	Count	22	29	51
		% Health Issues are a Problem	43.1%	56.9%	100.0%
	Mildly Agree	Count	6	7	13
		% Health Issues are a Problem	46.2%	53.8%	100.0%
	Strongly Agree	Count	0	8	8
		% Health Issues are a Problem	.0%	100.0%	100.0%
Total		Count	48	82	130
		% Health Issues are a Problem	36.9%	63.1%	100.0%

Chi-square = 6.65, df = 4, P = 0.155

In the survey, residents were asked if anyone in their current residence had been diagnosed with depression, respiratory illness, or cancer. It is interesting to consider how the diagnosis of an illness affects the perception of neighborhood health. Of those that answered yes to the diagnosis of depression, 54 percent did not view health issues as a problem in their neighborhood, while 16.2 percent agreed to some extent that they are (Table 7.4). Of those not diagnosed with depression, 38 percent did not view health issues as a problem, while approximately 15 percent did. Many of the respondents (43%) that answered no to the question of depression diagnosis were also more likely to neither agree nor disagree with the statement.

Table 7.4 Perception of neighborhood health based on diagnosed depression.

			Depression Diagnosed		Total
			Yes	No	
Health Issues are a Problem	Strongly Disagree	Count	10	30	40
		% Health Issues are a Problem	25.0%	75.0%	100.0%
	Mildly Disagree	Count	10	8	18
		% Health Issues are a Problem	55.6%	44.4%	100.0%
	Neither Agree nor Disagree	Count	11	40	51
		% Health Issues are a Problem	21.6%	78.4%	100.0%
	Mildly Agree	Count	2	11	13
		% Health Issues are a Problem	15.4%	84.6%	100.0%
	Strongly Agree	Count	4	4	8
		% Health Issues are a Problem	50.0%	50.0%	100.0%
Total		Count	37	93	130
		% Health Issues are a Problem	28.5%	71.5%	100.0%

Chi-square = 10.83, df = 4, P = 0.029

In terms of respiratory illness, respondents who had a family member diagnosed were more likely to agree that health issues were a problem in their neighborhood (Table 7.5). Approximately 27 percent of those respondents agreed with the statement, while 45 percent disagreed. Of those respondents that did not have a family member diagnosed with respiratory illness, only 12.6 percent felt that health issues were a problem in their neighborhood. Approximately 44 percent of the same group of respondents disagreed with the statement. They were also less likely to agree or disagree in general (43.2 percent).

Table 7.5 Perception of neighborhood health based on respiratory illness diagnosed.

			Respiratory Illness Diagnosed		
			Yes	No	Total
Health Issues are a Problem	Strongly Disagree	Count	9	31	40
		% Health Issues are a Problem	22.5%	77.5%	100.0%
	Mildly Disagree	Count	7	11	18
		% Health Issues are a Problem	38.9%	61.1%	100.0%
	Neither Agree nor Disagree	Count	10	41	51
		% Health Issues are a Problem	19.6%	80.4%	100.0%
	Mildly Agree	Count	5	8	13
		% Health Issues are a Problem	38.5%	61.5%	100.0%
	Strongly Agree	Count	4	4	8
		% Health Issues are a Problem	50.0%	50.0%	100.0%
Total		Count	35	95	130
		% Health Issues are a Problem	26.9%	73.1%	100.0%

Chi-square = 6.14, df = 4, P = 0.189

One of the more interesting images of the perception of neighborhood health is that of residences where a family member had been diagnosed with cancer (Table 7.6). Approximately 18 percent of the respondents answered yes to the diagnosis of cancer. Of those, only 8.6 percent agreed that health issues were a problem in their neighborhood, while 26.1 percent strongly disagreed. The majority of the individuals that mildly or strongly agreed (17.8 percent) that neighborhood health issues were a problem did not have any family members diagnosed with cancer. Of the 23 respondents that answered yes to the diagnosis of cancer, 22 were covered by health insurance and the lone non-insured respondent did not agree or disagree that health issues were a problem.

Table 7.6 Perception of neighborhood health based on diagnosed cancer.

			Cancer Diagnosed		**Total**
			Yes	**No**	
Health Issues are a Problem	Strongly Disagree	Count	6	34	40
		% Health Issues are a Problem	15.0%	85.0%	100.0%
	Mildly Disagree	Count	3	15	18
		% Health Issues are a Problem	16.7%	83.3%	100.0%
	Neither Agree nor Disagree	Count	12	39	51
		% Health Issues are a Problem	23.5%	76.5%	100.0%
	Mildly Agree	Count	2	11	13
		% Health Issues are a Problem	15.4%	84.6%	100.0%
	Strongly Agree	Count	0	8	8
		% Health Issues are a Problem	.0%	100.0%	100.0%
Total		Count	23	107	130
		% Health Issues are a Problem	17.7%	82.3%	100.0%

Chi-square = 3.173, df = 4, P = 0.529

Brown (2003) notes that illnesses that result from contaminated communities are almost all detected by members of the community who have been affected. Scientists and government agencies do not typically carry out routine surveillance and though cancer registries are mandated to publish reports of cancer excesses, they do not have to notify the cities or towns where this occurs. Though a number of lay cancer cluster reports have been submitted in recent years, health departments usually make it difficult for the situations to be investigated. They often respond to informants by giving a "…routine response emphasizing the lifestyle causes of cancer, the fact that one of three Americans will develop some form of cancer, and that clusters occur at random" (Brown 2003, 1790). From this perspective, it is not surprising that many diagnosed with cancer do not attribute their illness to the environment. For them, it is more likely a result of genetics and lifestyle.

Another interesting comparison considered the number of illnesses diagnosed in each family and how that impacted their view of neighborhood health (Table 7.7). Respondents who answered yes to all three types of diagnosis were more likely to agree to some extent that health issues were a problem (20 percent). Approximately 18 percent of those who had a family member diagnosed with at least one illness also agreed with the statement. Only 11 percent of the respondents with no diagnosis agreed and they were much more likely to strongly disagree with the statement (40 percent). However, those respondents that answered yes to all the questions on the diagnosis of disease were also hesitant to accept the fact that they might live in an unhealthy neighborhood.

Table 7.7 Perception of neighborhood health based on number of diagnosed illnesses.

			Health Index			
			No Illnesses Diagnosed	**One Illness Diagnosed**	**More Than Two Illnesses Diagnosed**	**Total**
Health Issues are a Problem	Strongly Disagree	Count	24	10	6	40
		% Health Issues are a Problem	60.0%	25.0%	15.0%	100.0%
	Mildly Disagree	Count	5	7	6	18
		% Health Issues are a Problem	27.8%	38.9%	33.3%	100.0%
	Neither Agree nor Disagree	Count	23	24	4	51
		% Health Issues are a Problem	45.1%	47.1%	7.8%	100.0%
	Mildly Agree	Count	5	7	1	13
		% Health Issues are a Problem	38.5%	53.8%	7.7%	100.0%
	Strongly Agree	Count	3	2	3	8
		% Health Issues are a Problem	37.5%	25.0%	37.5%	100.0%
Total		Count	60	50	20	130
		% Health Issues are a Problem	46.2%	38.5%	15.4%	100.0%

Chi-square = 16.031, df = 8, P = 0.042

One issue of concern in the use of qualitative data revolves around lay concepts of health and illness. Often, there is a reluctance of people living in poor communities to accept the notion that health inequality exists. By doing so, individuals have to accept that the places and the people living in them are disadvantaged and this can be difficult (Popay et al. 2003). Popay et al.

(2003) also note that many respondents do provide detailed accounts of living in difficult places, indicating that they do realize that inequalities exist in their neighborhoods.

Over 50 percent of the respondents whose families were insured did not feel that health issues were a concern in their neighborhood (Table 7.8). For those not insured, approximately 23 percent disagreed with the statement. Approximately 31 percent of the uninsured respondents did believe that health issues were a problem. It is interesting to note that respondents who indicated that a family member had been diagnosed with a respiratory illness were less likely to have health insurance (54 percent). Those families where a member was diagnosed with depression were also less likely to have health insurance.

Table 7.8 Perception of neighborhood health based on health insurance status.

			Health Insurance		
			Yes	**No**	**Total**
Health Issues are a Problem	Strongly Disagree	Count	38	2	40
		% Health Issues are a Problem	95.0%	5.0%	100.0%
	Mildly Disagree	Count	17	1	18
		% Health Issues are a Problem	94.4%	5.6%	100.0%
	Neither Agree nor Disagree	Count	45	6	51
		% Health Issues are a Problem	88.2%	11.8%	100.0%
	Mildly Agree	Count	12	1	13
		% Health Issues are a Problem	92.3%	7.7%	100.0%
	Strongly Agree	Count	5	3	8
		% Health Issues are a Problem	62.5%	37.5%	100.0%
Total		Count	117	13	130
		% Health Issues are a Problem	90.0%	10.0%	100.0%

Chi-square = 8.482, df = 4, P = 0.075

In comparing rural and urban responses in the county, those in urban areas were slightly more likely to agree to some extent that health issues were a problem in their neighborhoods

(Table 7.9). Those in rural areas, for the most part, strongly disagreed (50 percent). Though rural respondents tended to consider their neighborhoods healthy as a whole, approximately 14 percent strongly agreed that problems existed. This is interesting in comparison to urban zip codes where only 6.2 percent strongly agreed. The major difference between rural and urban areas was that a number of respondents in urban zip codes mildly agreed with the statement, while those in rural zip codes either strongly agreed or strongly disagreed.

Table 7.9 Perception of neighborhood health based on rural or urban residence.

			Rural-Urban Comparison		**Total**
			Rural	**Urban**	
Health Issues are a Problem	Strongly Disagree	Count	7	33	40
		% Health Issues are a Problem	17.5%	82.5%	100.0%
	Mildly Disagree	Count	0	18	18
		% Health Issues are a Problem	.0%	100.0%	100.0%
	Neither Agree nor Disagree	Count	5	46	51
		% Health Issues are a Problem	9.8%	90.2%	100.0%
	Mildly Agree	Count	0	13	13
		% Health Issues are a Problem	.0%	100.0%	100.0%
	Strongly Agree	Count	2	6	8
		% Health Issues are a Problem	25.0%	75.0%	100.0%
Total		Count	14	116	130
		% Health Issues are a Problem	10.8%	89.2%	100.0%

Chi-square = 7.363, df = 4, P = 0.118

The questions on the survey dealing with the built environment tended to reveal more about urban zip codes. As a result, it is likely that the built environment has more of an impact on individuals living in urban areas, while other factors may be more important to those living in rural communities. Phillips and McLeroy (2004) and Hartley (2004) note that a great deal of health research in rural areas is deeply rooted in concerns about access to health care and the equitable distribution of health professionals. They also contend that rural health problems such as obesity, tobacco use, and the failure to use seat belts are not likely to be impacted by an increased presence of general practitioners and physician specialists. The focus of this research was on the built environment and this may be the primary reason why comparisons between rural and urban zip codes in Mobile County indicated that those in urban areas were likely to suffer more from poor health.

In terms of proximity to a four-lane road, those respondents closer to a four-lane road were slightly more likely to agree to some extent that health issues were a problem (Table 7.10). In the survey, there were four possible choices for proximity to a four-lane road: on a main road, one to two blocks away, three to four blocks away, and more than five blocks away. Those that were three to four blocks away were the most likely to agree with the statement (37 percent). Respondents on a major road tended to disagree (36 percent) and they were also less likely in general to agree or disagree with the statement. Respondents more than five blocks away from a major road were likely to strongly disagree with the statement (46 percent). Only 14 percent of those more than five blocks away agreed to some extent that health issues were a problem in their communities.

Table 7.10 Perception of neighborhood health based on proximity to a four-lane road.

			Proximity to Four-Lane Road				
			On a Major Road	**1 - 2 Blocks Away**	**3 - 4 Blocks Away**	**>5 Blocks Away**	**Total**
Health Issues are a Problem	Strongly Disagree	Count % Health Issues are a Problem	1 2.5%	12 30.0%	4 10.0%	23 57.5%	40 100.0%
	Mildly Disagree	Count % Health Issues are a Problem	4 22.2%	11 61.1%	2 11.1%	1 5.6%	18 100.0%
	Neither Agree nor Disagree	Count % Health Issues are a Problem	8 15.7%	18 35.3%	6 11.8%	19 37.3%	51 100.0%
	Mildly Agree	Count % Health Issues are a Problem	0 .0%	3 23.1%	6 46.2%	4 30.8%	13 100.0%
	Strongly Agree	Count % Health Issues are a Problem	1 12.5%	3 37.5%	1 12.5%	3 37.5%	8 100.0%
Total		Count % Health Issues are a Problem	14 10.8%	47 36.2%	19 14.6%	50 38.5%	130 100.0%

Chi-square = 30.397, df = 12, P = 0.002

Using the same categories as those used for proximity to a four-lane road, proximity to a bus stop was analyzed to determine if there were any relationships with perception of health (Table 7.11). Respondents more than five blocks away from a bus stop tended to disagree with the statement on health issues (50 percent). Only 15 percent agreed to some extent that health issues were a concern in their neighborhoods. The ones most likely to agree with the statement were three to four blocks away from a bus stop (31 percent).

Table 7.11 Perception of neighborhood health based on proximity to a bus stop.

			Proximity to a Bus Stop				
			<1 Block	1 - 2 Blocks Away	3 - 4 Blocks Away	>5 Blocks Away	Total
Health Issues are a Problem	Strongly Disagree	Count	6	5	4	25	40
		% Health Issues are a Problem	15.0%	12.5%	10.0%	62.5%	100.0%
	Mildly Disagree	Count	8	4	1	5	18
		% Health Issues are a Problem	44.4%	22.2%	5.6%	27.8%	100.0%
	Neither Agree nor Disagree	Count	12	14	4	21	51
		% Health Issues are a Problem	23.5%	27.5%	7.8%	41.2%	100.0%
	Mildly Agree	Count	2	2	3	6	13
		% Health Issues are a Problem	15.4%	15.4%	23.1%	46.2%	100.0%
	Strongly Agree	Count	4	0	1	3	8
		% Health Issues are a Problem	50.0%	.0%	12.5%	37.5%	100.0%
Total		Count	32	25	13	60	130
		% Health Issues are a Problem	24.6%	19.2%	10.0%	46.2%	100.0%

Chi-square = 18.31, df = 12, P = 0.107

Another aspect of the built environment that revealed a relationship with health was vacant buildings (Table 7.12). Those respondents that indicated vacant buildings were not present in their neighborhood were more likely to disagree with the statement (47 percent). Of those respondents who answered yes to the presence of vacant buildings, approximately 40 percent disagreed with the statement. Respondents who answered no to the presence of vacant buildings tended to agree more with the statement (18 percent) than those who answered yes. It is interesting to note that 50 percent of those that responded yes to the presence of vacant buildings neither agreed nor disagreed with the statement.

Table 7.12 Perception of neighborhood health based on vacancy.

			Vacant Buildings		
			Yes	**No**	**Total**
Health Issues are a Problem	Strongly Disagree	Count	11	29	40
		% Health Issues are a Problem	27.5%	72.5%	100.0%
	Mildly Disagree	Count	6	12	18
		% Health Issues are a Problem	33.3%	66.7%	100.0%
	Neither Agree or Disagree	Count	21	30	51
		% Health Issues are a Problem	41.2%	58.8%	100.0%
	Mildly Agree	Count	4	9	13
		% Health Issues are a Problem	30.8%	69.2%	100.0%
	Strongly Agree	Count	1	7	8
		% Health Issues are a Problem	12.5%	87.5%	100.0%
Total		Count	43	87	130
		% Health Issues are a Problem	33.1%	66.9%	100.0%

Chi-square = 3.635, df = 4, P = 0.458

The survey results did indicate that there were some relationships between health, socioeconomic status, and the built environment. It should also be noted that information obtained through surveys can be extremely valuable in research on the built environment and health. With a larger response rate, particularly in minority and low income ZCTAs, results would likely be more conclusive in identifying those characteristics that individuals perceive to be significant in affecting neighborhood health. Though more research needs to be conducted in order to truly understand the complex nature of health determinants, the built environment does appear to have an impact on health. Though some argue that the redistribution of wealth is the way to alleviate health inequality in developed countries, it is probably more realistic to push for improvements in the built environments of poor communities (Wilkinson 2005).

7.2 The Built Environment: Unfair and Unjust?

Studies that incorporate larger scales, such as those at the state, national, and global level, allow researchers to compare socioeconomic characteristics across populations and determine those that influence health. Environmental risk factors and the built environment are more difficult to analyze using larger areal units. Studies at the local level definitely provide more insight about health in a given place (Murray, Gakidou, and Frenk 1999). This research has strengthened the notion that place matters when it comes to health. Health varies across space and, as a result, studies of health at the local level will enhance the decision-making capability of policymakers and planners as they seek to improve communities in need.

Boyle (2004) and Connolly, O'Reilly, and Rosato (2007) have contended that many cross-sectional studies conducted at two different points in time can be problematic because population migration is often ignored. If this is the case, then it is all the more important to study health in a given time and in a specific place. They argue that those living in disadvantaged areas that became ill or died prematurely may not have resided in their neighborhoods long enough for the environment to affect their health. Though migration may have an impact in neighborhoods where the social gradient in health is widening, one cannot infer that the built environment does not have some bearing on health.

If human well-being is one of the core purposes of government and human health is an important component of well-being, then solutions must be found to decrease the gap in health inequality in the United States (Perdue, Gostin, and Stone 2003). Though some may argue that access to health care and health behaviors are more significant in the determination of health, social and economic characteristics of individuals and populations are now becoming the focus of research and their impacts on health realized (Dunn 2000). The concept of 'population health,’ which focuses on socio-economic influences on health, is widely used in studies of health inequality in Canada (Dunn 2000).

The explanations of lack of health care, diet, physical activity, and genetics can no longer account for the health gaps noted between poor whites and rich white Americans (Robinson 2007). The U.S. spends more on health care than any nation in the world, and yet, in terms of health indicators, they are at the bottom of the 30 countries that make up the Organization for Economic Co-operation and Development (OECD). Robinson (2004) contends that health care does matter, but access to medical treatment cannot explain all of the patterns observed.

Easterlow, Smith, and Mallinson (2000), note that healthy housing policy has been a key concern for the public health movement since the end of the 19th century. From their perspective, the lack of progress over the last 100 years indicates that society is still a long way from achieving a healthy housing policy. If unhealthy housing and environments are here to stay, then policy should at least take into consideration those people with health problems and mobility needs. This idea of ‘medical’ rehousing has been an effective health intervention in England. When individuals move into healthier housing and cleaner environments, they tend to have reduced symptoms and better access to health care professionals (Easterlow, Smith, and Mallinson 2000).

Resnik and Roman (2007) state that bioethical accounts of justice in health should focus on the impact of an environmental factor on health inequality and assess the practicality of a developed intervention strategy to address the inequality. “This can be seen most clearly in the physical fabric of places and the physical fabric is the most obvious and immediate direct determinate of public health” (Tunstall, Shaw, and Dorling 2004, 8). Wilkinson (1996) contends that poor housing and environmental conditions intensify the stress associated with being at the bottom of the socioeconomic ladder. As a result, those living in poor built environments tend to be more susceptible to a wide range of health problems.

Resnik and Roman (2007) noted that it is difficult to argue against reducing poverty and economic inequality. They also contended, however, that it is more difficult to reduce income inequalities and poverty than it is to develop new drugs, enhance air or water quality, and secure access to health care. The political, economic, social, and legal barriers associated with poverty and income policies are very difficult to overcome in many developed countries, including the United States (Resnik and Roman 2007). There are many social inequalities that are directly related to health inequalities, and often, those inequalities lead to inequity. Syme (2008) stated, "It might be that a discussion of unfairness and inequity simply results in affirmative nods but no substantial and sustained action" (p. 458). If it is difficult to improve well-being through specific policies to eradicate poverty, then efforts must be made to reduce health inequalities through other means.

One approach is to educate local citizens about the potential negative impacts of the environments in which they live. Srinivasan, O'Fallon, and Dearry (2003) said that it might be wise to promote sustainable communities and the health benefits associated with them. Sustainable communities incorporate ideas of green space and environmentally conscious construction. In the study of Mobile County, it was revealed that those in urban ZCTAs fared worse in terms of health. Frumkin (2003) noted that urban form has much to do with health and that researchers should focus on specific places, particularly in the context of the built environment. The two ZCTAs with the highest HIQ in Mobile County are urban, and both are suffering from extreme social inequality. Those inequalities are evident in their built environments; built environments that truly are unfair and unjust. The differential outcomes in health in these two ZCTAs are inequitable and morally unacceptable (Margai 2006). The built environments of these communities are prime examples of the concept of health inequity.

7.3 Does Health Inequity Present a New Opportunity for the Environmental Justice Movement?

"A basic premise of the environmental justice movement is that all people and communities have a right to live, work, and play in places and communities that are safe, healthy, and free of life-threatening conditions" (Corburn 2004, 544). From this perspective, it would make sense for the environmental justice movement to take on issues associated with health and the built environment. The fact that the movement has been extremely successful at the local level further enhances the likelihood that its organizational structure is well suited to fight for equality in the built environment. Though the movement adopted a public health model of prevention, it could benefit many communities today through the initiation of sustainable neighborhood concepts that have a positive impact on health.

From the perspective that the distribution of environmental harm affects all people, the movement can have the most influence in making the public aware of potential health issues associated with the built environment. Using a concept like HIQ and shifting the research focus from the spatial inequality of exposure to the examination of a combination of unequal health effects, those conducting research in environmental justice can help to identify the components of the built environment most likely to impact health (Figure 4.1).

The environmental justice movement has fared well at the local level in regards to the spatial inequality of exposure and it has been most successful at the community level in protecting individuals from environmental degradation (Brulle and Pellow 2006). Shutting down major incinerators and landfills, preventing polluting operations from being built and expanded, and securing relocations and/or buyouts for residents in polluted areas are just a few examples the movement's accomplishments (Brulle and Pellow 2006). To solve issues of health inequality, it will be necessary to address the underlying social determinants of environmental inequality (Brulle and Pellow 2006). In dealing with health inequality, it is not only important to address problems related to health care. There are many other environmental factors that can affect the distribution of health, including geography, housing, environmental regulation, and economic development (Resnik and Roman 2007). Focusing on socioeconomic characteristics, risk factors, and the built environment in conjunction with exposure allows for the possibility of identifying those factors most associated with poor health at the local level.

Those associated with the movement could then assist residents of communities with high health inequity to organize and develop strategies for pursuing environmental justice. Survey results from Mobile County revealed, for the most part, that residents were willing to participate in citizen activism if they felt their actions would help to improve their neighborhood. Though 43 percent of the respondents were undecided on whether or not they would resort to activism, 43 percent were willing to participate. Only 14 percent were not willing. For those that agreed with the statement that health issues were a problem in their neighborhood, 21.4 percent were willing to participate through citizen activism (Table 7.14). It is also interesting that 22.3 percent of those that agreed with the statement were not willing.

Table 7.13 Neighborhood health issues and citizen activism.

			Citizen Activism			Total
			Willing	Not Willing	Undecided	
Health Issues are a Problem	Strongly Disagree	Count	19	6	15	40
		% Health Issues are a Problem	47.5%	15.0%	37.5%	100.0%
	Mildly Disagree	Count	7	1	10	18
		% Health Issues are a Problem	38.9%	5.6%	55.6%	100.0%
	Neither Agree or Disagree	Count	18	7	26	51
		% Health Issues are a Problem	35.3%	13.7%	51.0%	100.0%
	Mildly Agree	Count	8	1	4	13
		% Health Issues are a Problem	61.5%	7.7%	30.8%	100.0%
	Strongly Agree	Count	4	3	1	8
		% Health Issues are a Problem	50.0%	37.5%	12.5%	100.0%
Total		Count	56	18	56	130
		% Health Issues are a Problem	43.1%	13.8%	43.1%	100.0%

Chi-square = 10.483, df = 8, P = 0.233

From the perspective of familiarity, only about a quarter of the respondents indicated that they knew about the environmental justice movement. One respondent who was not familiar with the movement also believed that it was not necessary. Those most familiar with the movement were the ones who would most likely benefit. Approximately 31 percent of the respondents whose income was less than $20,000 were familiar with the movement (Table 7.15). As income increased, familiarity decreased. For those whose income was over $75,000, only 16 percent were familiar with the movement. Approximately 58 percent of those familiar with the movement were willing to participate in citizen activism (Table 7.16). That percentage decreased to 38 percent for those not familiar with the movement. Respondents not familiar with the movement were more likely to select “not willing to participate” or “undecided” in regards to citizen activism.

Table 7.14 Household income and familiarity with the environmental justice movement.

			Household Income			Total
			Less than $20,000	$20,000 - $75,000	More than $75,000	
Familiarity with Environmental Justice Movement	Yes	Count	4	24	5	33
		% Familiarity with Environmental Justice Movement	12.1%	72.7%	15.2%	100.0%
	No	Count	9	62	26	97
		% Familiarity with Environmental Justice Movement	9.3%	63.9%	26.8%	100.0%
Total		Count	13	86	31	130
		% Familiarity with Environmental Justice Movement	10.0%	66.2%	23.8%	100.0%

Chi-square = 1.890, df = 2, P = 0.389

Table 7.15 Willingness to participate in activist movements.

			Citizen Activism			Total
			Willing	Not Willing	Undecided	
Familiarity with Environmental Justice Movement	Yes	Count	19	1	13	33
		% Familiarity with Environmental Justice Movement	57.6%	3.0%	39.4%	100.0%
	No	Count	37	17	43	97
		% Familiarity with Environmental Justice Movement	38.1%	17.5%	44.3%	100.0%
Total		Count	56	18	56	130
		% Familiarity with Environmental Justice Movement	43.1%	13.8%	43.1%	100.0%

Chi-square = 6.034, df = 2, P = 0.049

Though the following examples are not the result of the environmental justice movement, similar actions would be the desired outcomes for communities seeking to improve their built environments. Residents in neighborhoods in Detroit participated in all stages of a project designed to understand housing and its relationship to health. They assisted in designing the survey, collecting the data and analyzing the results (Hood 2005). Community involvement is significant, particularly as a major factor in mobilizing efforts for change. In Seattle, Washington, residents are being asked to provide input in the design of a new community. The community is slated to have walking paths and trails, a number of small parks and one large park, a grocery store, a public library and a community health center. Community officials also plan to educate local citizens on the importance of keeping their homes and communities healthy are (Hood 2005).

In Cleveland, Ohio, substandard housing created not only an increase in the incidence of asthma, but also a crisis in childhood lead poisoning (Bashir 2002). As a result, the Cleveland Housing Network and the Cleveland Department of Public Health's Lead-Safe Housing Program coordinated with the Lead+ Asthma Project to combine asthma trigger control intervention with existing programs to conduct parent education, hazard assessment, and environmental intervention (Bashir 2002). Many cities are undergoing financial stress and have limited resources to initiate major housing overhaul programs. Thus, it would benefit both local governments and community residents if they could work together to identify the most pressing needs in unhealthy places.

As Taylor, Hughes and Garrison (2002) note, "It is possible that *geography is more powerful than any risk factor yet to be discovered"* (p. 550). Geographical (place) inequalities can be associated with material conditions and with individual and collective experiences. The concept of place-identity may be useful in further understanding the relevance of social capital and the constant cycle of geographical inequalities in health. From the environmental justice perspective, it would be invaluable to see environmental health and environmental protection unified through concerted research efforts, particularly at the local level.

CHAPTER 8 - Conclusion

This research investigated the association between numerous characteristics of socioeconomic status, environmental risk, and the built environment on population health in Mobile County, Alabama. The primary purpose of the study was to supplement the current literature on health by introducing the concept of a health inequity index (HIQ) and its potential importance in identifying locations where health inequality is likely to be higher. As a result, those areas are also more likely to exhibit health inequities, particularly in the context of the built environment. Research to date has typically focused on one characteristic of socioeconomic status, environmental risk or exposure, and the built environment. This study encompassed all three in an effort to determine those factors that most impact health in Mobile County.

The impact of the built environment on health in Mobile County was a major component of this research. In order to understand the built environment and health at the individual level within zip code tabulation areas (ZCTAs) in Mobile County, a survey was conducted. The survey primarily focused on the built environments in which people live, but did allude to questions on familiarity with the environmental justice movement, willingness to be involved with community activism, and perception of neighborhood health. The contingency table analysis provided significant information in regards to those aspects of the built environment that were likely to influence the diagnosis of cancer, respiratory illness, and heart disease.

The second stage of the analysis relied on multiple linear regression to determine the impact of socioeconomic status, environmental risk, and the built environment on health. The dependent variables of crude death rate, cause-specific death rate for cancer, and cause-specific death rate for heart disease were analyzed in relation to a pooled set of independent variables associated with socioeconomic status, environmental risk, and the built environment. Crude death rate, cause-specific death rate for cancer, and cause-specific death rate for heart disease were calculated using data from the Center for Health Statistics in Alabama. The dataset was based on the number of deaths for each ZCTA in the county in 2000.

The independent variables were selected in consideration of their potential impact on health. The multiple linear regression analysis provided variables for possible use in the development of the HIQ. The final stage of the multilevel analysis involved the use of geographically weighted regression to test the effectiveness of the regression models at the local level. The standardized residuals for each ZCTA were calculated and mapped in order to identify any potential problems with the models.

The multilevel analysis provided the variables for input into the HIQ. The variables from the original pool that were determined to have the most impact on health in the county were percent poverty, educational attainment, toxic release rank, percent vacancy, and percent renter occupied. The variables were then weighted based on significance and appearance in the regression models. The variable that was identified as being the most significant was percent poverty. Educational attainment, percent vacancy, and percent renter occupied were evenly weighted in the index. The toxic release rank was identified as the most important of the chosen environmental risk variables, but was the least weighted variable in the index.

Once the index was developed, the HIQ for each ZCTA in the county was calculated. Using the process of natural breaks, the HIQ was broken down into four categories: low, moderate low, moderate high, and high. Most of the ZCTAs that fell in the moderate high and high categories were associated with the urban core. The two highest scores were urban ZCTAs where the built environment is extremely poor. Though most of the ZCTAs designated as moderate high were related to the urban core, there was one classified as rural and two associated with the suburban ring. The two ZCTAs with the highest HIQ were also predominantly African-American. This was not the case with the rural ZCTA or the two suburban ZCTAs.

The research did assume that health in Mobile County was not randomly distributed and that those in minority and low income neighborhoods would suffer from greater health inequality. There were strong indications of differences in health between rural and urban areas. For Mobile County, health was found to be worse in urban areas than in rural areas. Suburban areas had the lowest scores of HIQ, and likely, fewer problems with issues of health inequality. The connection between health inequality and the built environment was also evident. As a result, it was determined that the built environment can be considered an inequity.

Local issues in regards to the placement of toxic facilities have long been a concern of the environmental justice movement. The fact that the movement has been successful at that level implies that they have the potential to do the same in regards to the built environment. Through an analysis of the environmental justice movement in current literature, it was revealed that a limited amount of research has specifically focused on health. Numerous articles did mention issues of health, but the environmental justice movement can make more headway into solving problems of environmental inequity by focusing on the built environment and its impacts on health. Thus, a shift from a research focus on the spatial inequality of exposure to one identifying determinants of health, particularly from the perspective of the built environment, is recommended.

Health inequality research is not only important in academics. It has the capability of making significant contributions to policy as well (Asada 2007). Neighborhoods have not often been the focus of studies of population health. The need for neighborhood improvement, however, is increasingly being acknowledged in issues associated with urban policy and health

(Ellaway, Macintyre, and Kearns 2001). Much of this research focuses on the role of social capital and its impact as a determinant of health (Ellaway, Macintyre, and Kearns 2001). There has recently been a renewed interest in place, particularly at the community level, and its effects on health. One of the major issues associated with the study of health in a given community is the inability of researchers to define explicitly what characteristics of that place influence health (Macintyre and Cummins 2002).

This study did exhibit some weaknesses in regards to structure that should be considered in future research. One issue involves the under-reporting of toxic release to the US Environmental Protection Agency. This could impact the results, particularly in regards to the HIQ, where toxic release is a significant component. As a result, it would be worthwhile to investigate exposure, and determine the possible importance of that variable in the equation.

Another potential weakness in this research revolves around the dependent variables chosen for this study. Crude death rate, cause-specific death rate for cancer, and cause-specific death rate for heart disease allowed for the determination of characteristics that impact health, but future research should consider age-specific causes of death. This could limit issues associated with inaccurate characterization of a population’s health in a given ZCTA. For example, if cancer is prevalent in a ZCTA, and the average age of the population in that area is older, it might impact the significant variables.

Though the survey provided a great deal of information for this study, there are a number of questions that should be considered in future research. It would be valuable to consider more aspects of the built environment from an individual or residential perspective. Current research is leaning toward the impact of perception on health and questions at the individual level would allow for a stronger analysis in this regard. Data collected at the individual level can provide a substantial amount of information about the built environment and perception of neighborhood health. In studies dealing with health inequality, this is particularly important. Using data in the context of a larger scale does not allow researchers to truly determine the impact of environmental risk and the built environment on a population in a given place.

Survey questions involving specific health problems would also benefit future analysis. In this study, only three questions on the survey were health-related. Those questions dealt with cancer, depression, and respiratory illness. Heart disease is the leading cause of death in the county. Though this variable was used in the regression analysis, it was left off the survey, and it could potentially provide more detailed information at the ZCTA level. Fieldwork is likely to produce more results at the local level. Future research on health inequality in Mobile County will require the strengthening of networks to aid with the collection of survey information. The realization that many view health as a sensitive topic indicates that researchers need to work with community and neighborhood leaders to ensure that they understand the purpose of the research. It is quite likely that this “insider” approach will elicit a greater number of willing participants and more significant results.

The results of this dissertation indicate that more research is needed to link environmental inequalities, particularly from the aspect of the built environment, with health outcomes. Though certain components of the built environment were identified as impacting health in Mobile County, it is important from a policy perspective to specifically focus on those that are most likely to improve community health. For instance, will the community benefit from the addition of numerous parks and recreational facilities, or will the improvement of housing in the community have a greater impact on health? With limited financial resources available at the local, state, and national level, researchers, policymakers and planners must wisely invest in renewal projects, ensuring that those most in need receive the necessary assistance to improve their neighborhoods, and ultimately, their health.

During a time in which there is great debate on health care, it makes sense to find potential preventative health measures that decrease health inequalities. From this perspective, the concept of improvements to the built environment in neighborhoods of poor health is not too farfetched. As Ellaway, Macintyre, and Kearns (2001) note, "…if one wishes to improve neighborhood cohesion as a route to better health outcomes, then creating highly mixed or polarized communities (with some people much better off than others) is not the way to proceed…" (p. 2315).

Thomson, Mitchell and Williams (2006) recognize that "Creating scientific knowledge to reduce and ultimately eliminate health disparities involves significant definitional and methodological challenges" (p. 24). This statement sets the tone for the work that is needed in order to solve health inequalities. Hopefully, researchers will one day be able to empirically test the notion that improvements in the built environment do change health behaviors, and potentially, increase community cohesion and social capital (Cohen et al. 2000; Hood 2005). It is possible that living in low-income housing and feeling unsafe may limit the effectiveness of strategies to enhance physical activity (Bennett et al. 2007). The bottom line, however, is that regardless of negative activity in a community, developed countries have an obligation to ensuring that all citizens have access to a healthy environment.

In this dissertation, new ideas on defining health, health inequality, and health inequity were presented. The study of Mobile County, Alabama, reveals that health/medical geographers can use the knowledge and tools associated with the discipline to aid in understanding why health inequalities exist where they do and what can be done to improve health in a given place.

It is also evident that a framework for measuring population health that brings together different types of indicators is necessary to understand the connections between individuals, neighborhoods, and health.

The environmental justice movement can play a major role in working with communities to organize local groups whose knowledge of the places in which they live can be beneficial in arguing for neighborhood improvement. It will take a concerted effort from local citizens, scientists, planners, and policymakers to identify communities in need and to initiate the call for equality in the context of the built environment. In the words of Phil Brown (2003), it is important to practice popular epidemiology – the idea where laypeople work together with scientists to look at the distribution and causes of illnesses (Brulle and Pellow 2006; Kaplan 2008). In this way, those concerned with health can gain a better understanding of local communities and discover underlying characteristics that would otherwise never be considered.

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Appendix A - Survey Cover Letter

Dear Respondent:

We are conducting a study to determine the relationship between health and inequality, and to assess the impact of social characteristics, environmental risk, and the built environment on population health in Mobile County, Alabama. As part of the study, we would like to ask you a series of questions and/or your opinions regarding your built environment, health of you and your family members, and other relevant information.

We would very much appreciate your collaboration in completing this questionnaire, and returning the completed questionnaire to us in the provided postage paid envelope by **June 30, 2009**. All information in this survey will be kept anonymous. Information received will be used for academic research purposes. No one else will have access to the information provided by you.

Your participation in this survey is strictly voluntary and you do not have to answer questions if you do not wish to do so. Please note that your participation involves no foreseeable risks, there will be no penalty for not participating, and you can quit at any time while completing the questionnaire. If you have questions about the rights of subjects in this study or about the manner in which the study is conducted, you may contact **Dr. Rick Scheidt**, IRB Chair, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, USA; phone: 0-1-785-532-3224.

If you have any questions, please feel free to contact one of us at the address/phone number provided below. **Thank you very much** for your participation in this important study.

Sincerely,

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Appendix B - The Built Environment and Health Survey

What is your zip code? _______________

The Built Environment and Health: A Survey of Mobile County, Alabama Residents

Q1 Which best describes the kind of building in which you live?

1 A MOBILE HOME
2 A ONE-FAMILY HOUSE DETACHED FROM ANY OTHER
3 A ONE-FAMILY HOUSE ATTACHED TO AT LEAST ONE OTHER HOUSE
4 AN APARTMENT BUILDING

Q2 Approximately when was your housing built?

1 PRE-1914
2 1914-1939
3 1940-1969
4 1970-1989
5 1990+

Q3 How many children's play areas does your housing area have?

1 NONE
2 ONE
3 TWO
4 THREE
5 FOUR+

Q4 Are there any vacant buildings evident in your housing area?

1 YES
2 NO

Q5 Are there any signs of vandalism (i.e., broken windows, damaged equipment) within the housing area?

1 NO
2 SOME SIGNS
3 MANY SIGNS

Q6 Are there patches of graffiti in the housing area?

1 NO
2 SOME SIGNS
3 MANY SIGNS

Q7 How close are you to a four-lane road?

1 ON A MAJOR ROAD
2 ONE-TWO BLOCKS AWAY
3 THREE-FOUR BLOCKS AWAY
4 MORE THAN FIVE BLOCKS AWAY

Q8 Are you located near a bus stop?

1 LESS THAN ONE BLOCK
2 ONE-TWO BLOCKS AWAY
3 THREE-FOUR BLOCKS AWAY
4 MORE THAN FIVE BLOCKS AWAY

Q9 How close are you to a park or “green space”?

1 LESS THAN ONE BLOCK
2 ONE-TWO BLOCKS AWAY
3 THREE-FOUR BLOCKS AWAY
4 MORE THAN FIVE BLOCKS AWAY

Q10 Does everyone in your household have health insurance?

1 YES
2 NO

Q11 Has anyone in your current household been diagnosed with cancer?

1 YES
2 NO

Q12 Has anyone in your current household been diagnosed with respiratory illness (i.e., asthma)?

1 YES
2 NO

Q13 Has anyone in your current household been diagnosed with depression?

1 YES
2 NO

Q14 Health issues are a major problem in my neighborhood.

1 STRONGLY DISAGREE
2 MILDLY DISAGREE
3 NEITHER AGREE NOR DISAGREE
4 MILDLY AGREE
5 STRONGLY AGREE

Q15 I am familiar with the environmental justice movement.

1 YES
2 NO

Q16 I would be willing to be involved in citizen activism if I felt my neighborhood could be improved.

1 WILLING
2 NOT WILLING
3 UNDECIDED

Q17 Which of the following best describes your present marital status?

1 NEVER MARRIED
2 MARRIED
3 DIVORCED
4 SEPARATED
5 WIDOWED
6 NO ANSWER

Q18 What is your present age?

1 UNDER 25 YEARS
2 26-35 YEARS
3 36-45 YEARS
4 46-55 YEARS
5 56-65 YEARS
6 OVER 65 YEARS
7 NO ANSWER

Q19 What is your annual household income

1 LESS THAN $20,000
2 $21,000 - $40,000
3 $41,000 - $75,000
4 $76,000 - $99,000
5 MORE THAN $100,000
6 NO ANSWER

Q20 How long have you resided at your present address?

____

Appendix C - Survey Results

The results of the survey conducted on the built environment and health in Mobile Country, Alabama are presented in the following pages.

Zip	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
36509	4	4	1	1	2	1	4	4
36522	2	5	5	1	1	2	4	4
36523	1	5	1	1	3	2	1	1
36525	1	4	1	1	2	1	4	4
36541	2	4	1	2	1	1	4	4
36541	2	4	1	1	1	1	2	1
36541	1	5	3	1	1	1	4	1
36541	2	3	1	2	1	1	4	4
36541	2	3	2	2	1	1	2	1
36541	2	1	1	1	2	1	2	1
36544	1	4	5	2	1	1	3	1
36544	2	4	1	2	1	1	3	4
36544	2	5	1	2	1	1	4	4
36544	1	5	5	2	1	1	4	4
36544	2	4	5	2	1	1	4	2
36544	2	4	1	2	1	1	4	4
36544	2	4	2	2	1	1	4	4
36571	2	4	2	2	1	1	2	3
36571	4	4	1	1	2	1	2	4
36571	2	5	1	2	1	1	2	1
36571	2	4	2	2	1	1	2	1
36571	2	4	3	2	1	1	2	1
36571	2	5	2	2	1	1	1	1
36571	4	2	2	1	1	2	1	1
36571	2	3	2	2	1	1	2	4
36571	2	5	1	2	1	1	2	4
36571	2	4	2	2	1	1	4	4
36571	2	4	3	1	1	1	4	4
36572	2	5	3	2	1	1	4	4
36572	2	4	1	2	1	1	4	4
36572	2	4	3	2	1	1	2	2
36572	2	4	3	2	1	1	4	4
36575	2	5	1	1	1	1	4	4
36575	2	3	1	1	2	2	1	1
36575	2	4	1	2	2	1	2	1
36575	2	3	1	1	2	1	4	3
36575	3	4	1	2	1	1	4	4
36575	2	4	2	2	1	1	4	4
36575	2	5	1	2	1	1	4	4
36582	2	4	5	1	1	1	4	4
36582	2	5	1	2	1	1	4	4
36582	2	3	1	1	3	2	4	4
36582	2	3	1	2	1	1	2	4
36587	2	3	5	1	1	1	4	4
36587	2	4	1	1	2	2	4	4
36587	2	4	1	2	1	1	4	4

Zip	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
36509	3	1	1	2	2	3	1	3
36522	4	1	2	1	1	1	2	2
36523	4	2	2	2	2	3	2	3
36525	4	2	1	1	2	3	2	3
36541	4	1	2	2	2	1	2	3
36541	1	1	2	2	2	1	1	1
36541	2	1	2	2	2	3	1	3
36541	4	1	1	1	2	1	1	1
36541	1	1	2	1	1	5	2	2
36541	1	2	2	1	1	3	1	3
36544	4	2	2	2	1	4	2	1
36544	3	1	2	1	2	4	2	3
36544	4	1	2	2	1	4	2	2
36544	1	1	2	2	2	1	1	3
36544	4	1	2	1	2	4	1	1
36544	4	1	2	2	2	5	2	1
36544	4	1	2	2	2	1	1	3
36571	3	1	2	1	1	2	1	1
36571	4	2	2	1	2	3	2	3
36571	1	2	2	2	2	2	2	3
36571	1	1	2	2	1	1	2	1
36571	1	1	2	2	1	2	2	1
36571	1	1	2	2	1	1	2	3
36571	1	1	2	2	1	2	2	1
36571	2	1	2	2	1	2	2	3
36571	4	1	2	2	2	3	2	3
36571	2	1	2	2	2	1	2	1
36571	4	1	1	2	2	3	2	1
36572	4	1	2	2	2	1	2	2
36572	4	1	2	2	2	1	1	1
36572	1	1	2	2	2	2	2	1
36572	4	1	2	2	2	3	2	3
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36575	4	1	1	1	2	2	2	3
36575	4	2	2	1	1	5	2	3
36575	4	1	2	2	2	3	2	3
36575	4	1	2	2	1	1	1	1
36575	4	1	2	1	2	4	2	1
36575	4	1	1	2	2	3	2	1
36582	4	1	1	2	2	3	1	1
36582	1	1	2	1	2	2	1	1
36582	4	1	2	2	1	1	2	1
36582	4	1	2	2	2	3	2	2
36587	4	1	1	2	2	1	2	1
36587	4	1	2	2	2	3	2	3
36587	1	1	2	2	2	5	2	1

Zip	Q17	Q18	Q19	Q20
36509	1	1	1	8
36522	2	3	3	8
36523	1	1	6	5
36525	2	2	1	1.5
36541	1	2	2	30
36541	2	2	3	7
36541	2	1	2	0.5
36541	5	6	3	43
36541	5	6	1	49
36541	2	4	2	20
36544	2	1	1	2
36544	2	2	6	4
36544	2	6	4	19
36544	1	2	2	6
36544	4	5	6	28
36544	2	6	1	12
36544	2	5	2	30
36571	2	2	3	25
36571	3	3	1	5
36571	1	1	6	8
36571	2	6	6	12
36571	2	6	6	12
36571	2	4	6	8
36571	2	4	6	8
36571	2	2	3	10
36571	2	2	5	3
36571	2	3	4	5
36571	2	5	3	18
36572	2	3	6	8
36572	5	6	2	26
36572	2	4	6	7
36572	6	7	5	28
36575	2	2	3	5
36575	2	4	6	20
36575	2	6	6	15
36575	2	6	3	35
36575	2	5	4	30
36575	2	6	2	35
36575	2	6	4	25
36582	5	6	3	20
36582	2	2	3	3
36582	4	4	2	10
36582	5	6	6	65
36587	2	5	3	25
36587	2	6	3	30
36587	2	4	5	5

Zip	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
36587	1	5	1	2	1	1	4	4
36587	2	4	1	1	1	1	4	4
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36603	2	5	2	1	3	2	2	2
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36604	2	1	3	2	1	1	2	2
36604	2	3	1	1	2	1	3	1
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36608	2	4	2	2	1	1	4	4
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36609	2	5	2	2	1	1	3	4
36609	2	4	2	2	1	1	2	2

Zip	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
36587	4	1	2	2	2	1	2	2
36587	4	1	1	1	2	1	2	1
36602	1	1	2	2	2	4	1	1
36603	4	2	2	2	2	1	2	3
36604	1	1	2	2	2	2	1	3
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36604	4	2	2	1	2	5	2	1
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36605	2	1	1	2	1	2	1	1
36605	4	1	2	2	2	1	2	1
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36606	4	1	2	2	1	5	2	2
36606	2	1	1	2	2	3	2	1
36606	4	1	2	2	2	3	2	3
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36607	1	2	2	1	2	3	2	1
36607	3	1	2	2	2	3	2	3
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36607	2	1	2	1	2	4	2	3
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36608	4	1	1	2	1	3	2	3
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36608	4	1	2	2	2	3	2	3
36608	3	1	2	2	2	1	2	3
36608	3	1	2	1	2	1	2	3
36608	3	1	2	1	1	1	2	3
36609	1	1	2	2	2	3	2	1
36609	2	1	2	1	2	3	2	3
36609	2	1	2	1	1	2	1	3
36609	4	1	2	2	2	1	1	3

Zip	Q17	Q18	Q19	Q20
36587	2	5	3	11
36587	5	6	3	16
36602	3	6	1	4
36603	1	3	2	8
36604	2	4	5	4
36604	2	4	3	15
36604	2	5	3	20
36604	2	3	6	18
36605	2	5	4	9
36605	2	5	5	24
36605	2	3	5	7
36605	2	6	3	44
36606	1	5	1	52
36606	5	6	2	58
36606	5	6	2	41
36606	2	4	3	8
36606	2	3	5	12
36606	2	2	4	3
36606	2	5	3	5
36606	6	6	6	8
36606	2	2	3	5
36606	2	2	3	5.5
36607	2	4	6	20
36607	2	3	4	10
36607	1	3	5	4
36607	1	1	2	3
36607	2	3	4	10
36608	2	5	3	15
36608	3	3	3	4
36608	2	4	6	20
36608	2	5	5	15
36608	1	2	6	6
36608	1	5	6	17
36608	3	4	5	5
36608	2	3	5	9
36608	2	5	4	12
36608	2	6	6	53
36608	2	6	3	30
36608	5	6	3	44
36608	2	5	5	12
36608	2	2	2	6
36608	2	3	6	5
36609	1	2	2	5
36609	2	1	1	0.5
36609	2	5	3	8
36609	2	6	3	24

Zip	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
36609	2	5	1	2	1	1	3	3
36609	2	3	1	1	2	1	3	1
36609	2	4	1	2	1	1	2	2
36610	2	3	3	2	1	1	2	2
36611	2	4	1	2	2	2	2	1
36611	2	4	2	2	1	1	3	1
36611	2	2	1	1	1	1	2	3
36611	2	3	1	1	2	1	3	4
36611	2	3	1	1	1	1	4	4
36612	2	4	2	1	1	1	1	1
36612	2	3	1	1	2	1	2	1
36613	1	5	1	1	1	1	4	4
36613	2	3	1	2	1	2	3	4
36613	2	4	1	2	1	1	4	4
36617	2	3	1	2	1	1	4	1
36619	1	5	5	2	1	2	4	4
36619	2	3	1	1	1	1	3	4
36619	2	4	3	2	1	1	4	2
36619	2	5	1	2	1	1	2	4
36693	2	3	1	2	1	1	3	3
36693	2	3	2	2	1	1	1	1
36693	2	4	1	2	1	1	3	4
36695	4	4	2	2	1	1	1	1
36695	4	5	3	2	1	1	1	1
36695	2	5	2	1	2	1	2	2
36695	2	4	2	1	2	1	2	4
36695	2	5	5	2	2	1	4	4
36695	2	4	5	1	2	2	4	4
36695	2	5	1	2	1	1	4	4
36695	2	5	1	2	1	1	2	3
36695	2	5	1	2	1	1	4	4
36695	2	5	1	2	1	1	2	4
36695	2	5	1	2	1	1	4	4
36695	1	4	1	2	1	1	3	4
36695	2	5	1	2	1	1	4	4
36695	3	4	1	2	1	1	1	1
36695	2	4	2	2	1	1	2	1
36695	4	4	1	2	1	1	2	3

Zip	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
36609	4	1	2	2	2	1	2	3
36609	3	1	2	2	1	3	1	2
36609	2	1	1	2	2	3	2	3
36610	3	2	2	2	2	3	2	1
36611	1	1	1	1	1	2	2	3
36611	1	1	2	2	2	3	2	3
36611	3	1	2	2	2	3	1	1
36611	4	1	2	1	2	3	2	1
36611	4	1	1	2	2	4	1	3
36612	2	1	2	2	2	2	2	1
36612	3	1	2	2	1	2	2	3
36613	4	1	2	2	2	3	2	2
36613	4	1	2	2	2	3	2	1
36613	4	1	2	2	1	3	2	3
36617	3	1	2	2	2	1	1	1
36619	4	2	2	1	1	5	1	1
36619	4	1	2	2	2	4	2	1
36619	1	1	2	2	1	3	2	2
36619	1	1	2	2	2	1	1	1
36693	3	1	2	2	2	4	1	1
36693	4	1	1	1	1	3	2	3
36693	3	1	1	1	2	4	1	3
36695	1	1	2	2	1	3	2	1
36695	1	1	2	2	1	3	2	1
36695	2	1	2	1	2	3	2	3
36695	3	1	2	1	2	1	2	3
36695	1	2	2	2	1	1	1	1
36695	4	1	2	2	2	1	2	1
36695	1	1	2	2	2	1	2	3
36695	2	1	2	2	2	4	2	1
36695	4	1	2	2	1	1	2	1
36695	3	1	2	2	1	2	2	3
36695	4	1	2	2	1	3	2	3
36695	4	1	2	1	2	3	2	1
36695	4	1	2	2	2	1	2	3
36695	1	1	2	2	2	5	2	2
36695	4	1	2	1	1	2	1	3
36695	4	1	2	2	1	3	2	2

Zip	Q17	Q18	Q19	Q20
36609	2	2	6	2
36609	2	6	2	16
36609	2	5	3	12
36610	2	5	2	36
36611	2	4	3	10
36611	2	2	3	3
36611	2	3	3	3
36611	2	3	5	9
36611	2	6	6	46
36612	2	4	2	7
36612	5	4	2	20
36613	2	6	2	12
36613	5	6	1	11
36613	3	6	1	1.5
36617	5	6	1	20
36619	2	4	1	0.5
36619	2	2	3	3
36619	2	3	5	4
36619	2	4	5	5
36693	6	6	2	60
36693	5	6	2	12
36693	3	6	2	8
36695	2	2	6	1
36695	2	2	6	1
36695	2	4	5	2
36695	2	4	4	3
36695	2	3	3	1
36695	2	4	6	24
36695	2	6	6	4
36695	2	2	5	3
36695	2	5	5	12
36695	2	4	4	6
36695	5	5	6	16
36695	2	6	4	2
36695	2	3	5	4
36695	5	6	6	5
36695	2	5	3	15
36695	2	4	3	1

Appendix D - Contingency Table Analysis

Illness Diagnosed Variable	Built Environment Variable	Chi-Square	DF	P
Cancer	House Type	1.937	3	0.586
Cancer	Children's Play Areas	5.066	4	0.281
Cancer	Vacant Buildings	1.366	1	0.243
Cancer	Vandalism	0.811	2	0.667
Cancer	Proximity to Four-Lane Road	1.433	3	0.698
Cancer	Proximity to a Bus Stop	0.951	3	0.813
Cancer	Green Space	5.101	3	0.165
Cancer	Household Income	4.046	5	0.543
Cancer	Rural-Urban	1.275	1	0.259
Depression	House Type	0.725	3	0.867
Depression	Proximity to Green Space	2.702	3	0.44
Depression	Household Income	5.069	5	0.407
Depression	Years at Current Residence	44.769	37	0.178
Depression	Year Built	4.569	4	0.334
Depression	Children's Play Areas	4.852	4	0.303
Depression	Vandalism	0.397	2	0.82
Depression	Graffiti	0.198	1	0.657
Depression	Rural-Urban	0.381	1	0.537
Respiratory Illness	House Type	1.683	3	0.641
Respiratory Illness	Children's Play Areas	0.576	4	0.966
Respiratory Illness	Vacant Buildings	0.358	1	0.55
Respiratory Illness	Graffiti	0.354	1	0.552
Respiratory Illness	Proximity to Four-Lane Road	1.977	3	0.577
Respiratory Illness	Proximity to a Bus Stop	2.578	3	0.461
Respiratory Illness	Green Space	0.564	3	0.905
Respiratory Illness	Household Income	3.762	5	0.584
Respiratory Illness	Years at Current Residence	36.486	37	0.493
Respiratory Illness	Rural-Urban	2.025	1	0.155