ABSTRACT

Analysis of Hypertension Prevalence and Associated Disease Mortality Among Low-Socioeconomic Status Residents of Cook County, IL

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The socioeconomic gradient in health is well established in the field of public health, but studies of this phenomenon as it relates to chronic disease in vulnerable populations yield mixed results. This thesis statistically analyzes data from the Illinois Department of Public Health, National Behavioral Risk Factor Surveillance System, Chicago Department of Public Health, and Healthy Chicago Survey for a variety of demographic, socioeconomic, health, and mortality indicators, in order to identify relationships between socioeconomic determinants and mortality related to chronic hypertension. Although the socioeconomic determinant of primary importance was expected to be related to income level or poverty status, the study revealed that race appears to demonstrate a stronger relationship with mortality from diseases associated with chronic hypertension. Hypertension itself demonstrates a weak relationship with poverty, though analysis of various combinations of SES indicators implies a complex interaction mechanism that influences health outcomes.

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ANALYSIS OF HYPERTENSION PREVALENCE AND ASSOCIATED DISEASE MORTALITY AMONG LOW-SOCIOECONOMIC STATUS RESIDENTS OF COOK COUNTY, ILLINOIS

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CHAPTER ONE

Introduction and Background Information on Hypertension

Introduction

Medicine is one of the most complex and intriguing areas of human endeavor. Its long history has been punctuated with groundbreaking discoveries, and recent efforts to expand research have led to unprecedented innovation. As technology in the modern era has allowed for exponential growth and development in medical science, Americans have become accustomed to having a known treatment or cure for most conditions. However, there are many well-recognized diseases for which no cure exists, and there are countless organizations dedicated to raising money and awareness for these causes. Most people would consider themselves well-acquainted with the purposes behind the American Cancer Society, Cystic Fibrosis Foundation, or Multiple Sclerosis Society… the list goes on to include many organizations determined to cure debilitating diseases. There are far fewer groups, though, that would host fundraisers and benefits with the central focus of a very different kind of "silent killer" – hypertension. Less commonly discussed but much more commonly afflicting, chronic hypertension is a serious condition in the United States, and only about 54% of people who have it report having control of the disease despite effective available treatment options (Centers for Disease Control). As medicine progresses and life expectancy increases, chronic illnesses have emerged as primary causes of death in modern Americans; this makes them an important subject of discussion and study, especially when methods of control are established but rates of control are low. A related component of chronic disease which may be especially pertinent in

determining how to improve public health, then, is understanding social or economic conditions of the diseased which may exacerbate symptoms or prevent adequate management, otherwise known as the social determinants of health.

Hypertension

In 2008, one fourth of American adults were diagnosed as having hypertension: abnormally high blood pressure caused by an increase in arteriolar tone. The parameters of blood pressure that are defined as "normal" by the Centers for Disease Control and Prevention are systolic measurements at or below 120 mmHg and diastolic at or below 80 mmHg. Hypertension is classically identified by a systolic blood pressure of at least 140 mmHg and diastolic blood pressure of at least 90 mmHg. Though the differences between these values may appear small, the hypersensitive nature of the human body to disruptions in homeostasis can lead to catastrophic effects after long-term compensation for such an abnormality. Chronic high blood pressure can result from a variety of causes, including hormonal or chemical input that constricts blood vessels, or mechanical disruptions to the body's functioning that restrict normal blood flow. One hormone that is often associated with hypertension is cortisol, released as a response to chronic stress. Elevated levels of other hormones such as angiotensin and estrogen may also cause physiologic changes that lead to high blood pressure, and these elevations may occur for a number of pathologic reasons. Despite improvements in medicine, technology, and efforts to extend health care access to a greater fraction of the population since 2008, the proportion of affected individuals has risen to one third of adults in the US – about 75 million people total in 2016 (CDC). This staggeringly high prevalence within the

population places hypertension among the most widespread of chronic illnesses, and it contributes to some of the chronic conditions that have reached new epidemic proportions in modern society.

Not only does hypertension affect a sizeable amount of the population, but it is also extremely expensive for the country as a whole. The estimated monetary cost of hypertension, measured as the cost of health care services, medications for treatment, and missed days of work, was $63.5 billion in 2008 and $46 billion in 2016 (Chiong; CDC). The decrease in cost from 2008 to 2016 may be attributed to less expensive drug treatments and other modern cost-saving efforts of many researchers, healthcare policymakers, and providers. Despite this decrease in cost, tens of billions of dollars in spending related to a treatable chronic condition make it worthy of attention. In addition to these astounding numbers, perhaps one of the most disturbing statistics is this: more than 360,000 Americans died in 2013 due to hypertension as a "primary or contributing cause" – that adds up to almost 1000 deaths every day from this condition (CDC). Alleviating the growing burden of hypertension on this country is non-optional with so many lives on the line.

Adverse Consequences of Hypertension

To understand the importance of controlling hypertension, it is necessary to discuss the complications that can arise from a prolonged time without adequately controlled blood pressure. One of the most common comorbidities with hypertension, a result of hypertension and consequently related to associated adverse events, is atherosclerosis. Atherosclerosis describes the narrowing of arteries due to buildup of

cholesterol and other lipids which create plaques in the vessel wall. Arteries are naturally highly elastic, but over a prolonged time with increased trauma to vessel walls related to hypertension, artery walls may harden (arteriosclerosis) and begin to accumulate a variety of substances that condense into plaques. These plaques further decrease the cross-sectional area of blood vessels, which can lead to a variety of advanced complications. As vascular resistance grows due to elevated blood pressure, the heart must contract more forcefully to maintain steady blood flow to tissues; over time, this may cause the muscles of the heart to hypertrophy or thicken. The blood vessels delivering blood and nutrients to heart muscle, however, do not necessarily enlarge or multiply proportionally to the growth of cardiac tissue. Therefore, in extreme cases, blood flow to the heart may be inadequate to perfuse the tissue completely and efficiently, leading to serious deficits in functioning or even death of tissue.

These plaques can diminish the natural elasticity of arteries, preventing them from stretching normally to absorb some of the pressure created by the contraction of the heart. This mechanism increases the level of natural resistance in blood vessels that the heart encounters in contraction, and can lead to increased systolic blood pressure. By this account, atherosclerosis is not only a result of hypertension, but sometimes also a cause. Plaques can also break apart and dislodge, creating emboli and potential blockages in the smaller vessels that branch from arteries, preventing blood flow to tissues. Finally, atherosclerotic plaques may create such a narrow vessel that blood begins to clot around the region of plaque buildup, forming a thrombus in that vessel which can occlude the vessel or dislodge and occlude a smaller distal vessel. Each of these possible complications of atherosclerosis is incorporated into a mortality measure in this study.

Though these diseases are most often directly caused by atherosclerosis, the association between atherosclerosis with hypertension makes them effective indicators of adverse outcomes from inadequate management or treatment of hypertension as a chronic illness.

There are three main categories of potential adverse events that arise most frequently from chronic hypertension and are potentially fatal conditions: heart disease, stroke, and end-stage renal failure. The heart may be damaged in a variety of ways by chronic hypertension and its complications. Due to atherosclerotic disease in coronary arteries, reduced blood flow to the heart can cause coronary ischemia, compromising the functionality of cardiac tissue as nutrient delivery is limited. If unresolved rapidly, decreased blood flow to this tissue may cause it to necrose, or die, known as a myocardial infarct – a heart attack. Another way that hypertension may damage the heart is through its hypertrophy in response to higher contractile demand. In order to maintain cardiac output at higher blood pressure, the heart muscle overcompensates by increasing in size to accommodate pumping against higher pressure. This stiffens the tissue and impairs the heart's effective contractility. It also creates a higher oxygen demand to the tissue, which may not be sustainable or even possible long-term with chronic arterial disease. As the heart begins to decompensate after too long accommodating for uncontrolled hypertension, congestive heart failure can result. Each of these potential damages to the heart are ways that uncontrolled hypertension can cause harmful or even fatal conditions.

By a similar mechanisms to heart disease, hypertension can also lead to stroke and kidney failure. Vessels in the brain are particularly susceptible to occlusion and/or rupture as a result of atherosclerosis. High blood pressure can cause stroke in two different ways. Hemorrhagic stroke occurs when blood vessels in the brain rupture,

reducing blood and thereby oxygen supply to tissues. Ischemic stroke occurs by loss of blood supply for other reasons, such as blockages or clots in blood vessels feeding the brain. Under anoxic conditions, tissues do not receive the oxygen they need and tissue can begin to necrose, leading to severe neurologic deficits or even death. End-stage renal disease, or kidney failure, can also occur as a result of hypertension; when high blood pressure creates degenerative changes in vasculature, blood flow to the filtration apparatus in the kidney can be reduced. This filtration apparatus, the glomerulus, may itself become damaged over time and incapable of performing its function. This inhibits the kidney's ability to adequately filter blood to sustain the metabolic needs of the body. The kidney itself is also a regulator of blood pressure through the renin-angiotensin system. This feedback mechanism can become disrupted when renal blood flow is impaired by arteriosclerosis, resulting in uncontrollable hypertension. When the artery to the kidney is narrowed by arteriosclerosis, the kidney responds to what it interprets as shock-like conditions by producing more renin, which raises blood pressure further. Stroke and kidney failure are two of the leading causes of death among people with uncontrolled hypertension, due to the variety of ways that prolonged high blood pressure can affect the functioning of critical organ systems.

The question then arises: if so many people are dying from this disease, why is such a medically advanced country as America doing such a poor job of recognizing and treating it? One answer lies in that very sentence, in the word "poor." In addition to the shocking number of people dying from hypertension or hypertension-related acute events, it is also important to consider *who* is dying of these afflictions. Which characteristics are shared between that half of the population that has its hypertension

under control, and what defines the population who is more commonly found suffering from the above diseases in the emergency room?

Socioeconomic Status

To examine this issue further, it is important to explicate what is meant by socioeconomic status and how this measure of social conditions can manifest into health issues. Socioeconomic status (SES) includes a diverse breadth of demographic factors; such as income, race/ethnicity, gender, sexuality, occupation, education attainment, geographical location, etc. Donald Barr, in his book *Health Disparities in the United States: Social Class, Race, Ethnicity, and Health,* defines SES as "a person's place on the hierarchy of social and economic attainment" (Barr 39). This descriptor is therefore a combination of an individual's position in several different aspects of life and includes both the social and economic effects of this positioning. In combination, these factors culminate in a status differential between individuals within society, which can manifest in the form of health disparities among those of low status. Barbara Wolfe, in her book *The Biological Consequences of Socioeconomic Inequalities*, argues that "variations in social status and status-patterned exposures, experiences, cognitive-emotional processes, and behaviors are transduced into electrochemical and biochemical signals in the body that lead to variations in biological functioning and subsequent disease risk," therefore "an individual's level of SES may be a major determinant of physical wellbeing" (Wolfe 64). She goes on to note that "an individual's place in the socioeconomic hierarchy has a profound influence on how that individual thinks, feels, behaves, and is exposed to the

stressors, strains, and toxins of everyday life," all of which contribute to tangible health effects (64).

Social gradients have been found to have a distinctive relationship with heart disease in particular, which is directly related to hypertension as a potential cause. Therefore, even though many studies on the relationship between hypertension and SES yield conflicting results about the nature of their correlation, it is important to also consider common denominators between the two – complications like cardiovascular disease – and examine whether differential analysis may offer insight into disparities that may be masked by confounding factors. The interaction of social and economic factors that determine SES and the disease process of hypertension specifically are both so complex that identifying a simple correlational relationship between hypertension and SES may not be feasible. However, if SES proves to be associated with a gradient in the outcomes associated with this chronic illness, and low SES individuals have higher risk of suffering negative effects from prolonged, uncontrolled hypertension, then identifying a socioeconomic gradient in health related to hypertension is possible. This thesis will examine some factors that have been found to increase risk of hypertension and how those factors may be associated with indicators of SES. This will hopefully lend insight into the complex interaction between SES and illness, and yield suggestions for health policy changes that might alleviate some of this disparity in the health of the poor. Though individuals living at or below the poverty line are the primary subjects of study, this thesis also seeks to examine other contributing factors to differentials in health and status which may exacerbate the negative health effects of poverty and account for some discrepancy in health within the low-income population itself.

Income

Income has long been known as a primary risk factor for disparities in health. Disturbing as the realization may be, it is not news that those of low-SES are disproportionately plagued by health problems. According to Wolfe, there is a "positive gradient between SES and health for morbidity, mortality, health habits, measures of general health, and functional limits" (Wolfe 1). Wolfe also found that cardiovascular "risk markers" have higher incidence among low-income populations, highlighting the relationship between SES and biological indicators of health (127). Income is often used as a measure of SES because it limits the resources an individual possesses to maintain health and productivity (20). "The logic behind using income as a measure of SES," writes Wolfe, "is that income allows for inputs into the production of health, such as healthier consumption (nutrition), access to health care, access to opportunities for exercise, more public safety, lower environmental risks via neighborhood choice" (23). However, despite several hypotheses on the mechanisms by which income may be a determinant of health status, "we cannot fully account for the observed disparities in health across income" (30). There is more than income alone involved in the complex equation that results in one's ability to achieve and maintain a healthy lifestyle. It is important to note additionally that separating the components of SES and considering them independently with relation to health outcomes proves extremely difficult; in most research, statistical significance disappears when all SES components are controlled for except for one, such as income, because it is the complicated interaction of several social and economic indicators that most often displays a correlation with health status (77-83).

Region and Age

Some other key components of SES include demographics like regional location and age. Regional factors have been found to be associated with hypertension, with Southern non-Hispanic white men and non-Hispanic black men and women displaying higher rates of hypertension than their Northern counterparts (Chiong). This is part of the reason the Southeastern part of the US has come to be known as the "stroke belt," since complications related to hypertension, such as stroke, occur with much higher incidence in this region. Additionally, age is very strongly related to systolic blood pressure. Most cases of hypertension are identified in mid-to-late adulthood, and severity often increases with age. After mid-adulthood, SES also tends to decrease as age increases, as changing social norms, labor market demands, and transitions out of the workforce may cause older adults' social and economic power to decrease in relation to the total population. Therefore, hypertension onset occurs right around the time that the aging experience a decline in SES in a "perfect storm" of integrating social and health factors. If aging naturally relates to declines in SES and health, though, then one would expect all aging individuals to face similar effects related to diminishing status, regardless of factors like race/ethnicity, income, etc. The only group expected to display markedly poorer health as they age would be those who had poorer health from the outset due to chronic or congenital disease. On the contrary, aged racial/ethnic minorities and the aged poor experience much worse health as a group than middle-income white Americans, indicating that some factors in addition to age are exacerbating their health problems. The SES gradient in health is actually measured to decrease into elderly age, meaning the

width of disparity diminishes at the far end of the age spectrum. This is theorized to occur not because socioeconomic disparities in health really decrease, but instead because those of low SES die at earlier ages and are not then accounted for in statistical analysis (85). Although age can be identified as a contributor to declining status and health, the notably worsened mortality of the aging population with lower SES when compared to their higher SES counterparts indicates that more factors than age alone contribute to adverse health effects.

Race and Ethnicity

Not only does age have a significant impact on risk of hypertension and complications related to the disease, but race and ethnicity are also notable determinants of risk. According to "Controlling Hypertension from a Public Health Perspective" by Jun Chiong, race is likely to influence one's ability to access care, risk of comorbidities like diabetes and obesity, and overall susceptibility to hypertension. This study found that rates of hypertension control are significantly lower in Mexican Americans than in other racial groups, and black people in America are twice as likely as non-Hispanic whites to have hypertension (Chiong). The National Health and Nutrition Examination Survey, conducted in 2000, found that the incidence of hypertension in the US black population was 5% higher than in the white population; and interestingly, although black and white individuals were equally likely to be aware of their hypertension, black Americans were much less likely to report achieving control of their blood pressure (L. Cooper). Race is one of the most important factors involved in determining SES, since the impact of racial identity is deeply engrained in American society, and the consequences of lower SES due

to minority racial status are pervasive in hypertension statistics. Hypertension has been found to be more severe in black Americans when analyzing data on hypertension-related complications (L. Cooper). This group has nearly twice the risk of developing end-stage renal disease (ESRD) and a 4.6-fold increased risk of death from cardiovascular disease – in fact, cardiovascular disease accounts for 35% of the excess overall mortality in the black American population, largely related to hypertension (L. Cooper).

In another study in 2000, Elizabeth Baker found that the death rate due to heart disease in black Americans was 29% higher than that in whites (Baker et al.). One potential explanation for this disparity is an increased stress level in black people compared to white due to racial prejudice and discrimination they face in everyday life. A study by Richard S. Cooper published in 2015 supported prior evidence of a gradient in hypertension development in "societies of the African diaspora" and confirmed that "African-origin populations with lower social status in multi-racial societies, such as the US and South Africa, experience more hypertension than anticipated based on anthropometric and measurable socioeconomic risk factors" compared to majority black African countries (R. Cooper). Disparities in hypertension development do not point to a biological predisposition in black populations, but rather indicate that an inherent quality of societies in which black people experience lower status creates a mechanism for higher risk of hypertension development. Wolfe finds that allostatic load (AL), a biological measure of cumulative stress level, is highest among those in severe poverty and higher for black Americans than whites at all observed ages – clearly, something about one's race holds serious implications for health in this society (Wolfe 82). She argues that this may also indicate that aging is faster and/or more severe in black Americans and poor

Americans than other groups. The impact of race on SES, control of hypertension, and susceptibility to acute hypertension-related complications is a telling narrative regarding the complex but sizeable impact of one condition on several other aspects of life.

Figure 1: Distribution of Systolic Blood Pressure for Black Males in African Countries and the United States

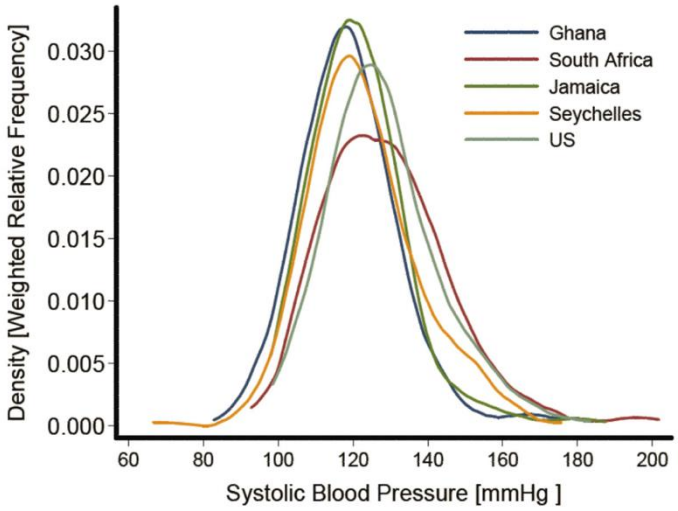


Figure 1a.
Frequency distribution of systolic blood pressures for men, by site, in METS

This figure from Richard Cooper's 2015 study shows the density of systolic hypertension for United States males was higher than that of about half of the other African countries. This supports the theory that some characteristic of being black in a highly socially-stratified environment like that in the United States seems to be more important to developing hypertension than simply being black.

Figure 2a: Prevalence of Hypertension for Black Men and Women in African Countries and the United States

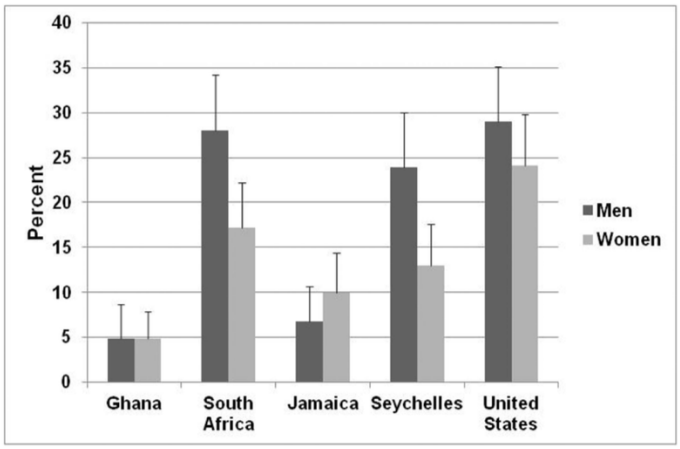


Figure 2a.
Prevalence of hypertension, by site and gender, in METS

Figure 2b: Awareness, Treatment, and Control of Hypertension for Black Individuals in African Countries and the United States

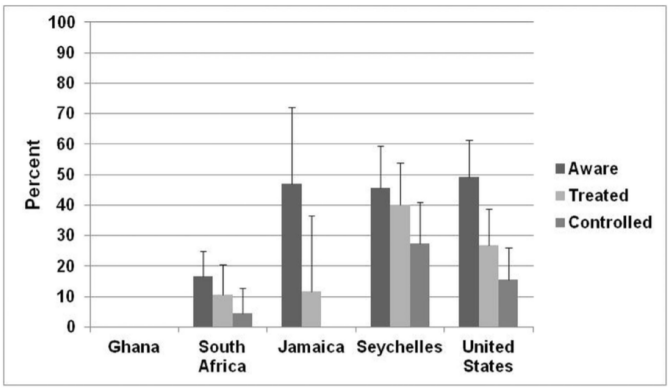


Figure 2b.
Proportion of male hypertensive participants aware of condition, taking medications for hypertension and having their hypertension controlled in METS. Number of hypertensive participants by site: Ghana (n=10), South Africa (n=66), Jamaica (n=17), Seychelles (n=55), United States (n=71)

Figures 2a and 2b show that hypertension prevalence appears to be higher for black individuals in the United States than in African countries, and management of the disease leaves plenty of margin for improvement. Multiple African countries assessed in Cooper's study had substantially lower prevalence and better control rates than the United States, one of the most medically technologically advanced countries in the entire world.

Neighborhood and Environment

When one considers SES, the first components that come to mind are usually income, race, age, and geographical location, the last of which may be often considered less important than the others. However, especially in the case of hypertension, the implications of geography can be extremely important in revealing the consequences of low SES. Major implications of geography from a health standpoint include proximity and access to health care, environmental toxins and pollutants, and the social and physical attributes of a neighborhood that affect health behaviors such as eating nutritional food and exercising. This discussion is more detailed than some other factors that indicate status because of the high importance of accessing health care, eating well, and exercising to preventing and controlling hypertension in a population. Neighborhood and environment are some of the most significant factors that affect low-income individuals' ability to participate in these behaviors, because neighborhoods tend to be formed and divided predominately by class status.

First and foremost, proximity to a place of quality health care is a crucial determinant of health. Physicians and hospitals tend to be concentrated away from neighborhoods with low average income and those in rural areas, which makes obtaining

regular or emergency care difficult for inhabitants of those neighborhoods. Proximity to a place of health care matters, and so does the type of health care available. Not all hospitals are capable of treating stroke and heart attack, and, not surprisingly, the hospitals that have the technology for proper treatments are often located far away from those of lowest SES. Access to health care can mean life or death when it comes to these complications, so geographical exclusion leaves those of low SES dangerously far from help when help is needed.

Proximity to well-equipped hospitals is only one of many characteristics that define the population health of a neighborhood. Another important factor to consider is the physical construction of a neighborhood, including where and when it was built, as well as what has been constructed around it. Low-SES neighborhoods and many workplaces for residents of these neighborhoods are "characterized by increased environmental hazards like pollutants, toxins, carcinogens, etc. which affect biological functioning" (Wolfe 64). Often, people of low SES live in neighborhoods with older construction, which leaves them prone to the negative health effects of mold and chemicals such as lead paint that may have been used years ago before their potential harm was understood. When chemical or radioactive waste must be disposed of, the locations of disposal are often much closer to low-income, high minority-populated neighborhoods. Many individuals with low income are excluded from better employment opportunities due to lack of education; this demographic, therefore, is more likely to work in entry-level jobs that require manual labor or are in undesirable fields of work, and they may be exposed to a greater degree of physical distress and environmental toxins in their workplace. Over time, each of these environmental disadvantages can

manifest into health problems; combined with increased difficulty in obtaining quality health care, the low SES population is threatened by worse overall health and greater obstacles to methods of correcting for these health deficits.

Several studies have addressed low-SES neighborhoods in efforts to encourage understanding and intervention from a population health perspective. Paulina Kaiser and colleagues, in the 2015 article "Neighborhood Environments and Incident Hypertension in the Multi-Ethnic Study of Atherosclerosis," detail the results of a longitudinal analysis of over 3000 adults at six cities across America. They analyzed healthy food availability, walking environment, neighborhood social cohesion and safety, and geographic density of nutritional food stores and recreational resources for men and women aged 45-84 of white, Hispanic, black, and Chinese-American backgrounds. Respondents had no clinical cardiovascular disease or hypertension at the beginning of the study, and researchers collected data at regular intervals to observe which environmental and racial factors may be associated with a higher risk of developing hypertension and/or an associated complication, atherosclerotic disease. This study is unique because it combines physical and social characteristics into a more comprehensive understanding of the environment people live in – not just what it looks like, but also how it feels. Their data indicate that healthy food environment, physical activity environment, and social environment are all directly related to both education attainment and income level. There was little variation between males and females, but significant variation by race, which indicates that minority racial status exacerbates the problems faced by people who have low-SES due to other reasons. "Neighborhood SES may be a confounder of the relationship between specific features of the neighborhood environment and hypertension if it is associated

with neighborhood physical and social environments and has an independent effect on hypertension," writes Kaiser. Neighborhood, an often-overlooked but revealing indicator of SES, can greatly shape the opportunities and norms for healthy living in America and results in grave disparities in health in the long term.

At the end of the Kaiser study, almost 40% of participants had developed hypertension – an expected result due to the pervasiveness of this condition in that age group in America. Of their results, the most significant findings were that increasing healthy food availability was associated with a decreased prevalence of hypertension; "older participants, black participants, participants with less education, and those living in low-SES census tracts were overrepresented in the incident hypertension group," and "those who developed hypertension lived in areas with significantly lower healthy food, physical activity, and social environment summary scores" (Kaiser et al.). Healthy food, pleasantness of walking environment, and safety were all inversely related to incidence of hypertension; after adjusting for race/ethnicity, these relationships all remained with the exception of the relationship with safety.

The most important factor in preventing and controlling hypertension and related complications, it appears, is that healthy food is available in low-SES neighborhoods. Whereas most public health policies have traditionally focused on the aforementioned problems of safety, health care availability and reduction of toxic pollutants, when looking at the condition of hypertension specifically, it appears that significant health improvements could be made simply from increasing the accessibility, affordability, and consumption of nutritious food in such neighborhoods. Obesity is understood to be a major risk factor for developing hypertension and atherosclerosis, due to its relation to

elevated blood lipid levels, risk of metabolic syndrome and diabetes. Providing people in neighborhoods with generally low socioeconomic status with means to avoid obesity by increasing availability of nutritious food can help these communities to also avoid chronic diseases like hypertension. Wolfe found supporting results in her own research, stating that smoking, greater intake of high-fat and high-sugar foods, low intake of fruits and vegetables, and overall greater caloric intake are more prevalent in low-SES groups (Wolfe 67). What Americans eat daily not only reflects their status in society but also predicts health as they age. This lends support to social policies that increase affordability and accessibility of nutritious food options in low-SES neighborhoods – one seemingly small change that can have life-altering and life-saving effects in the long term.

Whereas Kaiser's research was more directly focused holistically on the accessibility of healthy food given the unique physical and social environments of low-SES neighborhoods, Laura Tach and Ariana Amorim conducted a study that was primarily concerned with how income and race specifically affect the ability of low-SES individuals to obtain healthy food. They studied three neighborhoods in Philadelphia, PA (66 respondents), two of which were predominately comprised of low-income, black individuals and one which was more mixed racially and income-wise (Tach and Amorim). They found that poor, minority neighborhoods have less access to healthy, affordable food than more advantaged neighborhoods; the low-SES areas contained fewer places to buy fresh produce, large grocery stores, or healthy food products within a close distance. Since many low-income individuals cannot afford a car, and public transit can be expensive and unreliable at times, being within safe walking distance of healthy food is crucial for residents of these areas. Fewer supermarkets also indicates that quality of

food in these areas may be lower and, due to decreased competition, sold at a higher cost (Tach and Amorim). For a family who is barely getting by on its current income, the cost difference between healthy food and fast food may be insurmountable, especially with the added difference in convenience.

A similar study conducted in 2005 by Shannon Zenk and colleagues found that a resident in a typical low-income, predominately black neighborhood lives over one mile further from the closest supermarket than a resident of a typical low-income, predominately white neighborhood (Zenk et al.). This is just one of many visible representations of the additional problems faced by members of multiple types of low-SES groupings, especially when one of these is race. In an urban environment especially, walking an additional mile through potentially dangerous areas can force residents of these neighborhoods to opt for the less nutritious but safer meal option rather than risk going to the supermarket. As Kaiser and colleagues determined, healthy food is arguably the most important determinant of risk of hypertension, and thereby of related acute and chronic illnesses. When people of low SES are systemically excluded from obtaining healthy food due to other intervening obstacles, they are left at a higher risk of falling victim to this disease process. When health care is difficult to locate and afford, management of chronic conditions can become nearly impossible, and complications become ever-increasingly probable.

Elizabeth Baker also found in a study of urban St. Louis, MO, that access to fast food restaurants and supermarkets, and other places where individuals can obtain fruit, vegetables, and other suggested foods that comply with USDA dietary guidelines, can be at least partially predicted by racial and income distributions (Baker et al.). Obviously,

people are only able to comply with guidelines for healthy living if they have access to the food options suggested. Therefore, people living in areas with high poverty or high-racial-minority ratios are less likely to have the proper tools available to live healthily when it comes to eating. Zenk conducted another study on food acquisition behaviors of black women and environmental factors in the low-income, high-crime Chicago neighborhood of Greater Englewood, and found that "women identified multiple environmental barriers—material, economic, and social-interactional—to acquiring food in an acceptable setting" (Zenk 2014). These women reported adapting to these challenges by "optimizing, settling, being proactive, and advocating," and Zenk suggests that "efforts to improve neighborhood food environments should address not only food availability and prices, but also the physical and social environments of stores as well" (Zenk 2014). People of low-SES, especially in urban environments as these studies show, are constrained by geographical and environmental factors that prevent them from satisfying the primary requirement for prevention of hypertension and its complications: healthy eating. From this failure stems several other problems which compound as people age and lead to a variety of health issues that transcend hypertension alone and extend into serious complications.

Cook County, IL

Having established that geographical location is integral to the discussion of hypertension and other chronic illnesses among individuals of low SES, it is pertinent to discuss the selection of Cook County, IL for this analysis. Cook County is the northern Illinois county containing Chicago; because of Chicago's rich history as a prevalent

demonstrator of socioeconomic disparities in health, it is an appropriate subject in this area of study. As one of the largest urban hubs of America, Chicago is home to a diverse population including a wide spectrum of social, economic, and health disparities. Some infamous examples of the consequences to public health of marginalizing people of low status have taken place in Chicago. For example, in 1995, Chicago was hit with a record-breaking heat wave, during which over 700 people died from heat-related conditions. When examining which groups suffered the most as a result of this event, it was revealed that the strongest predictors for death were old age and low income (Barr). The elderly who were living alone – a group that occupies low status in society due to deteriorating market skills, lack of labor, increasing health problems, and limited mobility – were found to have been largely affected (Barr). Many of the victims lived on upper floors of tall buildings and were unable to leave or communicate with others if their air conditioning was not functioning sufficiently to combat the heat. It is also believed that the elderly were disproportionally affected because they are more likely to live in poverty (Barr). The neighborhoods in which many of the aged poor live experience high levels of crime, so they were often afraid to leave doors and windows open to let heat escape due to the threat of crime. In a city of almost three million people, 700 is a small fraction; however, when about 21% of the city falls below the federal poverty line, and the poor are disproportionately affected by public health issues, concern about socioeconomic indicators of health become far more important (Data USA 2015).

The population of Cook County, Illinois, was about five and a quarter million people in 2015, with a poverty rate of 16% and median household income around $57,000. Today, the median household income is reported at $54.5K. Chicago, which

comprises the majority of the county, had a population of 2.72 million in 2015, and a median household income of about $51,000. Today, the median household income is $47K. To put these numbers in perspective, the median household income for the state of Illinois today is nearly $57K, slightly above Cook County and significantly above Chicago; the United States as a whole reports a median household income of $53K. These data make evident the disparity that exists between the city of Chicago and its wealthy suburbs, as well as the significant impact that poverty in the inner city has with respect to the nation's average. Studying Chicago by Census Tract makes data analysis particularly interesting due to the diversity that exists within the city itself. There are multiple neighborhoods on every point in the median income spectrum, from Lincoln Park ($88K) and the Loop ($85.7K), to Logan Square ($55.9K) and Hyde Park ($53.6K), to Austin ($34.1K) and Chatham ($35.3K). Chicagoland also contains a high degree of racial/ethnic diversity and is therefore useful for studying interactions of different socioeconomic indicators as they pertain to health outcomes. The city will serve as a reasonable representative of phenomena pervading much of urban America, but is of course only one city out of the entire United States, and is therefore limited in universal generalization for significant findings. The location of Chicago in the Northern part of the country is important in consideration of many cultural and dietary trends that may differ substantially in other geographical regions of the country, which are especially relevant to hypertension management concerns.

Risk Factors and Stress

Often, the SES-health gradient comes to light during times of tragedy such as that in Chicago in 1995. Daily, though, this gradient manifests in a frequently overlooked way through comorbidities to chronic disease. "A significant body of research," writes Wolfe, "also documents SES gradients in a wide array of metabolic biomarkers and in the prevalence and incidence of metabolic conditions, such as insulin resistance and diabetes, and the metabolic syndrome, which is a constellation of cardiovascular risk factors, including elevated blood pressure, high levels of blood lipids (or low levels of HDL cholesterol), high levels of fasting blood glucose, and large waist circumference" (Wolfe 77). Baker also found rates of obesity to be higher among some racial/ethnic minorities and low-income individuals; African Americans experience rates of obesity nearly twice that of the total US population in general, and over 10% higher than Hispanics (Baker et al.). Trends for these conditions follow the trends of hypertension among low-SES individuals largely due to commonalities in the factors that are thought to cause these diseases: unhealthy eating, poor preventative techniques, and high stress. There are a variety of stressors associated with low-SES, many of which have already been discussed, including high crime, discrimination and treatment disparities due to racial/ethnic or other social/economic identity, low levels of social support and inability to exercise safely in low-SES neighborhoods, and poor-quality environmental conditions. Another area of research in recent decades has been the extent to which low-SES individuals may be more severely and more frequently affected by the same types of stressors faced by the rest of the population.

The series of biological responses to "normal" amounts of stress is known in the medical field as the stress cascade, technically a combination of the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system (SNS) response. The stress cascade initiates a hormone response in the body; the primary stress hormone, cortisol, instigates such changes as blood glucose increases, and SNS activation also decreases storage of blood glucose while increasing production, in addition to releasing catecholamines which increase heart rate and cardiac output. These responses are helpful in the short term – they allow a "fight or flight" response which can help people escape from dangerous situations. They are intended for the short term, though, and so long-term exposure to stress, such as is the case for low-SES individuals, can cause harmful effects. Wolfe writes that lower SES is associated with more exposure to "stressors including daily hassles, traumatic life events, and perceived burdens" (Wolfe 64). Daily hassles might include such seemingly minor events as losing car keys, gas prices rising, or sitting in traffic – for most, they are small inconveniences, but for people of low-SES who may have to drive long distances to their jobs or are unable to afford rising gas prices, the consequences of these struggles are more severe. When many small stressors accumulate, the consequence physically and emotionally can be comparable to much larger stresses, like divorce or death of a loved one. The same scenario goes for these traumatic life events and perceived burdens: when money is hard to come by and life is a constant battle, relationships suffer, relaxation and self-care rarely happen, and every problem that arises is more spiritually-draining, leaving an individual increasingly hopeless, and eventually at higher risk of physical disease (Wolfe; Barr).

Not only do low-SES individuals experience a greater magnitude of these stressors, but the long-term effect of such exposure can lead to changes in thinking and feeling that can compound the severity of the response (66). Wolfe argues that "specific perceptions, such as perceived lack of control, as well as characteristic ways of thinking, such as pessimistic orientation or the tendency to perceive threat or harm even in neutral situations, can influence the physiology of the body" since negative emotions are known to activate the stress cascade while positive emotions downregulate it (66). It may also be the case that this phenomenon is a unique development of highly stratified societies, where one could observe the prosperity of a neighbor and experience stress due to feelings of relative inferiority and potential injustice. She found that lower SES is associated with "decreased psychosocial resources," greater experience of negative emotions and lesser of positive emotions, reduced access to social support and feelings of control, which all affect how one copes with stress (66). Due to the interaction of these various factors, "nervous system and cardiovascular functions controlled by the nervous system are less efficient at recovering from stress exposure in those with lower occupational status" (75). Evidence for this claim comes from an imaging study which revealed that those with self-reported low-SES have "diminished gray matter in the section of the brain that modulates stress compared with those who rank themselves higher" (22). In Wolfe's own study, she found that those of low-SES have greater overall cortisol levels and "flatter slopes of decline" – i.e. their levels of cortisol do not naturally decline to the same extent that other groups' levels do throughout the day (69). This group maintains higher baseline levels of stress than average.

Finally, “patterns of health behavior engagement also tend to be affected by stress experience; smoking and alcohol use, poor dietary intake, and lowered physical activity may be more likely under times of stress in some individuals” (67). Overall, as individuals of low SES experience greater, more overwhelming levels of stress, their bodies suffer severely. They are much more likely to develop poor health and complications related to manageable diseases because their bodies are in a constant state of distress. In the case of hypertension, stress directly aggravates the disease process because the same physiological processes that cause hypertension are caused by stress. For example, increased sodium content in the blood causes the body to retain more water; with a greater volume of blood plasma, the pressure in arteries and veins is increased, leading to a cascade of effects which may lead to hypertension. Similarly, SNS activation constricts certain blood vessels to redirect blood flow; in the chronic sense, this increased tension can cause elevated blood pressure. The human body is not intended to handle such high pressure for long amounts of time, and eventually this can culminate in a variety of different events like heart attack, stroke, aneurysm rupture, acute kidney failure, etc.

Heredity and Epigenetics

This analysis focuses on the environmental influence on health, but when dealing with any disease, especially such common chronic diseases and acute events as hypertension, stroke, heart attack, and kidney failure, heredity must be acknowledged. The Centers for Disease Control and Prevention states that heritability of cardiovascular disease is related to “clustering of specific lifestyle and other risk factors, each of which

has environmental and genetic contributors." In other words, there is a diverse breadth of both lifestyle and hereditary variables related to the development of cardiovascular disease and other chronic illnesses that both the environment an individual lives in and his or her unique genetic makeup contribute to risk of developing a disease. Risk of cardiovascular disease is 45% higher if one's sibling has it; risk of stroke is 50% higher if a first-degree relative has it; risk of peripheral arterial disease is 80% higher if it runs in one's family (CDC). This lends significant support to the postulate that genetics have a noteworthy influence on one's risk of developing a chronic illness such as hypertension.

Though the heritability of traits related to hypertension and related conditions to cardiovascular disease, ESRD, and stroke may seem to contradict hypotheses regarding the environment's impact on health, heredity does not effectively undermine conclusions that may be drawn from this or similar studies. As was indicated above in reference to Wolfe's extensive research, no research to date has suggested that hypertension is higher within particular subpopulations due to any strictly genetic cause. In fact, a study by R. Cooper and C. Rotimi in 1997 assessed hypertension among black populations in the United States compared to various countries in Africa, and found that the black population in America experiences hypertension at a rate of more than double the rate in some majority black countries in Africa (R. Cooper and Rotimi). In other words, there is not a "hypertension gene" found in higher frequencies in specific populations for genetic reasons at the exclusion of environmental or cultural influence. Because the data collected in the US Census is organized into clusters by census tract, it is reasonable then to exclude the hereditary component of hypertension as a major confounding variable, since it likely affects all clusters in a similar manner.

Epigenetics describes the set of modifications to higher order structural qualities of DNA that an individual develops over his or her lifetime as a result of environment, experiences, interactions, etc. Epigenetic changes to the genome are understood to have a significant impact on the expression of genetic traits in individuals, and these changes vary based on the degree to which individuals experience major life conditions and events. Some epigenetic changes may turn genes on or off which can prevent or exacerbate conditions related to hypertension; therefore, an individual's genome is not the only biological component indicating risk of developing certain diseases. Explaining the extent to which heredity may influence any conclusions drawn from this study is not intended to negate the effects of genetics nor environment on one's risk of chronic illness. Rather, it is necessary to acknowledge that health is a complex interaction of the genome and the influence of the outside world, and that there is value in studying those agents individually as well as in conjunction in order to attempt to discern the extent to which they each affect health outcomes. One major way that biology and environmental factors do need to be considered together, though, is in determining a course of treatment for affected patients.

Treatment

The Seventh Report of the Joint National Commission on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) establishes updated treatment guidelines for controlling hypertension. With such a clear and detailed treatment protocol, one would assume that hypertension control would be easy to obtain. However, data indicate otherwise. As medicine has advanced and knowledge about the causes and

treatment mechanisms of hypertension have developed, it is difficult to identify one textbook example of a hypertensive patient; this makes creating one ideal treatment plan infeasible, even for experts. This is a fair argument, but there are also more factors at play that are preventing adequate control of hypertension despite the existence of the JNC 7.

Pharmaceutical methods of treatment for hypertension may include diuretics, aldosterone receptor blockers, beta blockers (BBs), angiotensin-converting-enzyme (ACE) inhibitors, angiotensin II antagonists, calcium channel blockers, alpha receptor blockers, and direct vasodilators. These drugs all attempt to interrupt agents in the aforementioned stress cascade, specifically by means of the sympathetic nervous system and renin-angiotensin-aldosterone system. The guidelines for hypertension treatment often recommend an aggressive combination of pharmaceutical interventions in conjunction with lifestyle changes such as dietary restrictions and exercise. Because the test for hypertension is a simple blood pressure measurement that can be taken via a manual or electronic cuff device, the primary cost to patients results from medications or the initial visit to the physician. Although the JNC 7 establishes recommendations for treatment in extensive detail, as was stated previously, only about half of patients diagnosed with hypertension establish adequate control of their condition.

Physician and Patient Noncompliance

While the discretion of the physician in treatment decisions is invaluable, and is in fact central to the entire purpose of medical training, there is an important distinction to be made regarding the purpose of deviating from treatment protocol between valid, patient-specific mandates and general misinformation. In other words, physicians may

cite the uniqueness of each patient as reason to disregard the JNC 7 in some cases, and therefore they feel more comfortable deviating from protocol, which society accepts on the grounds of physicians' expertise. Not only is this inadvertently putting the blame exclusively on patients for failure to control hypertension based on adherence to prescribed treatment, but it also ignores the physician's responsibility to adhere to treatment guidelines. The end result is that physicians are failing largely to adhere to hypertension treatment protocol, which is putting lives at risk and exacerbating the already pervasive problem of hypertension in modern society (Ardery et al.). Gail Ardery and colleagues conducted a study on physician adherence to the JNC 7 in 6 community-based clinics, with specific interest in whether adherence deviate more frequently for subpopulations with higher risk of specific comorbidities, and analyzed these trends in adherence over 18 months (Ardery et al.). Researchers also sought to determine how often nonadherence is justified, and identify the factors that may prevent adherence or promote nonadherence. The results of this study raise concern for a variety of reasons.

First and foremost, adherence to JNC 7 guidelines for hypertension treatment was only a shocking 53.5% of cases (Ardery et al.). This pattern did not change significantly over time, and in a similar study by Dr. Rick Turner, 36% of patients were identified by third party hypertension experts as being treated inappropriately, even after evaluation for justifiability of nonadherence (Turner). What was perhaps even more unsettling than these data, though, was the revelation that physicians in these clinics had not been formally trained on the JNC 7 guidelines (Ardery et al.). They had been briefed by pharmacists in clinic who were appropriately trained, but the physicians themselves had, for the most part, not even read the guidelines. For such a common chronic condition, the

fact that the professionals in charge of treatment decision-making had not even been properly informed about up-to-date standards of care reveals an enormous flaw in the system – just one way that medicine has become specialized to a sometimes debilitating degree. Ardery cites the difficulty and density of reading the guidelines as a primary reason for physicians' lack of information; physicians do not have time to sift through hundreds of pages of figures and explanations for why the standard of treatment is set the way it is, so they do not. This is not only costly to the patients' health, but the individual cost of inappropriate treatment was found to equal over $234 annually in 2006 dollars (Turner et al.). That amounted to a national cost of inappropriate treatment of $13 billion in 2006 dollars. What may seem given in the medical field – that physicians will prescribe the most effective treatment and that patients will comply with said treatment – is in fact often a myth that is extremely expensive for America as a whole.

Hypothesis

After detailed research into hypertension, its related complications, and the factors that contribute to development and treatment of the disease, analysis of the data collected begins with two primary questions: is there a correlation between hypertension-related complications and income level, and is this relationship exacerbated by minority status?

Because low-income individuals have lower SES, they are more susceptible to barriers to maintaining good health. They have less access to quality healthcare and nutrition, and face high levels of stress and compounding disadvantage as a result of their low status in society. This manifests in a diminished ability to effectively manage chronic illnesses like hypertension, which leads to higher risk of acute events such as heart attack

and stroke. The main hypothesis of this study is that the incidence of death from diseases related to chronic hypertension, specifically heart disease, coronary artery disease, kidney failure, stroke, and diet-related diseases, is higher among low-income individuals when compared to higher-income counterparts in Cook County, IL, due to their unique socioeconomic conditions which prevent effective management of their condition. The specific socioeconomic status determinants in consideration will be education attainment, insurance status, availability of a primary care provider, and race/ethnicity across the three most common racial/ethnic groups in the country. It is expected that education will correlate negatively with adverse health outcomes, and minority racial status may correlate in a direct manner with higher rates of acute and chronic diseases related to hypertension. It is also expected that individuals in poverty will be negatively associated with having health insurance and a regular primary care provider.

CHAPTER TWO

Data and Methods

Data Source

The data used in this study was collected by the Smart Chicago Collaborative and the Chicago Department of Public Health and published as a part of the Chicago Health Atlas. The Chicago Department of Public Health Office of Epidemiology compiled, analyzed, and interpreted this data from the combination of a variety of sources, including six subdivisions of the Chicago Department of Public Health, the Chicago Fire Department and Police Department, Chicago Department of Family & Support Services, Illinois Department of Human Services, Illinois Department of Public Health, the US Census Bureau, the US Centers for Disease Control and Prevention (CDC), and more[1].

At the outset of this study, only data from the US Census of 2010 was assessed; that analysis yielded confounded results which not only failed to support the hypotheses stated previously, but also contradicted accepted theory in epidemiology. For example, for respondents from low-income households, increases in socioeconomic status showed a strong positive correlation with hypertension prevalence, and this relationship held for respondents of moderate and high income households as well. There was also a stronger and more significant positive relationship between white racial identification and having hypertension, and even a negative relationship between the rate at which residents of a neighborhood identified as Hispanic and the rate of hypertension incidence. Considering the background of established research which suggests there is a negative gradient between health and socioeconomic status, and that research which suggests that having

low socioeconomic status or minority racial status leads to worse health outcomes, these results seem to be the products of a failure of that data source to provide a comprehensive picture of the way these variables interact. Because the Census Bureau relies on survey data, there are a variety of ways that this data may be skewed based on which populations may be more likely to respond to the survey, or potentially the confounding influence of access to health care on whether or not respondents were even aware of the health conditions they had. The 2010 Census data was also collected before the nationwide and statewide expansion of Medicaid in Illinois, which could influence the accuracy of the data to current conditions, since the primary subjects of interest likely qualify to receive care through this insurance program.

Method

Due to the unreliability of any potential conclusions from that initial analysis, data from the Chicago Health Atlas was selected for analysis instead, as a more current and comprehensive source. This data set also includes some measures that were not available in the previous analysis, such as diet and health behaviors, crime statistics, and health insurance coverage. The Chicago Health Atlas is a reliable source of information which will more likely provide more accurate insight into the mechanisms by which socioeconomic status may influence health (and vice versa). The analytics were run using the statistical analysis software JMP Pro version 14. All variables were analyzed together for bivariate correlations, then a series of multivariate correlations and partial correlations were assessed for particular variables of interest.

Measures

Health Factors

"Hypertension"*:* the percent of adults aged 18 or older diagnosed with hypertension. The Chicago Health Atlas collected data from the Illinois Department of Public Health, Behavioral Risk Factor Surveillance System (2000-2009), Chicago Department of Public Health, and Healthy Chicago Survey (2014-2016) to determine the estimated number of adults (age 18 or older) who reported that a physician, nurse, or other health professional has diagnosed them with high blood pressure (Chicago Health Atlas). This does not include those with borderline high blood pressure, pre-hypertensive patients or hypertension diagnosed only during pregnancy. This count has been divided by the estimated number of adults in that geographical population and is expressed as a percentage.

"Heart Disease": Data from the Illinois Department of Public Health Division of Vital Records, Death Certificate Data Files were assessed to determine the number of people per 100,000 who died due to heart disease in a given year.

"Coronary Heart Disease": Data from the Illinois Department of Public Health Division of Vital Records, Death Certificate Data Files were assessed to determine the number of people per 100,000 who died due to coronary heart disease in a given year.

"Kidney Disease": Data from the Illinois Department of Public Health Division of Vital Records, Death Certificate Data Files were assessed to determine the number of people per 100,000 who died due to kidney disease, including nephritis, nephrotic syndrome, and nephrosis, in a given year.

"Stroke": Data from the Illinois Department of Public Health Division of Vital Records, Death Certificate Data Files were assessed to determine the number of people per 100,000 who died as a result of stroke in a given year.

"Diet": Data from the Illinois Department of Public Health Division of Vital Records, Death Certificate Data Files were assessed to determine the number of people per 100,000 who died due to chronic diseases that resulted from nutrition-related causes in a given year. Specific examples of such chronic illnesses were not provided in the information on indicators in Chicago Health Atlas, but presumably these would include Type 2 Diabetes, anemia, some cancers, and many of the hypertension-associated diseases individually assessed in this study.

"Inactivity": Data from the Illinois Department of Public Health, Behavioral Risk Factor Surveillance System from 2000-2009, Chicago Department of Public Health, and Healthy Chicago Survey from 2014-2016 were used to determine the percentage of adults aged 18 or older within a population of adults who reported that they did not participate in any physical activities or exercises in the past month. This measure was weighted to represent the population from which the sample is drawn, since only adults are considered.

“Primary Care Provider (PCP)”: Data were used from the Illinois Department of Public health, Behavioral Risk Factor Surveillance System from 2000-2009, Chicago Department of Public Health, and Healthy Chicago Survey from 2014-2016 to estimate the percent of adults aged 18 or older who report having at least one person that they consider their personal doctor or health care provider, weighted to represent the population of adults considered.

“Checkup”: Data from the Illinois Department of Public Health, Behavioral Risk Factor Surveillance System from 2000-2009, Chicago Department of Public Health, and Healthy Chicago Survey from 2014-2016 were used to estimate the percent of adults aged 18 or older who reported visiting a doctor or healthcare provider for a routine checkup in the past year.

“No insurance”: The US Census Bureau: American Community Survey in 2015 five-year estimates and 2010-2015 one-year estimates for Chicago and different racial groups were used to determine the percentage of people with no health insurance coverage within the total civilian, non-institutionalized population.

Demographics, Social and Economic Status Indicators

"Whites": Data were collected from the US Census Bureau: American Community Survey in 2010 five-year estimates and Chicago one-year estimates to determine the percent of Non-Hispanic White people within a total geographical population.

"Hispanics": Data were collected from the US Census Bureau: American Community Survey in 2010 five-year estimates and Chicago one-year estimates to determine the percent of people who claim Hispanic ethnicity within a total geographical population.

"Asians": Data were collected from the US Census Bureau: American Community Survey in 2010 five-year estimates and Chicago one-year estimates to determine the percent of Non-Hispanic Asians or Pacific Islanders within a total geographical population.

"Blacks": Data were collected from the US Census Bureau: American Community Survey in 2010 five-year estimates and Chicago one-year estimates to determine the percent of Non-Hispanic Black or African American people within a total geographical population.

"College": The US Census Bureau: American Community Survey in 2010 and 2015 five-year estimates, as well a 2010-2015 one-year estimates for Chicago were used to determine the percentage of a geographical population who has attained a college degree or higher education.

“Neighborhood Safety”: Data from the Chicago Department of Public Health and Healthy Chicago survey were used to determine the percentage of adults aged 18 or older who report feeling safe in their neighborhood a majority of the time.

“Crime”: The Chicago Data Portal and 2010 Census were used to determine the rate of reported violent crime incidents per 100,000 people.

“Poverty”: The US Census Bureau: American Community Survey 2010 and 2015 five-year estimates and the 2010-2015 one-year estimates for Chicago and different racial groups were used to determine the percentage of households living below the federal poverty threshold.

CHAPTER 3

Results: Data Exploration and Correlations

Overview of Results

This data analysis produced descriptive results of the degree of strength of relationships between variables. Because data like that of hypertension prevalence were collected and reported as rates within the population studied, but other data like causes of mortality were normalized by rate per 100,000 persons, the decimal values shown in the following tables communicate not a numerical relationship between variables, but rather a graded strength of association. The relationships described are separated in terms of strength of correlation: a correlation output of 0.01-0.30 will be labeled "weak"; a value of 0.40-0.70 will be termed "moderate"; and a correlation of 0.80 or greater will be labeled "strong." Values in between these intervals will be hyphenated, because their placement into one category over the other would be arbitrary according to common practice.

As expected, hypertension is found to show a moderate-strength positive association with incidence of death from heart disease, coronary artery disease, kidney disease, and diet-related illnesses. The exception to this trend between hypertension and mortality causes is stroke, for which the correlation is more appropriately considered weak-moderate. The relationship between individuals living in poverty and those diagnosed with hypertension is also weak-moderate. A stronger relationship was anticipated given the background information and prior research indicating that those living in poverty have poorer health on average than their wealthier counterparts, but results did not support that hypothesis. People living in poverty are negatively associated with having a regular primary

care provider, and when asked if they had a checkup in the past year, the positive relationship between living in poverty and having a checkup was weak. Poverty is weakly associated if at all associated with the mortality measures – another surprising result. Partial correlations tell a slightly different story. A hypothetical American living in poverty who reported being diagnosed with hypertension displayed a correlation with death from any given mortality measure to a moderate positive degree. Given that a hypothetical American was diagnosed with hypertension and also died of one of the given mortality measures, that person is associated with living in poverty to a weak positive degree.

People who have hypertension and live in poverty are positively correlated with being black, but are negatively correlated with being white. For individuals who completed college and have a primary care provider, the relationship between hypertension and poverty is negative for black Americans, and essentially zero for white Americans. Americans who identify as white display a moderate negative relationship with hypertension. By contrast, Americans who identify as black have a moderate positive relationship with hypertension. For all of the mortality measures in this study, there is a stronger or more positive correlation for those with black racial identification than for whites. Controlling for being black dramatically reduces the association between hypertension and dying of heart disease, whereas controlling for being white only slightly reduces this number. This control mechanism reduces the association between hypertension and kidney disease to one-third of the bivariate value, and reduces the relationship between hypertension and stroke to basically zero. The moderate positive association between having hypertension and dying of diet-related causes is cut in half when controlling for those who identify as black.

Hypertension is positively associated with having a primary care provider, and negatively associated with having completed a 4-year college degree. Given that individuals live in areas of high crime and in poverty, the association between hypertension and one of the mortality measures was always a low-end moderate strength, with the exception of diet-related deaths, for which this positive correlation was stronger. Given an individual does not have health insurance, the association between hypertension and death from heart disease is moderate and positive. There is a positive relationship between hypertension and living in areas of high crime, as well as with living in poverty. The association between poverty and high crime is so strong that controlling for one essentially makes relationships with the other negligible.

In summary, the relationships identified through this method of analysis were restricted almost exclusively to a weak or moderate strength, and the only significantly strong relationship visible is between multiple mortality variables. Race proves to be more closely related to health outcomes than poverty, but the interaction of socioeconomic status indicators is most helpful to understanding how mortality from hypertension-related diseases may be mediated or exacerbated. Further research may select specific variables and create linear regression models that would add predictive value to the following results.

As shown in Table 1, hypertension displays a statistically significant, moderately strong positive correlation with all of the mortality measures studied: deaths related to heart disease, coronary artery disease, kidney disease, stroke, and dietary habits. The weakest relationship exists between hypertension and stroke (0.3819), and the strongest relationship exists between hypertension and diet-related deaths (0.5738). Though the numbers shown have no inherently predictive value, it can still be concluded with confidence that as hypertension prevalence increases, due to the moderately strong positive relationships between hypertension and the mortality measures below, the frequency with which people die of heart disease, coronary artery disease, kidney disease, stroke, and diet-related causes could be expected to also increase.

Table 1: Hypertension Association with all Mortality Measures

Multivariate

Correlations

	Hypertension	Heart_Dis	Coronary	Kidney	Stroke	Diet
Hypertension	1.0000	0.5389	0.4684	0.5381	0.3819	0.5738
Heart_Dis	0.5389	1.0000	0.9463	0.7544	0.8333	0.9866
Coronary	0.4684	0.9463	1.0000	0.6981	0.7497	0.9264
Kidney	0.5381	0.7544	0.6981	1.0000	0.7650	0.8092
Stroke	0.3819	0.8333	0.7497	0.7650	1.0000	0.8638
Diet	0.5738	0.9866	0.9264	0.8092	0.8638	1.0000

There are 2 missing values. The correlations are estimated by REML method.

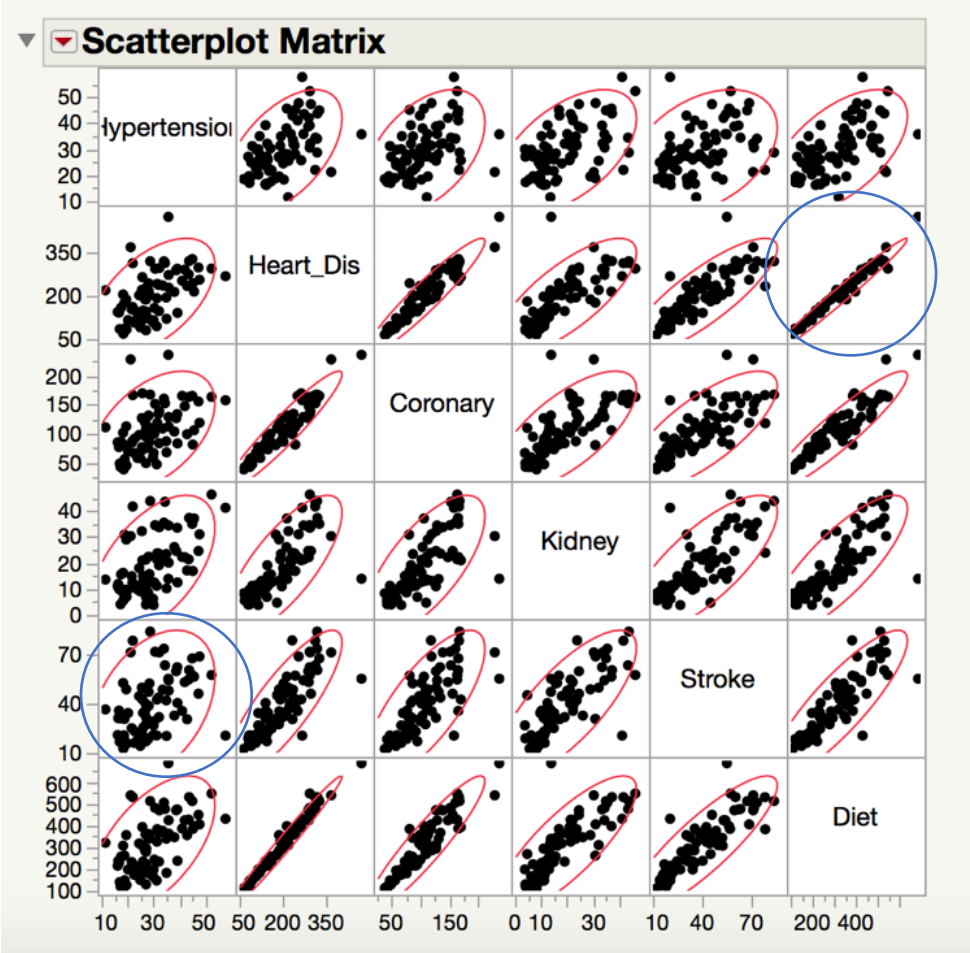
Correlation Probability

	Hypertension	Heart_Dis	Coronary	Kidney	Stroke	Diet
Hypertension	<.0001	<.0001	<.0001	<.0001	0.0007	<.0001
Heart_Dis	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Coronary	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Kidney	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Stroke	0.0007	<.0001	<.0001	<.0001	<.0001	<.0001
Diet	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

This table provides a baseline for understanding how chronic hypertension relates to mortality from heart disease, coronary artery disease, kidney disease, stroke, and diet-related illnesses, all of which were established in the literature review for this study as recognized complications of disease related to hypertension. As prevalence of hypertension increases within the sample population from Cook County, IL, there is also a moderately increased frequency of death from each of those causes of mortality. The associations shown here are all highly statistically significant, with the slight exception of Hypertension x Stroke, which has a correlation probability value of over 0.0001. This insinuates that there is probably at least one other influential factor relating hypertension and mortality from stroke, which makes logical sense given the complicated set of causes of stroke.

The following scatterplot displays visually the results of Table 1 in the form of clusters. The density of the cluster is indicative of the strength of the trend shown. For example, the correlation between death from heart disease and death from diet-related causes is a strong positive (0.9866). The cluster relating Heart Disease and Diet is nearly completely linear because of the strength of this relationship. By contrast, the association between hypertension and death from stroke is, as described above, one of the weaker relationships seen in Table 1 (0.3819). The scatterplot relating these two variables has a much less linear appearance, and the points plotted are significantly less dense around a hypothetical line with slope equal to the strength of the association.

Figure 3: Clusters of Hypertension and Mortality



Hypertension and Poverty

The correlation between hypertension and poverty is a weak-moderate positive at 0.3471. This association is slightly weaker than what could be expected given background information and prior research on poverty and health. People living in poverty tend to have poorer health on average than people who are not living in poverty, so there are some potential explanations related to the method of data collection for the data used in this study that may explain this discrepancy. The association also has a weaker significance level than is conventionally identified, indicating that confounding variables may influence this relationship.

Table 2.1 and Figure 4: Association between Hypertension and Poverty Status

Multivariate

Correlations

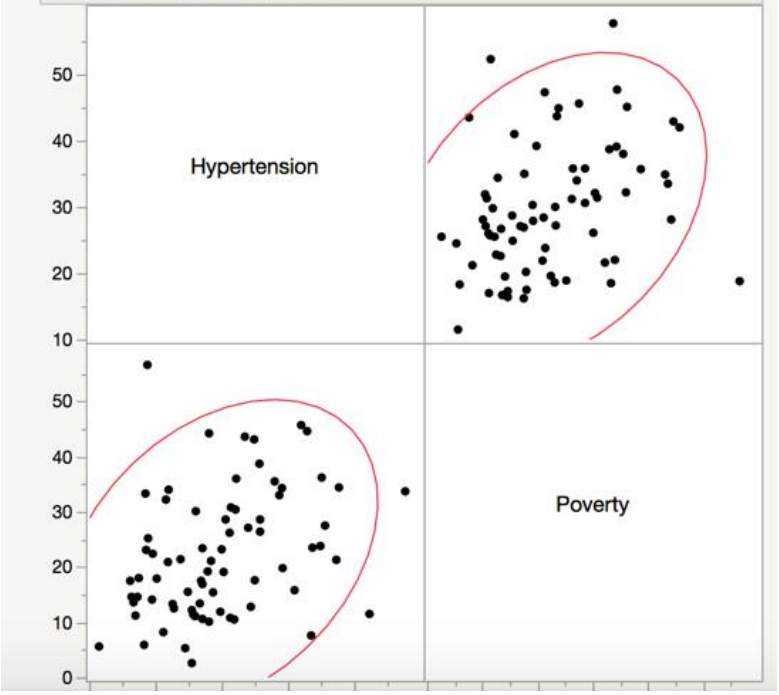
	Hypertension	Poverty
Hypertension	1.0000	0.3471
Poverty	0.3471	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Poverty
Hypertension	<.0001	0.0023
Poverty	0.0023	<.0001

Scatterplot Matrix



The scatterplot clearly displays the weak nature of the relationship between poverty and hypertension. Although the decimal value of the degree of positive correlation falls between a weak and moderate strength level, the sparsely distributed plotted points and radius of comprising circle indicate that the association is substantially less strong than the one between heart disease and diet-related deaths, for example (Figure 3).

The table below is a distribution plot of hypertension that indicates a potential confounding factor inherent in the data used for this study. The distribution is not uniform, meaning there were more data available for some areas within the county than there were in others. Because the county represents such a diverse breadth of neighborhood settings, any areas for which fewer data were available could influence the accuracy of the results in this study.

Table 2.2: Poverty Association with Primary Care Access

Multivariate

Correlations

	Poverty	PCP	Checkup	No_Insurance
Poverty	1.0000	-0.1604	0.3005	0.3904
PCP	-0.1604	1.0000	0.2087	-0.2028
Checkup	0.3005	0.2087	1.0000	-0.1773
No_Insurance	0.3904	-0.2028	-0.1773	1.0000

There are 1 missing values. The correlations are estimated by REML method.

Correlation Probability

	Poverty	PCP	Checkup	No_Insurance
Poverty	<.0001	0.1691	0.0079	0.0004
PCP	0.1691	<.0001	0.0724	0.0810
Checkup	0.0079	0.0724	<.0001	0.1229
No_Insurance	0.0004	0.0810	0.1229	<.0001

Table 2.2 shows that there is a weak negative correlation between living in poverty and reporting having a primary care provider (-0.16). Additionally, for those living in poverty, there is only a very weak-moderate association with visiting a primary care provider for a checkup in the last year (0.30). So people who live in poverty are both less likely to have a primary care provider and are not likely to have annual checkups.

Mortality and Poverty

Poverty alone has a more minimal association with each mortality measure. Its strongest correlation is with diet-related deaths; those who live under the federal poverty line are associated to a degree of 0.2623 with death from diet-induced causes. There is no statistically significant association between poverty and death from coronary artery disease, and the probability of statistical significance of the positive associations between poverty and heart disease, stroke, and diet-related deaths is limited.

Table 3: Poverty Correlations with Causes of Mortality

Multivariate

Correlations

	Poverty	Heart_Dis	Coronary	Kidney	Stroke	Diet
Poverty	1.0000	0.2542	0.0786	0.2478	0.1818	0.2623
Heart_Dis	0.2542	1.0000	0.9463	0.7544	0.8333	0.9866
Coronary	0.0786	0.9463	1.0000	0.6981	0.7497	0.9264
Kidney	0.2478	0.7544	0.6981	1.0000	0.7650	0.8092
Stroke	0.1818	0.8333	0.7497	0.7650	1.0000	0.8638
Diet	0.2623	0.9866	0.9264	0.8092	0.8638	1.0000

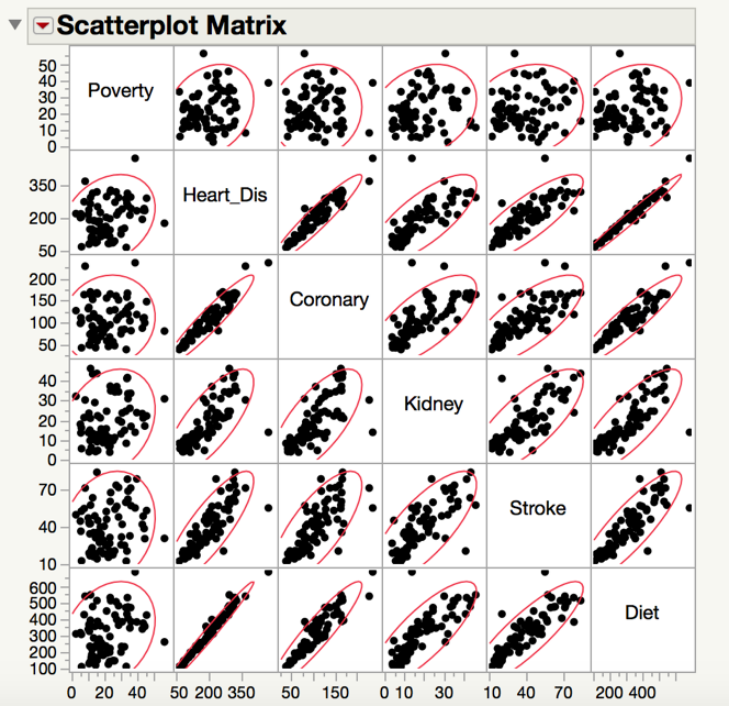
The correlations are estimated by Row-wise method.

Correlation Probability

	Poverty	Heart_Dis	Coronary	Kidney	Stroke	Diet
Poverty	<.0001	0.0257	0.4970	0.0298	0.1135	0.0212
Heart_Dis	0.0257	<.0001	<.0001	<.0001	<.0001	<.0001
Coronary	0.4970	<.0001	<.0001	<.0001	<.0001	<.0001
Kidney	0.0298	<.0001	<.0001	<.0001	<.0001	<.0001
Stroke	0.1135	<.0001	<.0001	<.0001	<.0001	<.0001
Diet	0.0212	<.0001	<.0001	<.0001	<.0001	<.0001

Figure 5 shows that poverty is only weakly associated with the mortality measures studied. The clusters are broad and non-linear.

Figure 5: Mortality Clusters with Poverty



Partial Correlations for Poverty and Outcomes

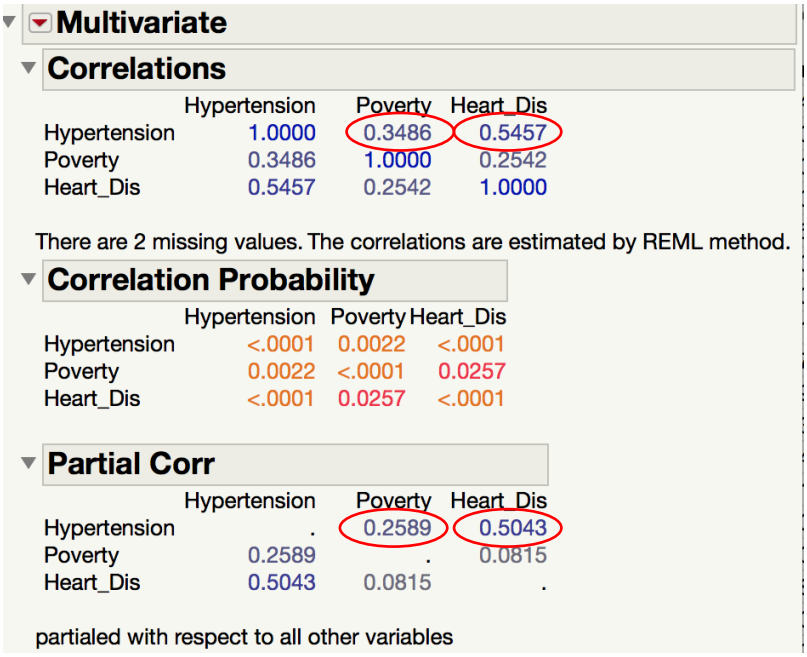
A partial correlation combines two or more variables to determine the degree of relationship of the combination with another varying factor. The values circled in the tables below represent a sentence of the following formula: "Given that an individual is hypertensive and living in poverty, then the correlation with death from heart disease is ____."

Though poverty alone does not show much of a significant association with the mortality measures, multivariate analysis that hypothetically assesses a hypertensive individual living in poverty yields clearer results. For each mortality measure except stroke, the strength of

association between an individual with hypertension living in poverty and dying of a given mortality cause is about 0.50. This association is only slightly reduced for stroke, at 0.44. The relationship is slightly strengthened for hypertensive and impoverished individuals and dying of diet-related causes, at almost 0.59. Additionally, assessing the partial correlations from a different outlook, an individual who died of one of the hypertension-associated outcomes and had hypertension is increasingly likely to live in poverty.

Table 4.1 shows that for individuals who reported being diagnosed with hypertension and died from heart disease, the strength of association with living in poverty was almost 0.26. For individuals who reported having hypertension and living below the federal poverty line, the strength of association with dying of heart disease was over 0.50. These relationships are slightly weaker in partial correlations than the bivariate correlations.

Table 4.1: Relationships between Hypertension, Poverty, and Death from Heart Disease



Multivariate

Correlations

	Hypertension	Poverty	Heart_Dis
Hypertension	1.0000	0.3486	0.5457
Poverty	0.3486	1.0000	0.2542
Heart_Dis	0.5457	0.2542	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Poverty	Heart_Dis
Hypertension	<.0001	0.0022	<.0001
Poverty	0.0022	<.0001	0.0257
Heart_Dis	<.0001	0.0257	<.0001

Partial Corr

	Hypertension	Poverty	Heart_Dis
Hypertension	.	0.2589	0.5043
Poverty	0.2589	.	0.0815
Heart_Dis	0.5043	0.0815	.

partialed with respect to all other variables

Table 4.2 shows that given individuals reported being diagnosed with hypertension and died from coronary artery disease, the association with living in poverty was 0.3554. For individuals who reported having hypertension and living below the federal poverty line, the association with dying of coronary artery disease was 0.4807. The bivariate correlation values are circled to show that the strength of correlation increases for partial correlations; when the two measures of health or when hypertension and poverty are assessed together in comparison to a third variable, the strength of relationship increases. Coronary artery disease is the only mortality measure assessed in this study for which the multivariate correlation is stronger than the bivariate correlation.

Table 4.2: Relationships between Hypertension, Poverty, and Death from Coronary Artery Disease

Multivariate

Correlations

	Hypertension	Poverty	Coronary
Hypertension	1.0000	0.3489	0.4765
Poverty	0.3489	1.0000	0.0786
Coronary	0.4765	0.0786	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Poverty	Coronary
Hypertension	<.0001	0.0022	<.0001
Poverty	0.0022	<.0001	0.4970
Coronary	<.0001	0.4970	<.0001

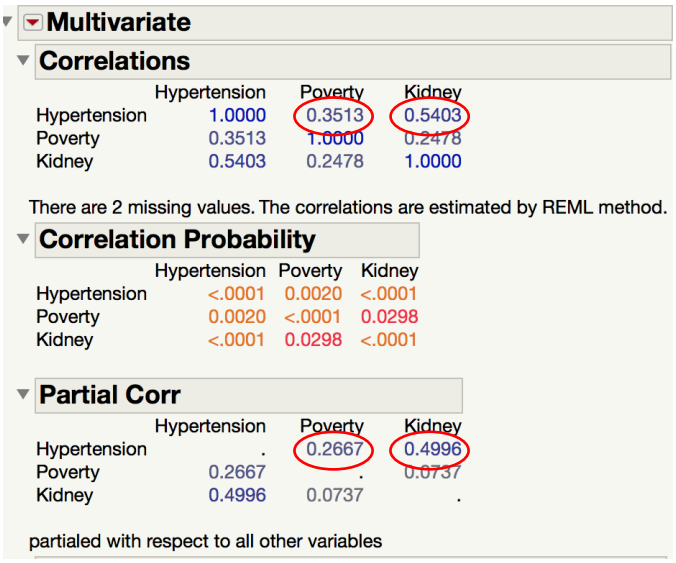
Partial Corr

	Hypertension	Poverty	Coronary
Hypertension	.	0.3554	0.4807
Poverty	0.3554	.	-0.1064
Coronary	0.4807	-0.1064	.

partialed with respect to all other variables

Table 4.3 shows that individuals who reported being diagnosed with hypertension and died from kidney disease display a weak positive correlation with poverty at 0.2667. For individuals who reported having hypertension and living below the federal poverty line, the association with mortality from kidney disease was moderate and positive at 0.4996. These relationships, similarly to heart disease, are slightly weaker in the multivariate comparison than the bivariate.

Table 4.3: Relationships between Hypertension, Poverty, and Death from Kidney Disease



Multivariate

Correlations

	Hypertension	Poverty	Kidney
Hypertension	1.0000	0.3513	0.5403
Poverty	0.3513	1.0000	0.2478
Kidney	0.5403	0.2478	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Poverty	Kidney
Hypertension	<.0001	0.0020	<.0001
Poverty	0.0020	<.0001	0.0298
Kidney	<.0001	0.0298	<.0001

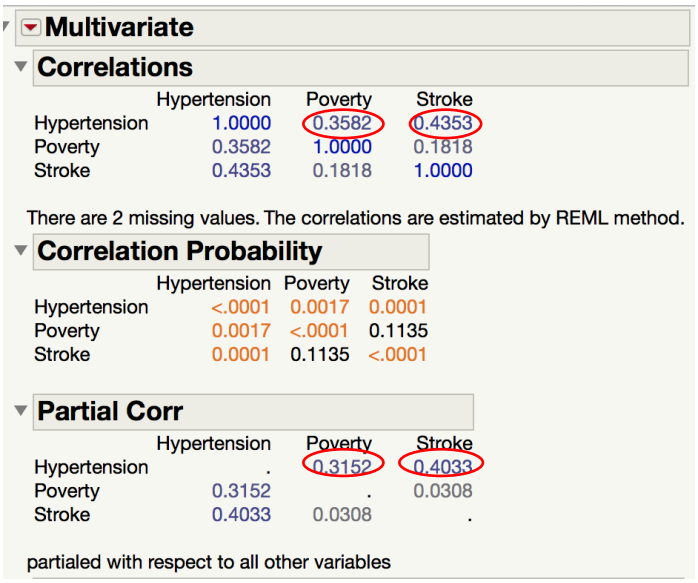
Partial Corr

	Hypertension	Poverty	Kidney
Hypertension	.	0.2667	0.4996
Poverty	0.2667	.	0.0737
Kidney	0.4996	0.0737	.

partialed with respect to all other variables

Table 4.4 indicates that individuals who reported being diagnosed with hypertension and died from stroke display a weak-moderate positive correlation with poverty at 0.3152. For individuals who reported having hypertension and living below the federal poverty line, the association with mortality from stroke was moderate and positive at 0.4033. The multivariate correlations are slightly weaker than the bivariate comparison.

Table 4.4: Relationships between Hypertension, Poverty, and Death from Stroke



Multivariate

Correlations

	Hypertension	Poverty	Stroke
Hypertension	1.0000	0.3582	0.4353
Poverty	0.3582	1.0000	0.1818
Stroke	0.4353	0.1818	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Poverty	Stroke
Hypertension	<.0001	0.0017	0.0001
Poverty	0.0017	<.0001	0.1135
Stroke	0.0001	0.1135	<.0001

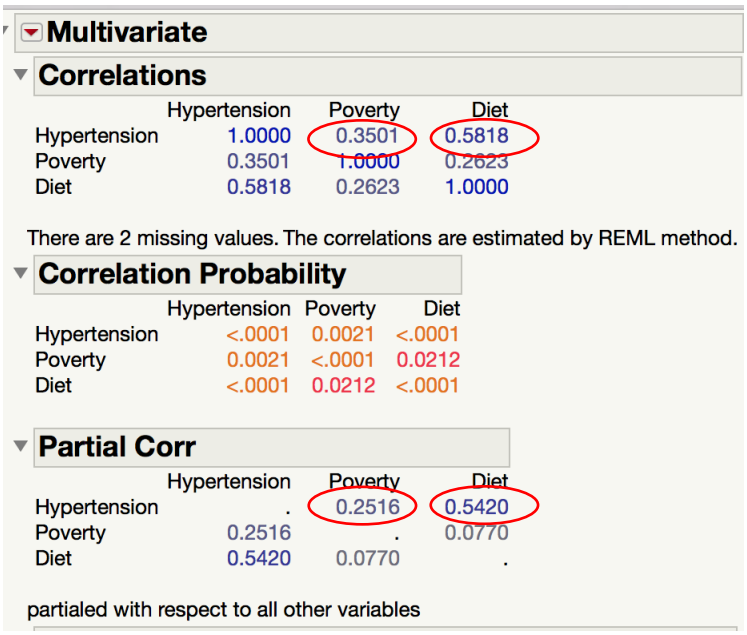
Partial Corr

	Hypertension	Poverty	Stroke
Hypertension	.	0.3152	0.4033
Poverty	0.3152	.	0.0308
Stroke	0.4033	0.0308	.

partialed with respect to all other variables

Table 4.5 shows that individuals who reported being diagnosed with hypertension and died from diet-related illnesses display a weak positive correlation with poverty at 0.2516. For individuals who reported having hypertension and living below the federal poverty line, the association with mortality from diet-related causes was moderate and positive at 0.5420. These relationships are weaker in the multivariate comparison than the bivariate.

Table 4.5: Relationships between Hypertension, Poverty, and Diet-related Deaths



Multivariate

Correlations

	Hypertension	Poverty	Diet
Hypertension	1.0000	0.3501	0.5818
Poverty	0.3501	1.0000	0.2623
Diet	0.5818	0.2623	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Poverty	Diet
Hypertension	<.0001	0.0021	<.0001
Poverty	0.0021	<.0001	0.0212
Diet	<.0001	0.0212	<.0001

Partial Corr

	Hypertension	Poverty	Diet
Hypertension	.	0.2516	0.5420
Poverty	0.2516	.	0.0770
Diet	0.5420	0.0770	.

partialed with respect to all other variables

Hypertension and Race

Hypertension displays a moderately strong negative association with white racial identification to a degree of -0.4654, and weak-moderate association with Hispanic identification of -0.3823. There is no statistically significant association between hypertension and Asian Americans, but there is a moderate positive correlation between having hypertension and being black (0.6325). Because white Americans are the least likely of these groups to have hypertension (strongest inverse association) and black Americans are the most likely (strong positive association), this study primarily compares these two racial groups in terms of health outcomes and socioeconomic indicators.

Table 5.1: Hypertension Association with Race

Multivariate

Correlations

	Hypertension	Whites	Hispanics	Asians	Blacks
Hypertension	1.0000	-0.4654	-0.3823	-0.1391	0.6325
Whites	-0.4654	1.0000	-0.0954	0.2189	-0.6935
Hispanics	-0.3823	-0.0954	1.0000	-0.1165	-0.6008
Asians	-0.1391	0.2189	-0.1165	1.0000	-0.3438
Blacks	0.6325	-0.6935	-0.6008	-0.3438	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Whites	Hispanics	Asians	Blacks
Hypertension	<.0001	<.0001	0.0007	0.2339	<.0001
Whites	<.0001	<.0001	0.4092	0.0558	<.0001
Hispanics	0.0007	0.4092	<.0001	0.3129	<.0001
Asians	0.2339	0.0558	0.3129	<.0001	0.0024
Blacks	<.0001	<.0001	<.0001	0.0024	<.0001

Partial Corr

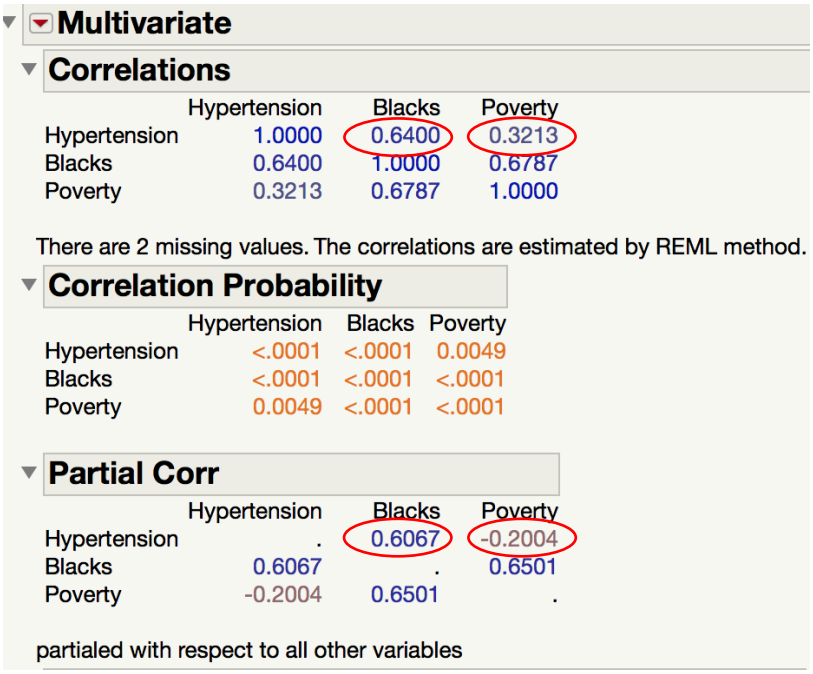
	Hypertension	Whites	Hispanics	Asians	Blacks
Hypertension	.	0.0579	0.0597	0.0675	0.0753
Whites	0.0579	.	-0.9993	-0.9965	-0.9995
Hispanics	0.0597	-0.9993	.	-0.9971	-0.9995
Asians	0.0675	-0.9965	-0.9971	.	-0.9973
Blacks	0.0753	-0.9995	-0.9995	-0.9973	.

partialed with respect to all other variables

Partial Correlation for Race: in Table 5.2a, given that one has hypertension and lives in poverty, the correlation with being black for that individual is 0.6067, a moderate positive relationship. By contrast, in Table 5.2b, if one has hypertension and lives in poverty, the association with being white for that individual is a weak negative one, -0.3326. So, when looking at individuals who live below the federal poverty line and reported being diagnosed with chronic hypertension, the frequency with which any of these individuals will identify as white is expected to decrease, and the frequency with which one identifies as black is expected to increase.

Partial Correlation for Poverty: according to Table 5.2a, given one has hypertension and is black, the correlation with living in poverty is a weak negative one, -0.2004. In other words, black individuals who report having hypertension may also be expected to report living in poverty less frequently. The association between black racial identification and hypertension is moderate-strength and positive, so the diminished relationship when incorporating poverty in a multivariate comparison is worth noting. By contrast, given that one has hypertension and is white, that person is weak-moderately negatively associated with living in poverty, to a degree of -0.3326. In the multivariate comparison, given that an individual has hypertension and is white, the association with living in poverty is a very weak negative one.

Table 5.2a: Relationships between Hypertension, Black Racial Identity, and Poverty



Multivariate

Correlations

	Hypertension	Blacks	Poverty
Hypertension	1.0000	0.6400	0.3213
Blacks	0.6400	1.0000	0.6787
Poverty	0.3213	0.6787	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

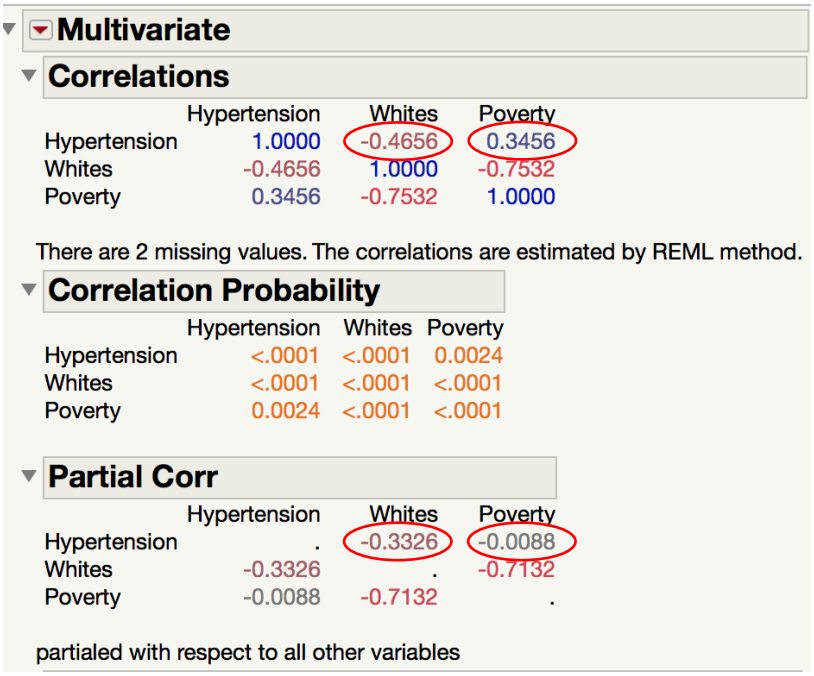
	Hypertension	Blacks	Poverty
Hypertension	<.0001	<.0001	0.0049
Blacks	<.0001	<.0001	<.0001
Poverty	0.0049	<.0001	<.0001

Partial Corr

	Hypertension	Blacks	Poverty
Hypertension	.	0.6067	-0.2004
Blacks	0.6067	.	0.6501
Poverty	-0.2004	0.6501	.

partialed with respect to all other variables

Table 5.2b: Relationships between Hypertension, White Racial Identity, and Poverty



Multivariate

Correlations

	Hypertension	Whites	Poverty
Hypertension	1.0000	-0.4656	0.3456
Whites	-0.4656	1.0000	-0.7532
Poverty	0.3456	-0.7532	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Whites	Poverty
Hypertension	<.0001	<.0001	0.0024
Whites	<.0001	<.0001	<.0001
Poverty	0.0024	<.0001	<.0001

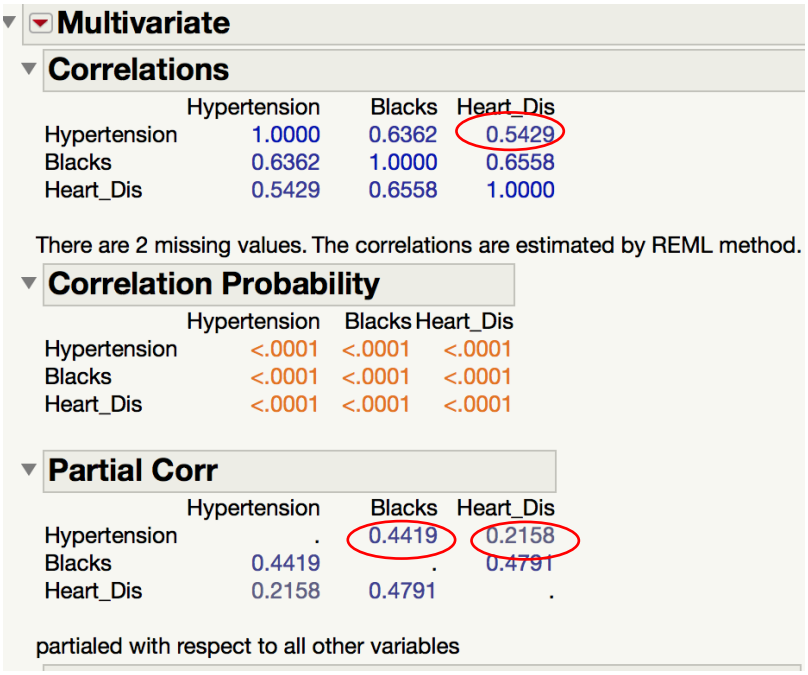
Partial Corr

	Hypertension	Whites	Poverty
Hypertension	.	-0.3326	-0.0088
Whites	-0.3326	.	-0.7132
Poverty	-0.0088	-0.7132	.

partialed with respect to all other variables

Tables 5.3a and 5.3b show that given that an individual had hypertension and died of heart disease, the correlation with the individual being black is 0.4419. If an individual had hypertension and identified as black, the correlation with death from heart disease is 0.2158. In other words, when controlling for black racial identity, the moderate association between hypertension and dying of heart disease (0.5429) is reduced to only a weak association of 0.2158. By contrast, when controlling for white racial identity, the association between hypertension and heart disease is barely reduced to 0.4795. Given that an individual had hypertension and died of heart disease, the correlation with the individual being white is weak-moderately negative at -0.3754.

Table 5.3a: Hypertension and Heart Disease for Black Americans



Multivariate

Correlations

	Hypertension	Blacks	Heart_Dis
Hypertension	1.0000	0.6362	0.5429
Blacks	0.6362	1.0000	0.6558
Heart_Dis	0.5429	0.6558	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Blacks	Heart_Dis
Hypertension	<.0001	<.0001	<.0001
Blacks	<.0001	<.0001	<.0001
Heart_Dis	<.0001	<.0001	<.0001

Partial Corr

	Hypertension	Blacks	Heart_Dis
Hypertension	.	0.4419	0.2158
Blacks	0.4419	.	0.4791
Heart_Dis	0.2158	0.4791	.

partialed with respect to all other variables

Table 5.3b: Hypertension and Heart Disease for White Americans

Multivariate

Correlations

	Hypertension	Whites	Heart_Dis
Hypertension	1.0000	-0.4656	0.5458
Whites	-0.4656	1.0000	-0.3040
Heart_Dis	0.5458	-0.3040	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Whites	Heart_Dis
Hypertension	<.0001	<.0001	<.0001
Whites	<.0001	<.0001	0.0072
Heart_Dis	<.0001	0.0072	<.0001

Partial Corr

	Hypertension	Whites	Heart_Dis
Hypertension	.	-0.3754	0.4795
Whites	-0.3754	.	-0.0672
Heart_Dis	0.4795	-0.0672	.

partialed with respect to all other variables

Similarly to the results given in Table 5.3, Table 5.4 shows that the association between hypertension and dying of coronary artery disease is significantly reduced (almost in half) by controlling for black racial identification.

Table 5.4: Hypertension and Coronary Artery Disease for Black Americans

Multivariate

Correlations

	Hypertension	Blacks	Coronary
Hypertension	1.0000	0.6365	0.4736
Blacks	0.6365	1.0000	0.4601
Coronary	0.4736	0.4601	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Blacks	Coronary
Hypertension	<.0001	<.0001	<.0001
Blacks	<.0001	<.0001	<.0001
Coronary	<.0001	<.0001	<.0001

Partial Corr

	Hypertension	Blacks	Coronary
Hypertension	.	0.5353	0.2639
Blacks	0.5353	.	0.2336
Coronary	0.2639	0.2336	.

partialed with respect to all other variables

Table 5.5 reveals that when controlling for identifying as black, the association between having hypertension and dying of kidney disease is reduced to almost one-third of the bivariate relationship.

Table 5.5: Hypertension and Kidney Disease for Black Americans

Multivariate

Correlations

	Hypertension	Blacks	Kidney
Hypertension	1.0000	0.6380	0.5368
Blacks	0.6380	1.0000	0.6790
Kidney	0.5368	0.6790	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Blacks	Kidney
Hypertension	<.0001	<.0001	<.0001
Blacks	<.0001	<.0001	<.0001
Kidney	<.0001	<.0001	<.0001

Partial Corr

	Hypertension	Blacks	Kidney
Hypertension	.	0.4416	0.1833
Blacks	0.4416	.	0.5180
Kidney	0.1833	0.5180	.

partialed with respect to all other variables

Table 5.6 shows that given an individual reports having hypertension and died of stroke, the association with being black is of moderate strength and positive (0.5467). The direct relationship between having hypertension and dying of stroke is 0.3941, almost into the moderate strength range and clearly positive, but when controlling for being black, this association is reduced to 0.0629. Due to the higher correlation probability, the relationship between hypertension and stroke when controlling for being black is essentially negligible.

Table 5.6: Hypertension and Stroke for Black Americans

Multivariate

Correlations

	Hypertension	Blacks	Stroke
Hypertension	1.0000	0.6367	0.3941
Blacks	0.6367	1.0000	0.5556
Stroke	0.3941	0.5556	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Blacks	Stroke
Hypertension	<.0001	<.0001	0.0005
Blacks	<.0001	<.0001	<.0001
Stroke	0.0005	<.0001	<.0001

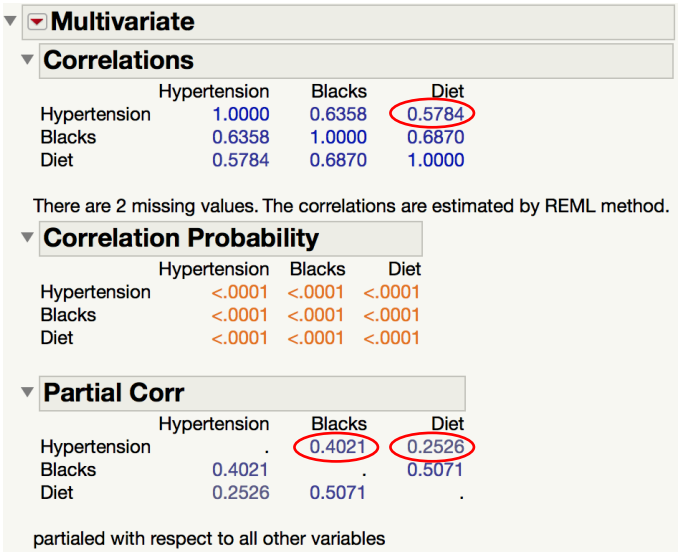
Partial Corr

	Hypertension	Blacks	Stroke
Hypertension	.	0.5467	0.0629
Blacks	0.5467	.	0.4299
Stroke	0.0629	0.4299	.

partialed with respect to all other variables

Table 5.7 shows that, given an individual had hypertension and died of diet-related causes, the frequency with which this individual would report being black is likely to increase, due to the moderate correlation of 0.4021. The bivariate association between having hypertension and dying from diet-related causes is 0.5784, but this is cut in half to 0.2526 when controlling for being black.

Table 5.7: Hypertension and Diet-Related Mortality for Black Americans



Multivariate

Correlations

	Hypertension	Blacks	Diet
Hypertension	1.0000	0.6358	0.5784
Blacks	0.6358	1.0000	0.6870
Diet	0.5784	0.6870	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Blacks	Diet
Hypertension	<.0001	<.0001	<.0001
Blacks	<.0001	<.0001	<.0001
Diet	<.0001	<.0001	<.0001

Partial Corr

	Hypertension	Blacks	Diet
Hypertension	.	0.4021	0.2526
Blacks	0.4021	.	0.5071
Diet	0.2526	0.5071	.

partialed with respect to all other variables

Tables 5.8 a and b show that hypertension is positively correlated with having a primary care provider. It also appears to have a weak negative correlation with having completed a college education. When controlling for those who completed college and have a primary care provider, the association between hypertension and poverty is -0.2261 if the individual is black, and 0.0164 if the individual is white. It follows then that the socioeconomic status indicators of education and regular healthcare are only influential in concordance with racial status.

Tables 5.8a and 5.8b: Hypertension, Race, and Multiple Indicators of Socioeconomic Status

Table 5.8a: Associations between Hypertension, College Education, Living in Poverty, and Having a Primary Care Provider for Black Individuals

Correlations

	Hypertension	Blacks	College	Poverty	PCP
Hypertension	1.0000	0.6401	-0.3135	0.3313	0.2097
Blacks	0.6401	1.0000	-0.3625	0.6787	-0.0667
College	-0.3135	-0.3625	1.0000	-0.5387	0.1237
Poverty	0.3313	0.6787	-0.5387	1.0000	-0.1694
PCP	0.2097	-0.0667	0.1237	-0.1694	1.0000

There are 3 missing values. The correlations are estimated by REML method.

Partial Corr

	Hypertension	Blacks	College	Poverty	PCP
Hypertension	.	0.6184	-0.2397	-0.2261	0.3242
Blacks	0.6184	.	0.1500	0.6125	-0.1511
College	-0.2397	0.1500	.	-0.4494	0.1133
Poverty	-0.2261	0.6125	-0.4494	.	-0.0534
PCP	0.3242	-0.1511	0.1133	-0.0534	.

Table 5.8b: Associations between Hypertension, College Education, Living in Poverty, and Having a Primary Care Provider for White Individuals

Correlations

	Hypertension	Whites	College	Poverty	PCP
Hypertension	1.0000	-0.4755	-0.3165	0.3571	0.2350
Whites	-0.4755	1.0000	0.7470	-0.7532	0.1755
College	-0.3165	0.7470	1.0000	-0.5387	0.1249
Poverty	0.3571	-0.7532	-0.5387	1.0000	-0.1686
PCP	0.2350	0.1755	0.1249	-0.1686	1.0000

There are 3 missing values. The correlations are estimated by REML method.

Partial Corr

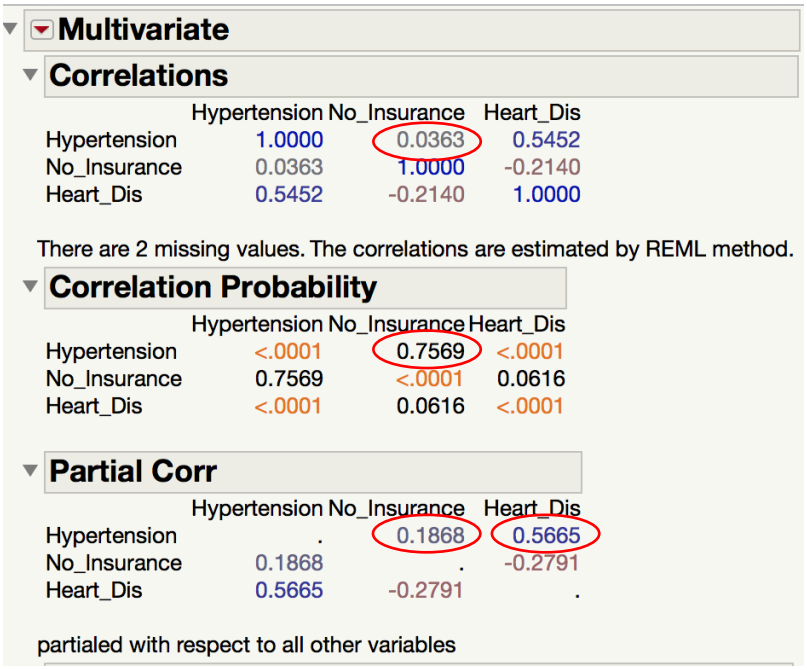
	Hypertension	Whites	College	Poverty	PCP
Hypertension	.	-0.3484	0.0740	0.0164	0.3695
Whites	-0.3484	.	0.6006	-0.5758	0.1836
College	0.0740	0.6006	.	0.0529	-0.0333
Poverty	0.0164	-0.5758	0.0529	.	-0.0579
PCP	0.3695	0.1836	-0.0333	-0.0579	.

Multivariate SES and Hypertension

Some of the measures of socioeconomic status in this study include insurance status, neighborhood crime, poverty, education, and availability of a primary care provider. Those who are uninsured, do not have a primary care provider, live in poverty in areas of high crime, and are uneducated have diminished SES. For many of the mortality measures studied, lower SES is associated with higher mortality of the hypertension-related outcomes.

Table 6.1 indicates that hypertension alone does not display a significant association with not having insurance. Given that an individual reported having hypertension and died from heart disease, the association with being uninsured for this individual would be 0.1868. More strikingly, the association between hypertension and mortality from heart disease is moderate and positive when controlling for not having health insurance.

Table 6.1: Hypertension and Death from Heart Disease for the Uninsured



Multivariate

Correlations

	Hypertension	No_Insurance	Heart_Dis
Hypertension	1.0000	0.0363	0.5452
No_Insurance	0.0363	1.0000	-0.2140
Heart_Dis	0.5452	-0.2140	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	No_Insurance	Heart_Dis
Hypertension	<.0001	0.7569	<.0001
No_Insurance	0.7569	<.0001	0.0616
Heart_Dis	<.0001	0.0616	<.0001

Partial Corr

	Hypertension	No_Insurance	Heart_Dis
Hypertension	.	0.1868	0.5665
No_Insurance	0.1868	.	-0.2791
Heart_Dis	0.5665	-0.2791	.

partialed with respect to all other variables

Table 6.2 indicates that hypertension prevalence has a moderately strong positive association with crime in neighborhoods (0.4357). Given that an individual lives in poverty in an area of high crime, the association between having hypertension and dying from heart disease is also moderately strong and positive at 0.4372. It is also worth noting that the relationships between hypertension and poverty as well as hypertension and crime are essentially cancelled out in the partial correlations, indicating that crime and poverty are strongly related.

Table 6.2: Hypertension Associations with Neighborhood Crime, Poverty, and Death from Heart Disease

Multivariate

Correlations

	Hypertension	Crime	Poverty	Heart_Dis
Hypertension	1.0000	0.4357	0.3480	0.5457
Crime	0.4357	1.0000	0.8057	0.5152
Poverty	0.3480	0.8057	1.0000	0.2542
Heart_Dis	0.5457	0.5152	0.2542	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Crime	Poverty	Heart_Dis
Hypertension	<.0001	<.0001	0.0022	<.0001
Crime	<.0001	<.0001	<.0001	<.0001
Poverty	0.0022	<.0001	<.0001	0.0257
Heart_Dis	<.0001	<.0001	0.0257	<.0001

Partial Corr

	Hypertension	Crime	Poverty	Heart_Dis
Hypertension	.	0.0087	0.1466	0.4372
Crime	0.0087	.	0.8039	0.4835
Poverty	0.1466	0.8039	.	-0.3461
Heart_Dis	0.4372	0.4835	-0.3461	.

partialed with respect to all other variables

Similarly to the results in Table 6.2, given that an individual lives in poverty in an area of high crime, the association between having hypertension and dying of coronary artery disease is moderately strong and positive (0.4079).

Table 6.3: Hypertension Associations with Neighborhood Crime, Poverty, and Death from Coronary Artery Disease

Multivariate

Correlations

	Hypertension	Crime	Poverty	Coronary
Hypertension	1.0000	0.4387	0.3436	0.4766
Crime	0.4387	1.0000	0.8057	0.3341
Poverty	0.3436	0.8057	1.0000	0.0786
Coronary	0.4766	0.3341	0.0786	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Crime	Poverty	Coronary
Hypertension	<.0001	<.0001	0.0025	<.0001
Crime	<.0001	<.0001	<.0001	0.0030
Poverty	0.0025	<.0001	<.0001	0.4970
Coronary	<.0001	0.0030	0.4970	<.0001

Partial Corr

	Hypertension	Crime	Poverty	Coronary
Hypertension	.	0.0907	0.1323	0.4079
Crime	0.0907	.	0.8069	0.3800
Poverty	0.1323	0.8069	.	-0.3630
Coronary	0.4079	0.3800	-0.3630	.

partialed with respect to all other variables

Table 6.4 follows the trend of Tables 6.3 and 6.2: given an individual lives in poverty and in an area of high crime, the relationship between reporting hypertension and dying from kidney disease under these conditions is a moderate positive one (0.4437).

Table 6.4: Hypertension Associations with Neighborhood Crime, Poverty, and Death from Kidney Disease

Multivariate

Correlations

	Hypertension	Crime	Poverty	Kidney
Hypertension	1.0000	0.4355	0.3433	0.5355
Crime	0.4355	1.0000	0.8057	0.3863
Poverty	0.3433	0.8057	1.0000	0.2478
Kidney	0.5355	0.3863	0.2478	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Crime	Poverty	Kidney
Hypertension	<.0001	<.0001	0.0026	<.0001
Crime	<.0001	<.0001	<.0001	0.0005
Poverty	0.0026	<.0001	<.0001	0.0298
Kidney	<.0001	0.0005	0.0298	<.0001

Partial Corr

	Hypertension	Crime	Poverty	Kidney
Hypertension	.	0.1519	0.0415	0.4437
Crime	0.1519	.	0.7783	0.2206
Poverty	0.0415	0.7783	.	-0.1223
Kidney	0.4437	0.2206	-0.1223	.

partialed with respect to all other variables

The relationship between hypertension and dying of stroke is slightly diminished in comparison to similar relationships for the other mortality measures when accounting for areas of poverty and high crime. Table 6.5 indicates that this association is weaker than what would be classically considered moderate in strength (0.3224).

Table 6.5: Hypertension Associations with Neighborhood Crime, Poverty, and Death from Stroke

Multivariate

Correlations

	Hypertension	Crime	Poverty	Stroke
Hypertension	1.0000	0.4368	0.3479	0.4241
Crime	0.4368	1.0000	0.8057	0.3611
Poverty	0.3479	0.8057	1.0000	0.1818
Stroke	0.4241	0.3611	0.1818	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Crime	Poverty	Stroke
Hypertension	<.0001	<.0001	0.0022	0.0001
Crime	<.0001	<.0001	<.0001	0.0013
Poverty	0.0022	<.0001	<.0001	0.1135
Stroke	0.0001	0.0013	0.1135	<.0001

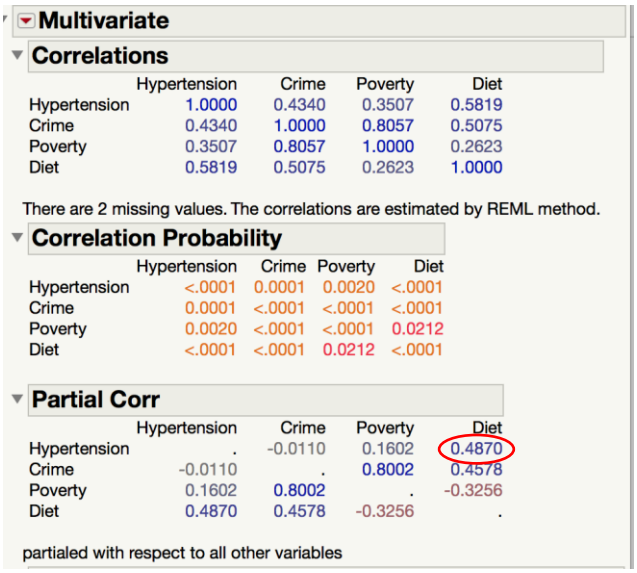
Partial Corr

	Hypertension	Crime	Poverty	Stroke
Hypertension	.	0.1608	0.0594	0.3224
Crime	0.1608	.	0.7856	0.2924
Poverty	0.0594	0.7856	.	-0.2059
Stroke	0.3224	0.2924	-0.2059	.

partialed with respect to all other variables

The strongest relationship between hypertension and a mortality measure for individuals in Cook County given the conditions of living in poverty and an area of high crime exists for diet-related deaths (0.4870). This result likely supports claims that living conditions like safety and income-level are related to nutrition availability.

Table 6.6: Hypertension Associations with Neighborhood Crime, Poverty, and Death from Diet-Related Causes



Multivariate

Correlations

	Hypertension	Crime	Poverty	Diet
Hypertension	1.0000	0.4340	0.3507	0.5819
Crime	0.4340	1.0000	0.8057	0.5075
Poverty	0.3507	0.8057	1.0000	0.2623
Diet	0.5819	0.5075	0.2623	1.0000

There are 2 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Crime	Poverty	Diet
Hypertension	<.0001	0.0001	0.0020	<.0001
Crime	0.0001	<.0001	<.0001	<.0001
Poverty	0.0020	<.0001	<.0001	0.0212
Diet	<.0001	<.0001	0.0212	<.0001

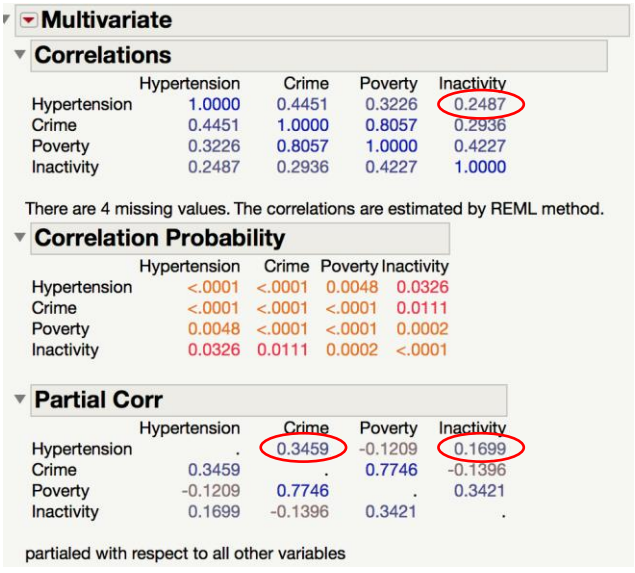
Partial Corr

	Hypertension	Crime	Poverty	Diet
Hypertension	.	-0.0110	0.1602	0.4870
Crime	-0.0110	.	0.8002	0.4578
Poverty	0.1602	0.8002	.	-0.3256
Diet	0.4870	0.4578	-0.3256	.

partialed with respect to all other variables

Finally, Table 6.7 shows that hypertension displays a weak positive correlation with physical inactivity (0.2487). For individuals who live in areas of poverty and crime, this relationship is weaker, 0.1699. Given an individual lives in poverty and reports physical inactivity, the association between hypertension and high crime is weak-moderate and positive, 0.3459.

Table 6.7: Hypertension Associations with Neighborhood Crime, Poverty, and Physical Inactivity



Multivariate

Correlations

	Hypertension	Crime	Poverty	Inactivity
Hypertension	1.0000	0.4451	0.3226	0.2487
Crime	0.4451	1.0000	0.8057	0.2936
Poverty	0.3226	0.8057	1.0000	0.4227
Inactivity	0.2487	0.2936	0.4227	1.0000

There are 4 missing values. The correlations are estimated by REML method.

Correlation Probability

	Hypertension	Crime	Poverty	Inactivity
Hypertension	<.0001	<.0001	0.0048	0.0326
Crime	<.0001	<.0001	<.0001	0.0111
Poverty	0.0048	<.0001	<.0001	0.0002
Inactivity	0.0326	0.0111	0.0002	<.0001

Partial Corr

	Hypertension	Crime	Poverty	Inactivity
Hypertension	.	0.3459	-0.1209	0.1699
Crime	0.3459	.	0.7746	-0.1396
Poverty	-0.1209	0.7746	.	0.3421
Inactivity	0.1699	-0.1396	0.3421	.

partialed with respect to all other variables

Table 7: All Possible Correlations

Correlations

	Hypertension	Whites	Hispanics	Asians	Blacks	College	Safety	Crime	Poverty	Heart_Dis	Coronary	Kidney	Stroke	Diet	Inactivity	PCP	Checkup	No_Insurance
Hypertension	1.0000	-0.4638	-0.3890	-0.2367	0.6394	-0.3207	-0.2467	0.4462	0.3458	0.5489	0.4802	0.5385	0.4221	0.5843	0.2721	0.2102	0.3886	0.0292
Whites	-0.4638	1.0000	-0.0954	0.2189	-0.6935	0.7470	0.7822	-0.6168	-0.7532	-0.3040	-0.1518	-0.4011	-0.2901	-0.3572	-0.6221	0.1769	-0.3261	-0.5535
Hispanics	-0.3890	-0.0954	1.0000	-0.1165	-0.6008	-0.3582	-0.0893	-0.4620	-0.1937	-0.5522	-0.4414	-0.4893	-0.5165	-0.5520	0.2541	-0.1503	-0.4138	0.6441
Asians	-0.2367	0.2189	-0.1165	1.0000	-0.3438	0.3062	0.2189	-0.2672	-0.0558	-0.1869	-0.1434	-0.1868	0.0513	-0.1664	-0.2666	0.1622	-0.1144	0.0113
Blacks	0.6394	-0.6935	-0.6008	-0.3438	1.0000	-0.3625	-0.5510	0.8297	0.6787	0.6558	0.4601	0.6790	0.5556	0.6870	0.3395	-0.0598	0.5519	-0.0671
College	-0.3207	0.7470	-0.3582	0.3062	-0.3625	1.0000	0.6841	-0.4093	-0.5387	-0.3239	-0.2872	-0.3263	-0.2658	-0.3367	-0.7057	0.1311	-0.2638	-0.6641
Safety	-0.2467	0.7822	-0.0893	0.2189	-0.5510	0.6841	1.0000	-0.6214	-0.8123	-0.0840	0.0765	-0.2157	-0.1410	-0.1083	-0.5572	0.2507	-0.3225	-0.5072
Crime	0.4462	-0.6168	-0.4620	-0.2672	0.8297	-0.4093	-0.6214	1.0000	0.8057	0.5152	0.3341	0.3863	0.3611	0.5075	0.2921	-0.1478	0.4079	0.0722
Poverty	0.3458	-0.7532	-0.1937	-0.0558	0.6787	-0.5387	-0.8123	0.8057	1.0000	0.2542	0.0786	0.2478	0.1818	0.2623	0.4188	-0.1661	0.3005	0.3904
Heart_Dis	0.5489	-0.3040	-0.5522	-0.1869	0.6558	-0.3239	-0.0840	0.5152	0.2542	1.0000	0.9463	0.7544	0.8333	0.9866	0.2244	0.1271	0.4166	-0.2140
Coronary	0.4802	-0.1518	-0.4414	-0.1434	0.4601	-0.2872	0.0765	0.3341	0.0786	0.9463	1.0000	0.6981	0.7497	0.9264	0.1543	0.1066	0.3073	-0.1877
Kidney	0.5385	-0.4011	-0.4893	-0.1868	0.6790	-0.3263	-0.2157	0.3863	0.2478	0.7544	0.6981	1.0000	0.7650	0.8092	0.2992	-0.0836	0.4426	-0.1831
Stroke	0.4221	-0.2901	-0.5165	0.0513	0.5556	-0.2658	-0.1410	0.3611	0.1818	0.8333	0.7497	0.7650	1.0000	0.8638	0.1981	0.0136	0.3986	-0.1670
Diet	0.5843	-0.3572	-0.5520	-0.1664	0.6870	-0.3367	-0.1083	0.5075	0.2623	0.9866	0.9264	0.8092	0.8638	1.0000	0.2389	0.1041	0.4411	-0.2026
Inactivity	0.2721	-0.6221	0.2541	-0.2666	0.3395	-0.7057	-0.5572	0.2921	0.4188	0.2244	0.1543	0.2992	0.1981	0.2389	1.0000	-0.0395	0.2980	0.4932
PCP	0.2102	0.1769	-0.1503	0.1622	-0.0598	0.1311	0.2507	-0.1478	-0.1661	0.1271	0.1066	-0.0836	0.0136	0.1041	-0.0395	1.0000	0.2010	-0.2024
Checkup	0.3886	-0.3261	-0.4138	-0.1144	0.5519	-0.2638	-0.3225	0.4079	0.3005	0.4166	0.3073	0.4426	0.3986	0.4411	0.2980	0.2010	1.0000	-0.1773
No_Insurance	0.0292	-0.5535	0.6441	0.0113	-0.0671	-0.6641	-0.5072	0.0722	0.3904	-0.2140	-0.1877	-0.1831	-0.1670	-0.2026	0.4932	-0.2024	-0.1773	1.0000

There are 6 missing values. The correlations are estimated by Pairwise method.

Partial Corr

	Hypertension	Whites	Hispanics	Asians	Blacks	College	Safety	Crime	Poverty	Heart_Dis	Coronary	Kidney	Stroke	Diet	Inactivity	PCP	Checkup	No_Insurance
Hypertension	.	-0.2857	-0.4221	-0.3061	.	-0.1191	0.0362	-0.1103	-0.0634	-0.2491	0.1709	-0.0551	-0.0759	0.1961	0.0105	0.3216	-0.0859	0.1898
Whites	-0.2857	.	-0.4148	-0.1541	.	-0.1160	0.1729	-0.2151	-0.1839	0.0172	0.4347	-0.2479	0.1990	-0.3882	-0.0344	0.1187	-0.1759	-0.3083
Hispanics	-0.4221	-0.4148	.	-0.2727	.	-0.5798	0.0148	-0.4506	-0.2763	-0.1605	0.1381	-0.3996	-0.1248	0.0518	0.1085	-0.0111	-0.3541	0.1515
Asians	-0.3061	-0.1541	-0.2727	.	.	0.0316	0.2720	-0.2910	0.4229	-0.3706	0.3495	-0.2331	0.4729	0.0753	-0.0321	0.3038	-0.0066	0.1315
Blacks	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
College	-0.1191	-0.1160	-0.5798	0.0316	.	.	0.2813	-0.2063	-0.1239	-0.0522	-0.1077	-0.2304	-0.0657	0.0157	-0.1166	-0.0972	-0.3156	-0.2752
Safety	0.0362	0.1729	0.0148	0.2720	.	0.2813	.	-0.0658	-0.4749	0.0346	-0.0200	-0.0635	-0.3945	0.1867	-0.0505	-0.0071	-0.1423	0.0946
Crime	-0.1103	-0.2151	-0.4506	-0.2910	.	-0.2063	-0.0658	.	0.3209	0.0994	-0.0589	-0.3546	-0.1235	0.0206	-0.0533	-0.2315	-0.0450	-0.0326
Poverty	-0.0634	-0.1839	-0.2763	0.4229	.	-0.1239	-0.4749	0.3209	.	0.2043	-0.1937	0.0229	-0.4100	-0.0307	-0.0047	-0.0778	-0.1682	0.2082
Heart_Dis	-0.2491	0.0172	-0.1605	-0.3706	.	-0.0522	0.0346	0.0994	0.2043	.	0.5883	-0.3818	0.2407	0.6939	0.1897	0.2976	-0.1388	-0.1252
Coronary	0.1709	0.4347	0.1381	0.3495	.	-0.1077	-0.0200	-0.0589	-0.1937	0.5883	.	0.2419	-0.4814	0.0937	-0.1479	-0.3469	0.0833	0.3209
Kidney	-0.0551	-0.2479	-0.3996	-0.2331	.	-0.2304	-0.0635	-0.3546	0.0229	-0.3818	0.2419	.	0.1363	0.3468	0.2043	-0.1914	-0.1178	-0.2267
Stroke	-0.0759	0.1990	-0.1248	0.4729	.	-0.0657	-0.3945	-0.1235	-0.4100	0.2407	-0.4814	0.1363	.	0.3172	-0.0403	-0.2948	-0.0107	0.2607
Diet	0.1961	-0.3882	0.0518	0.0753	.	0.0157	0.1867	0.0206	-0.0307	0.6939	0.0937	0.3468	0.3172	.	-0.1106	0.0048	0.0728	-0.1587
Inactivity	0.0105	-0.0344	0.1085	-0.0321	.	-0.1166	-0.0505	-0.0533	-0.0047	0.1897	-0.1479	0.2043	-0.0403	-0.1106	.	0.0631	0.1891	0.1466
PCP	0.3216	0.1187	-0.0111	0.3038	.	-0.0972	-0.0071	-0.2315	-0.0778	0.2976	-0.3469	-0.1914	-0.2948	0.0048	0.0631	.	0.2025	-0.0245
Checkup	-0.0859	-0.1759	-0.3541	-0.0066	.	-0.3156	-0.1423	-0.0450	-0.1682	-0.1388	0.0833	-0.1178	-0.0107	0.0728	0.1891	0.2025	.	-0.2454
No_Insurance	0.1898	-0.3083	0.1515	0.1315	.	-0.2752	0.0946	-0.0326	0.2082	-0.1252	0.3209	-0.2267	0.2607	-0.1587	0.1466	-0.0245	-0.2454	.

CHAPTER FOUR

Discussion and Conclusions

Many of the results of the statistical analysis aligned with or supported theory established in the section on background information and prior research, but there were some surprising relationships as well. Most notably, it appears that the main hypothesis of this study was not fully supported by the data. The hypothesis stated that the incidence of mortality from diseases related to chronic hypertension, specifically heart disease, coronary artery disease, kidney failure, stroke, and diet-related disease, is higher among low-income individuals when compared to higher-income counterparts in Cook County, IL, because products of low socioeconomic status provide barriers to managing the condition and maintaining good health. Although some of the socioeconomic indicators did display significant relationships with poverty and health, the associations between poverty and health indicators themselves were minimal. This limits the ability of these results to confirm that poorer health is directly related to lower income level. However, one of the other socioeconomic status indicators assessed, namely race/ethnicity, did appear to substantially mediate or exacerbate the effects of other socioeconomic status indicators, and displayed a stronger relationship with health than poverty alone.

First, it was necessary to establish a statistical link between hypertension and the mortality measures used in this study, to confirm validity of the medical association as well as to test the reliability of the data collected. Hypertension is found to show a moderate-strength positive association with incidence of death from heart disease,

coronary artery disease, kidney disease, and diet-related illnesses. The exception to this trend between hypertension and mortality causes is stroke, for which the correlation is more appropriately considered weak-moderate. Stroke tends to be an outlier in many of the analyses in this study, an explanation for which may be a direction for future research. The association between hypertension and the mortality factors is strongest for diet-related deaths, supporting the theory that access to a healthy diet has a significant impact on management of hypertension and effectiveness of treatment.

The strength of relationship between hypertension and diet-related deaths, in comparison to the other mortality measures, is notable because of its implications for the importance of lifestyle variance to health outcomes. The other diseases have some degree of genetic heritability, but diet-related illnesses are almost exclusively related to lifestyle. That includes personal choice but also access to healthy food, and speaks to the importance of available nutritious food sources as a management strategy for chronic hypertension. Nutrition has long been established as a key mechanism to managing hypertension, but due to the many barriers that people living in poverty face when it comes to obtaining healthy food, this statistical result aligns with the claim that those living in poverty suffer worse outcomes related to hypertension than higher-income counterparts in Cook County. However, that result did not necessarily manifest in the statistical analysis of the data used in this study. Those who live under the federal poverty line are associated to a weak positive degree with death from diet-induced causes. There is no statistically significant association between poverty and death from coronary artery disease, and the probability of statistical significance of the positive associations between poverty and heart disease, stroke, and diet-related deaths is limited. While it appears from

these results that poverty is related to mortality to a weak degree, the data did not necessarily support the conclusion that people in poverty are associated with worse outcomes than people who do not live in poverty. The analysis revealed only a questionable association between poverty on its own and health at all but did indicate that poverty affects diet-related mortality.

The relationship between poverty and hypertension was weaker than expected, at only 0.3471 in the positive direction. A plausible explanation for the result shown relates to the likelihood that individuals living below the federal poverty line have limited access to primary care due to health insurance, financial, geographical, and other barriers. Hypertension is diagnosed through a blood pressure test, which is administered routinely by healthcare providers and is monitored by primary care physicians as an indicator of health but is often asymptomatic except in severe cases. Chronic hypertension would typically be diagnosed during a routine checkup and treated by a primary care provider, so individuals who do not regularly see a primary care provider may have no alternative method of knowing they have high blood pressure. As stated in Chapter Two: Data and Methods, the data on hypertension in this study was collected from a variety of sources that all relied on self-reports of a prior diagnosis of the condition. If a significant proportion of individuals living in poverty do not have access to a provider who would diagnose them with hypertension before the occurrence of a more severe complication of the disease, the count of poor individuals with this disease would be greatly underestimated.

Due to the many hardships faced by individuals living in poverty that set them up for higher risk of health problems, chronic hypertension could be expected to be greater

in this population than in others, in which case a stronger positive correlation would exist. This analysis did show that people living in poverty are negatively associated with having a regular primary care physician. There is only a weak positive relationship between living in poverty and having a checkup in the past year. These correlations both reveal a potential source of data inaccuracy in hypertension prevalence among low-income Americans; if a person has hypertension, but does not regularly see a physician or go to a primary care provider to check his blood pressure, then this condition would likely go undetected and would not be reported to the data sources used in this study. For this reason, disparities in hypertension treatment and control among those living in poverty are better visualized through analysis of hypertension-related complications and fatal diseases, which can be tracked without such reliance on self-report data. The data used in this study proves insufficient for making empirical claims about the prevalence of chronic disease in low-SES populations when compared to counterparts of higher status.

Another potential explanation given these data is that poverty is not as strong of an indicator of health risks as was hypothesized. There may be other factors associated with low socioeconomic status which have stronger associations with poor health status, and these factors may be the driving force behind results of prior research that argue that SES is a strong and reliable predictor of poorer health. Poverty is weakly if at all associated with the mortality measures studied, and these associations display limited statistical significance. This result would seem to support a claim that poverty alone is not responsible for poorer health. Based on information given in the background and prior research section, this conclusion logically follows. Poverty is an influencing factor on the opportunities that people have to maintain good health and seek healthcare

resources, but money alone may not influence health quite so directly. Lifestyle habits are an important mechanism that can be influenced by personal choice as well as opportunities, so even though poverty creates barriers to exceptional health due to lacking resources, it is understood that health is a complicated phenomenon that is influenced by the complex interaction of multiple varying factors. Some of these factors fall under personal control, while others are driven primarily by macrosocial forces. Poverty independent of all of the mechanisms to promote maintaining good health, therefore, may not be a reliable predictor of end-stage health outcomes.

When assessing partial correlations, the following results were obtained: a hypothetical American living in poverty who reported being diagnosed with hypertension was associated with death from any given mortality measure to a moderate-strength degree of about positive 0.50. Given a hypothetical American who reported being diagnosed with hypertension and one who died of one of the given mortality measures, an individual under both circumstances is associated with living in poverty to a weak positive degree. Therefore, when it is known that someone in poverty has hypertension, the association with a mortality measure for poverty is stronger than the association given in the direct correlations between poverty and mortality. This does align to a degree with the prior research established, because people who live in poverty are expected to have poorer health outcomes than those who do not live in poverty, especially in the case of chronic conditions that require active management. It also contradicts the bivariate correlation between poverty and health measures, which reveals that some trends in social determinants of health may be easily masked by incorporating too few or the wrong variables, especially in a population of this size and diversity.

The result of the partial correlation supports some of the alternate explanations stated previously for why the results of this statistical analysis do not fully support the hypotheses based on background information. An individual diagnosed with hypertension, in accordance with guidelines established by the Joint National Commission on Hypertension, requires an individualized and strict regimen of healthy eating habits, exercise, blood pressure controlling prescription medications, and regular monitoring of blood pressure. Individuals in poverty experience significant obstacles to such chronic disease maintenance for a variety of reasons, including barriers to healthy food access, inability to afford prescription medications, and inability to regularly visit a primary care provider for monitoring. Therefore, though the association between poverty and mortality measures is barely existent, the partial correlation for individuals in poverty who know they have hypertension reveals that the binomial correlation may encapsulate too wide a set of influencing factors to indicate reliably the effect of poverty on health.

Similarly to what was discovered when studying poverty's effect on hypertension-related mortality measures, race has a profound influence on mortality from the chronic illness. In fact, race proved to show even more dynamic results than income when it comes to population health. Controlling for being black dramatically reduces the association between hypertension and dying of heart disease, whereas controlling for being white only slightly reduces this number. This control mechanism reduces the association between hypertension and kidney disease to one-third of the bivariate value, and reduces the relationship between hypertension and stroke to basically zero. In other words, most of the relationship between dying of stroke if one has hypertension is dependent on that individual also being black. The fact that race has such a substantial

mediating effect on mortality reveals the importance of addressing the influence of social institutions on mechanisms for improving health. Race is known to be a social, rather than a biological, construct, and so as an indicator of socioeconomic status, the difference between mortality for whites and mortality for blacks calls the systems for adequate healthcare into question (Witzig).

The case of diet-related mortality is an especially interesting one when it comes to race. When controlling for being black, the relationship between having hypertension and dying from a diet-related disease is reduced to about half of the bivariate value. Because diet-related mortality indicates lifestyle- or nutrition-related disease, rather than one that could be more directly caused by genetic factors, this supports theory that the increased mortality for black individuals is not related to any kind of genetic difference in black individuals' response to hypertension, but may be inherent in something situational or cultural about being black in Chicagoland. If, as was determined from Table 5.2, people who have hypertension and live in poverty are positively associated with being black, but negatively associated with being white, then it follows that as the number of hypertensive people living in poverty increases, the frequency with which these people will be black will increase, and the frequency with which they will be white will decrease. If a disproportionately high number of hypertensive people living in poverty are black, then race seems to be inextricably tied to the conditions of poverty or low socioeconomic status that prevent healthy eating habits in hypertension management. This conclusion would contradict historical medical thought that black patients should be treated with different medications than white patients for reasons related to genetic responses to

hypertension management; biology does not appear to cause complications, but rather, sociology (Wright et al.).

Although the combination of living in poverty and having hypertension is positively correlated with being black, the converse partial correlation does not display the same trend. Given that an individual has hypertension and is black, the association with living in poverty is weak and negative. In other words, black individuals who report having hypertension may also be expected to report living in poverty less frequently. This lends support to the theory that those people who reported having hypertension to the sources used in this study are more likely to have better access to diagnostic resources, insinuating higher income and better access to preventative care and treatment, since prior research cited in the opening section of this study determined that there does not appear to be a strong correlation between income and likelihood of having hypertension. In this study, the association between being black and having hypertension is moderate and positive, so the fact that this relationship changes direction completely when poverty is accounted for reveals a potential discrepancy inherent in the data. It supports the idea that those in poverty underreport having hypertension, so the higher income individuals who are aware that they have hypertension are reporting it in a way that appears disproportionate to the entire population of hypertensive individuals.

Likewise, positive correlations between having hypertension and having a primary care provider support the theory that much of the data collected was contingent on reports from primary care providers. There is nothing intrinsic about the set of individuals who have a regular primary care provider that would increase their risk of having hypertension, so this trend in the data should not be expected to exist.

Hypertension is also negatively correlated with having completed a college education, another indicator of elevated socioeconomic status, so hypertension appears to be inversely related to education, supporting one of the minor hypotheses. Prior research conflicts on this point; at very high levels of education, hypertension prevalence tends to increase, likely as a result of the high stress associated with the work and lifestyle of people who hold positions of higher SES. Similarly, the very different but still very real stressors related to low socioeconomic status, which this study focuses on primarily, would also be expected to lead to higher levels of a stress-associated illnesses such as hypertension. The negative relationship between education and hypertension that this study identified lends support to the association between the chronic disease and low socioeconomic status. However, consensus may be that this trend is likely nonlinear, and the negative relationship could be a result of a variety of factors that skew the trend one way slightly over the other. Race is related to these other indicators of socioeconomic status, as well. Given an individual with hypertension who completed college and has a primary care provider (higher socioeconomic status), that individual is negatively associated with being black, and has no significant association with being white. So—and this point encapsulates much of the goal of this entire study—it appears that there is only a health benefit to having higher socioeconomic status for black individuals, at least when compared to white individuals.

The final socioeconomic status indicator that this study assessed was crime, in conjunction with its association with poverty. The strongest relationship between hypertension and a mortality measure given the conditions of living in poverty and an area of high crime exists for diet-related deaths, but this positive relationship itself is only

of moderate strength. This supports prior research which determined that low-income neighborhoods are often associated with high crime rates and limited access to nutritious foods. There is a positive relationship between hypertension and living in areas of high crime, as well as with living in poverty. The association between poverty and high crime is so strong that controlling for one essentially makes relationships with the other negligible. This supports theory that hypertension is a stress-related disease, since the main correlating factor for poverty and high crime rates is stress, due to feelings of insecurity or unsafety. The positive association between high crime and physical inactivity supports the theory that even exercise is more difficult to maintain when neighborhood safety is low. This also supports community development efforts in low-income communities to incorporate a wider variety and accessibility of healthy food, as well as mechanisms of safe exercise, since lack of safety obviously has a measurable impact on the health of the population as a whole.

Overall, those individuals of low SES may be moderately associated with a higher frequency of reporting hypertension, but income status alone is not sufficient for determining a definite direct relationship with having hypertension and dying of hypertension-related causes. People who have hypertension, and people who report a combination of indicators of low socioeconomic status, are positively associated with experiencing mortality from hypertension-related diseases, especially from lifestyle-associated diseases that primarily depend on dietary causes. The relative strength of association between hypertension and diet-related deaths, given a variety of mediating factors and compared to other mortality measures, lends support to the importance of

healthy food sources in low SES neighborhoods that was presented in the opening chapter of this study.

These relationships are influenced by the complex interaction of separate indicators of SES, but in conjunction support the narrative that individuals of low SES are associated with poorer health outcomes overall from chronic illness. The most important risk factor, it appears, more-so than income, is race—however, this trend holds true only for black individuals. Asian Americans and Hispanic Americans experience moderately different results from white Americans, but being white seems to diminish many risk factors, while being black greatly exacerbates them. The results of this study were expected to show that poverty directly relates to poorer health, and this effect of a social determinant of health is influenced by other socioeconomic indicators such as race, education, and neighborhood safety; instead, the analysis indicates that poverty is one of many social determinants that have similar importance to health and interact in complex ways, but that the greatest determining factor of hypertension and related causes of mortality is being black in Chicago.

It is worth noting that a completely different data source was used at the outset of this study, before the more comprehensive data set from the Chicago Health Atlas was collected. Initial analysis was conducted using data from the 2010 Census exclusively, and this yielded very few logical conclusions, as well as some conclusions that directly oppose results of this study. The only moderate and strong relationships existed between hypertension, a few of the diseases used as mortality measures in the final analysis (heart disease, kidney disease, stroke), and having a place of health care, or being seen in the emergency department. In fact, the correlation between reporting hypertension and

visiting the emergency room in the past year was almost completely direct. Since chronic hypertension is better diagnosed in a primary care setting, the fact that so many individuals reported the diagnosis in emergent settings supports some theories presented above. People of extremely low income typically use emergency departments as their usual source of healthcare, due to lack of insurance or underinsurance, and hypertension is typically not explicitly diagnosed in emergency rooms unless it is a major contributing factor to an acute disease, such as heart attack or stroke. Essentially, the Census data could have been catching the problem too late; people may have been more likely to know they had hypertension if they had spent time in the emergency room, likely for an acute event, but were not being actively treated to manage the chronic illness in the primary care setting as is anticipated when assessing data on chronic disease.

Otherwise, there were minimal if any associations between poverty and hypertension, and the only substantial relationship between race and hypertension existed for white individuals. Hispanic individuals were moderately negatively associated with hypertension, which does not appear to have a reasonable explanation other than that this group may be the least likely to report hypertension. With white individuals reporting hypertension to the Census with significantly higher frequency than other racial/ethnic groups, the reliability of the Census health data to accurately depict the diseases of the American population is clearly limited. This speaks to the importance of studying the most comprehensive data set available when assessing trends in population health, and it also reveals a level of ineffectiveness in one of the main ways that policymakers attempt to collect information on public health. A better assessment of the actual prevalence of hypertension within a population would require a controlled study where researchers

medically tested individuals within a population and collected individualized data on various indicators of socioeconomic status in order to visualize trends. Data resources typically used to study population and public health are proving inadequate for this type of assessment.

The correlations produced by this analysis are only linear correlations with no technically predictive value. Future research may include linear regression analyses to produce models that would more accurately predict the specific degree of change expected to occur in other variables as one changes. In other words, the relationships identified in this study describe the strength and direction of associations between identified variables, but further analysis is needed to determine how the risk of having one health indicator changes as another changes. With the analyses presented in this study, conclusions follow the formula: "As the percentage of people reporting a diagnosis of hypertension increases, the frequency of heart disease-related deaths per 100,000 can be anticipated to increase as well, due to the moderate positive correlation between the variables Hypertension and Heart Disease." In order to make statements such as "per every ___% of people diagnosed with hypertension, it can be expected that ___ deaths occur due to heart disease," a linear regression analysis would need to be conducted for Hypertension and Heart Disease; that analysis would therefore determine one's risk of dying of heart disease after diagnosis of hypertension in Cook County, IL. Such a model would be extremely beneficial to both healthcare providers and other professionals dedicated to improving public health in low-income communities.

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