The Hispanic Health Paradox, as it Relates to Cardiovascular Disease

An Analysis of the Prevalence of Cardiovascular Disease in Diabetic and Foreign-Born Populations

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ABSTRACT

The Hispanic health paradox (HHP) is an epidemiological paradox that describes the observation that the Hispanic population in the United States tends to have better health outcomes than would be expected, given the socioeconomic profile of this population. As a clear correlation between socioeconomic status (SES) and health outcomes has been established, one would expect the Hispanic population to have relatively poorer outcomes than the non-Hispanic (NH) white population and comparable outcomes to the NH black population. Among other health outcomes, the HHP has been observed with respect to cardiovascular disease (CVD), as analyses by the American Heart Association and Centers for Disease Control have shown that the Hispanic population has a lower prevalence of CVD than the NH white and NH black populations. However, some smaller studies challenge the existence of the HHP. Additionally, the impact of CVD risk factors (such as diabetes) and level of acculturation to the United States on the HHP is understudied. By utilizing data from the 2018 National Health Interview Survey, this thesis will support the existing literature that shows that the HHP is found with respect to CVD. I will also argue that the HHP with respect to CVD is present among populations with diabetes but to a lesser extent than within the general population. This suggests that the prevalence of CVD among Hispanic individuals in the general population may be artificially low due to lack of health care utilization. Finally, I will argue that the HHP is present among both U.S.-born and foreign-born populations, indicating that the high proportion of immigrants in the Hispanic population and "healthy immigrant selection" are not enough to account for the paradox.

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CHAPTER I: INTRODUCTION

Introduction to the Hispanic Health Paradox

The Hispanic health paradox (HHP) refers to the "relatively good health of Latinos within the U.S., despite what lower levels of socioeconomic status might predict" (Camacho-Rivera et al., 2015). For example, the Hispanic population has been shown to have a longer life expectancy and lower rates of cancer than the non-Hispanic (NH) white population, as well as comparable infant mortality rates and rates of low-birth-weight infants to the NH white population (Kochanek et al., 2019; Siegel et al., 2015; Kaiser Family Foundation, 2017; Acevedo-Garcia et al., 2007). This is paradoxical given that the Hispanic population is, on average, less educated and less wealthy than the NH white population (Fontenot et al., 2018) (US Census Bureau, 2017). A clear relationship between socioeconomic status (SES) and health has been established, by which lower SES confers worse health outcomes (Adler et al., 1994). Given this gradient, one would expect the Hispanic population to have worse health outcomes than the NH white population, not similar (or better) health outcomes. The paradox likely does not apply indiscriminately to all Hispanic individuals, but instead varies depending on a variety of factors such as region of birth, gender, level of acculturation and socioeconomic status.

The HHP has also been observed when studying cardiovascular disease (CVD), although these studies are somewhat controversial. National surveys utilized by the American Heart Association and Centers for Disease Control show that the Hispanic population has a lower prevalence of CVD than the NH white and NH black populations. However, some smaller studies have shown that Hispanic individuals have a similar, if not higher prevalence of CVD compared to NH white individuals. (Hunt et al., 2002; Pandey et al., 2001) There are several possible explanations that could account for this difference, one being that two of the small-scale

studies referenced examined Mexican-Americans instead of the Hispanic population in general. (Hunt et al., 2002; Pandey et al., 2001) More information regarding the HHP with respect to CVD is needed in order to determine if the paradox is a true phenomenon or the result of under-reporting and ambiguous disease classifications.

The purpose of this thesis is two-fold: one, to add to the existing research that shows that the Hispanic population has an unexpectedly low prevalence of CVD in the United States; and two, to answer the following two research questions:

1) Is the HHP (with respect to CVD) present among populations with diabetes, a CVD risk factor?
2) Is the HHP (with respect to CVD) present when region of birth is taken into account?

Brief Overview of the Hispanic Population

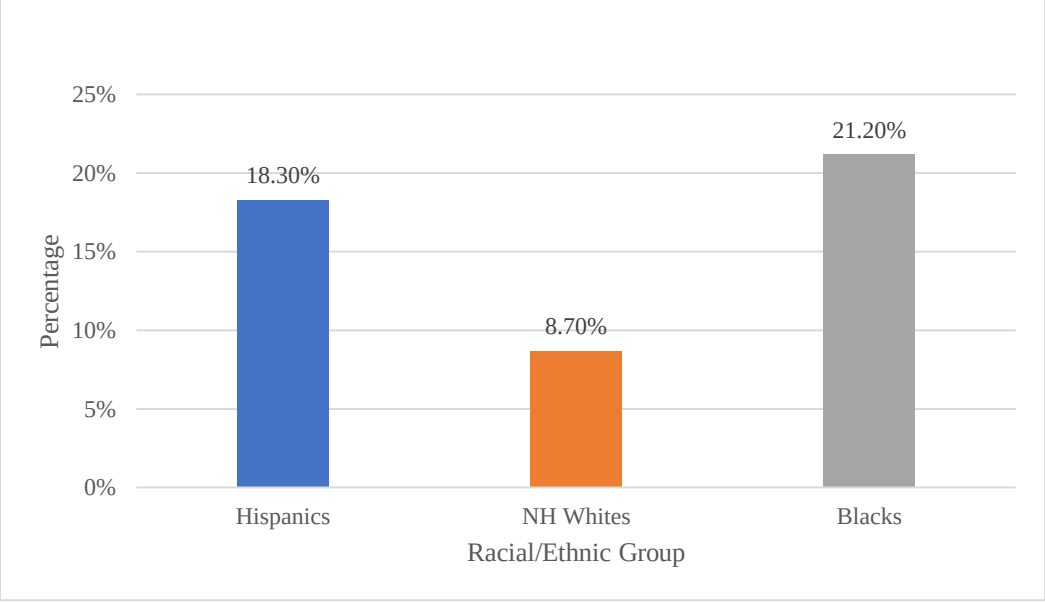
The Hispanic population is the largest racial or ethnic minority population in the United States. As of July 2018, there were 59.9 million Hispanics in the U.S., constituting 18.3% of the nation's population (Frances Alonzo, 2019). Ten states contain a population of 1 million or more Hispanic residents: Arizona, California, Colorado, Florida, Georgia, Illinois, New Jersey, New Mexico, New York and Texas (Frances Alonzo, 2019). The Hispanic population in the U.S. includes both U.S.-born Hispanics as well as foreign-born individuals who immigrated from Latin American, the Caribbean, or Spain (Velasco-Mondragon et al., 2016).

The Hispanic health paradox (the motivating phenomenon behind this thesis) centers around the concept of socioeconomic status. In light of this, I will provide information regarding income and education levels within the Hispanic population. I will provide the same information with regards to the NH black and NH white populations as well. I will do this in order to show

that the Hispanic population is socioeconomically comparable to the NH black population but lower than the NH white population.

The Hispanic population is similar to the NH black population in terms of income level, but far below that of the NH white population. In 2017, the real median income for Hispanic households was $50,486, while that of black households was $40,258 (data regarding the NH black population unavailable) (Fontenot et al., 2018). The NH white household real median income was nearly 25% greater than that of Hispanics at $68,145 (Fontenot et al., 2018). Also in 2017, 18.3% of the Hispanic population (representing 10.8 million people) in the U.S. lived below the federal poverty level (FPL), comparable to 21.2% of the black population (Fontenot et al., 2018). Conversely, only 8.7% of the NH white population lived below the FPL (Figure 1) (Fontenot et al., 2018).

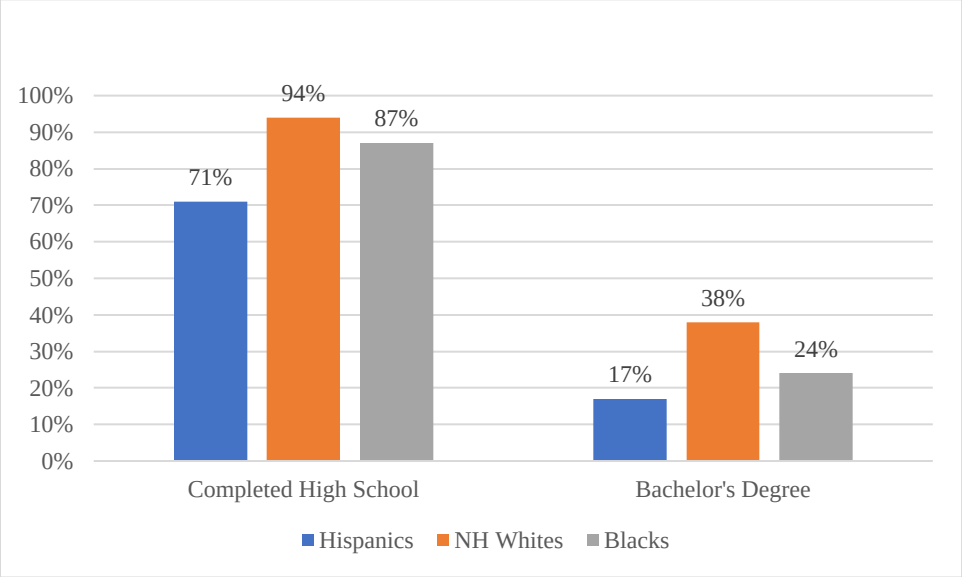
Figure 1: Percentage of Population Living Beneath the Federal Poverty Level, 2017 (Fontenot et al., 2018)



In 2017, the percentage of Hispanic individuals aged 25 or older who had graduated from high school (71%) was significantly less than that of NH white individuals (94%) (US Census

Bureau, 2017). The percentage of Hispanic individuals who had graduated from high school was also less than the black population (87%) by a fairly wide margin. Only 17% of the Hispanic population and 24% of the black population aged 25 or older had completed a bachelor's degree or higher level of education. Meanwhile, 38% of NH white population above 25 years old had reached this level of education—over twice as many as the Hispanic population in terms of percentage (Figure 2). (US Census Bureau, 2017).

Figure 2: Educational Attainment by Race/Ethnicity, 2017 (US Census Bureau, 2017)



Outline of This Thesis

The second chapter of this thesis will provide a review of the literature regarding the Hispanic health paradox. I will identify the various fields in which the HHP has been observed, as well as give an overview of the proposed explanations for the HHP. I will end by pointing out the gaps in the existing literature that motivated my data analysis.

The third and fourth chapters of this thesis will consist of a data analysis and discussion. I will utilize data from the National Health Interview Survey (NHIS), a survey conducted annually across thousands of households throughout the country. I will use this data to show that the prevalence of CVD within the Hispanic population in the United States is lower than within the

NH white and NH black populations. I will also show that the prevalence of CVD within the Hispanic population with diabetes is lower than within the NH white and NH black populations, arguing that the HHP is still present among populations with diabetes. However, I will show that the differences between the prevalence of CVD in the Hispanic population and NH white and NH black populations with diabetes are smaller than within the general population, suggesting that the presence of the HHP with respect to CVD in the general population may be exaggerated due to low rates of health care utilization. Finally, I will show that the prevalence of CVD within the foreign-born Hispanic population is lower than within the foreign-born NH white population. Thus, I will argue that the HHP is still present within the foreign-born population, as it is in the U.S.-born population, suggesting that the high proportion of immigrants in the Hispanic population is not enough to account for the paradox. I will conclude with a summation of the literature review, data analysis and discussion.

A Note on Terminology

The term "Hispanic" refers to people who speak Spanish and/or are descended from Spanish-speaking populations, whereas Latino refers to people who are from and/or descended from people from Latin America (Cole, 2019). Both terms are used in the literature. In this thesis, the term "Hispanic" will be used unless the study in question specifically examined Latin Americans. Additionally, Mexican immigrants comprise 64% of all Hispanic immigrants in the United States (Smith-Miller et al., 2017). Thus, studies which focus on Mexican immigrants exclusively will be included in this discussion, as this population makes up the majority of Hispanic immigrants. To avoid confusion or false conclusions, the population studied (Hispanic, Latin American or Mexican immigrants) will be specified as it is discussed.

CHAPTER II: LITERATURE REVIEW

Outline of Literature Review

The Hispanic health paradox (known as the Latino health paradox, or simply the Hispanic/Latino paradox) has been described as an epidemiological phenomenon (Markides & Coreil, 1986; Ruiz et al., 2016). Generally, the term refers to the trend that the Hispanic population in the United States has better health outcomes than expected relative to other racial/ethnic groups. The terminology used may vary based on the specific condition being discussed; for example, the observance of the HHP with respect to life expectancy is often called the "Hispanic mortality paradox" (Ruiz et al., 2016). This literature review will provide an explanation of the socioeconomic status-health gradient, how it demonstrates the paradoxical nature of Hispanic health outcomes with respect to a number of conditions, and then provide an overview of the discussion of the HHP with respect to cardiovascular disease.

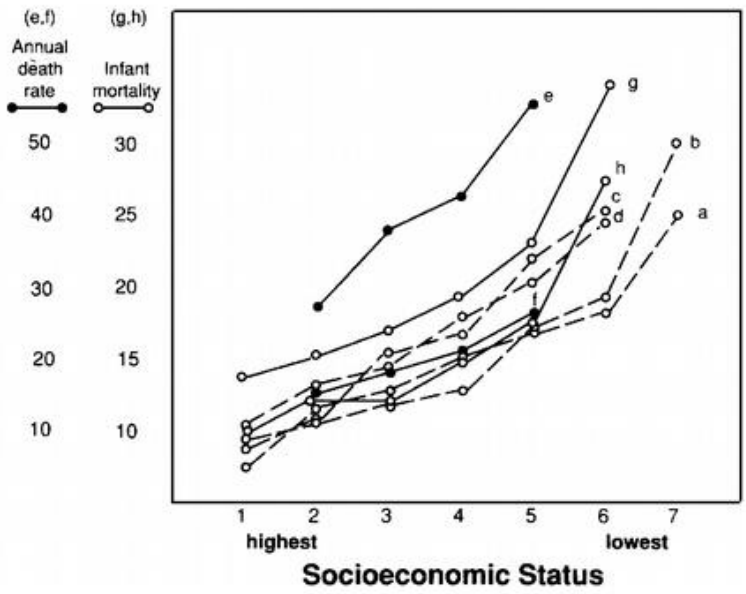
The Socioeconomic Status (SES)-Health Gradient

It has been well-established that there is a correlation between SES and health.(Adler et al., 1994) SES is usually described as some combination of income level, education level and occupation, which typically serve as means of measuring economic status, social status, and work status, respectively (Adler et al., 1994). Differences in SES are linked with rates of mortality and morbidity for nearly every disease and condition (Adler et al., 1994). Multiple studies have shown that individuals who are classified as having a low SES experience worse health outcomes than individuals classified as having a high SES, with a step-by-step gradient in between (Adler et al., 1994). This gradient is known as the SES-health gradient.

The most famous study documenting the SES-health gradient is the Whitehall study, conducted by M.G. Marmot and colleagues. This study covered 17,350 British civil servants over a ten-year period. These civil servants were classified according to employment grade by the researchers. The following classifications were made, from lowest status to highest status: the "others," consisting primarily of unskilled manual workers; the clerical workers; the professional/executive workers; and the administrative officials. Marmot et al. found that for nearly every major cause of death, the lower two grades (the "others" and clerical workers) had a higher mortality risk than the two higher grades (professionals/executives and administrators). This list includes but is not limited to coronary heart disease (which accounted for 43% of all deaths), lung cancer, chronic bronchitis, accidents and violence, and suicide. Marmot et al. also controlled for smoking, a major health behavior, and found that differences in smoking behavior did not fully account for the differences in deaths from respiratory diseases. Perhaps most shocking, there was a three-fold difference in relative risk of mortality between the lowest grade group and the highest grade group (Marmot et al., 1984).

A composite of several studies that examined mortality rates of at least four levels of SES shows a nearly-linear relationship between SES and mortality. Annual death rates and infant mortality rates are highest in the lowest SES populations and then decrease in a stepwise fashion with rising SES and are lowest within the high SES populations (Adler et al., 1994). Thus, it is clear that differences in health outcomes occur at every level of SES.

Figure 1: Figure pulled from Adler et al. Shows that across four separate studies, annual death rate and infant mortality increase as SES decreases. This figure demonstrates the step-wise nature of the SES-health gradient (Adler et al., 1994).



The HHP and Immigration Status

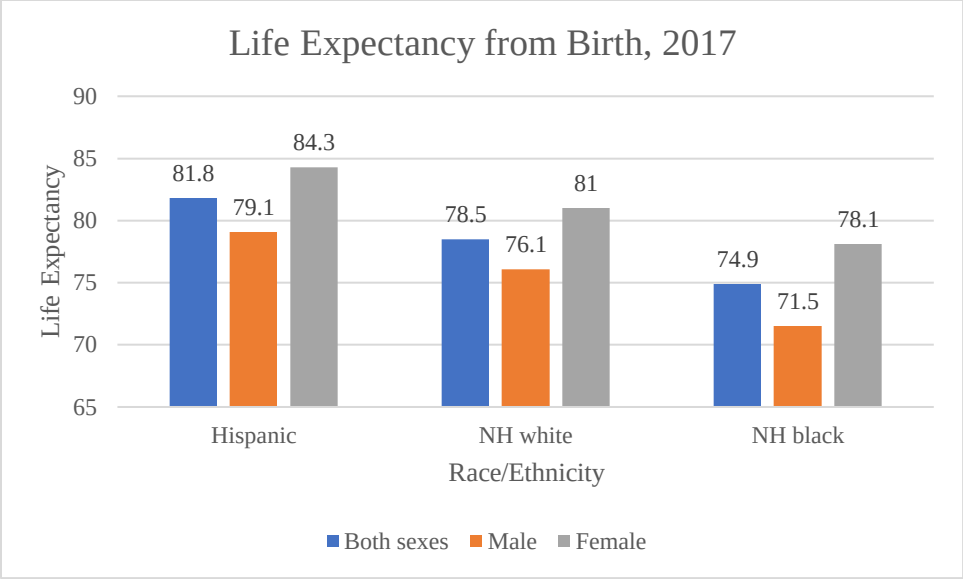
An additional element of the HHP is the role that immigration status plays in the lives of many Hispanic individuals. A large proportion (34%) of the Hispanic population in the U.S. is composed of immigrants (Flores, 2017). Castañeda and colleagues argue that in order to achieve a substantive change in health outcomes, "immigration must be treated as a health determinant itself" (2015). As Castañeda et al. point out, much of the research that seeks to explain the HHP focuses on individual behavioral choices, while ignoring the broader social and economic contexts influencing these choices. Many studies also focus on specific cultural practices, which unfortunately can lead to "superficial or stereotyped notions of culture" (Castañeda, 2015). For example, researchers may simplify "notions of gender, family relations and cultural values such as…'machismo'" (Castañeda, 2015). These over-simplifications not only ignore the diversity within the Hispanic population, but also ignore structural factors that impact immigrant health. Castañeda et al. list "poor access to transportation, elevated health care costs, changing access to healthy foods, [and] differences in labor practices" as structural factors that disproportionately

affect immigrants (2015). Thus, it is clear that when seeking to understand the HHP, cultural factors alone are insufficient. Immigration status has profound impacts on the economic and social context in which many Hispanic individuals operate, and thus must be studied as a social determinant of health.

The HHP and Life Expectancy

The clearest way to see the Hispanic health paradox is to look at life expectancy. In the United States, individuals of Hispanic origin live longer than non-Hispanic individuals. This particular aspect of the HHP is often referred to as the Hispanic mortality paradox (or advantage) (Ruiz et al., 2016). It was first documented in 1983 by K.S. Markides and colleagues and has persisted to this day (Markides, 1983). For example, in 2017, Hispanic individuals had a life expectancy advantage at birth of 3.3 years over NH white individuals and 6.9 years over NH black individuals (Kochanek et al., 2019). The life expectancy at birth for the Hispanic population was 81.8 years (79.1 years for males and 84.3 years for females), which significantly exceeded 78.5 years (76.1 years for males, 81.0 years for females) for the NH white population and 74.9 years (71.5 years for males, 78.1 years for females) for the NH black population (Kochanek et al., 2019). The Centers for Disease Control (CDC) has documented this trend of the Hispanic population living longer since 2006; unfortunately, the CDC did not report life expectancy information by Hispanic ethnicity prior to this time (CDC, 2018). However, earlier researchers were able to use creative methods to approximate the life expectancy of the Hispanic population in the U.S. For example, Markides et al. utilized a study in which researchers analyzed the mortality rates among persons in Texas with Spanish surnames (Markides, 1983).

Figure 2*:* Life Expectancy from Birth, 2017 (Kochanek et al., 2019).



Methodological Explanations for the HHP, based on the Hispanic Mortality Paradox

Two primary hypotheses have been proposed to explain the Hispanic mortality paradox as a function of data bias, meaning that the HHP is only observed because of a lack of a comprehensive review of the entire Hispanic population and not because Hispanic individuals have a health advantage (Abraído-Lanza, 1999). Presumably, these hypotheses can be extended to the HHP. The first hypothesis, the *salmon bias hypothesis*, proposes that Hispanic mortality in the United States is artificially low because a large portion of the Hispanic population are immigrants, and many of these immigrants choose to return to their country of origin before passing away. Abraído-Lanza et al. tested the *salmon bias hypothesis* by examining the mortality rate amongst Hispanic populations that had a high likelihood of dying in the United States (1999). They examined Cubans residing in the U.S., because at the time of this study (1999) Cubans could not easily return to their home country. They also looked at Puerto Ricans, as even if these individuals chose to return to their homeland, their mortality would still be counted in the overall U.S. morality rate. Finally, they also assumed that U.S.-born Hispanic individuals would be more likely to pass away in the U.S. than foreign-born Hispanic individuals. This assumption

was based off the concept of *familism*, which describes "the importance of family regarding support, comfort and services" in Hispanic culture (Hernández & Bámaca-Colbert, 2016). The results showed that Puerto Ricans and Cubans have lower mortality than NH whites, and U.S.-born Hispanics have lower overall mortality than U.S.-born whites. Thus, when specifically examining Hispanic individuals likely to die in the U.S., the researchers found that these individuals still have a lower mortality rate than U.S.-born NH white individuals. This undermines the hypothesis that the death rate amongst Hispanics in the U.S. is artificially low because Hispanics choose to return to their county-of-origin before passing away, as these three groups were chosen *because* they were likely to die in the U.S. Given that these three groups were likely to die in the U.S. yet still have paradoxically low mortality rates, this study does not support the *salmon bias hypothesis* and instead suggests that the Hispanic mortality paradox is a true phenomenon (Abraído-Lanza et al., 1999).

The second hypothesis that attempts to explain the Hispanic mortality paradox is the *healthy migrant hypothesis*. This hypothesis proposes that the "healthy migrant effect," meaning the fact that immigrants are typically healthier than the general population, is responsible for the low Hispanic mortality rate, as a large proportion (about 34%) of the Hispanic population is composed of immigrants (Flores, 2017). Abraído-Lanza et al. tested this hypothesis by examining the mortality rates amongst both foreign-born Hispanic and NH white individuals. If this hypothesis were true, then there would be no difference between foreign-born Hispanic and foreign-born NH white individuals, as all immigrants are subject to selection factors (1999). However, Abraído-Lanza et al. found that foreign-born Hispanics do, in fact, have lower mortality than their foreign-born white counterparts (1999). In the 45-64 age group, foreign-born Hispanic individuals were about half as likely to die than foreign-born NH white individuals in

the time period studied, while in the 65+ age group foreign-born Hispanic individuals were less than half as likely to die than their NH white counterparts (Abraído-Lanza et al., 1999). This indicates that even amongst immigrants, Hispanics have a health advantage. This suggests that the large proportion of immigrants within the Hispanic population alone does not account for the Hispanic mortality advantage. While not refuting the *healthy migrant hypothesis,* this study suggests that this hypothesis alone is not sufficient to account for the HHP. Thus, neither the *salmon bias hypothesis* nor the *healthy migrant hypothesis* can adequately account for the Hispanic mortality advantage.

The HHP and Other Health Outcomes

Psychiatric Illness: A study published by Marvin Karno and Robert Edgerton in 1969 regarding mental illness amongst Mexican-Americans was one of the first studies remarking on the HHP. Karno and Edgerton observed that Mexican-Americans in California under-utilized psychiatric facilities. For example, Mexican-Americans accounted for only 3.3% of the resident population of "California's state hospitals for the mentally ill," whereas Karno and Edgerton expected this number to be closer to 9-10% (Karno & Edgerton, 1969). Karno and Edgerton described this finding—and other similar findings—as an "epidemiological paradox" (Karno & Edgerton, 1969).

Cancer: Although cancer is the number one cause of death in the Hispanic population in the United States, the lifetime probability of developing cancer among Hispanic men and women is less than among NH white men and women. The lifetime probability of developing cancer among Hispanic men and women is 39% and 34%, respectively, while the lifetime probability of developing cancer among NH white men and women is 42% and 39%, respectively (Siegel et al.,

2015). Additionally, Hispanic individuals are less likely than NH white individuals to be diagnosed with prostate, breast, lung and bronchus and colorectum cancers, the four most common cancers (Siegel et al., 2015). Thus, the HHP is present when studying cancer.

Birth outcomes: The HHP has also been observed when studying birth outcomes in the United States. Hispanic infants are found to have a similar low-birth-weight (LBW) rate compared to white infants, although the SES-health gradient would predict that Hispanic women would have a higher LBW rate (Fuentes-Afflick & Lurie, 1997). A 1997 study conducted by Fuentes-Afflick and Lurie found that the LBW rate among Hispanic infants (referred to as "Latino" in the study) was 6.2%, comparable to the LBW rate of 5.8% among white infants. It is worth noting that a later study, conducted in 2007, distinguished between the LBW rates of foreign-born and U.S.-born Hispanic populations. Acevedo-Garcia et al. found that foreign-born Hispanic women were less likely to have LBW infants than U.S.-born Hispanic women (2007). This supports the *healthy migrant hypothesis*, as the protective effect against LBW seems to be much more present amongst immigrant Hispanic women compared to U.S.-born Hispanic women.

Infant Mortality: The Hispanic population in the U.S. has a similar infant mortality rate to the NH white population in the U.S. Similarly to the discussion regarding low birth weight, this is paradoxical given that the socioeconomic profile of the Hispanic population would predict a higher infant mortality rate than the NH white population. In 2017, the infant mortality rate within the Hispanic population was 5.1 infants per 1,000 live births (Kaiser Family Foundation, 2017). Similarly, the infant mortality rate within the NH white population was 4.7 infants per 1,000 live births. The NH black population had an infant mortality rate about twice that of the

Hispanic and NH white populations: 10.9 infants per 1,000 live births (Kaiser Family Foundation, 2017). Given that the NH black and Hispanic populations have similar socioeconomic profiles, one would expect that the Hispanic infant mortality rate would be closer to that of the NH black population rather than the NH white population. Again, this observation, that the Hispanic population has an unexpectedly low infant mortality rate, is part of the epidemiological phenomenon known as the HHP.

The HHP and Cardiovascular Disease (CVD)

Ambiguity around the term "CVD"

Cardiovascular disease (CVD) is the number one cause of death globally (WHO, 2017). The World Health Organization (WHO) defines CVD as "a group of disorders of the heart and blood vessels" (WHO, 2017). Unfortunately, there is no clear consensus as to which diseases fall into the category of CVD. This becomes an issue when studying the literature regarding CVD, as it can be difficult to compare the prevalence of CVD published by organizations that define the term differently. For example, both the CDC and the AHA have published the prevalence of CVD in the United States. The CDC utilized the National Health Interview Survey (the same dataset that I use in my data analysis) and referred to CVD as "all types of heart disease" (Villarroel et al., Table A-1, 2019). The AHA utilized the National Health and Nutrition Examination Survey (NHANES) and referred to CVD as "total cardiovascular diseases" (Virani et al., 2020). Both includes a different subset of diseases under the category of CVD, as shown in Table 1.

Table 1: Diseases that Qualify as CVD, According to the AHA and the CDC

AHA*	CDC**

Coronary heart disease	Coronary heart disease
Stroke	Angina
Heart failure	Heart attack
(Hypertension)	"Any other heart condition or disease"

*from the American Heart Association (AHA) Heart Disease and Stroke Statistics—2020 Update (Ch. 13) (Virani et al., 2020)
**from the Summary Health Statistics of the National Health Interview Survey, 2018, published by the Centers for Disease Control (CDC) (Villarroel et al., Table A-1, 2019)

The CDC and AHA share only one specific condition under the umbrella term “CVD:” coronary heart disease, a condition caused by the buildup of plaque in the arteries surrounding the heart (AHA, "Coronary Artery Disease"). The two otherwise differ. The AHA includes stroke, a form of cerebrovascular disease that involves interruption of constant blood flow to the brain (American Association of Neurological Surgeons, “Cerebrovascular Disease”); and heart failure, which is when the heart reaches a state in which it is unable to pump a sufficient amount of blood to meet the body’s needs (National Heart, Lung and Blood Institute, “Heart Failure”). The AHA also classifies hypertension as a form of CVD, although it also includes data on CVD with the exclusion of hypertension. This is likely because hypertension is more commonly considered a risk factor for CVD than a form of CVD itself (Virani et al., 2020). The AHA defines hypertension, or chronically high blood pressure, as having a systolic blood pressure ≥ 130 mmHg or a diastolic blood pressure ≥ 80 mmHg; as well as having been told twice by a health professional that one has high blood pressure (Virani et al., 2020). on the AHA website (AHA, "Understanding Blood Pressure Readings").

The CDC classifies angina, severe chest pain caused by a lack of oxygen to the heart, and a heart attack, an event in which blood flow bringing oxygen to the heart is severely reduced or interrupted completely, as forms of CVD (AHA, “Angina (Chest Pain)” and “About Heart Attacks”; Villarroel et al., Table A-1, 2019). This is somewhat confusing, as both angina and heart attacks are considered indicators of coronary heart disease (which, to add to the confusion, is sometimes referred to as coronary artery disease, although the two are technically different) (CDC, "Coronary Artery Disease"). The CDC also includes the category of “any other heart condition or disease,” which is rather vague (Villarroel et al., Table A-1, 2019).

A final issue with the term CVD is that often in population-based surveys, such as the NHIS and NHANES, only a few forms of CVD are specified (refer to Table 1). However, there are many types of diseases that fall under the category of CVD. For example, the WHO provides an extensive list of diseases that are considered forms of CVD. Consistent with NHIS and NHANES, this list includes coronary heart disease and cerebrovascular disease (such as stroke). However, the list goes on to include peripheral artery disease, rheumatic heart disease, congenital heart disease, and deep vein thrombosis (WHO, 2017). Thus, it is clear that the data from NHIS and NHANES are limited with regards to the many forms of CVD that exist.

I hope that in the above paragraphs I illustrated the ambiguity surrounding the term “cardiovascular disease.” The AHA and CDC define CVD differently with varying diseases in each category. Additionally, many of these diseases overlap: for example, angina is categorized as a form of CVD by the CDC, but is also a symptom of coronary heart disease, another form of CVD. Finally, the list of diseases that qualify as forms of CVD is extensive, and few studies provide a comprehensive overview of all of these diseases.

Large Studies Show the Hispanic Population has a Lower Prevalence of CVD

According to the 2020 Heart Disease and Stroke Statistics Update from the American Heart Association, the Hispanic population in the U.S. experiences lower rates of cardiovascular disease than the non-Hispanic population (Virani et al., 2020). As noted above, the AHA defines CVD as including coronary heart disease, heart failure and stroke. The AHA also includes rates of CVD with and without hypertension. As I regard hypertension as a risk factor for CVD more so than a form of CVD, I have reported the results that exclude hypertension. The AHA reports that 7.8% of Hispanic males and 8.0% of Hispanic females have CVD in the United States, the lowest prevalence in any racial/ethnic group other than Asians. NH white males and females have a CVD prevalence of 9.7% and 8.1%, respectively. NH black males and females have a CVD prevalence of 10.7% and 10.5%, respectively, the highest of any racial/ethnic group. NH Asian males and females have a prevalence of 6.5% and 4.6%, respectively (Virani et al., 2020). Data are not available for NH Alaskan Native/American Indian males and females, likely due to small sample size. When hypertension is included as a form of CVD, the CVD prevalence skyrockets. For example, within the Hispanic population, the prevalence of CVD when hypertension is included is 49.0% for males and 42.6% for females (Virani et al., 2020). Throughout my data analysis, I will exclude hypertension from CVD.

The fact that fewer Hispanic individuals experience CVD than NH white and NH black individuals is especially perplexing due to the fact that Hispanics have high rates of obesity, hyperlipidemia (high cholesterol), and diabetes, three major risk factors for CVD. The AHA reports that NHANES data from the years 2011-2014 examining adults aged 20 years or older show that 73.6% of NH white males are either overweight or obese, while 64.3% of NH white females are overweight or obese (Virani et al., 2020). These rates, while startlingly high, are

lower than those of the Hispanic population where 80.8% of Hispanic males and 77.8% of Hispanic females are either overweight or obese (Virani et al., 2020). NH black males have a lower rate of overweight/obesity than Hispanic males (69.1%) but NH black females have a higher rate (79.5%) (Virani et al., 2020).

The Hispanic population also has a high rate of hyperlipidemia (defined as total cholesterol $\geq$ 200 mg/dL). Between 2013-2016, the rates of hyperlipidemia among Hispanic adults aged 20 years or older was 39.9% of Hispanic males and 38.9% of Hispanic females (Virani et al., 2020). This is higher than NH whites (where the prevalence was 35.4% among males and 41.8% amongst females), and NH blacks (where the prevalence was 29.8% and 33.1%, respectively) (Virani et al., 2020). Thus, according to these two risk factors (obesity and hyperlipidemia) the Hispanic population is at an even greater risk for CVD than the NH white population.

Finally, the Hispanic population has a high prevalence of diabetes, a major risk factor for CVD (Dokken, 2008). Data from the CDC, which utilizes the 2018 NHIS, the same dataset that I use, show that the prevalence of diabetes in the Hispanic population is 13.2% (Villarroel et al., Table A-4, 2019). This far exceeds that of the NH white population, which is 8.0%. The NH black population has a prevalence of 13%, while the Alaskan Native/American Indian population has a rate of 23.5% and the Asian population has a rate of 11.4% (Villarroel et al., Table A-4, 2019). Thus, the following question presents itself: how is it possible that the Hispanic population in the U.S. has a lower prevalence of CVD than NH white and NH black populations, given that this population has a higher prevalence of major risk factors (specifically the increased rates of overweight/obesity, hyperlipidemia, and diabetes)?

Some Small Studies Challenge the HHP with respect to CVD

While many studies support the existence of the HHP with respect to CVD, other studies challenge its existence. For example, Joshua Z. Willey and colleagues examined 2,671 participants in the Northern Manhattan Study (NOMAS), a population-based study that recruited individuals aged over 39 years with no history of stroke (2012). At the beginning of Willey's study, none of the participants had clinical CVD. Willey et al. found that Hispanic participants were at a paradoxically lower risk of coronary deaths and vascular deaths (two forms of CVD) than NH white and NH black participants; however, they did not have a lower risk of nonfatal myocardial infarction (MI; also known as a heart attack). The Willey study is unique in two main ways: the majority of the Hispanic cohort examined was made up of Caribbean Hispanics, whereas many other studies primarily examine Mexican-Americans. Secondly, it is one of the few studies that examines specific cardiovascular outcomes, such as coronary death, vascular deaths and nonfatal MI; many other studies solely use the umbrella term "cardiovascular disease" (Willey et al., 2012). This study points out that the HHP must be examined through a lens which considers the country-of-origin of Hispanics, as well as particular cardiovascular outcomes rather than CVD as a whole.

The San Antonio Heart Study presents some of the strongest evidence against the Hispanic health paradox (Hunt et al., 2002). During the study 827 individuals with diabetes were examined over an approximately ten-year period. Hunt and colleagues found that U.S.-born Mexican Americans were at a greater risk of all-cause and cardiovascular mortality compared to NH whites, whereas Mexico-born Mexican Americans were at a similar risk (Hunt et al., 2002). These results directly oppose those that would be predicted on the basis of the HHP, where Mexican Americans would have had lower rates of all-cause and cardiovascular mortality than NH whites. It is notable that this study only examined diabetic individuals, and found evidence

that contradicts the HHP. This calls for more research into the HHP that takes CVD risk factors, such as diabetes, into consideration.

Lastly, a study conducted by Dilip K. Pandey and colleagues in Corpus Christi, Texas, compared the coronary heart disease mortality between 785 Mexican Americans and 862 NH white women and men (2001). Pandey et al. found that coronary heart disease mortality was greater amongst Mexican Americans than NH whites (although the results were not statistically significant amongst men). These data go against the prevailing reports that Mexican Americans have lower rates of mortality from coronary heart disease (Pandey et al., 2001). Similarly to the study of Hunt et al., the Corpus Christi study directly refutes the HHP with regards to CVD.

A Call for More Research

As the above studies show, there is a need for more research related to the Hispanic health paradox. There is great debate over whether or not the HHP actually exists, or is merely a function of under-reporting of negative Hispanic health outcomes. Abraído-Lanza et al. showed that the *salmon bias hypothesis* and the *healthy migrant hypothesis* cannot account for the Hispanic mortality paradox, but similar analyses need to be conducted with respect to other manifestations of the HHP (1999). Additionally, there is question as to whether or not the Hispanic population truly has a health advantage over the NH white population, or if the low prevalence of CVD is due to the high proportion of immigrants in this population. Finally, there is conflicting data as to whether or not the HHP exists with respect to CVD. Two large-scale studies, utilized by the AHA and CDC, show that Hispanic individuals have a lower prevalence of CVD than NH white individuals (Virani et al., 2020; Villarroel et al., Table A-1, 2019). However, smaller studies led by Willey, Hunt and Pandey show the opposite (2012, 2002, 2001).

In order to expand upon the body of research exploring these aspects of the HHP, I will focus on two points of study in the scope of my analysis. The first point of study is that the impact of CVD risk factors on the prevalence of CVD in the Hispanic population, with respect to other racial/ethnic groups, is largely unknown. As shown in the San Antonio Heart Study, some data suggests that the HHP does not exist in the population with diabetes, a major risk factor for CVD (Hunt et al., 2002). In order to explore if this holds true nationally, throughout my data analysis I will ask the question: is the HHP (with respect to CVD) observed among populations with diabetes? This will be assessed by determining if Hispanic populations with diabetes still have a lower prevalence of CVD than NH white populations and NH black populations with diabetes, as they do in the general population.

The second point of study that requires more data in order to understand is the impact of country-of-origin on the HHP. The *healthy migrant hypothesis* suggests that the prevalence of CVD in the Hispanic population is low due to a high proportion of immigrants within this population. In order to either support or refute this hypothesis, I will examine the prevalence of CVD within U.S.-born and foreign-born Hispanic populations. I will ask the question**:** is the HHP (with respect to CVD) present when region of birth is taken into account?

CHAPTER III: METHODS

Introduction

I utilized data from the National Health Interview Survey (NHIS), a cross-sectional survey of the civilian, non-institutionalized population in the United States. This data is made available through the IPUMS database (Blewett et al., 2019). It is conducted annually by the National Center for Health Statistics (NCHS), a branch of the Centers for Disease Control and Prevention (CDC) (National Center for Health Statistics, "About the National Health Interview Survey"). I looked specifically at the year 2018 in my data analysis, in which the total number of respondents was 72,226 individuals. Interviews are voluntary and conducted in person, and one adult from each household is randomly selected to complete the Sample Adult component of the survey. The majority of my analysis focused specifically on respondents within the Sample Adult condition. More information regarding the methodology of the NHIS is published elsewhere (National Center for Health Statistics, "About the National Health Interview Survey"). I used StataIC 16.0 to analyze the data.

Results

The Hispanic Population Has a Comparably Low CVD Prevalence

I will begin by showing that the Hispanic population consistently has a lower prevalence of CVD than the NH white population, NH black population, and NH Alaskan Native/American Indian population. Figure 1 shows that the prevalence of CVD in the Hispanic population (8.02%) is about half that of the NH white population (16.1%). The Hispanic population also has a lower prevalence of CVD than the NH black (12.1%) and NH Alaskan Native/American Indian (15.5%) populations. This low prevalence of CVD within the Hispanic population, compared to

other racial/ethnic groups, show that the Hispanic health paradox is present with respect to CVD in the general population (Figure 1 and Table 1). The prevalence of CVD within the NH Asian population (8.36%) is about the same as that of the Hispanic population, indicating that the HHP is not present with respect to the NH Asian population.

Figure 1: Prevalence of CVD by Race/Ethnicity, 2018.

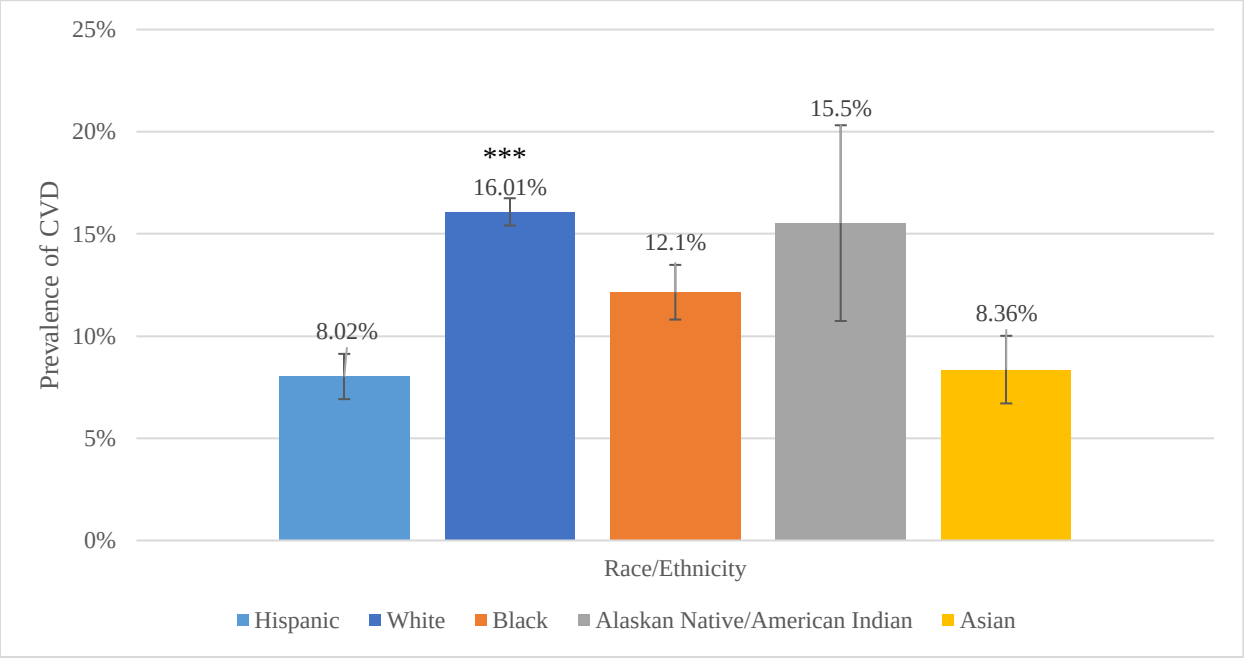


Table 1: Prevalence of CVD, 95% CI and p-value in General Population, 2018

Race/Ethnicity	No.	Prevalence of CVD	95% CI	Mean Difference from Hispanic	p-value*
NH White***	20,608	0.161	0.154-0.167	0.0804677	0.000
NH Black***	3,605	0.121	0.108-0.135	0.0411452	0.000
NH Alaskan Native/American Indian**	322	0.155	0.107-0.203	0.0750634	0.003
NH Asian	1,643	0.084	0.067-0.100	0.0033862	0.738
Hispanic (ref)	3,958	0.080	0.069-0.091	--	--

Note: * indicates p<0.05, ** indicates p<0.01, and *** indicates p<0.001 (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed t-test. "No." refers to the total number of individuals sampled within each group.

The data shown in Figure 1 and Table 1 are similar to CVD data published by the CDC, which also utilized the 2018 NHIS (the same dataset that I analyzed). The CDC reports the prevalence of CVD for the following populations: Hispanic population 8.2%, NH white population 12.2%, NH black population 10.0%, Alaskan/Native population 14.6%, and Asian population 7.7% (Villarroel et al., Table A-1, 2019). The prevalence of CVD within the Hispanic population in this analysis is very similar to that reported by the CDC (with only a 0.18% difference). The CDC reported a slightly lower prevalence of CVD in the NH white and NH black populations than my analysis shows. This difference could be due to the fact that I included stroke when calculating the prevalence of CVD, while the CDC did not. I chose to do this because stroke is often regarded as a form of CVD (for example, it is classified as such by the American Heart Association, as discussed in the literature review) (Virani et al., 2020). Finally, the CDC analysis also shows a lower prevalence of CVD in the Alaskan Native/American Indian and Asian populations than my analysis. Data regarding the non-Hispanic subsets of these populations is not available, but likely would not differ significantly. Again, this difference is likely because I included stroke as a form of CVD in my analysis.

Age

In order to show that the Hispanic health paradox is not limited to the general population as a whole, I examined sub-populations that differ in terms of age, income and education level. Figure 2 and Table 2 show the prevalence of CVD within three age ranges in each racial/ethnic population: 18-44, 45-64, and 65 and older. The Hispanic population consistently has a statistically-significant lower prevalence of CVD than the NH white population within all three age groups. The Hispanic population also has a lower prevalence of CVD than the NH black and NH Alaskan Native/American Indian populations. These differences are statistically significant

in the older two age groups but not the youngest. Finally, the Hispanic population has a slightly higher prevalence of CVD than the NH Asian population in the first two age groups, but a slightly lower prevalence in the oldest age group. None of these differences are statistically significant. This breakdown shows that after controlling for age, the Hispanic population has lower rates of CVD than NH white, NH black, and NH Alaskan Native/American Indian populations, but not necessarily NH Asian populations.

Figure 2: Prevalence of CVD by Age Across Race/Ethnicity, 2018

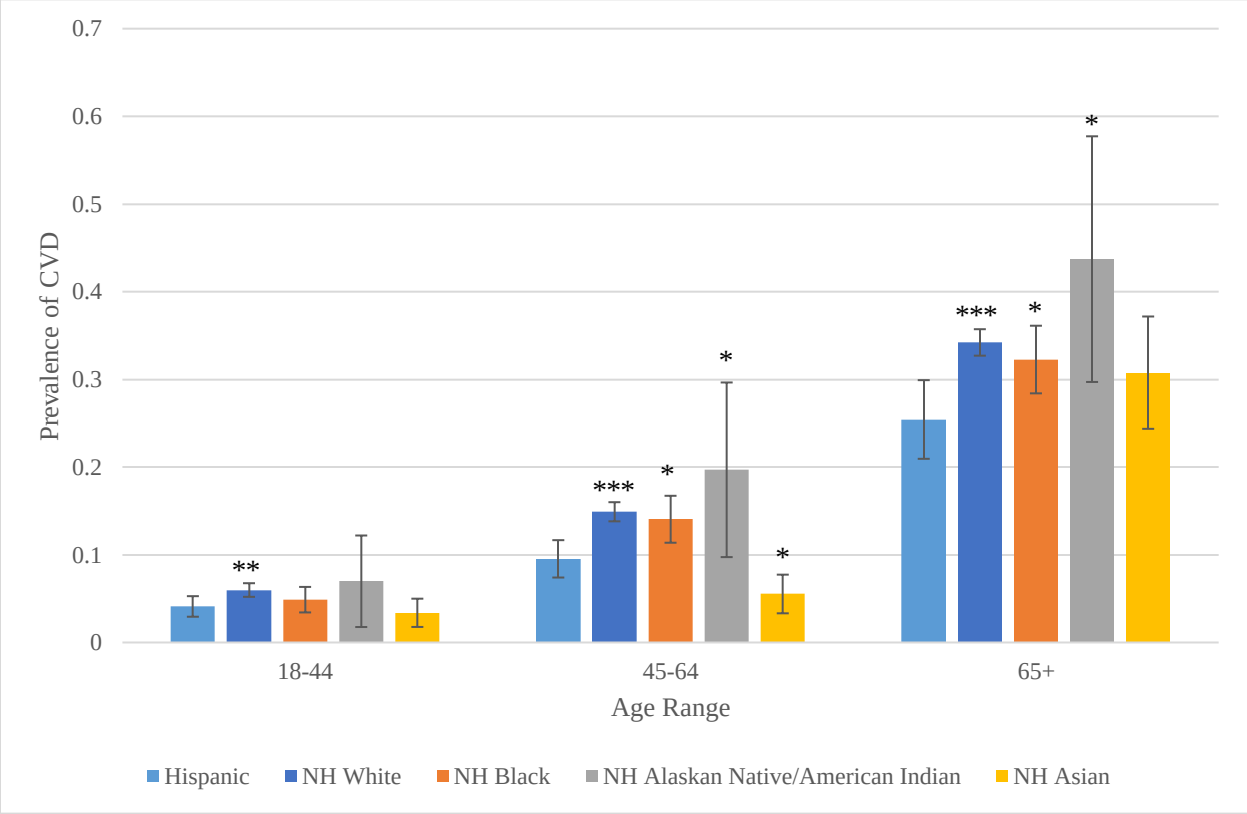


Table 2: Prevalence of CVD, 95% CI and p-value in General Population by Age, 2018

Age Range	Race/Ethnicity	No.	Prevalence of CVD	95% CI	Mean Difference from Hispanic	p-value
18-45	NH White** NH Black	7,190 1,556	0.060 0.049	0.052-0.068 0.034-0.063	0.019 0.008	0.009 0.407

	NH Alaskan Native/American Indian	161	0.070	0.018-0.122	0.029	0.290
	NH Asian	810	0.034	0.018-0.050	-0.007	0.481
	Hispanic (ref)	2,260	0.041	0.029-0.053	--	--
45-64	NH White***	7,190	0.149	0.138-0.160	0.054	0.000
	NH Black*	1,199	0.141	0.114-0.167	0.045	0.010
	NH Alaskan Native/American Indian*	100	0.197	0.097-0.297	0.102	0.048
	NH Asian*	505	0.055	0.033-0.077	-0.040	0.010
	Hispanic (ref)	1,098	0.095	0.074-0.117	--	--
65+	NH White***	6,228	0.342	0.327-0.357	0.088	0.000
	NH Black*	850	0.323	0.284-0.361	0.068	0.022
	NH Alaskan Native/American Indian*	61	0.437	0.297-0.577	0.183	0.015
	Asian	328	0.308	0.244-0.372	0.053	0.167
	Hispanic (ref)	600	0.254	0.209-0.299	--	--

Note: * indicates $p<0.05$, ** indicates $p<0.01$, and *** indicates $p<0.001$ (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed t-test. "No." refers to the total number of individuals sampled within each group.

Income Level

I also broke down the general population by income level in order to determine if the HHP shown in Figure 1 holds true after controlling for income. As shown in Figure 3, the Hispanic population has a lower prevalence of CVD across all five income levels than the NH white population. All of these differences are statistically significant. This difference is greatest in the lowest two income categories. In the $0-$34,999 category, the prevalence of CVD in the Hispanic population (11.55%) is slightly over half that of the NH white population (22.90%) (Figure 3). In the $35,000-$49,999 income category, the prevalence of CVD in the Hispanic population is only 6.33%, a third of the NH white population at 19.79% (Table 3). This trend persists in the remaining three income categories, with the Hispanic population always having a prevalence of CVD at least 6% less than the NH white population. Thus, it is clear that across

income levels, the Hispanic population has a lower prevalence of CVD than the NH white population.

The Hispanic population also has a lower prevalence of CVD than the NH black population (Figure 3). This difference is less dramatic than between the Hispanic and NH white population, but still present. This difference is greatest in the second-highest income category, $75,000-$99,999, in which the prevalence of CVD within the Hispanic population (5.63%) is over 7% less than the NH black population (12.82%) (Table 3). While the Hispanic population still has a lower rate of CVD than the NH black population in the middle income category, this difference is not statistically significant. With the exception of the middle income category ($50,000-$74,999), the Hispanic population always has a statically-significant lower prevalence of CVD than the NH black population.

The Hispanic population also has a lower prevalence of CVD compared to the NH Alaskan Native/American Indian populations across all income levels, although this difference is not statistically significant. While there are fluctuations between different income levels, the Hispanic population generally has a similar prevalence of CVD as the NH Asian population. This is consistent with the data presented in Figures 1 and 2 regarding the general population as well as the age-specific populations. While the Hispanic population has similar rates of CVD to the Asian population across income levels, it does have a health advantage over the NH white, NH black, and NH Alaskan Native/American Indian populations across income levels.

Figure 3: Prevalence of CVD by Total Family Income, 2018

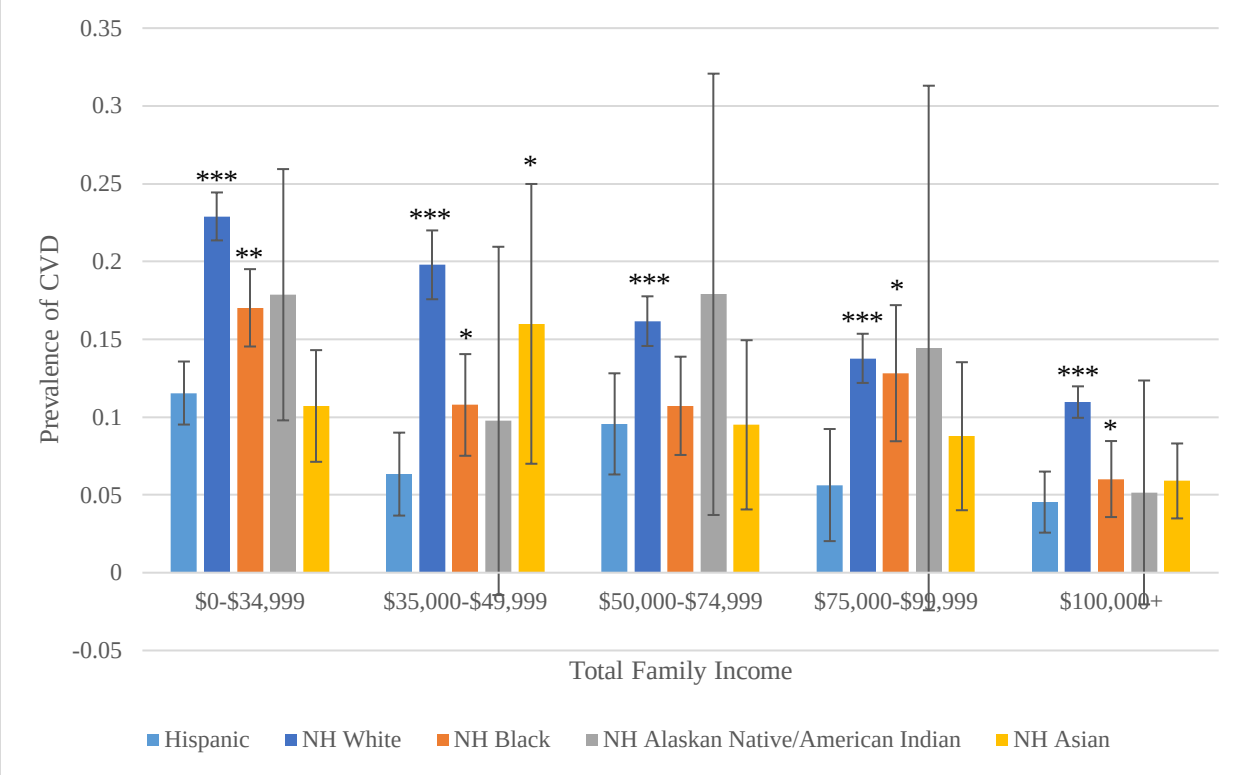


Table 3: Prevalence of CVD, 95% CI and p-value by Total Family Income, 2018

Income Level	Race/Ethnicity	No.	Prevalence of CVD	95% CI	Mean Difference from Hispanics	p-value
$0-$34,999	NH White***	4,998	0.229	0.214-0.244	0.114	0.000
	Black**	1,574	0.170	0.145-0.195	0.0548	0.001
	Alaskan Native/ American Indian	167	0.179	0.098-0.259	0.0632	0.131
	Asian	370	0.107	0.071-0.143	-0.008	0.693
	Hispanic (ref)	1,464	0.115	0.095-0.136	--	--
$35,000-$49,999	White***	2,023	0.198	0.176-0.220	0.135	0.000
	Black*	361	0.108	0.075-0.140	0.044	0.046
	Alaskan Native/ American Indian	33	0.098	-0.0144-0.209	0.034	0.563
	Asian*	130	0.160	0.070-0.250	0.097	0.043
	Hispanic (ref)	494	0.063	0.037-0.090	--	--
$50,000-$74,999	White***	3,113	0.162	0.146-0.178	0.066	0.000
	Black	483	0.107	0.076-0.139	0.012	0.620
	Alaskan Native/ American Indian	35	0.179	0.037-0.321	0.083	0.264
	Asian	195	0.095	0.040-0.135	-0.001	0.985

	Hispanic (ref)	565	0.096	0.020-0.092	--	--
$75,000-	White***	2,704	0.138	0.122-0.154	0.081	0
$99,999	Black*	309	0.128	0.084-0.172	0.072	0.014
	Alaskan Native/ American Indian	29	0.144	-0.024-0.313	0.088	0.317
	Asian	196	0.088	0.040-0.135	0.031	0.304
	Hispanic	358	0.056	0.020-0.092	n/a	n/a
$100,000+	White***	5,469	0.110	0.100-0.120	0.081	0
	Black*	398	0.060	0.036-0.085	0.072	0.014
	Alaskan Native/American Indian	30	0.052	-0.020-0.124	0.088	0.317
	Asian	540	0.059	0.035-0.083	0.031	0.304
	Hispanic (ref)	543	0.045	0.026-0.065	--	--

Note: * indicates $p<0.05$, ** indicates $p<0.01$, and *** indicates $p<0.001$ (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed t-test. "No." refers to the total number of individuals sampled within each group.

Education Level

Finally, I divided the general population by education level in order to determine if the HHP (that is, the Hispanic population has a lower rate of CVD than NH white, NH black, and NH Alaskan Native/American Indian populations) is still present after controlling for education. As shown in Figure 4, the Hispanic population consistently has a significantly lower prevalence of CVD than the NH white population in every education level. As with income, these differences are greatest in the lowest two education levels. Amongst individuals who never graduated high school, the prevalence of CVD within the Hispanic population (9.52%) is 15% less than in the NH white population (24.58%). Amongst individuals who received a high school diploma or the equivalent, the prevalence of CVD within the Hispanic population is 9.80% less than the NH white population. The gaps between the two populations are smaller in the remaining three educational categories, but never dip below 4%. Thus, it is clear that across all education levels, the Hispanic population has a lower prevalence of CVD than the NH white population.

The same is true for the NH black population—across all education levels, the Hispanic population has a lower prevalence of CVD than the NH black population. While this difference is not statistically significant in the two highest education categories (bachelor's degree and master's degree or higher), it is in the remaining three education categories. As with the NH white population, the difference between the Hispanic population and NH black population is highest in the group that never graduated high school. Within this population, the prevalence of CVD within the NH black population is 13.52%, over 9% greater than the Hispanic population at 9.52% (Table 4). Thus, the data show that the prevalence of CVD within the Hispanic population is less than the NH white and black populations across all education levels.

The relationship between the Hispanic population and the NH Alaskan Native/American Indian population is less consistent. In some categories, the two appear to have a similar level of CVD, whereas in other categories, the NH Alaskan Native/American Indian population has much higher prevalence of CVD. Regardless, the difference between the two populations is not statistically significant in any education level. The difference between the Hispanic population and the NH Asian population is also not statistically significant at any education level. (Figure 4). The two populations appear to have a similar prevalence of CVD in the highest three educational categories, while the NH Asian population has a higher prevalence of CVD in the lower two educational categories. Unfortunately, due to the lack of statistical significance, it is difficult to determine the nature of the relationship between the Hispanic, NH Alaskan Native/American Indian, and NH Asian populations in different education levels.

Figure 4: Prevalence of CVD by Education Level, 2018

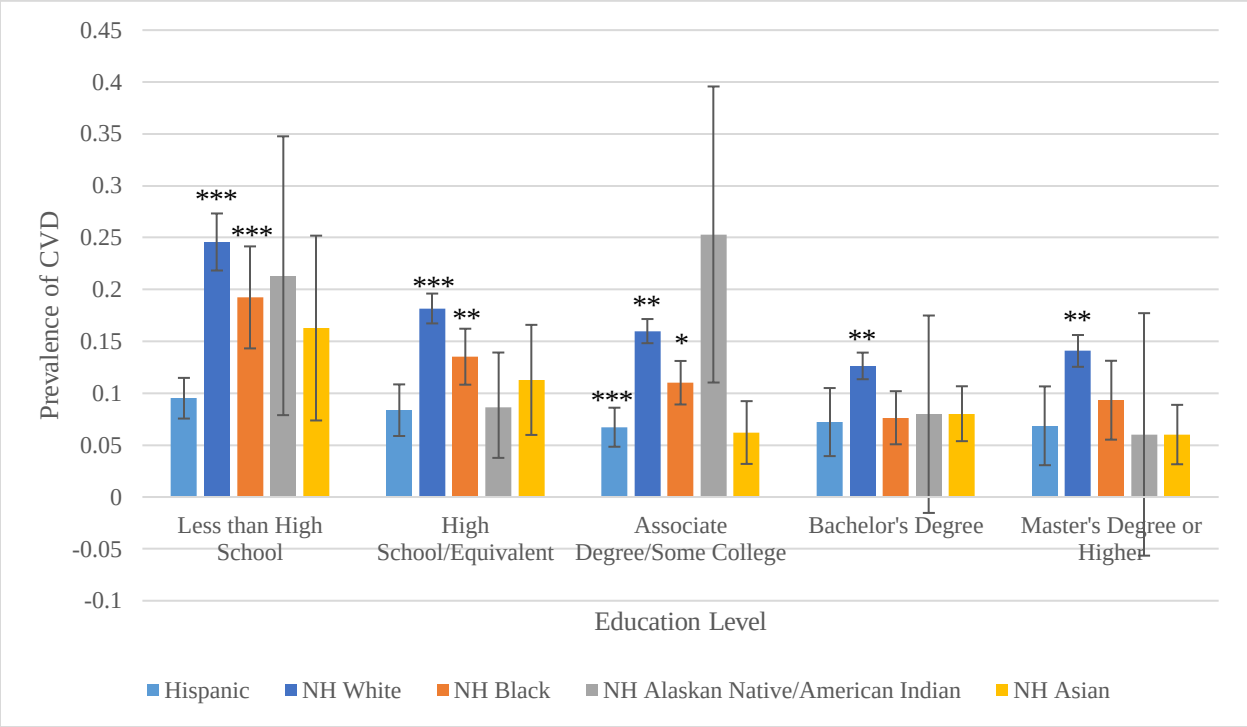


Table 4: Prevalence of CVD, 95% CI and p-value by Education Level, 2018

Education Level	Race/Ethnicity	No.	Prevalence of CVD	95% CI	Mean Difference from Hispanic	p-value
Less than High School	White***	1,490	0.246	0.218-0.273	0.151	0.000
	Black***	570	0.192	0.143-0.242	0.097	0.000
	Alaskan Native/ American Indian	60	0.213	0.789-0.348	0.118	0.087
	Asian	118	0.163	0.074-0.252	0.068	0.15
	Hispanic (ref)	1,135	0.095	0.076-0.115	--	--
High School or Equivalent	White***	5,042	0.182	0.167-0.196	0.098	0.000
	Black**	1,026	0.135	0.108-0.162	0.052	0.006
	Alaskan Native/ American Indian	113	0.086	0.038-0.135	0.003	0.928
	Asian	246	0.113	0.059-0.166	0.029	0.309
	Hispanic (ref)	1,035	0.084	0.059-0.109	--	--
Associate Degree or Some College	White***	6,349	0.160	0.148-0.172	0.093	0.000
	Black**	1,148	0.110	0.089-0.131	0.043	0.003
	Alaskan Native/ American Indian*	92	0.253	0.110-0.396	0.186	0.012
	Asian	328	0.062	0.032-0.092	-0.005	0.783
	Hispanic (ref)	993	0.067	0.048-0.086	--	--
	White**	4,751	0.126	0.114-0.139	0.054	0.003

Bachelor's Degree	Black	522	0.076	0.051-0.102	0.004	0.847
	Alaskan Native/ American Indian	36	0.080	-0.015-0.175	0.008	0.883
	Asian	515	0.080	0.054-0.107	0.008	0.717
	Hispanic (ref)	489	0.072	0.039-0.105	--	--
Master's/ Professional/ Doctoral Degree	White**	2,821	0.141	0.125-0.156	0.072	0.001
	Black	288	0.093	0.055-0.131	0.025	0.36
	Alaskan Native/ American Indian	19	0.060	-0.057-0.177	-0.008	0.894
	Asian	410	0.060	0.032-0.089	-0.008	0.728
	Hispanic (ref)	214	0.067	0.031-0.107	--	--

Note: * indicates $p<0.05$, ** indicates $p<0.01$, and *** indicates $p<0.001$ (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed t-test. "No." refers to the total number of individuals sampled within each group.

In conclusion, the Hispanic population consistently has a lower prevalence of CVD than the NH white and NH black populations after controlling for age, income level and education level. The difference between the Hispanic population and the NH white population is greatest and was statistically significant in each of the analyses performed. The Hispanic population has a lower prevalence of CVD than the NH Alaskan Native/American Indian population after controlling for age. This seems to be the case across income level and education level as well, but this is difficult to determine due to the lack of statistical significance. The Hispanic population has similar levels of CVD compared to the NH Asian population within different age groups, income levels and education levels.

Populations with Diabetes: Hispanic Population Still Has Comparably Low CVD Prevalence

After establishing that the Hispanic population has lower rates of CVD than the NH white and NH black populations (and, with less certainty, the NH Alaskan Native/American Indian populations), I will now examine the rates of CVD amongst individuals with diabetes. As described in the literature review, there is a lack of research that examines the HHP in the context of populations at risk for CVD. Diabetes is a major risk factor for cardiovascular disease,

so I expect to see higher rates of CVD within this population than the general population. The data are consistent with this expectation. Figure 5 shows that the prevalence of CVD within populations with diabetes is, on average, 16% higher than in the general population. The Hispanic population with diabetes has a lower prevalence of CVD than the NH white population with diabetes. This is consistent with the rates of diabetes in the general population, although the difference between the two racial/ethnic groups is less dramatic in the population with diabetes. The prevalence of CVD in the Hispanic population with diabetes is 24.30%, about two-thirds of the prevalence of CVD in the NH white population with diabetes at 36.35% (Table 5). This difference, though large, is less than in the general population, in which the prevalence of CVD in the Hispanic population is half that of the NH white population.

The Hispanic population with diabetes also has a lower prevalence of CVD (24.30%) than the NH black population with diabetes (30.34%). This too is consistent with the general population, although the difference in the population with diabetes is smaller and not statistically significant. The prevalence of CVD amongst Hispanic individuals (8.02%) is only one-third smaller than the prevalence of CVD amongst NH black individuals (12.14%) in the general population (Table 1). However, the prevalence of CVD amongst Hispanic individuals with diabetes (24.30%) is only one-fifth smaller than the prevalence of CVD amongst black individuals with diabetes (30.4%) (Table 5).

The prevalence of CVD in the Hispanic population with diabetes is very similar to the NH Alaskan Native/American Indian populations with diabetes (24.09%) (Figure 5). This is different from the relationship between the two in the general population, in which the prevalence of CVD amongst Alaskan Native/American Indian population is about twice that of the Hispanic population (Figure 1). The incongruency could be due to small sample size. The

NH Alaskan Native/American Indian population only consists of 857 individuals, while the population with diabetes only consists of 132 individuals. The prevalence of CVD within the Hispanic population with diabetes is similar to that of the NH Asian population with diabetes (25.98%), consistent with what is seen in the general population (Figure 5).

Figure 5: Prevalence of CVD in Individuals with Diabetes by Race/Ethnicity, 2018

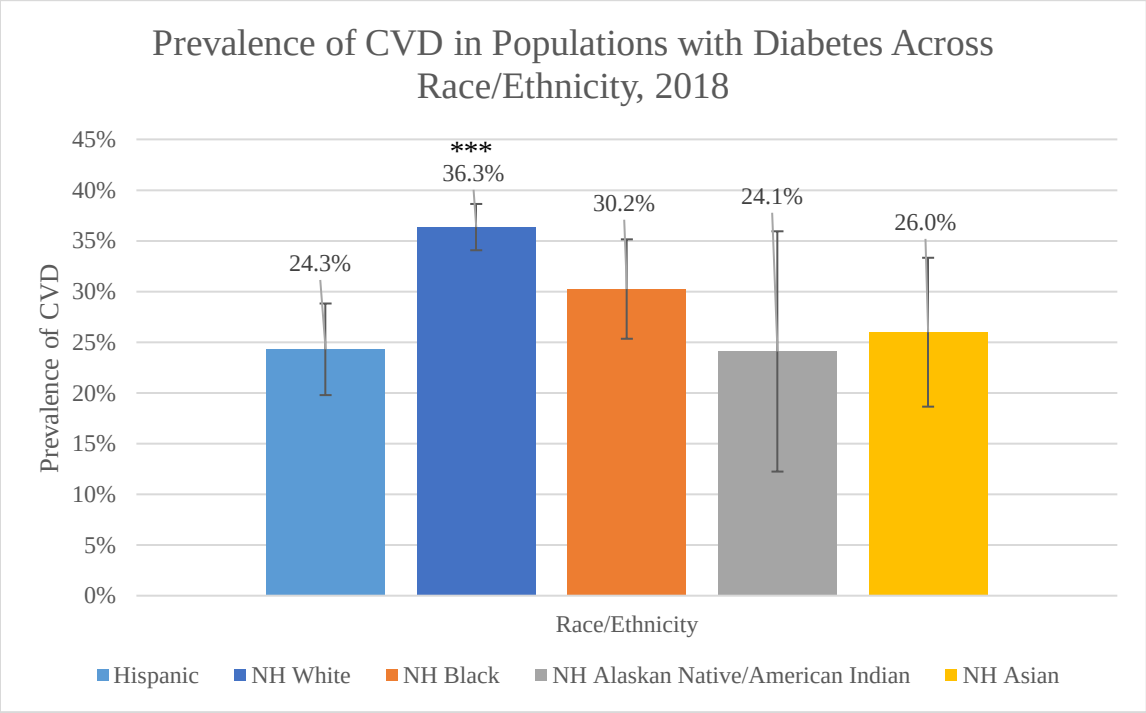


Table 5: Prevalence of CVD, 95% CI and p-value in Individuals with Diabetes, 2018

Race/Ethnicity	No.	Prevalence of CVD	95% CI	Mean Difference from Hispanic	p-value
White***	2,304	0.363	0.341-0.386	0.121	0.000
Black	578	0.302	0.253-0.351	0.059	0.082
Alaskan Native/American Indian	63	0.241	0.122-0.359	-0.002	0.974
Asian	202	0.260	0.186-0.333	0.017	0.700
Hispanic (ref)	501	0.243	0.198-0.288	--	--

Note: * indicates p<0.05, ** indicates p<0.01, and *** indicates p<0.001 (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed t-test. "No." refers to the total number of individuals sampled within each group.

Age

Next, in order to show that the Hispanic population with diabetes does not have lower rates of CVD than the NH white, NH black, and NH Alaskan Native/American Indian populations solely due to a disproportionate number of older individuals, I controlled for age by comparing each population in age-specific groups. Figure 6 shows that Hispanic individuals with diabetes have a lower prevalence of CVD than NH white individuals with diabetes in each age category. The greatest difference is within the 45-64 age group, with the prevalence of CVD amongst Hispanics with diabetes at 19.3% compared to the NH population at 30.6%. The difference in the youngest age group is not, however, statistically significant (Table 6). The Hispanic population with diabetes also has a lower prevalence of CVD than the NH black population with diabetes, although these differences are also not statistically significant.

The relationship between the prevalence of CVD within the Hispanic and the NH Alaskan Native/American Indian populations with diabetes is somewhat variable. In the 18-44 and 65+ age groups, the NH Alaskan Native/American Indian population with diabetes has a lower rate of CVD, whereas in the 45-64 age group the Hispanic population with diabetes has a lower rate of diabetes (Figure 6). As with the NH black population with diabetes, none of these differences are statistically significant. The relationship between CVD prevalence in the Hispanic population with diabetes and the NH Asian population with diabetes is similarly variable, fluctuating between age groups with no statistical significance (Figure 6).

Figure 6: Prevalence of CVD in Individuals with Diabetes by Age, 2018.

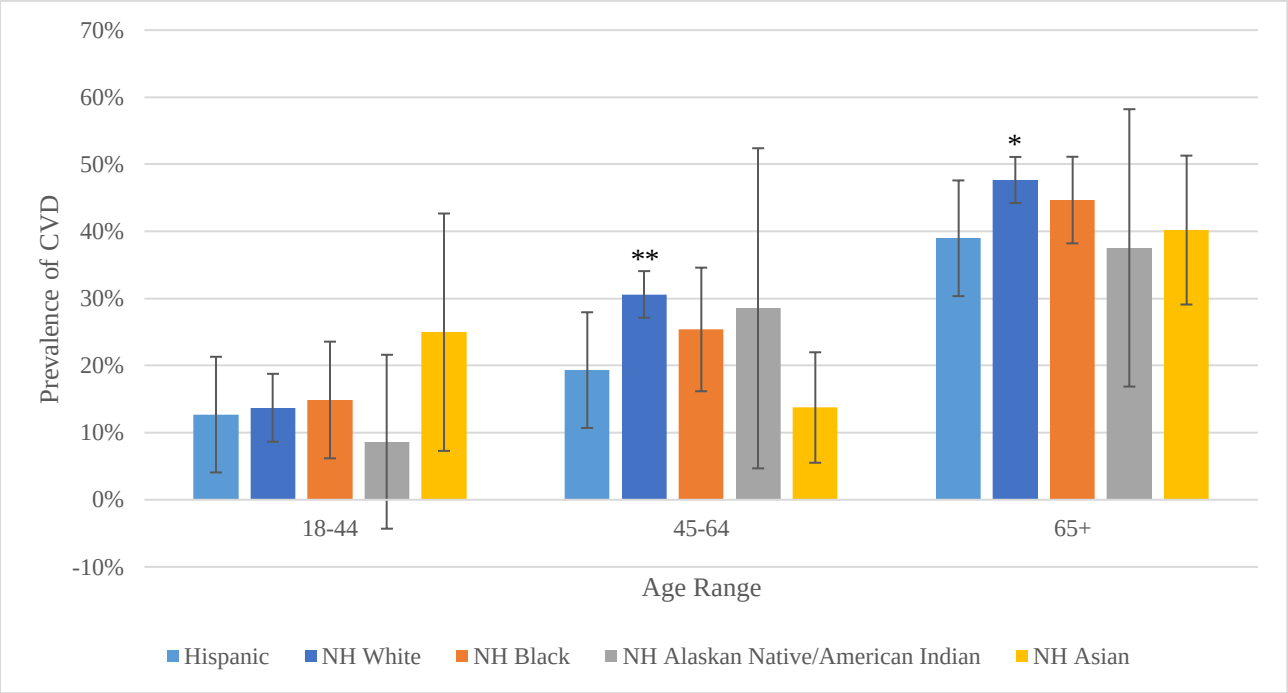


Table 6: Prevalence of CVD, 95% CI and p-values in Individuals with Diabetes by Age, 2018

Age Range	Race/Ethnicity	No.	Prevalence of CVD	95% CI	Mean Difference from Hispanic	p-value
18-44	White	235	0.137	0.087-0.188	0.010	0.842
	Black	91	0.149	0.062-0.236	0.022	0.731
	Alaskan Native/American Indian	16	0.087	-0.043-0.216	-0.040	0.607
	Asian	38	0.250	0.073-0.427	0.123	0.216
	Hispanic (ref)	84	0.127	0.041-0.213	--	--
45-64	White**	841	0.306	0.271-0.341	0.113	0.003
	Black	206	0.254	0.162-0.346	0.061	0.295
	Alaskan Native/American Indian	22	0.285	0.047-0.524	0.092	0.467
	Asian	78	0.138	0.055-0.220	-0.056	0.304
	Hispanic (ref)	208	0.193	0.130-0.256	--	--
65+	White*	1,228	0.477	0.442-0.511	0.087	0.046
	Black	281	0.447	0.382-0.511	0.057	0.273
	Alaskan Native/American Indian	25	0.375	0.169-0.582	-0.014	0.901
	Asian	86	0.402	0.291-0.513	0.012	0.865
	Hispanic (ref)	209	0.390	0.310-0.469	--	--

Note: * indicates $p<0.05$, ** indicates $p<0.01$, and *** indicates $p<0.001$ (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed t-test. "No." refers to the total number of individuals sampled within each group.

In conclusion, the Hispanic population with diabetes has a lower prevalence of CVD than the NH white and NH black populations with diabetes, but to a lesser degree than in the general population. This relationship is true across age groups, although the differences between the Hispanic population with diabetes and NH black population with diabetes are not statistically significant within individual age groups. The prevalence of CVD within the NH Alaskan Native/American Indian population with diabetes is similar to that of the Hispanic population with diabetes, defying what is seen in the general population. Within the individual age groups, the prevalence of CVD in the NH Alaskan Native/American Indiam populations fluctuates with respect to the NH Hispanic population with diabetes. The relationship between the Hispanic and NH Asian populations with diabetes is similar to in the general population: the prevalence of CVD are about the same between the two racial/ethnic groups. However, as with the NH Alaskan Native/American Indian population with diabetes, the differences in CVD prevalence between the NH Asian and Hispanic populations fluctuate greatly between age classes. Although the data regarding NH Alaskan Native/American Indian populations are variable, the Hispanic population still has a lower prevalence of CVD than the NH white and NH black populations with diabetes.

U.S.-Born and Foreign-Born Hispanic Population Has Comparably Low Prevalence of CVD

I will now consider the prevalence of CVD within populations born in the United States (U.S.-born) and born outside the United States (foreign-born). Unsurprisingly, the prevalence of CVD in the U.S.-born population is very similar to the prevalence of CVD in the general population

(within 1.5% in each racial/ethnic group) (Figure 1, Figure 7). As in the general population, the U.S.-born Hispanic population has a lower prevalence of CVD (9.27%) than the U.S.-born NH white (16.25%), NH black (13.16%) and NH Alaskan Native/American Indian (16.47%) populations.

Each of the racial/ethnic groups has a lower prevalence of CVD within the foreign-born population, with the exception of NH Asian. This is consistent with the healthy migrant hypothesis, which postulates that immigrants are subject to selection and therefore are healthier than average (Abraído-Lanza et al., 1999). The prevalence of CVD within the foreign-born NH Alaskan Native/American Indian population is 0%, because out of the 28 individuals who identify as NH Alaskan Native/American Indian and were born outside of the U.S, none of them had CVD. Amongst foreign-born individuals, the Hispanic population still has a lower prevalence of CVD than the NH white population. As in the U.S.-born population, the prevalence of CVD in the foreign-born Hispanic population is about half that of the foreign-born NH white population (Table 7). Conversely to the U.S.-born population, foreign-born Hispanic individuals have a higher rate of CVD than foreign-born NH black individuals. Additionally, because the rate of CVD within the NH Asian population stayed relatively constant across U.S.-born and foreign-born individuals, Hispanics went from having a relatively higher rate of CVD in the U.S.-born population to a relatively lower rate of CVD in the foreign-born population (Figure 7).

Figure 7: Prevalence of CVD by Region of Birth in 2018

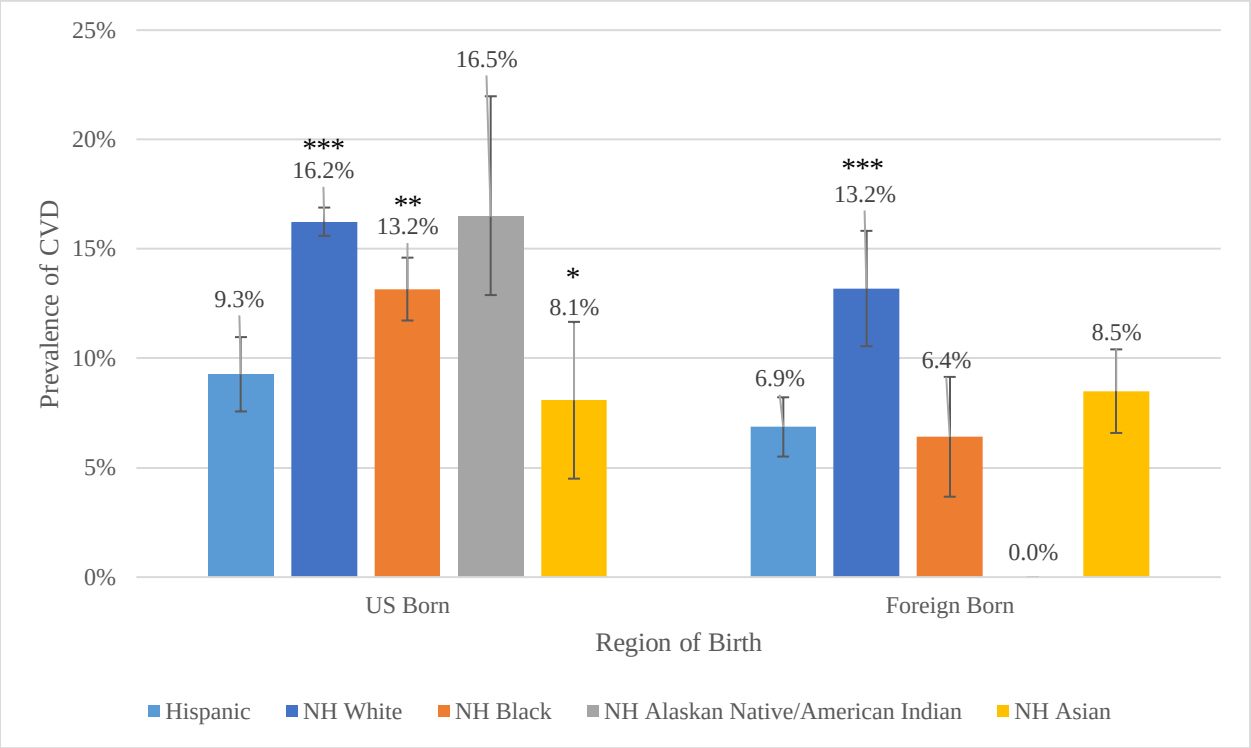


Table 7: Prevalence of CVD, 95% CI and p-value by Region of Birth, 2018

Region of Birth	Race/Ethnicity	No.	Prevalence of CVD	95% CI	Mean Difference from Hispanic	p-value
US Born	White***	19,513	0.162	0.156-0.169	0.070	0.000
	Black**	3,154	0.132	0.117-0.146	0.039	0.001
	Alaskan Native/American Indian*	307	0.165	0.120-0.220	0.072	0.014
	Asian	378	0.081	0.045-0.117	-0.012	0.557
	Hispanic (ref)	1,952	0.093	0.076-0.110	--	--
Foreign Born	White***	1,044	0.132	0.106-0.158	0.063	0.000
	Black	437	0.064	0.037-0.092	-0.005	0.772
	Alaskan Native/American Indian***	15	0	(omitted)	-0.069	0.000
	Asian	1,245	0.085	0.066-0.104	0.0164	0.171

	Hispanic (ref)	1,972	0.069	0.055-0.082	--	--

Note: * indicates $p<0.05$, ** indicates $p<0.01$, and *** indicates $p<0.001$ (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed t-test. "No." refers to the total number of individuals sampled within each group.

Age

Figure 8 shows that the U.S.-born Hispanic population consistently has a lower prevalence of CVD than the U.S.-born NH white population, across all three age ranges. However, these differences are not statistically significant. In fact, none of the differences between the U.S.-born Hispanic populations and the other U.S.-born racial/ethnic groups are statistically significant except with respect to NH Asians in the 45-64 age group, and with respect to NH Alaskan Native/American Indians in the 65+ age group. Although these results are not significant, the U.S.-born Hispanic population has a lower prevalence of CVD than the NH black population in the 45-64 and 65+ age groups, but not the 18-44 age group. These results are consistent with those shown in the age-specific prevalence of CVD in the general population, shown in Figure 2. Thus, the prevalence of CVD within the U.S.-born population supports the Hispanic health paradox with respect to the NH white and NH black populations.

Figure 8: Prevalence of CVD in U.S.-Born Individuals by Age, 2018

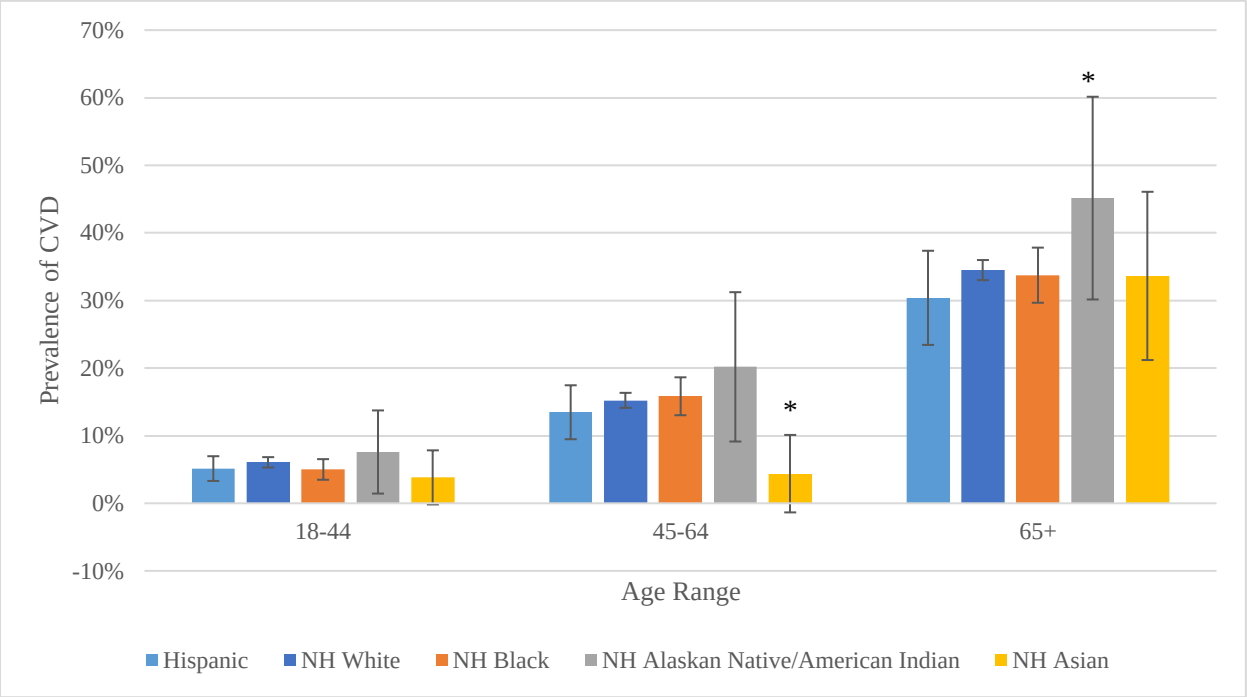


Table 8: Prevalence of CVD in U.S.-Born Individuals by Age, 2018

Age Range	Race/Ethnicity	No.	Prevalence of CVD	95% CI	Mean Difference from Hispanic	p-value
18-44	White	164	0.061	0.053-0.068	0.009	0.36
	Black	47	0.050	0.035-0.065	-0.001	0.915
	Alaskan Native/ American Indian	4	0.076	0.014-0.137	0.025	0.454
	Asian	12	0.038	-0.002-0.078	-0.013	0.561
	Hispanic (ref)	56	0.051	0.033-0.070	--	--
45-64	White	252	0.152	0.141-0.163	0.018	0.404
	Black	42	0.158	0.130-0.186	0.024	0.342
	Alaskan Native/ American Indian	4	0.202	0.091-0.312	0.067	0.262
	Asian*	5	0.044	-0.014-0.101	-0.091	0.011
	Hispanic (ref)	24	0.135	0.095-0.175	--	--
65+	White	375	0.345	0.330-0.360	0.041	0.259
	Black	53	0.337	0.297-0.378	0.034	0.416
	Alaskan Native/ American Indian*	5	0.451	0.302-0.601	0.148	0.08
	Asian	8	0.336	0.212-0.461	0.032	0.656
	Hispanic (ref)	23	0.304	0.234-0.374	--	--

Note: * indicates $p<0.05$, ** indicates $p<0.01$, and *** indicates $p<0.001$ (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed t-test. "No." refers to the total number of individuals sampled within each group.

While foreign-born individuals consistently have lower rates of CVD than U.S.-born individuals (Figures 8 and 9), the foreign-born Hispanic population consistently has lower rates of CVD than the foreign-born NH white population. While these differences are not statistically significant, the trend is consistent across all three age groups. Thus, the HHP is still shown between the Hispanic and NH white populations. However, the foreign-born Hispanic population has a higher prevalence of CVD than the foreign-born NH black population (Table 9). This is a different trend then has been seen before, as the NH black population has generally had a higher prevalence of CVD than the Hispanic population (including when broken down by income level, education level, and diabetes status). As consistently shown throughout this data analysis, the relationship between the Hispanic population and the NH Asian population is variable amongst foreign-born individuals (Figure 9). In conclusion, the foreign-born Hispanic population has a lower prevalence of CVD than the foreign-born white population, consistent with the U.S.-born population; however, the foreign-born Hispanic population has a higher prevalence of CVD than the foreign-born NH black population.

Figure 9: Prevalence of CVD in Foreign-Born Individuals by Age, 2018

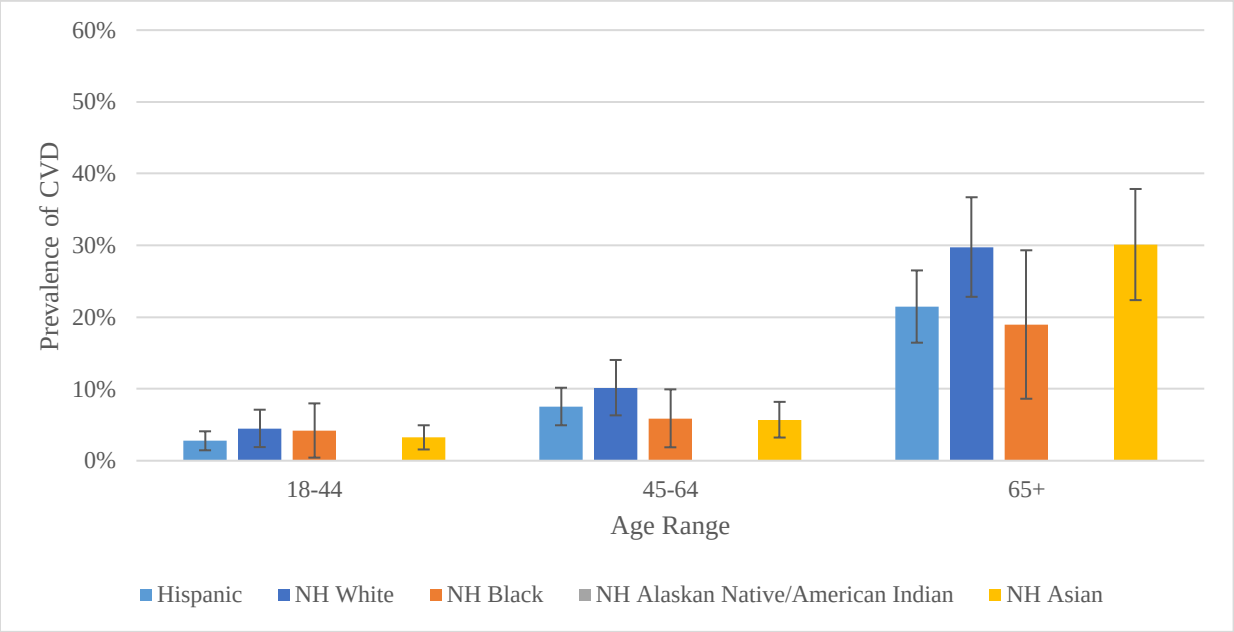


Table 9: Prevalence of CVD in Foreign-Born Individuals by Age, 2018

Age Range	Race/Ethnicity	No.	Prevalence of CVD	95% CI	Mean Difference from Hispanic	p-value
18-44	White	3	0.0450279	0.019-0.071	0.0172728	0.246
	Black	1	0.0421091	0.004-0.080	0.014354	0.482
	Alaskan Native/ American Indian	0	0	(omitted)	-0.0277551	0.000
	Asian	5	0.0325403	0.016-0.049	0.0047852	0.661
	Hispanic (ref)	9	0.0277551	0.015-0.041	--	--
45-64	White	16	0.101792	0.063-0.140	0.02624	0.27
	Black	20	0.0590659	0.019-0.099	-0.0164861	0.501
	Alaskan Native/ American Indian		0	(omitted)	-0.075552	0.000
	Asian	31	0.0571522	0.032-0.082	-0.0183998	0.317
	Hispanic (ref)	52	0.075552	0.049-0.102	--	--
65+	White	24	0.297749	0.228-0.367	0.0829399	0.058

	Black	17	0.1897939	0.086-0.293	-0.0250151	0.67
	Alaskan Native/ American Indian	0	0	(omitted)	-0.214809	0.000
	Asian	22	0.3011984	0.224-0.379	0.0863893	0.067
	Hispanic (ref)	30	0.214809	0.164-0.265	--	--

Note: * indicates p<0.05, ** indicates p<0.01, and *** indicates p<0.001 (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed t-test. "No." refers to the total number of individuals sampled within each group.

While the above results present evidence for the Hispanic health paradox, they are limited in that they do not control for a number of variables. In order to do so, a multivariate logistic regression accounting for diabetes, age, imputed income, education, health status, region of birth, and sex was performed. Region of birth was taken into account in terms of region within the U.S. (which the NHIS divided into Northeast, North Central/Midwest, South, and West); and based on whether or not respondents were U.S.-born or foreign-born (using the USBORN variable, as previously described). One of the limitations of the income variable used previously in this analysis is that it excludes about 10% of the total sample. In order to address this limitation, I used the natural logarithm of imputed incomes in the multivariate logistic regression, using the income values attributed to each respondent by the NHIS (IPUMS, "INCIMPPOINT1"). Only individuals in the Sample Adult condition were included in the multivariate logistic regression. Additionally, only four racial/ethnic categories were used (opposed to five in the other analyses): Hispanic, NH white, NH black, and NH "other."

Table 10: Odds Ratios (95% CI) of CVD Among Hispanic and NH White Individuals Aged 18 and Older, 2018

Variable	Hispanic	NH White
Diabetes	1.89*** 1.32-2.69	1.69*** 1.49-1.92

Age	1.03***	1.04***
	1.02-1.05	1.04-1.05
Ln(Income)	0.89	0.93*
	0.78-1.02	0.88-0.99
Education: No Diploma / GED (ref)		
High School Diploma / GED	1.16	0.90
	0.77-1.74	0.74-1.09
Associates Degree	1.31	0.95
	0.78-2.22	0.75-1.20
Bachelor's Degree	1.80	0.93
	0.96-3.35	.75-1.17
Master's Degree or Higher	1.06	0.99
	0.46-2.45	0.78-1.25
Health : Excellent (ref)		
Very Good	1.58	1.34**
	0.74-3.34	1.12-1.60
Good	1.80	2.37***
	0.89-3.66	1.99-2.82
Fair	7.11***	3.93***
	3.44-14.68	3.20-4.82
Poor	17.73***	6.83***
	7.96-39.52	5.23-8.92
No. Observations	3,112	17,390

Note: * indicates p<0.05, ** indicates p<0.01, and *** indicates p<0.001 (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed z-test.

Table 10 shows that individuals with diabetes are more likely than individuals without diabetes to have CVD, consistent with the previously shown data. NH white individuals with diabetes are 1.69 times more likely to have CVD than NH white individuals without diabetes, while Hispanic individuals with diabetes are 1.89 times more likely to have CVD than Hispanic individuals without diabetes. As age increases, both NH white and Hispanic individuals are slightly more likely to have diabetes. This, too, is consistent with the previously shown data.

Table 11: Odds Ratios (95% CI) of CVD Among Individuals Aged 18 and Older by Race/Ethnicity, 2018

Hispanic (ref)	NH White	NH Black	NH Other
--	1.48**	1.02	1.250

--	1.14-1.92	.76-1.38	.91-1.72

Note: * indicates $p<0.05$, ** indicates $p<0.01$, and *** indicates $p<0.001$ (statistically different from the Hispanic population). Statistical significance was evaluated using a two-tailed z-test.

Table 11 shows that after controlling for the specified variables, NH white individuals are 1.48 times more likely to have CVD than Hispanic individuals, while NH black individuals are 1.02 times more likely to have CVD than Hispanic individuals (although this difference is not statistically significant). Thus, the multivariate linear regression shows that Hispanic individuals maintain a health advantage over NH white individuals with respect to CVD. Additional analysis showed that when controlling for these specific variables, the prevalence of CVD within the NH white population is 13.6%, while the prevalence of CVD within the Hispanic population is 10.1%. Given this, it is clear that after accounting for additional variables the HHP is still present.

Conclusion

Within the general population, the Hispanic population has a lower prevalence of CVD than the NH white and NH black populations after controlling for age, income level and education level. Within the population with diabetes, the Hispanic population has a lower prevalence of CVD than the NH white and NH black populations but to a lesser degree than in the general population. Finally, the foreign-born Hispanic population has a lower prevalence of CVD than the foreign-born NH white population, but a similar if not higher prevalence of CVD compared to the foreign-born NH black population. The difference between the Hispanic and NH white groups is similar in both the foreign-born population and the general population—the Hispanic population has about half the prevalence of CVD compared to the NH white population.

Measurements

Race/Ethnicity: The NHIS provided several answer choices regarding race and ethnicity, which I consolidated into five groups: Hispanic, non-Hispanic (NH) white, NH black, NH Alaskan Native/American Indian, and NH Asian populations. The "Asian" category includes those who identify as Chinese, Filipino, Indian Asian, or "Other Asian" (IPUMS, "RACEA"). Hispanic individuals include anyone who identified as Mexican, Mexican-American, Puerto Rican, Cuban/Cuban American, Dominican, Other Hispanic, Central or South American, Other Latin American, Other Spanish, or Multiple Hispanic (IPUMS, "HISPETH)". These answer choices were provided by the NHIS, and the answers to this question was self-reported. When generating the five categories used in this analysis, I placed anyone who identified as Hispanic into the "Hispanic" category. Each individual is in one (and only one) category. Following this categorization, the racial/ethnic breakdown consisted of 12,481 Hispanic individuals, 46,222 NH white individuals, 8,317 NH black individuals, 857 Alaskan Native/American Indian individuals, and 4,349 Asian individuals.

Cardiovascular disease (CVD): I defined CVD as an umbrella term for any of the following: coronary heart disease, angina pectoris, heart attack (myocardial infarction), or stroke. I also included respondents who indicated that they had been diagnosed with "any kind heart condition or disease other than coronary heart disease, angina pectoris, or a heart attack" (IPUMS, "HEARTCONEV"). Although this description is ambiguous, I chose to include it because it is included in the CDC 2018 Summary Health Statistics report (Villarroel et al., Table A-1, 2019). Respondents were asked if they had ever been told by a doctor or other health care professional that they had one of the above listed conditions.

Income Level: When generating the income variable, I excluded 9,205 people. This was due to the NHIS survey set up. The variable provides "total group family income," meaning the combined income of all family members before taxes. Respondents were asked if their total family income was in between $0-$34,999; $35,000-$49,999; $50,000-$74,999; $75,000-$99,999; or $100,000 and over. However, respondents who could not provide precise information regarding their total family income were asked to estimate if their income was between $0-$49,000 or $50,000-$99,999. I excluded the 3,871 respondents who answered either $0-$49,000 or $50,000-$99,999, as I had no way of knowing which of the five smaller income categories they fell into. I also excluded anyone whose answer was categorized by the NHIS as "undefined" or "unknown." After these exclusions, the total sample size was 63,626 respondents for the year 2018.

Education Level: When generating the education variable, I excluded 5,057 people. I categorized survey respondents into the following categories: less than a high school education (includes anyone who never attended school, or who attended school but ended before receiving a diploma in 12th grade); high school education or equivalent (which includes anyone who graduated high school or obtained a GED or the equivalent); some college or an associates degree (which includes anyone who completed some college without receiving a degree, or anyone who completes an associates (AA) degree); bachelor's degree; or anyone with a master's, professional (such as MD or JD) or doctoral degree (such as PhD or EdD). Children under the age of five years old were not asked about their educational level and thus were excluded. I also excluded anyone whose education level was unknown.

Diabetes: Individuals were considered diabetic if they responded "yes" or "borderline" to the question "Have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?" Women were asked to exclude diabetes that occurred during pregnancy (IPUMS, "DIABETICEV"). Only 54% of NHIS respondents were asked this question (those that fell into the Sample Adult and Sample Children categories) (IPUMS, "DIABETICEV"). Of those who were asked the question, I excluded those whose response was interpreted as "unknown" within the NHIS. I also limited my analysis to adults aged 18 or older. After taking these steps, the total sample size of diabetic individuals was 7,266. The racial/ethnic breakdown was as follows: 989 Hispanic; 4,670 NH white; 1,100 NH black; 132 NH Alaskan Native/American Indian; and 375 NH Asian.

Region of Birth: NHIS respondents were asked "Where were you born?" Throughout my analysis, I will refer to respondents that answered "born in U.S. state or D.C." as U.S.-born. I will refer to those who answered "born in U.S. territory" or "born outside U.S. and U.S. territory" as Foreign-Born (IPUMS, "USBORN"). All those whose region of birth was recorded as "unknown" within the NHIS were excluded. The number of people in each category is as follows: 61,777 in the U.S.-born category and 10,784 in the foreign-born category.

Statistical Analysis

Sampling weights were used to account for the sampling design. For example, sampling weights were used to account for the fact that Hispanic, black and Asian individuals who were over 65 years old were oversampled in the Sample Adult condition (National Center for Health Statistics, "About the National Health Interview Survey"). The NHIS data was accessed through a publicly-

available database called IPUMS, which was previously an acronym for “Integrated Public Use Microdata Series” but is now known solely as IPUMS because not all of the organization’s data projects are for public use or contain microdata (IPUMS, “What is IPUMS?”). The sampling weight variable “SAMPWEIGHT” was utilized. A linear regression was used to determine the statistical significance of the results. Results were considered significant for p-values <0.05.

CHAPTER IV: DISCUSSION

Hispanic Population Has Low CVD Prevalence

A much larger proportion of Hispanic individuals fell within the lowest income and education categories compared to NH white individuals in the 2018 National Health Interview Survey (NHIS) (see Appendix, Figures 1 and 2). Additionally, a comparable proportion of Hispanic individuals fell within the lowest income category compared to NH black individuals, and a greater proportion fell in the lowest education category (see Appendix, Figures 1 and 2). The socioeconomic status (SES)-health gradient would predict that the Hispanic population would have a higher prevalence of cardiovascular disease (CVD) than the non-Hispanic (NH) white population, and a comparable (if not higher) prevalence of CVD compared to the NH black population (Adler et al., 1994). However, the data do not show these relationships.

The results of this data analysis show that the Hispanic population in the United States has a lower CVD prevalence than the NH white and NH black populations (Figure 1). This remains true even after controlling for age, as the Hispanic population consistently had a lower prevalence of CVD than the NH white and NH black populations in each age group, and all but one of these differences were statistically significant (Figure 2). The Hispanic population also had a significantly lower prevalence of CVD than the NH white population across all income and education categories (Figures 3 and 4). The same is true with respect to the NH black population, although not all differences were statistically significant. Thus, these results provide evidence of the existence of the Hispanic health paradox.

The prevalence of CVD within the Hispanic, NH white and NH black populations found in this analysis are fairly consistent with those published by the American Heart Association (AHA) and Centers for Disease Control (CDC) (Virani et al., 2020; Villarroel et al., Table A-1,

2019). The only major difference between these results and those published by the AHA is the prevalence of CVD within the NH white population. While my analysis, which utilized data from the 2018 NHIS, found a prevalence of 16.1% in the NH white population, the AHA reports a prevalence of 9.7% among NH white males and 8.4% among NH white females (data for the overall population unavailable) (Virani et al., 2020). A possible explanation for this difference is that the AHA utilized data from the National Health and Nutrition Examination Survey (NHANES), a survey that has both an interview and a physical examination component. The NHANES is composed of about 5,000 people each year, which is about one-fourteenth the size of the NHIS sample I studied (National Center for Health Statistics, "About the National Health and Nutrition Examination Survey"). This difference in sample size may have led to the discrepancy in the prevalence of CVD within the NH white population. Regardless, my analysis yielded results similar to those published by the CDC, which also used the 2018 NHIS (Villarroel et al., Table A-1, 2019). My analysis adds to the CDC report by showing that the Hispanic population consistently has a lower prevalence of CVD than the NH white and NH black populations after controlling income and education level.

Accounting for a Major CVD Risk Factor: Populations with Diabetes

The data show that the Hispanic population with diabetes still has a lower prevalence of CVD than the NH white and NH black populations with diabetes, but to a lesser extent than in the general population. The degree to which the prevalence of CVD within each racial/ethnic group differs is reduced. In the general population, the prevalence of CVD amongst Hispanic individuals is half that of NH white individuals. However, in the population with diabetes, the prevalence of CVD amongst Hispanic individuals is two-thirds that of NH white individuals.

This difference is still statistically significant. These data indicate that even after controlling for diabetes, a major CVD risk factor, the Hispanic population still has a lower prevalence of CVD than the NH white population. Given that both Hispanic individuals with diabetes and NH white individuals with diabetes are at risk for CVD, it is startling that proportionally, one-third more NH white individuals are diagnosed with CVD. This suggests that perhaps the Hispanic population is in some way protected from CVD.

Comparing the Hispanic population with diabetes to the NH black population with diabetes also suggests that Hispanic individuals are in some way protected from CVD. Only 24.30% of the Hispanic population with diabetes has CVD, compared to 30.24% of the NH black population. This difference, however, is not statistically significant. It is interesting that the difference in CVD prevalence between the Hispanic population and the NH white/NH populations is smaller among populations with diabetes compared to the general population. A possible explanation for the narrowing of this disparity relates to the likelihood of visiting health care professionals. Individuals who self-identified as having diabetes had necessarily visited a health care professional at some point in their lives, as they were asked the question: "Have you ever been told by *a doctor or health professional* that you have diabetes or sugar diabetes?" Perhaps Hispanic individuals with diabetes were more likely to continue to go to the doctor and therefore more likely to receive a subsequent diagnosis of CVD than Hispanic individuals in the general population. According to the 2010 U.S. Census, Hispanic individuals were less likely to go the doctor than NH white and NH black individuals. 42.3% of the Hispanic population reported not visiting a medical provider in the past year, compared to 22.8% of the NH white population and 29.7% of the NH black population (Brett O'Hara & Caswell, 2012). This explanation would support the argument that the HHP is a function of data bias—that is, the

prevalence of CVD within the Hispanic population is artificially low due to the fact that many Hispanic individuals do not go to the doctor.

Accounting for Region of Birth

The prevalence of CVD is lower in the Hispanic population than the NH white population in both the U.S.-born and foreign-born populations. In fact, the difference between the two groups stays about the same—the prevalence of CVD in the white population is about twice as much as the Hispanic population in both the U.S.-born and foreign-born populations (Figure 7). The fact that the prevalence of CVD amongst foreign-born individuals is lower than U.S.-born individuals suggests that American culture plays a large role in increasing susceptibility to CVD. This is unsurprising, given that the United States is one of the fattest countries in the world (Central Intelligence Agency, 2016). The data support the *healthy migrant hypothesis*, as it is shown that the prevalence of CVD is lower among foreign-born members than U.S.-born members of each racial/ethnic group. However, the data also indicate that the healthy migrant effect alone does not account for the HHP. If this were the case, then we would expect to see similar CVD prevalence amongst all foreign-born racial/ethnic groups. However, the data show that foreign-born Hispanic individuals still have a lower prevalence of CVD than NH white individuals. This is true after controlling for age, although the differences between the two populations are no longer statistically significant in individual age classes (likely due to small sample size). The fact that the foreign-born Hispanic population has a lower prevalence of CVD than the foreign-born NH white population suggests that the Hispanic population has some health advantage over the NH white population, regardless of immigration status.

Conclusion

The data support the existence of the Hispanic health paradox by showing that the Hispanic population has a lower prevalence of CVD than the NH white and NH black populations after controlling for age, income and education level. The data also show that the HHP is present in populations with diabetes, as the Hispanic population with diabetes has a lower prevalence of CVD than both the NH white and NH black populations with diabetes, but to a lesser degree than in the general population. However, this finding also suggests that the low prevalence of CVD in the Hispanic population could be due, in part, to under reporting of CVD amongst Hispanic individuals as a result of lower rates of doctor visitation. Finally, the data also show that the healthy migrant effect likely contributes to the low prevalence of CVD amongst the Hispanic population, but does not account for it entirely.

CHAPTER V: CONCLUSION

The data in this thesis show that the Hispanic health paradox (with respect to CVD) is a true phenomenon, but that it is likely exaggerated by under reporting of conditions within the Hispanic population. Consistent with studies from the American Heart Association and Centers for Disease control, the data showed that the Hispanic population in the United States does have a lower prevalence of CVD than the NH white and NH black populations. This remains true even after controlling for age, income, and education level. The HHP also holds true amongst populations with diabetes. The Hispanic population with diabetes also has a lower prevalence of CVD than the NH white and NH black populations, indicating that the Hispanic population has a health advantage over the other two. However, the differences between racial/ethnic populations with diabetes are smaller than those within the general population. In the general population, the prevalence of CVD in the Hispanic population is about half as small as the NH white population, whereas the prevalence of CVD in the Hispanic population with diabetes is only about one-third smaller than the NH white population with diabetes. The fact that the proportion of Hispanic individuals with CVD increases with respect to NH white individuals with CVD in the population with diabetes could reflect the frequency with which these two groups visit health care professionals. Within the general population, Hispanic individuals are less likely to go to the doctor than NH white individuals (O'Hara & Caswell, 2012). Within the population with diabetes surveyed in the NHIS, all respondents must have visited a doctor at least once to receive their diabetes diagnosis. Thus, it can be inferred that in the NHIS, the population with diabetes is more likely to go to the doctor than the general population. Perhaps the inflation of CVD rates within the Hispanic population with diabetes is due not only to an increased incidence of CVD, but also to increased detection of CVD. Given that the prevalence of CVD within the Hispanic

population with diabetes increases with respect to the NH white population with diabetes, it is likely that in the general population, the detection of CVD was lower in the Hispanic population than in the NH white population. This would lend support to the hypothesis that the observation of HHP is exaggerated by under reporting of conditions within the Hispanic population.

Additionally, the data support the existence of the HHP by showing that the low CVD prevalence amongst Hispanic individuals is not limited to those born in the United States. Though the *healthy migrant hypothesis*—which suggests that the advantageous health outcomes of Hispanic individuals in the United States is due to the selection of healthy immigrants—may still be true, it alone does not account for the HHP. Healthy immigrant selection likely plays some role, as the data show that foreign-born individuals have a lower prevalence of CVD amongst every racial/ethnic group compared to U.S.-born individuals. Because the Hispanic population has a high proportion of immigrants, it is likely that healthy immigrant selection has some effect on lowering the prevalence of CVD in this population (Flores, 2017). However, healthy immigrant selection alone does not account for the HHP. The data show that the foreign-born Hispanic population still has a lower prevalence of CVD than the foreign-born NH white population. This suggests that the Hispanic population has a health advantage over the NH white population, regardless of the relative proportion of immigrants in each population (as both these populations are completely composed of immigrants). Thus, the HHP cannot be explained merely by the high proportion of immigrants within the Hispanic population. The data indicate that the Hispanic population has some protective factor against CVD that needs to be further explored.

In conclusion, the data confirm the presence of the Hispanic health paradox within the context of CVD by showing that the Hispanic population in the United States has a lower

prevalence of CVD than the NH white and NH black populations. The data also show that the Hispanic population with diabetes still has a lower prevalence of CVD than the NH white and NH black populations, showing that the HHP is present among populations with diabetes. However, the differences between these populations are reduced, shedding light on the fact that the even-lower prevalence of CVD amongst Hispanics in the general population may be due to under-detection. Finally, the data show that both the U.S.-born and foreign-born Hispanic populations have a lower prevalence of CVD than the corresponding NH white populations, showing that the HHP is still present after controlling for region of birth. This finding indicates that the existence of the HHP is not due solely to the increased proportion of immigrants within the Hispanic population in the U.S., but that the Hispanic population is somehow protected from CVD compared with other racial/ethnic populations.

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APPENDIX

Figure 1: Breakdown of Education Level by Race/Ethnicity, 2018

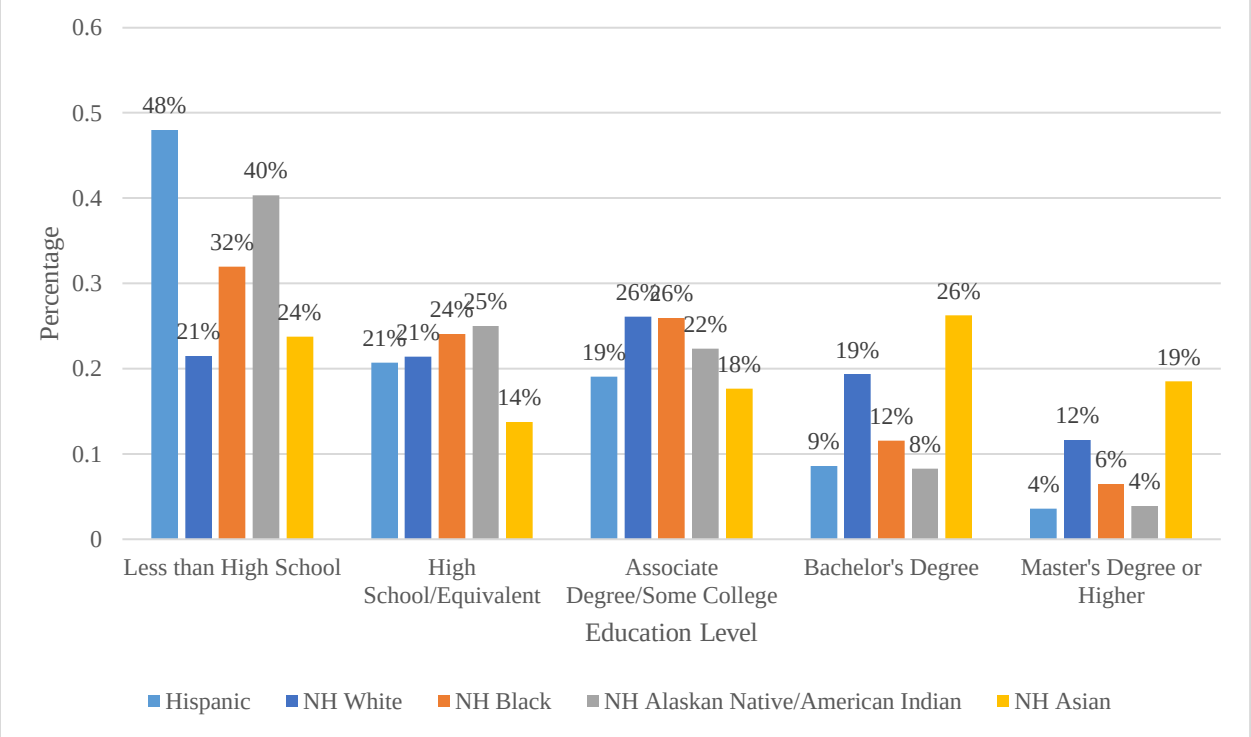

Figure 2: Breakdown of Income Level by Race/Ethnicity, 2018