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Beneficial Hispanic Stroke Mortality: An Exploration of Potential Explanatory Factors

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Beneficial Hispanic Stroke Mortality: An Exploration of Potential Explanatory Factors

by

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Dedication

To my wife, Kristen Peek, for her constant championing of my cause and putting up with the disruptions of student life.

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Beneficial Hispanic Stroke Mortality: An Exploration of Potential Explanatory Factors

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Stroke mortality rates are reported to be lower for Hispanics than non-Hispanic Whites. This project investigates factors that contribute to this lower rate in three ways: 1) examine the role of immigrant status in stroke incidence and mortality, 2) investigate the impact of cause of death ambiguity, and 3) examine the role of misreport of ethnicity on death certificates.

In examining the effect of immigrant status I used the Hispanic Established Populations for the Epidemiologic Study of the Elderly (EPESE) and the East Boston EPESE. This research compares baseline health characteristics of immigrants with native-born respondents. Additionally, I examine differences in stroke mortality, as well as the risk of stroke between waves. In both EPESE samples significant differences in demographics and co-morbidities existed at baseline between immigrants and the US born. However, the odds of stroke mortality or having a stroke during follow-up were not significantly different for immigrants and the US born in either the East Boston or Hispanic data.

To examine the impact of cause of death coding and misreport of ethnicity on death certificates, I used national vital registration data for the years 1989-1991 and 1999-2002, including foreign and US born Hispanics and non-Hispanic Whites. Hispanic deaths were adjusted for misclassification of ethnicity on the death certificate. These data were linked to census estimates and 5% census samples for the corresponding time periods, allowing for estimates of the foreign born population. Adjustment for nativity and death certificate misclassification removed the stroke mortality advantage for US born Hispanic men, but not women. After adjustment, US born Hispanic men and women have higher rates of mortality from subarachnoid stroke than Whites (RR 1.27 and 1.27 respectively), but lower rates of mortality from Ischemic (RR 0.85 and 0.79 respectively) and chronic effects of stroke (RR 0.95 and 0.79 respectively).

These results suggest that health benefits immigrants receive do not continue in older age with regards to stroke. Additionally, after adjustment for misclassification, the lower stroke mortality advantage for Hispanic men disappears, while an advantage still remains for Hispanic women. Part of the previously reported advantage is a combination of imprecise measurement and data quality.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

This dissertation explores the observed lower mortality of Hispanics in the US compared to non-Hispanic Whites relative to their socioeconomic position. This mortality advantage has been dubbed the *Hispanic Paradox.*[1] We specifically focus on stroke mortality given its prevalence in the older population and its contribution to mortality and morbidity. In the chapter that follows we first provide a background on Hispanics in the US and the *Hispanic Paradox*. We follow with a discussion of stroke types, outcomes and risk factors, as well as its relevance to Hispanics. Next, we discuss potential explanatory factors for lower stroke mortality among Hispanics relative to non-Hispanic Whites. From these factors we select three for explicit testing: migrant selection, accuracy of cause of death coding, and misreport of ethnicity on death certificates.

Hispanics in the U.S.

The term *Hispanic* is used in the U.S. to denote a person's cultural and ethnic origins being from countries in the Americas formerly ruled by Spain. The term Hispanic and the term Latino are sometimes used interchangeably. The U.S. Census Bureau currently defines "Hispanic or Latino" as "a person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race".[2] Hispanics have lived in North America since the 16th century. Indeed, Spain had the largest colonial enterprise in the Americas for nearly 300 years. Independence movements throughout the 19th century resulted in the fracturing of the Spanish empire.

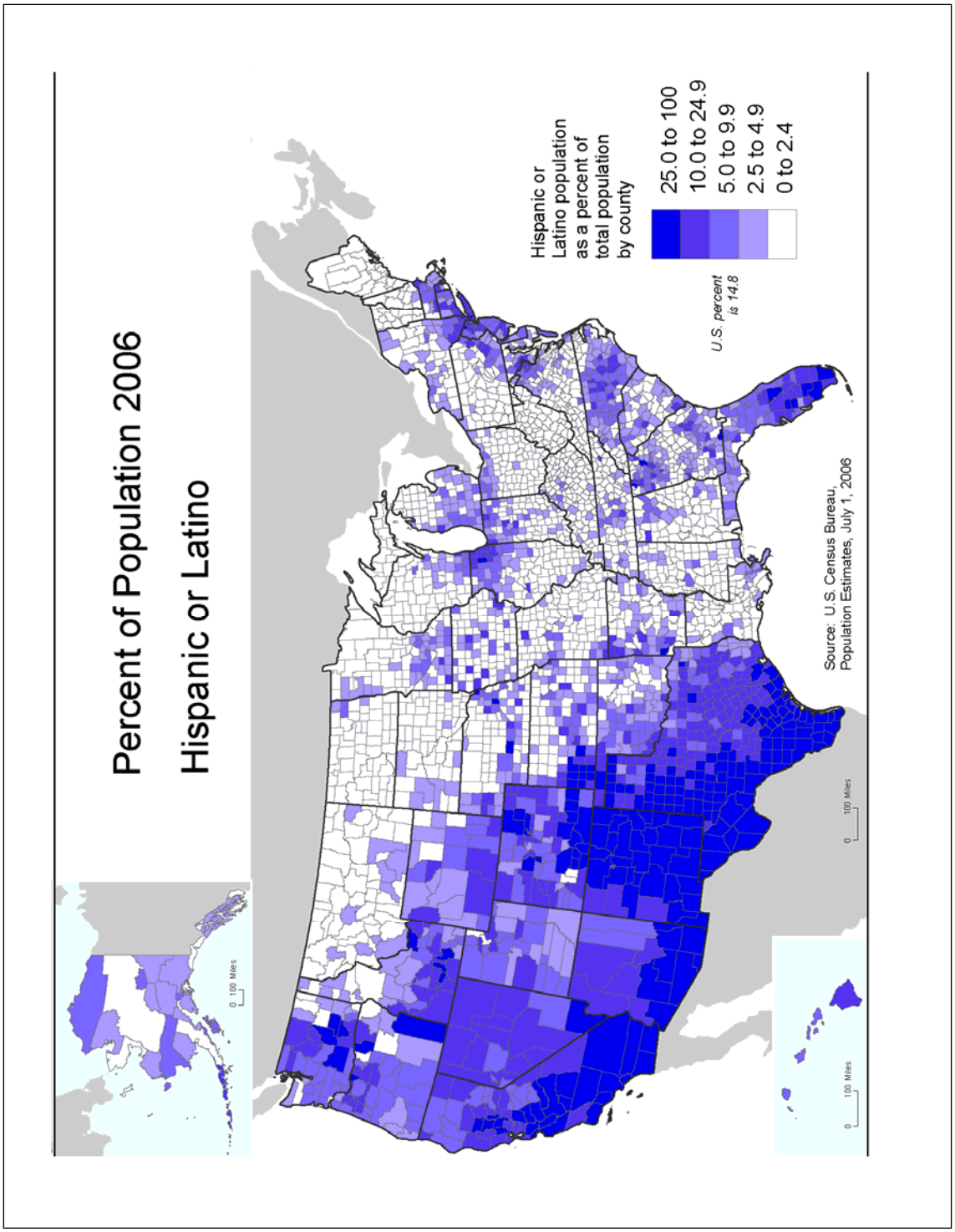


Figure 1. 1 - Distribution of Hispanic Population Source: US Census Bureau

During these 19th century upheavals, three events transpired that would influence directly the shape and composition of the United States. First, the United States annexed of the Republic of Texas in 1845. Second, the Mexican-American war was triggered by the annexation of Texas. This conflict resulted in the treaty of Hidalgo in 1848 which ceded 55% of Mexican territory to the US. Not only did these two events greatly expand the lands of the US, they also added a large population of former Mexican nationals to the US population. The third major event was the Spanish-American war of 1898. The resolution of this war resulted in the annexation of Puerto Rico, the Philippines, and Guam as territories of the US. While this annexation did not directly increase the size of the US it did create strong relationships between these territories and the US, resulting in Puerto Ricans being granted US citizenship.[3]

The distribution of Hispanics in the US has not changed dramatically in the centuries since Spanish colonization. Figure 1.1 shows the geographic distribution of Hispanics in the U.S. The highest concentration of Hispanics is along the US-Mexico border, with more than half of all Hispanics living in California and Texas. As seen in figure 1.2, Hispanics currently residing in the US are a heterogeneous group with origins in Mexico, Cuba, the Caribbean, and Central and South America. Hispanics living in the southwestern US are predominately of Mexican origin, those in Florida are primarily of Cuban origin, and Hispanics in the north east and mid west are primarily of Caribbean origin.[4] Hispanics of Mexican origin are the largest subgroup, accounting for more than

63% of the total Hispanic population. The heterogeneous origins of these Hispanic populations suggest that there may be variability in health measure across groups.

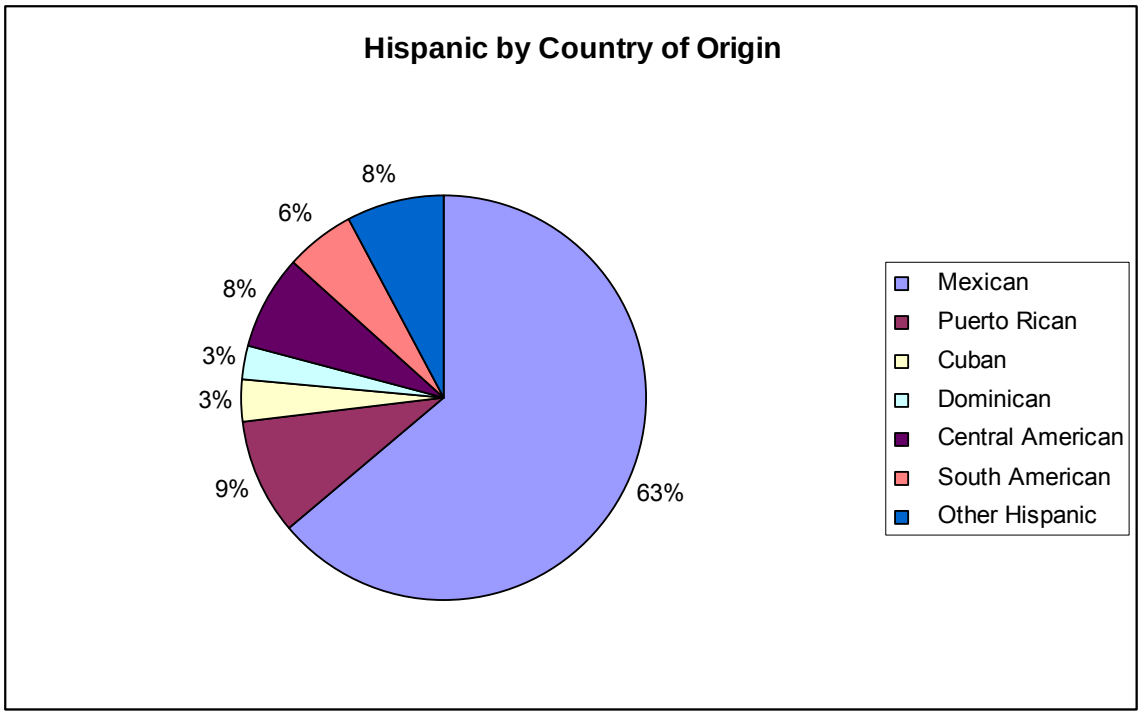


Figure 1. 2 Hispanic Origins Source: Current Population Survey

Hispanics are the fastest growing minority group in the US., increasing three times faster than the total population.[5] Hispanics are also the largest minority group in the US, accounting for 15% of the US population in 2006 and are projected to grow to 24% by 2050. Additionally, Hispanics accounted for one half of the population growth experienced by the U.S. between 2000 and 2006.

Table 1.1 presents select demographic details from the 2000 census to underscore the differences between the Hispanic and non-Hispanic White population. Compared to non-Hispanic Whites, Hispanics have lower rates of home ownership, and lower educational attainment, employment rates and

Table 1. 1 – Select Census Demographics

Census 2000 Demographic Profile Highlights

Characteristics	Total Population Count	%	Non-Hispanic White Count	%	Hispanic - Any Race Count	%
Total population	281,421,906		211,460,626		35,305,818	
Male	138,053,563	49	103,773,194	49	18,161,795	51
Female	143,368,343	51	107,687,432	51	17,144,023	49
Median Age	35		38		26	
Under 5 years	19,175,798	7	12,859,892	6	3,717,974	11
18 years and over	209,128,094	74	161,862,337	77	22,963,559	65
65 years and over	34,991,753	12	30,405,538	14	1,733,591	5
Owner-occupied housing units	69,815,753	25	59,693,948	28	4,212,520	12
High school graduate or higher	146,496,014	52	119,587,422	57	9,577,031	27
Bachelor's degree or higher	44,462,605	16	37,291,563	18	1,908,039	5
Foreign born	31,107,889	11	13,376,204	6	14,157,817	40
Male, Now married, except separated (population 15 years and over)	60,720,716	22	49,191,373	23	6,554,114	19
Female, Now married, except separated (population 15 years and over)	59,510,557	21	48,548,635	23	6,148,764	17
Speak a language other than English at home (population 5 years and over)	46,951,595	17	22,631,600	11	24,804,832	70
In labor force (population 16 years and over)	138,820,935	49	108,079,326	51	14,835,741	42
Median Household Income	41,994		44,687		33,676	
Per capita income in 1999 (dollars)	21,587		23,918		12,111	
Families below poverty level	6,620,945	2	3,548,532	2	1,495,297	4
Individuals below poverty level	33,899,812	12	18,847,674	9	7,797,874	22

Source: U.S. Census Bureau, Summary File 2 (SF 2) and Summary File 4 (SF 4)

lower median income. Additionally, Hispanics are more likely to live in poverty, speak a language other than English at home, and be foreign born.

Figure 1.3 shows the occupational distribution of Hispanics compared to the U.S population in 2006. Hispanic men are more likely to work in jobs requiring manual labor such as production, construction and service industry jobs Similarly, Hispanic women have higher rates of employment in the production and service industries. Both Hispanic men and women have lower rates of

employment as professionals compared to the total population. Nearly one third of the Hispanic population is uninsured and nearly a quarter lack a regular health care provider. Hispanics born outside the U.S or who don't speak English are more likely to be uninsured than U.S. born Hispanics.

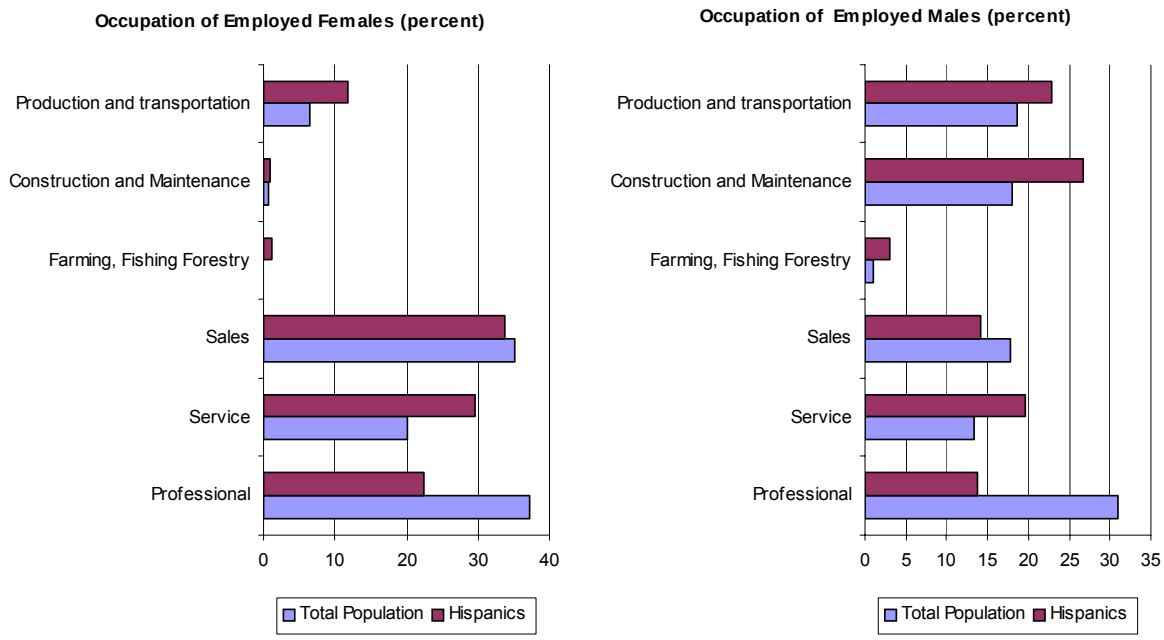


Figure 1.3 Hispanic Occupation - Source US Census 2006 American Community Survey

Hispanic Paradox

Socioeconomic Position and Health

Socioeconomic position is a measure of a person's social position relative to others. Socioeconomic position is commonly measured with indicators of income, occupation, education, and wealth. These indicators may be used individually or combined into a single measure. Regardless of how socioeconomic position or health is measured, people of low socioeconomic position generally have worse health outcomes than those at higher levels.[6-8]

Low socioeconomic position results in less access to healthful foods, safe housing and neighborhoods, and medical care. Low socioeconomic is also associated with increased tobacco and illicit drug use, and violent crime. Combined, these factors potentiate the risk of numerous health conditions such as hypertension, obesity, diabetes. Additionally, poor health can effect socioeconomic position.[9] If a person of low socioeconomic position becomes ill medical expenses and time away from work further deprive the individual of resources, thus perpetuating lower socioeconomic status.

The Paradox

As described previously, Hispanics possess a generally lower socioeconomic position relative to non-Hispanic Whites. However, despite this lower position, Hispanics have health related outcomes similar to, and in some cases, better than non-Hispanic Whites.[10] This so called *Hispanic Paradox* has been observed across the life course.[11-15] Table 1.2 summarizes the findings of studies that have examined the Hispanic health outcomes in regards to all cause and cause specific mortality and infant mortality, as well as outcomes such as chronic heart disease, stroke, and cancer. In summary, the evidence shows that relative to their socioeconomic position, Hispanics have mortality similar to or slightly lower than non-Hispanic Whites. This pattern holds for all cause mortality as well as mortality from CHD, stroke, and common cancers. At older ages (65+ years) this mortality advantage is even more prominent. Disease specific mortality ratios comparing Hispanics to non Hispanic Whites show only the ratios for Chronic Liver Disease, Diabetes, HIV, and homicide are

greater than 1, a rate ratio indicating higher mortality from these causes. The mechanism for the Hispanic Paradox is largely unknown. Several explanations have been put forward. It is likely that a single explanation does not exist, and that the mechanism must be multifactorial.

Stroke

Stroke is a useful lens through which to study the paradoxically better health outcomes experienced by Hispanics at older ages. Stroke is the third leading cause of death in the U.S. and a leading cause of disability. Nearly 25% of strokes lead to death within one year. Hispanics have lower stroke mortality than non-Hispanic Whites (discussed in greater detail below).

Stroke is characterized by a disturbance in the blood supply to the brain resulting in rapid loss of brain function. One of the first descriptions of this disease comes from Hippocrates.[16] He described a phenomenon of sudden paralysis and termed it ἀποπληξία, or apoplexia, loosely meaning stricken or struck suddenly. Subsequently, the terms stroke, cerebrovascular accident and brain attack have been used. Regardless of the term, stroke is a medical emergency which can lead to permanent neurological damage, functional impairment and death. Brain tissue ceases to function with 60 to 90 seconds of oxygen deprivation. This damage becomes permanent after a few hours. Onset of stroke is usually sudden.

Stroke Types

There are three general categories of stroke: ischemic, hemorrhagic and those with an unknown origin. This latter stroke type, sometimes referred to as

Table 1.2 Selected Studies

Selected Hispanic Health Outcome Studies

Authors	Definition of Hispanic	Data source	Population	Outcomes
			Mortality - All Cause	
Rosenwaike[17]	Nativity	Vital Statistics	Mexican, Puerto Rican and Cuban born	Lower mortality in Hispanic than non-Hispanic at older ages, higher at younger ages
Desenclos, Hahn[18]	death Certificate	Vital Statistics	US 1986-88	YLL <65 greater in Hispanics
Liao, Cooper et al[19]	self report	NHIS	US 1986-90	Hispanic mortality higher at younger ages, lower at older ages
Sorlie et al[20]	self report	Current population survey	1979-87	Hispanic mortality similar at younger ages, lower at older ages
			Infant Mortality	
Engle et al[21]	mother ethnicity on birth certificate	Vital Statistics	US Puerto Rican women	mortality higher and birth weight lower in PR born
Albrecht et al[22]	mother ethnicity on birth certificate	Vital Statistics	NCHS birth/death data	birth weight and mortality vary by Hispanic sub-group
Guendelman et al[23]	self report	California Perinatal reporting System	patients in California clinics 1984-89	mortality similar in Hispanic and non-Hispanic Whites, lower than in Blacks
			CHD	
Goff et al[24]	Spanish surname	Vital Statistics	Texas deaths, 1980-89	AMI and CHD mortality lower in Hispanic men than NHW, no difference for women
Wild et al[25]	death Certificate	Vital Statistics	California deaths 1985-90	mortality lower in Hispanics
Mitchell et al[26]	self report	San Antonio Heart Study	Mexican American and non-Hispanic Whites	diabetes and prevalence of AMI similar in the two groups
Goff et al[27]	self report	Corpus Christi Heart Project	Mexican American and non-Hispanic Whites	higher mortality for Mexican Americans than Whites
Rewers et al[28]	self report	San Luis Valley Diabetes Study	Residents of two Colorado counties	lower risk of CHD in Hispanic diabetics, risk similar in non-diabetics

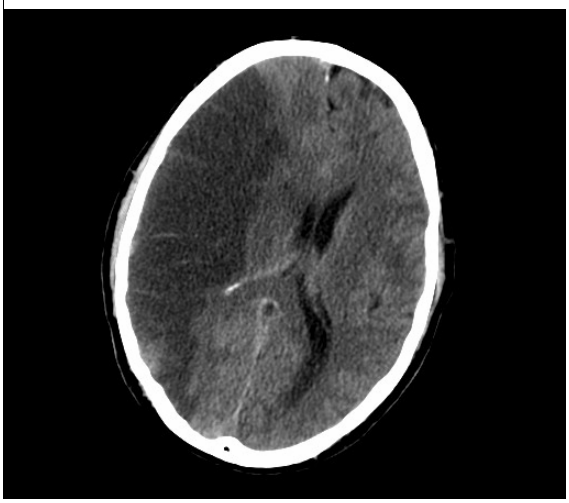
Table 1.2 - Continued

			Stroke	
Gillum[29]	death Certificate	Vital Statistics	Hispanic and non-Hispanic White deaths, 1989-91	Mortality rates similar at younger ages, lower in Hispanics at older ages
Sacco et al[30]	self report	Northern Manhattan Stroke Study	Northern Manhattan residents, 1993-96	incident stroke for Hispanics between that for non-Hispanic White and Blacks
Sacco et al[31]	surname - skin colour	Medical records	Stroke patients a single hospital, 1983-86	better outcomes for Hispanics than White or Black patients at 1 year
Morgenstern et al[32]	self report	Brain Attack Surveillance in Corpus Christi	Nueces County, TX, 2000-02	Mexican Americans have higher incidence of both ischemic and hemorrhagic stroke
Lisabeth et al[33]	self report	Brain Attack Surveillance in Corpus Christi	Nueces County, TX, 2000-02	Mexican Americans have lower 28 day and 36 month mortality following stroke
Lisabeth et al[34]	self report	Brain Attack Surveillance in Corpus Christi	Nueces County, TX, 2000-02	Mexican Americans have higher risk of recurrent stroke than non-Hispanic Whites; recurrence associated with similar risk of mortality
			Cancer	
Martin and Suarez[35]	Death certificate	Vital Statistics	Mexican Americans and Whites in Texas, 1969-1980	More stomach, liver, and gallbladder cancer in Mexican Americans Lower lung, colon, breast and prostate cancer in MA's
Rosenwaike[36]	Mexican born	Vital Statistics	deaths of Mexican born and Whites	mortality from common cancers lower in Hispanics, higher mortality from rare cancers

cryptogenic or ill-defined stroke, is often considered a type of ischemic stroke and accounts for 30-40% of all ischemic strokes.[37] Of all strokes, 87% are ischemic. Transient Ischemic Attack occurs when blood supply to a particular area of the brain is disrupted, resulting in brief neurologic dysfunction that persists, by definition, for less than 24 hours; if symptoms persist beyond that time frame then it is categorized as a stroke.

In ischemic stroke (figure 1.4), the blood supply to part of the brain is reduced, leading to a dysfunction of the brain tissue in that area.[37] This type of stroke often presents as a functional deficit in one or more categories including speech, movement and vision. There are several causes of ischemia. In an embolic stroke a blood clot forms somewhere in the body (often the heart) and travels through the bloodstream to the brain. The clot will pass through blood vessels until they become too narrow, resulting in blocked arterial blood flow. Thrombolytic strokes occur when a blood clot forms in-situ on the wall of a cerebral artery. This is often the result of blood vessels clogged with unhealthy deposits of plaque and cholesterol. The body reacts to this buildup by

Figure 1. 4 – CT scan of Ischemic Stroke. Reproduced under GNU public license.



forming a clot as if there were an injury. There are two types of thrombolytic strokes: large vessel and small vessel.

Hemorrhagic strokes (figure 1.5) occur when a blood vessel in the brain breaks, leaking blood into the brain or space surrounding the brain.[37] Hemorrhagic stroke often present as a severe and sudden headache sometimes referred to as a “thunder-clap” headache. This is due to the compression of the brain tissue from the blood leaking out the vessel. Hemorrhages can be caused by a number of disorders which affect the blood vessels, including long-standing high blood pressure and cerebral aneurysms. An aneurysm is a weak or thin spot on a blood vessel wall. Aneurisms can develop over a number of years and usually don't cause detectable problems until they break. There are two sub-types of hemorrhagic stroke: subarachnoid and intracerebral. In an intracerbral hemmorrhage, bleeding occurs from vessels within the brain itself. Hypertension is the primary cause of this type of hemorrhage. In a subarachnoid hemorrhage, an aneurism bursts in a large artery on or near the thin, delicate membrane surrounding the brain. Blood spills into the area around the brain which is filled with a protective fluid, causing the brain to be surrounded by blood-

Figure 1. 5 CT Scan of Hemorrhagic Stroke. Reproduced by permission under GNU public license.

contaminated fluid. This not only disrupts the flow of blood to the brain, but also increases pressure on the brain by increasing the volume of liquid inside the scull.

Effects of Stroke

Due to the complex structure of the brain, stroke can have drastically different effects depending on the type, severity and location of the stroke.[37] Because one side of the brain controls the opposite side of the body, a stroke affecting one side of the brain will result in neurological complications on the opposite side of the body. Thus, a stroke on the right side of the brain results in neurological impact on the left side of the body and face. This neurological deficit could result in paralysis, vision problems, inquisitive behavior, and memory loss.[37] Left brain strokes can also result in paralysis and memory loss. Additionally, left brain strokes can result in language and speech deficits (aphasia and apraxia) as well as slow, cautious behavior. A stroke survivor may have slurred speech (dysarthria) or difficulty swallowing (dysphagia). Dysphagia can lead to poor nutrition and pneumonia. Additional effects of stroke can include muscular spasticity, creating stiffness or tightness.[37] Balance can be compromised following stroke – approximately 40% of stroke survivor experience a serious fall within a year. A stroke survivors toes may curl as a result of neuromuscular imbalance. Also, stroke survivors may experience pain that simply will not go away known as central pain syndrome (thalamic pain).

Additionally, stroke survivors are at risk for depression, cognitive challenges during problem solving, personality changes, and one-side neglect.

Risk factors for stroke

Risk factors for stroke include both modifiable and non-modifiable factors.[38] Non-modifiable factors include:

- **Age**. One of the risk factors most strongly associated with stroke is increased age. Nearly three quarters of all strokes occur in the population ≥ 65 years of age. Mortality following stroke also follows an age gradient, with case mortality rates increasing markedly from 15 (/100,000) between age 45 and 54 to an astounding 1,141.8 at ages 85+. After the age of 55, the incidence of stroke doubles every additional ten years of life[38].
- **Gender.** Men are 1.25 times more likely to suffer strokes than women, yet 60% of deaths from stroke occur in women. Women live longer than men, thus, they are older on average when they have their strokes and more often die (NIMH 2002).
- **Family History.** Family history of stroke is also associated with an increased risk of incident stroke.
- **Previous Stroke or TIA.** 30% of patients presenting with a Transient Ischemic Attack (TIA) will have recurrent TIA's, as well as a 25-40% chance of having a stroke in the next 5 years.

The most important modifiable risk factors for stroke are high blood pressure and atrial fibrillation. Other modifiable risk factors include high blood

cholesterol levels, diabetes, cigarette smoking (active and passive), heavy alcohol consumption and drug use, lack of physical activity, obesity and unhealthy diet.

- **Blood pressure**. Hypertension accounts for 35-50% of stroke risk.[39] Lowering blood pressure has been conclusively shown to prevent both ischemic and hemorrhagic strokes.[40] It is equally important in secondary prevention of stroke. Even patients older than 80 years and those with isolated systolic hypertension benefit from antihypertensive therapy. Studies show that intensive antihypertensive therapy results in a greater stroke risk reduction.[41, 42] As much as a 30% reduction in stroke mortality has been shown in clinical trial using active treatments for hypertension.[43]
- **Atrial fibrillation.** Atrial fibrillation accounts for 15-20% of all strokes.[44] During atrial fibrillation, blood clots can form in the left atrium and can then travel on to form an embolic stroke. Patients with history of atrial fibrillation have a risk of 5% each year to develop stroke, and this risk is even higher in those with valvular atrial fibrillation.[45] Emboli prevention through the use of anticoagulation medications such as aspirin or warfarin can significantly reduce risk of stroke.[46-54]
- **Blood lipids.** High cholesterol levels have been inconsistently associated with (ischemic) stroke. Recent studies suggest a

relationship, albeit a weak one.[55] Statins have been shown to reduce the risk of stroke by about 15%.[56] Since earlier meta-analyses of other lipid-lowering drugs did not show a decreased risk, statins might exert their effect through mechanisms other than their lipid-lowering effects.[57]

- **Diabetes mellitus.** Patients with diabetes mellitus are 2 to 3 times more likely to develop stroke.[39] Diabetes is associated in 26.3% of lacunar strokes and 11.3% of non-lacunar stroke.[58] In addition, such patients commonly have hypertension and hyperlipidemia. Intensive disease control has been shown to reduce microvascular complications such as nephropathy and retinopathy but not macrovascular complications such as stroke. One year case fatality is no different with or without diabetes.[59]
- **Smoking**. The risk of ischemic stroke in people who currently smoke is about twice that of non-smokers.[39, 60-62] Smoking accounts for 22% of lucunar strokes and 11.4% of non-lacunar strokes.[58] Smoking cessation has almost immediate effect on the body resulting in an equally rapid reduction in the risk of stroke.[61]

Stroke Incidence and Mortality

The American Stroke Association estimates that over three quarters of a million people experience a stroke in the U.S. every year. Men's stroke incidence is greater than women at younger ages (<75 year) while women's incidence is higher than men's at older ages. Stroke accounted for one in 16

deaths in 2004. Mortality varies by severity and stroke type. Approximately 12% of ischemic strokes and 38% of hemorrhagic strokes result in death within 30 days. Following a first stroke, 21% of men and 24% of women die within 12 months. Women live longer than men. Correspondingly, more women die of stroke than men each year. Of all stroke deaths in 2004, 61% were women.

Stroke and Hispanics

Table 1.2 presents 2001 data on Hispanic and non-Hispanic White health behaviors from the Behavioral Risk Factor Surveillance System. These data illustrate the prevalence of potentially modifiable risk factors for stroke and show the comparison of Hispanics to non-Hispanic Whites. Hispanics have higher rates of obesity, lack of activity, diabetes and excessive alcohol intake.

Table 1. 3 - Bhavioral Risk Factor Surveilance System Data

Comparison of Prevalence of Stroke Risk Factors from the BRFS 2001
US Rates and Hispanic to non-Hispanic White Rate Ratio

	US Rate	Rate Ratio
Overweight	58.40	1.05
Obese	21.70	1.18
No Physical Activity	25.80	1.47
Smoking	23.00	0.99
Diabetes	6.60	1.17
Excessive Alcohol	14.60	1.18
Blood Pressure High	25.70	0.78
High Cholesterol	30.40	0.82

There are limited data available to assess incidence and survival after stroke. Most of existent data come from cross-sectional surveys which do not allow for follow-up, have insufficient samples of Hispanics, or are small area studies. Table 1.4 presents findings from several studies that examined stroke

outcomes among Hispanics and non-Hispanic Whites. Most studies report lower stroke mortality rates for Hispanics compared to non-Hispanic Whites when all stroke types are combined.[29, 33, 63-67] Additionally, there appears to be an age gradient where most of the Hispanic advantage is at older ages.[63, 65, 66] These same studies found that compared to non-Hispanic Whites, Hispanics have higher incidence and mortality rate from hemorrhagic strokes, particularly subarachnoid hemorrhage, at ages less than 65.

Table 1. 4 - Selected Studies: Hispanics and Stroke

Comparison of Hispanic Stroke Outcomes Studies		
Author	Data	Relevent Finding
Ayala et al, 2001[63]	NCHS Mortality Data	Mortality lower in Hispanics than non-Hispanic Whites at ages 65+ Hemorrhage mortality higher in Hispanics age 45 - 64
Gillum, 1995[29]	NCHS, NHANESII, HHANESII	Mortality from cerebrovascular accident higher in non-Hispanic Whites than Hispanics
Hartmann et al, 2001[64]	Northern Manhattan study	Over all no difference between Caribbean Hispanics and non-Hispanic Whites; Higher incident stroke mortality for Hispanics
Howard et al, 1994[65]	National Longitudinal Mortality Study	Hispanic have lower stroke mortality, especially at older ages
Karter et al, 1998[66]	California death certificates	Stroke mortality lower in Hispanic men and women age 65+; Hispanic stroke mortality higher a younger ages
Lisabeth et al, 2006[33]	Brain Attack Surveillance in Corpus Christi	Mexican Americans lower risk of mortality
Sacco et al, 1991[31]	NY Stroke databank	Stroke mortality and recurrence lower in Hispanics

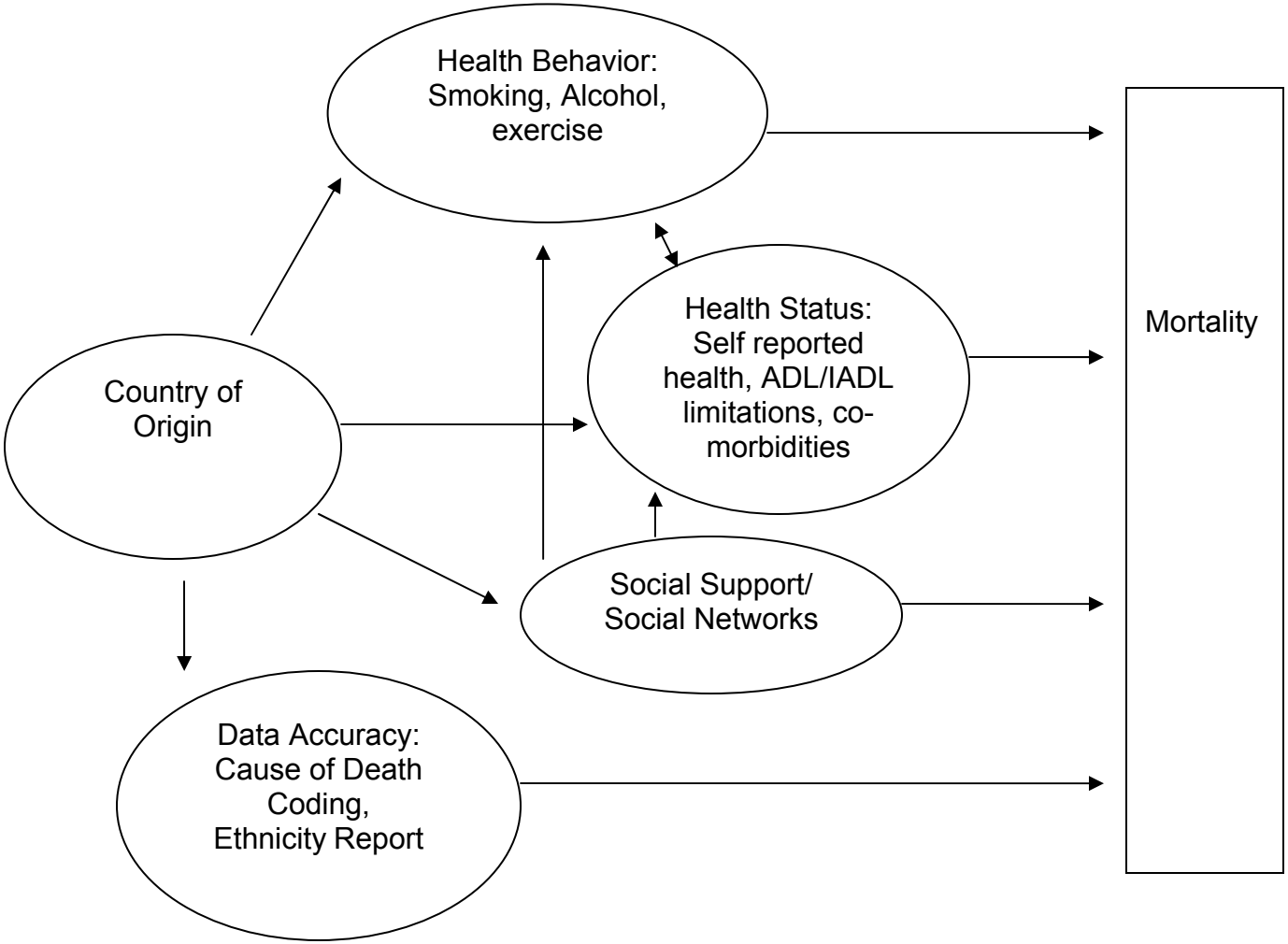
Why do Hispanics have lower stroke mortality?

There are several competing explanations for the paradoxically advantageous mortality outcomes experienced by Hispanics in the US. Some researchers suggest paradoxically good health is brought about through better health behaviors and beneficial genetic contribution.[1, 68] Such characteristics contribute directly to the overall health of Hispanics thus leading to more favorable outcomes. Other researchers suggest that beneficial health outcomes are due to socio-cultural components that Hispanics experience which are not experienced by the non-Hispanic population.[20, 69] They posit that denser social networks and supportive interpersonal interactions lead to reductions in stress and better ability to overcome illness. Social factors may influence health by increasing self-efficacy and sense of self control by directly reducing the negative physical effects of stress. This supportive interaction may also lead to better health behaviors such as lower rates of smoking and better diets.

Other researchers contend that the paradox is the product of some confounding issue or set of issues. Several explanations emerge in the literature, including: migrant selection (Healthy Immigrant- discussed below and return migration) [15, 20, 69] as well as data accuracy (ethnic identification – discussed below, misreport of ages, and record matching).[70-72]

Figure 1.6 presents an overview of these factors, showing the potentially complex mixture of confounders, methodologic errors and natural phenomenon that could contribute to the observed lower mortality of Hispanics. It is generally agreed that the factors in question fall into four categories: data

Figure 1.6 : Potential Model for Hispanic Mortality



quality, selective in-migration (*Healthy Migrant*) (both explained below), as well as selective out-migration (*Salmon Bias*), and cultural factors.

Prospective mortality follow-up surveys are typically surveys linked to the vital registration system. Such linkages do not have a means of accounting for individuals who emigrated back to their countries of origin during the follow-up period prior to death. This lack of observable death would tend to bias mortality rates downwards. A related migration effect has been labeled the *Salmon Bias*.[73] This takes the above hypothesis a bit further suggesting that those that return to their countries of origin are in worse health than those that do not return. This, too, would bias mortality rates downwards for those that remained in the US. Efforts to test this theory have mixed results. If anything, there is a weak relationship.[69, 73]

Combined, these competing theories paint a complicated picture of the Hispanic Paradox. Several studies have sought to test these various theories over the last 20 years. A study by Polloni and Arias in 2004[73] examined the contribution of data artifact, healthy-migrant effect, salmon bias effect, and a cultural effect. They conclude that the mortality advantage primarily appears in foreign born Other Hispanics –originating in Central and South America - and foreign born Mexican Hispanics. Subsequently, Turra and colleagues as evidence against the salmon bias indicate that the magnitude is insufficient to explain the mortality advantage for Hispanics.[74] While both of these studies show evidence of a salmon bias in effect, they both concede of these effects

explained only a part, if any, of the mortality difference between Hispanics and non-Hispanic Whites.

While studies have looked at all-cause mortality in regards to these potential explanatory factors, little work has examined the effect these factors might have on stroke. We test the effect of three of these factors on stroke incidence and stroke mortality in Hispanics in the US: migrant selection, accuracy of cause of death data, and misreport of ethnicity on death certificates.

Migrant selection

The literature describes what has come to be known as the "healthy immigrant" effect. This reflects the fact that on many health measures, immigrants are often healthier than U.S.-born residents who share similar ethnic or racial backgrounds. Outcomes include lower rates of all-cause and infant mortality, cancer, sexually transmitted infections, heart disease, obesity, diabetes, teen pregnancy, mental illness, suicide, as well as tobacco and alcohol use. This healthy immigrant phenomenon has been observed in the U.S, Canada, Australia, and Western European countries. This beneficial effect of immigrant status is surprising given that immigrants tend to have higher rates of poverty, lower levels of educational attainment, and less access to health care than the U.S. born. Immigrants often come from countries with lower standards of living than the U.S. which might predispose them to poor health and health altering exposures. However, in the U.S. and the other countries noted, this immigrant health advantage diminishes over time and with each successive generation.

The mechanism of this effect appears to be in the selection of immigrants. Immigrants have lower rates of chronic conditions, are less likely to smoke and have a healthier lifestyle than their native born counterparts. Immigrants must be heartier in order to survive the journey to a new land. In addition, it has been proposed that their may be a buffering effect of living in a community of other immigrants. Living in a community of that shares a common background may lead to stronger social networks which in turn lead to more promising health outcomes. The selection of robustness may not be deliberate on the part of the immigrant. Some hypothesize that the host country may have screening practices in place that turn away less healthy, would-be migrants. Thus, those allowed to enter may have superior health profiles.

Accuracy of Cause of Death Reporting

An additional methodological factor that may contribute to lower Hispanic stroke mortality involves data quality, specifically the accuracy of cause of death coding on the death certificate. The International Classification of Diseases, version 9 (ICD-9) and version 10 (ICD-10), may be too vague, leading to variability in diagnostic assessment.[75] The ICD-9 and ICD-10 codes both allow for diagnoses such as acute but ill-defined cerebrovascular disease (ICD-9 436), other and ill-defined cerebrovascular disease (ICD-9 437) and late effects of cerebrovascular disease (ICD-438). These diagnoses leave a great deal of room for interpretation.

The resulting diagnostic ambiguity may result in greater accuracy in diagnosis for death from an acute event (hemorrhagic or ischemic) relative to

diagnosis of more chronic effects of stroke (unspecified, other cerebrovascular disease and sequelae of stroke). Such generalization of cause of death may understate mortality from specific subtypes of stroke by lumping deaths into the general category. This ambiguity may be exacerbated by place of death. It has been shown that out of hospital stroke deaths are primarily due to the chronic effects of stroke rather than a specific acute subtype.[76, 77] The association of these unobserved deaths with ambiguous diagnoses suggests that deaths that occur outside of a care facility may not be accurately classified.

Misreport of Ethnicity On Death Certificate

Misreport of Hispanic ethnicity is another data quality issue which can influence mortality rates. Ethnicity on death certificates is usually assigned by the funeral director, which can introduce error.[78] Hispanics can be misidentified as non-Hispanics on death certificates leading to a biased mortality rate calculation.[72, 79, 80] Mortality rates are calculated by dividing the number of deaths for a given race/ethnicity by the census estimate of the number of people alive at the middle of the year in question. If Hispanics are under-reported on the death certificate, the corresponding mortality rate would be artificially suppressed. Investigators have estimated the extent of under ascertainment of Hispanic ethnicity on death certificates.

The 1980 Census was the first time that identification of Hispanic origin was used in the decennial census. Additionally, it was not until the late 1970's that a similar question appeared on death certificates. Initial analysis used the national longitudinal mortality study to assess accuracy of Hispanic ethnicity on

death certificates.[20] Examining a period from 1979 to 1985, Hispanic origin was found to be accurately coded on the death certificate in 89.7% of cases.

Subsequent to this early research, Arias and colleagues also assessed the impact of under reporting of Hispanic ethnicity on death certificates by linking the National Longitudinal Mortality Study (NLMS) to the Current Population Survey (CPS) which is linked to death certificates. In this way they were able to compare self-report of Hispanic ethnicity in the NLMS to death certificate classification. They found that foreign born Hispanics were very rarely misclassified (~2%), but US born Hispanics were estimated to be misclassified in 7% of cases.[81, 82] Thus, they adjust these rates by multiplying the numerators for foreign and US born Hispanics by 1.02 and 1.07 respectively.

Summary of Upcoming Chapters

Exploration of the three previously discussed explanatory factors for lower Hispanic stroke mortality follows in the next three chapters. In chapter 2 I explore the extent to which immigration selection effects might influence stroke incidence and post stroke mortality at older ages. To test the uniqueness of this effect in the Hispanic population I use a sample of older Mexican American living in five south western states taken from the Hispanic Established Populations for the Epidemiologic Study of the Elderly (EPESE) which is the longest running study of older Hispanics in the US. I contrast the Hispanic EPESES sample with a sample of European (primarily Italian) immigrants from the East Boston EPESE. This contrast will allow the examination of the healthy immigrant effect

on stroke outcomes in immigrants from two different world regions immigrating at two different periods of time.

In chapter 3 I recompile national mortality data for stroke. In so doing I stratify by immigrant status (a means of adjusting for place of birth) and apply the fore mentioned correction factors to adjust for misreport of Hispanic ethnicity on the death certificate. Additionally, I stratify by subtype of stroke (e.g., hemorrhagic, ischemic stroke, chronic effects) to compare presumably more accurate diagnoses with less accurate diagnoses. In chapter 4 I summarize the findings from the previous two chapters, discuss the relevance to healthcare, and suggest future directions of study.

Chapter 2: The Healthy Immigrant Effect on Stroke Incidence and Mortality in Two Immigrant Populations

Introduction

Advantageous stroke mortality for Hispanics may partially be explained by the presence or absence of risk factors. Compared to non-Hispanic Whites, Hispanics have lower prevalence of hypertension but are less likely to have it controlled. Hyper tension is strongly linked to stroke risk and mortality. However, Hispanics have higher prevalence of diabetes, which is also a risk factor for stroke and mortality.[83] Some researchers have argued that the more beneficial outcomes that Hispanics experience could be due in part to the large proportion of immigrants in the Hispanic population.[84-90]

Health Immigrant Effect

Research has shown that immigrants generally have more favorable health profiles and mortality rates compared to native-born individuals, as well as better health than those remaining in the country of origin. This effect is particularly pronounced for Hispanics in regards to all cause mortality, peri and post natal mortality, and mortality from common cancers. In regards to stroke, the data are somewhat less conclusive. Overall higher stroke mortality rates for all foreign born combined have been reported.[91] Conversely, an immigrant advantage for stroke has been observed with non-Hispanic Blacks, Japanese and Chinese Immigrants. The literature on this effect on stroke among Hispanics is limited. Some research suggests that differences in risk factors for stroke persist into older ages despite exposure to the host culture.

This study examines the effect of immigrant status on incident stroke and stroke mortality in two samples of older adults. In order to assess whether any such effect is unique to Hispanics, I analyze two samples from the Established Populations for Epidemiologic Studies of the Elderly (EPESE) that both have a large proportion of immigrants: Italian immigrants in East Boston EPESE and Mexican immigrants in the Hispanic EPESE. Because an immigrant advantage has been reported in other immigrant populations, I hypothesized that immigrant status would be associated with decreased risk of incident stroke and decreased mortality from stroke.

METHODS

Sample: East Boston EPESE

The East Boston EPESE (EB-EPESE) was collected as part of a larger multi-site study which examined East Boston, MA., Iowa and Washington counties, IA., New Haven, CT., and the Piedmont region of North Carolina.[92] The EPESE were originally designed as a prospective cohort study to measure death, chronic conditions, disabilities, and institutionalization among community dwelling elders. The study design included an in home baseline interview followed by repeat interviews every year. Factors tracked include disease, disability, institutionalization, hospitalization and mortality. East Boston is bordered on one side by Boston Logon airport and on the other by water. The population of East Boston at the time of the study was composed primarily of immigrants from Italy, as well as small numbers from Ireland, northern and central Europe. It was largely a blue-collar community, made up of low- and

middle-income working-class persons. All persons interviewed were non-Hispanic White.

Eligible individuals for this study were identified as part of a total community census performed concurrently with the baseline interview in 1982-1983. This census resulted in the identification of 4,562 East Boston residents 65 years of age or older, of which 3,812 (84 %) elected to participate. Following baseline data collection, six subsequent waves of follow-up interviews were collected from 1983-1993. Mortality was recorded from death certificates.

Sample: Hispanic EPESE

The Hispanic EPESE (H-EPESE)[93] is a representative sample of community-dwelling Mexican-American older adults, aged 65 years and older, residing in five southwestern: Arizona, California, Colorado, New Mexico, and Texas. However, unlike the previous EPESE surveys, which were conducted in restricted geographic areas, the Hispanic EPESE aimed at obtaining a representative sample of Mexican Americans across the southwestern region of the U.S. This study recruited 3,050 participants for the baseline interview in 1993-1994. Four subsequent waves of follow-up were performed between 1995 and 2003. Mortality was verified by death certificate lookup or reports from relatives.

I use three techniques to examine the effect of immigrant status on stroke mortality and stroke incidence. The first was simple Kaplan-Meier analysis examining survival time. Second, I performed Cox proportional hazard models to allow adjustment for covariates in the time to death models. Finally, I perform

discrete time hazard analyses to examine stroke incidence between waves of follow-up.

Censoring variable. The random variable was time to stroke death or time to stroke which was then censored by death due to other causes or end of study. Stroke was determined by the question: "Did your doctor ever tell you that you had a stroke?" Responses (Yes, No, Not sure, no response) are dichotomized into 1 (Yes) for those who responded with "yes" and 0 (No) for all others for whom there was data. In subsequent waves of data this question was phrased "Since the last time we spoke…had a stroke?" Mortality from stroke or other causes was determined by the ICD-9 codes listed as underlying cause of death on death certificate.

Primary predictor variable. Immigrant status is self reported in both datasets, and is derived from the question "Where were you born?" and was coded as 0 if immigrant and 1 if US-born.

Covariates. Socio-demographic variables included age at baseline, sex, marital status (married vs. not married, time varying), high school education. Co-morbid conditions, which included cancer, heart attack, hip fracture, hypertension and diabetes, were allowed to vary with time. Also included as time varying covariates were current smoking status, self-rated health (poor/ fair compared to good/ excellent) and Body Mass Index (BMI) using National Institutes of Health obesity standards (< 18.5, under weight;18.5-24.9, normal weight; 25-29.9, over weight; >=30, obese), count of Activities of Daily Living, and depressive symptoms (CESD score >=4).

Analyses

Initial Kaplan –Meier analyses were run to examine survival for all cause mortality as well as stroke mortality by nativity. Subsequent Cox proportional hazards models are run allowing for the control of covariates. Model 1 included only US born. Model 2 introduces baseline demographic measures: sex, age, years of education. Model 3 introduced health behavior measures: under weight, over weight, obese (normal weight as the referent) and smoking status. Model 4 adds health measures: self-rated health, depression, and limitations in Activities of Daily Living. Model 5 adds co-morbidities as time-varying covariates: hypertension, heart attack, cancer, and diabetes. Following the models, hazard ratios for the Hispanic and east Boston samples were compared using a Z test. Values greater than 1.96 indicate a significant difference between the samples.

Cox proportional hazard models are continuous time hazard models and require a specific event date. Because panel survey data use intervals to ascertain when an event occurred, discrete time hazard analyses are more appropriate. This technique uses quasi-maximum likelihood and allows for time-varying covariates. Discrete time hazard models were used to estimate the hazard ratio of incidence of stroke between waves.[94, 95] As with the Cox models, Model 1 included only US born. Model 2 introduces baseline demographic measures: sex, age, years of education. Model 3 introduced health behavior measures: under weight, over weight, obese (normal weight as the referent) and smoking status. Model 4 adds health measures: self-rated health, depression, and limitations in Activities of Daily Living. Model 5 adds co-

morbidities as time-varying covariates: hypertension, heart attack, cancer, and diabetes. Following the discrete time models, a Z test was performed to assess the difference between the East Boston and Hispanic samples. All analyses were repeated for the Hispanic and East Boston samples. The Hispanic data were weighted using probability weights. All analyses were performed using STATA 10 mp (StataCorp, 2008. Statistical Software: Release 10.mp. College Station, TX: Stata Corporation).

RESULTS

This analysis examined the relationship between immigrant status and stroke incidence and post stroke mortality in two contrasting samples of immigrant groups. Table 2.1 shows the baseline characteristics of the East Boston and the Hispanic EPESE samples. The East Boston sample consisted of 1229 immigrants and 2580 native born respondents. Chi square test showed significant differences existed between the foreign and US born on most measures. The Italian immigrant group was significantly older, had significantly more men, a significantly higher proportion were not married and had less education. Italian immigrants also were less obese (χ^2 20.33, $p<0.0001$) and less likely to smoke (χ^2 6.87, $p<0.009$). A small number of both groups were missing smoking status. There was no difference in self rated health or in reporting an existing health condition such as diabetes, hypertension, or stroke. However, US born Italian Americans were significantly more likely to report a heart attack or hip fracture.

The Hispanic EPESE population had 1344 immigrants and 1704 native born participants at baseline (table 2.1). Unlike the East Boston data, the Hispanic data show fewer significant differences (chi square) at baseline. The immigrant group was significantly older and significantly less likely to be married.

Table 2.1

Baseline Sample Characteristics for East Boston and Hispanic EPESE - %

	East Boston			Hispanic		
	Foreign Born n=1229	US Born n=2580		Mexico Born n=1344	US Born n=1704	
65-74	34.83	74.81	*	57.56	67.14	*
75-84	43.37	22.36	*	30.98	27.93	
85+	21.81	2.83	*	11.47	4.93	*
Female	59.48	63.14	*	57.04	58.27	
Married	45.87	54.98	*	53.09	57.39	*
Highschool or more	9.30	31.47	*	5.39	13.44	*
Currently Smoke	12.07	23.08	*	11.50	13.30	
Under Weight	19.04	7.13	*	2.32	1.60	
Normal Weight	5.21	7.40	*	29.05	28.19	
Over Weight	30.51	36.16	*	40.00	39.27	
Obese	15.22	21.40	*	28.63	30.94	
Depression	32.22	24.34	*	25.14	22.93	
Excellent	12.64	18.32	*	10.51	13.25	*
Good	39.90	43.37	*	27.08	28.05	
Fair	34.91	31.37	*	45.42	43.05	
Poor	12.55	6.94	*	16.99	15.65	
Diabetes	16.74	14.32		27.10	29.71	
Cancer	10.97	15.81	*	4.40	6.04	*
Hypertension	41.15	42.39		40.29	41.99	
Heart Attack	9.30	11.52	*	8.13	9.93	
Stroke	5.32	4.39		6.28	6.23	
Hip Fracture	4.91	3.19	*	4.19	2.70	*

*chi square significant : p≤0.05

Immigrants were similar to the US-born in the composition of females, BMI, smoking status, and most co-morbidities. The Mexican immigrants were less likely to report cancer, while US born Mexican Americans were less likely to report hip fracture.

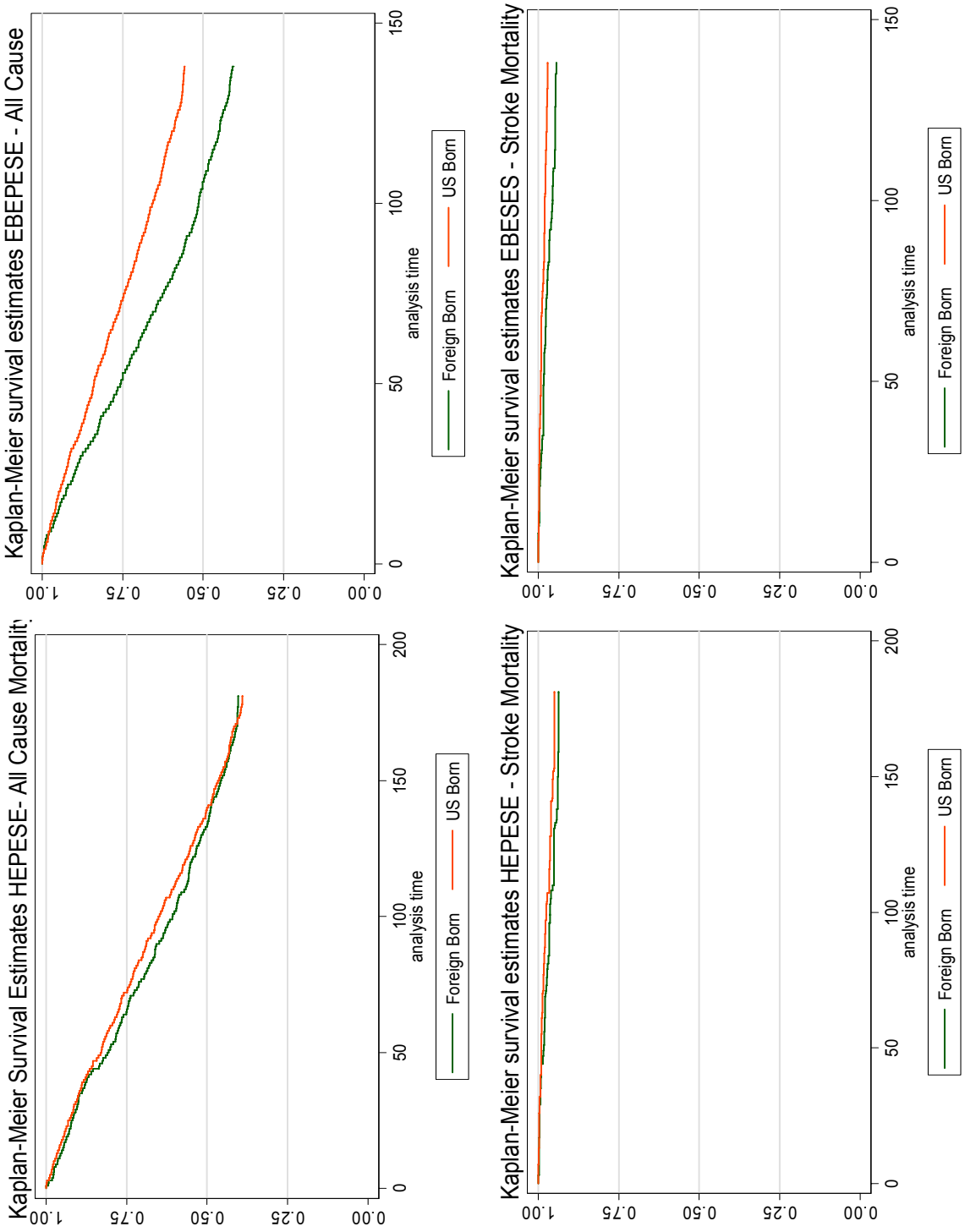


Figure 2. 1 - Kaplan-Meyer Survival Curves

Table 2.2

Cox Proportional Hazard Models Predicting the Hazard of Stroke Mortality
East Boston and Hispanic EPESE
Hazard Ratios (95% CI) and Z test

		East Boston	Hispanic	Z
Model 1:	usborn	0.50 (**0.34 - 0.74**)	0.75 (**0.45 - 1.24**)	1.98
Model 2:	Model 1 + Demographics	1.01 (**0.64 - 1.60**)	1.03 (**0.59 - 1.80**)	0.07
Model 3:	Model 2 + Health Behaviors	0.99 (**0.62 - 1.57**)	1.18 (**0.67 - 2.08**)	0.63
Model 4:	Model 3 + Health Indicators	1.14 (**0.71 - 1.85**)	1.12 (**0.63 - 2.01**)	-0.05
Model 5:	Model 4 + Comorbidities	1.22 (**0.75 - 2.00**)	1.12 (**0.62 - 2.01**)	-0.25

Note: demographics include age, female and high school ed.; Health behaviors include smoking and BMI; Health indicators include ADLs, Depression, Rated Health; Co-morbidities include hypertension, heart attack, stroke, diabetes and cancer.

Figure 2.1 displays the results of the Kaplan Meier survival analyses for all-cause mortality as well as stroke mortality. In the Hispanic sample very little difference is found for all cause mortality between the immigrant and US born. The East Boston sample shows a widening difference over time. The Kaplan-Meier curves for stroke mortality in both the Hispanic and East Boston data show only a small divergence over time.

Table 2.2 displays the results of the Cox proportional hazard models for stroke mortality. In the East Boston sample immigrant status is a significant predictor of stroke mortality before the inclusion of other covariates. After adding age, female and education to the model, immigrant status is no longer significant.

In each subsequent addition of covariates, the hazard ratio for immigrant status remains non-significant. Additionally, the magnitude of the hazard increases. Age, ADL limitations at baseline and diabetes are significant in the final model (HR 1.18, 95% CI 1.08-1.15; 1.15 95% CI 1.06-1.23; and 2.09, 95% CI 1.3-3.34 respectively).

The Hispanic sample shows no significant relationship between immigrant status and stroke mortality (table 2.2). The subsequent addition of covariates does not alter the role of immigrant status. The covariates also only show modest effect on the magnitude of the hazard ratio for immigrant status after the initial addition of demographics to the base model. Age and female sex are consistently significant across these models (HR 1.18, 95% CI 1.06-1.17 and 0.47, 95% CI 0.25-0.87 respectively). The *Z*-tests for differences between the

samples were less than 1.96 after adjustment for covariates. This indicates no significant differences between the hazard ratios for the two samples.

Table 2.3 presents the results of the discrete time hazard analyses of incident stroke. The first model shows the effect of nativity alone. In this model being US born is significantly associated with reduced hazard of incident stroke in east Boston but not in the Hispanic EPESE. With the addition of demographics -age, female and education - to the model, the significance of immigrant status disappears for the East Boston sample, and the magnitude of the odds decreases 16%. Immigrant status remains insignificant in the subsequent models for both samples. Additionally, the magnitude of the odds for immigrant effect shows little change in the subsequent models. In the final model, age, ADL limitations and current smoking are significant predictors of incident stroke. In the East Boston models, smoking status was associated with a 55% increase in the odds of stroke while ALD limitations were associated with a 35% increase in hazard of stroke between waves.

In the final model for the Hispanic sample, sex, education, smoking, ADL limitations, hypertension, and heart attack were all significantly associated with incident stroke. High school education, smoking, and ADL limitations were associated with increased odds of stroke. Female sex, hypertension and heart attack were associated with decreased odds of incident stroke. The Z-test showed no difference between the hazards ratio for immigrant status between the two samples.

Table 2.3

Discrete Time Hazard Models Prediciting Hazard of Stroke Between Waves East Boston and Hispanic EPESE Hazard Ratios (95% CI) and Z test

		East Boston	Hispanic	Z
Model 1:	usborn	**0.65** (0.47 - 0.89)	**1.12** (0.82 - 1.53)	1.96
Model 2:	Model 1 + Demographics	**0.81** (0.54 - 1.21)	**1.23** (0.90 - 1.69)	1.37
Model 3:	Model 2 + Health Behaviors	**0.78** (0.52 - 1.17)	**1.19** (0.86 - 1.64)	1.34
Model 4:	Model 3 + Health Indicators	**0.79** (0.52 - 1.19)	**1.19** (0.85 - 1.67)	1.27
Model 5:	Model 4 + Comorbidities	**0.80** (0.53 - 1.19)	**1.18** (0.83 - 1.66)	1.19

Note: demographics include age, female and high school ed.; Health behaviors include smoking and BMI; Health indicators include ADLs, Depression, Rated Health; Co-morbidities include hypertension, heart attack, stroke, diabetes and cancer.

Discussion

I examined the extent to which immigrant status may contribute to the report of beneficial outcomes for Hispanics following stroke. Additionally, I examine the uniqueness of any effect to Mexican Americans by also using Italian immigrants. Kaplan-Meier estimates, Cox models, and discrete time hazard analyses were estimated. The results of the Kaplan-Meier suggest different effects for immigrants in these two samples. For all cause mortality, virtually no difference is found in the Hispanic sample between the Mexican and US born. The East Boston sample shows a decrease in survival for the Italian immigrants over time. The Kaplan-Meier estimates for stroke mortality show very small differences in both samples. The immigrants in both samples appear to have lower survival, albeit a very small difference.

To assess the impact of covariates on survival, Cox proportional hazard analyses were performed. In the Cox models for East Boston an effect of migrant status emerges initially but in the opposite direction expected. However, this effect is mitigated by the addition of demographics and the other covariates. In the Hispanic EPESE, no significant contribution of migrant status is found in regards to stroke mortality. In both samples, the addition of other covariates did little to change the magnitude of the stroke hazard associated with immigrant status. This suggests that whatever the effect of immigrant status may have on survival is not acting through the other co-morbidities.

In examining the role of immigrant status in stroke incidence, discrete time hazard analyses were performed. These analyses showed an initial effect of

nativity in the East Boston sample but not in the Hispanic sample. In the East Boston sample, immigrant status is significant only until the addition of demographics.

The persistent and strong effect of age in the Cox models and discrete time models for both the Hispanic and East Boston samples is not surprising. Increased age is associated with an increased risk of stroke and stroke mortality. The effect of age on migrants in the East Boston data for both stroke mortality and incidence suggests that the differences in the age structures in the foreign and native born population potentiates the differences in outcomes. This appears to be supported by the baseline comparison of age where Italian immigrants in East Boston are significantly more likely to be older than the native born. This increase in age in turn possibly puts them at increased risk for stroke and stroke mortality.

There is little to suggest a Healthy Immigrant effect in the Hispanic sample except for significant differences in some baseline characteristics. The effect of age in Cox models is expected as age is independently associated with stroke mortality. The effect of age in the incidences models is completely mitigated by ADL limitations. This is not surprising as an increase in ADL limitation is associated both with age and presence of stroke. The differences between the East Boston and Hispanic sample samples may be seen also as differences in the underlying age structure. While the Mexican immigrants in the Hispanic sample were slightly more likely to be 85+, they were just as likely to be between 75 and 84 years. The Italian immigrants in the East Boston sample were much

more skewed towards the older age groups. It is plausible that the benefit of nativity is really a benefit of youth.

These findings fit in with those of other studies where the positive effect of immigrant status appears to be tempered with duration of stay in the host country. The average length of time since immigration for the Italian immigrants in East Boston was 55 years. The average length of time since immigration for the Mexican immigrants was 40 years. Such long duration of stay provides ample opportunity for the immigrants to assimilate into the host population, adopting unhealthy habits along the way. The lack of a significant immigrant effect in the older EPESE samples lends support to this. However, the age structure differences between the native and foreign born in both the East Boston and Hispanic samples imply that there is an effect of nativity – they are on average older at the start of both studies.

Limitations

One limitation of this study is the use of self-reported health data. However, other studies have shown a high correlation between reported health measures and conditions and actually clinical measures. Additionally, recent research suggests that self report of stroke is a good indicator of clinical stroke.[96] A second limitation is missing data for two of the measures: BMI and self-reported health. Neither measure shows significance in the models. Additionally, models were run with and without the measures showing no change in the relationship of nativity. A third limitation is loss due to follow-up. This was handled in two ways. First, mortality was confirmed using the NDI and death

certificate searches. Second, time to event analyses were used which allows individuals to contribute to the risk pool only during the intervals that they were under study.

Conclusion

This study examined the Healthy Immigrant effect on stroke mortality and incidence as a potential explanatory factor for the beneficial stroke mortality that have been reported for Hispanics. In addition, I examined the extent to which a similar effect occurs in an immigrant population with different history. I found no significant, direct relationship between nativity and either stroke incidence or mortality. Thus, the beneficial stroke outcomes reported for Hispanics is unlikely due directly to immigrant status. Additionally, the effect of immigrant status appears to be the same in two different immigrant groups. However, the significant differences in the age structure of the native and foreign born suggest a subtle selection effect whereby immigrants survive to older ages before being included in these two distinct samples.

Chapter 3: Lower Stroke Mortality Among Hispanics -- An Exploration of Potential Methodological Confounders

Introduction

Despite declines in stroke mortality over the previous decades, it remained the third leading cause of death in 2002.[63, 97-99] Studies have shown significant differences in mortality among different racial/ethnic groups. Hispanics have lower rates of stroke mortality, particularly at older ages.[63, 65, 66] This lower mortality from stroke is surprising, given that Hispanics occupy a lower socioeconomic position and more risk factors for stroke than non-Hispanic Whites. Lower socioeconomic position is associated with increased mortality from stroke.[100-102] This Hispanic mortality advantage may be the result of confounding factors (e.g., immigrants status, data error, social ties) and thus not entirely accurate.[73] The current study presents an examination of potential methodological explanations for the findings of lower stroke mortality in Hispanics.

As discussed previously, one potential contributor to lower Hispanic stroke morality is immigrant status. In all race/ethnic groups the foreign born have markedly lower rates of all cause mortality than those born in the United States.[103] Foreign born Hispanics have been shown to have significantly lower mortality rates due to circulatory causes (including but not limited to stroke) than their US born counter parts and non-Hispanic Whites.[104, 105] Nearly 40% of Hispanics in the United States are foreign born.[106] Thus, the lower stroke

mortality in Hispanics in the United States may be attributable to this “Healthy Immigrant” effect.

Two additional methodological factors that may contribute to lower Hispanic stroke mortality involve data quality. The first of these is accuracy of cause of death coding on the death certificate. The International Classification of Diseases, version 9 (ICD-9) and version 10 (ICD-10), may be too vague, leading to variability in diagnostic assessment.[75] For example, ICD-9 code 437 is used for “Other and ill-defined cerebrovascular disease.” Such a category could be used to lump many poorly diagnosed strokes together. Additionally, place of death may influence the reporting of underlying cause of death. Non-specific stroke types have been found to be associated with deaths that occur outside of hospital.[76, 77] The association of these unobserved deaths with ambiguous diagnoses suggests that deaths that occur outside of a care facility may not be accurately classified.

The second data quality issue is misreport of Hispanic ethnicity on death certificates. Hispanics can be misidentified as non-Hispanics on death certificates leading to a biased mortality rate calculation. [72, 78-80] The first study to suggest a means of correcting this oversight looked at California mortality data linked to survey data. Thus, they were able to compare the self-ascribed ethnicity of the decedent to the designation given on the death certificate. [24] These investigators have estimated the extent of under ascertainment of Hispanic ethnicity on death certificates and found that foreign born Hispanics were very rarely misclassified (~2%), but US born Hispanics were

estimated to be misclassified in 7% of cases. Subsequently, Arias and colleagues applied this method to national all cause mortality data.[81, 82]

The current study examines national vital statistic data combined with census estimates in order to calculate age-adjusted stroke mortality rates for foreign and US born Hispanics, correcting for misreport of ethnicity on death certificate. These rates are then compared to those for non-Hispanic Whites. These rates are then examined by subtype of stroke, focusing on deaths from acute stroke vs. deaths from chronic effects of stroke. I hypothesized that, after correction for under-ascertainment of Hispanic ethnicity, US born Hispanics would not have lower rates of stroke mortality than non-Hispanic Whites from acute stroke. I also expected that dying outside of a care facility would alter the likelihood of acute cause of death classification for Hispanics.

Data and Methods

Multiple cause-of-death mortality data from the National Vital Statistics System of the National Center for Health Statistics were used for deaths occurring within the United States for the years 1989-1991 and 1999-2002. International Classification of Diseases versions 9 and 10 (ICD-9 and ICD-10) were used for 1989-1991 and 1999-2002 respectively due to coding changes on death certificates. All records with an underlying cause of death classified as stroke were included, and grouped into two general categories: acute and chronic. These categories were further broken into subtypes. The acute category consisted of subarachnoid hemorrhage (ICD-9 codes 430, ICD-10 codes I60), intra-cerebral/intra-cranial hemorrhage (ICD-9 code 432, ICD-10

codes I61-I62), and acute ischemic stroke (ICD-9 codes 433-434, ICD-10 code I63). The chronic category consisted of stroke – Other and ill-defined cerebrovascular disease (ICD-9 code 437, ICD-10 code I64), and late effects of cerebrovascular disease (ICD-9 code 438, ICD-10 code I69). Transient ischemic attack (ICD-9 code 435, ICD-10 code G45) was not included in these analyses as it is not considered a stroke. These data were pooled to generate numerators by 5-year age groups, gender, race/ethnicity, and nativity for the time period around 1990 (1989-1991; n = 432,722) and 2000 (1999-2002; n = 662,121). Race/Ethnicity was defined as non-Hispanic White, foreign born Hispanic and US born Hispanic. Hispanic race/ethnicity was defined as having Hispanic ethnicity regardless of race category. Missing data on death certificates for age (<0.01%), Hispanic origin (~1.9%), and place of birth (~0.6%) were imputed using the hotdeck procedure in STATA version 9. The numerators were aggregated into four groups: all Hispanics combined, foreign born Hispanics, US born Hispanics and non-Hispanic Whites. The numerators for the foreign and US born Hispanics were then directly corrected for death certificate undercount by multiplying the number of deaths by 1.02 and 1.07 respectively as described in chapter 1.

The denominators were compiled from the Integrated Public Use Microdata Series (IPUMS) 5% samples for 1990 and 2000 combined with bridged-race population estimates from the National Center for Health Statistics (NCHS) for the years 1989-1991 and 1999-2002. The IPUMS data were used to develop a ratio for the percent foreign/US born in a given gender, ethnicity, and age group. This ratio was then used as a multiplier with the census estimates to

create denominators for both the foreign and US born Hispanics for each gender, ethnicity, and age group.

The numerators and denominators for the 1989-1991 and 1999-2002 were pooled to yield more robust estimates for each stroke subtype. The resulting crude stroke mortality rates were age adjusted using the direct method with the year 2000 US standard million population, and 95% confidence intervals were calculated. To estimate the overall excess stroke mortality among foreign and US born Hispanics, rate ratios were calculated for foreign and US born Hispanics using non-Hispanic Whites as the referent group. A contingency table was constructed by multiplying the rate for non-Hispanic Whites by the US born Hispanic population resulting in an expected number of deaths for Hispanics. The expected deaths and observed deaths were then analyzed in poisson regression stratified by sex. Covariates in the model were age group and acute stroke compared to other underlying cause. Death outside of a care facility was then added and differences in coefficient for acute stroke were compared to determine the impact of dying outside of an institution on acute diagnosis.

Results

Table 3.1 shows the effect of nativity and ethnicity misclassification on age-adjusted stroke mortality rates for Hispanics and non-Hispanic Whites. Data for both 1990 and 2000 are presented. Adjustment for misreport of Hispanic ethnicity on death certificates resulted in a small increase in the mortality rate for foreign born Hispanics. Adjusting for ethnicity misclassification resulted in an

Table 3. 1 - Age Adjusted Stroke Mortality

Age Adjusted* Stroke Mortality (/100 000) for 1990 and 2000
by Sex, Ethnicity, and Hispanic Nativity
with Correction for Hispanics Misreport on Death Certificate**

			Men				Women			
			Rate	95% CI	**Rate - Corrected**	95% CI	**Rate**	95% CI	**Rate- Corrected**	95% CI
1990	Hispanics		**49.94**	(48.65 - 51.23)			**43.41**	(42.37 - 44.45)		
		Foreign Born	**45.86**	(44.27 - 47.45)	**46.78**	(45.17 - 48.39)	**40.93**	(39.65 - 42.21)	**41.75**	(40.46 - 43.04)
		US Born	**56.57**	(54.37 - 58.77)	**60.53**	(58.26 - 62.80)	**47.37**	(45.59 - 49.15)	**50.69**	(48.85 - 52.53)
	Non-Hispanic Whites		**66.39**	(66.04 - 66.74)			**60.07**	(59.82 - 60.32)		
2000	Hispanics		**46.04**	(45.19 - 46.89)			**38.53**	(37.86 - 39.20)		
		Foreign Born	**43.34**	(42.28 - 44.40)	**44.21**	(43.14 - 43.14)	**36.64**	(35.81 - 37.47)	**37.37**	(36.54 - 36.54)
		US Born	**49.85**	(48.45 - 51.25)	**53.34**	(54.79 - 54.80)	**41.39**	(40.27 - 42.51)	**44.28**	(43.12 - 45.44)
	Non-Hispanic Whites		**54.71**	(54.47 - 54.95)			**52.76**	(52.58 - 52.94)		

*age adjusted using the 2000 US standard million; ** nummerators adjusted 2% for foreign born, 7% for US born

increase of greater magnitude for US born Hispanics than for the foreign born. Although the gap between Hispanics and non-Hispanic White rates narrowed, both foreign and US born Hispanic women still had substantially lower mortality rates, 29% and 15% lower respectively, in 2000. A similar pattern is found in the data for 1990 where corrected foreign born Hispanic female rate was 31% lower, and the US born Hispanic rate was 17% lower than that for non-Hispanic Whites. US born Hispanic men were not different from non-Hispanic Whites after adjustment for nativity and misreport of ethnicity on death certificates. Foreign born Hispanic men had rates 18% lower that non-Hispanic Whites in 2000.

Table 3.2 presents age adjusted stroke mortality rate ratios (non-Hispanic Whites as reference group) by sex and stroke subtype adjusting for nativity and misreport of ethnicity on death certificates. For ischemic stroke, ill defined stroke, and late effects of stroke, foreign born Hispanics had lower rates than

Table 3. 2 - Age Adjusted Stroke Mortality by Subtype

Age Adjusted Stroke Mortality Rate Ratios
Comparing Corrected Hispanic Rates to non-Hispanic White Rates
by Sex, Nativity and Stroke Subtype
United States, 1999-2002

	Men		Women	
	Foreign Born	US Born	Foreign Born	US Born
All Strokes	0.81	0.98	0.71	0.84
Acute Stroke	0.96	1.07	0.88	1.01
Subarachnoid Hemorrhage	1.31	1.29	1.29	1.28
Intracranial Hemorrhage	1.04	1.17	0.89	1.06
Ischemic	0.69	0.82	0.62	0.77
Chronic Effects	0.74	0.93	0.64	0.77
Other and Ill Defined Stroke	0.75	0.89	0.64	0.75
Late Effects of Stroke	0.73	1.10	0.65	0.88

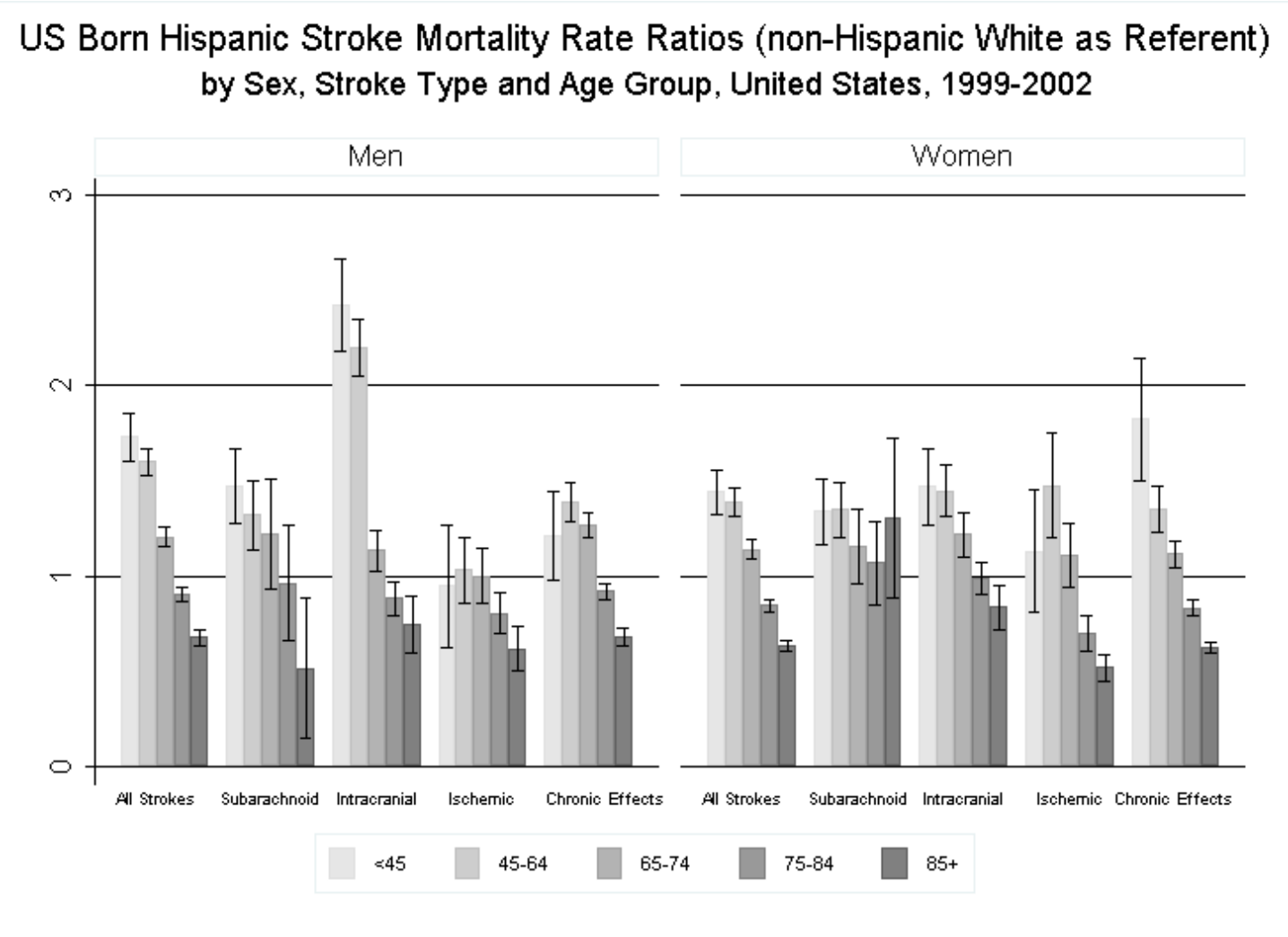


Figure 3. 1 Stroke mortality rate ratios by stroke type and sex, 95% confidence intervals

both non-Hispanic Whites and US born Hispanics. However, foreign born Hispanic men and women had higher rates of subarachnoid hemorrhage than non-Hispanic Whites and US born Hispanics. A similar pattern emerges in the case of US born Hispanics compared to non-Hispanic Whites. Rates for ischemic stroke, ill defined stroke, and late effects of stroke are lower for US born Hispanic women than the foreign born. In US born Hispanic men the rates are lower only for ischemic stroke and ill defined stroke. Rates for subarachnoid hemorrhage are much higher for US born Hispanic men and women than for non-Hispanic Whites.

Figure 3.1 shows US born stroke mortality by sex, age group, and stroke subtype adjusting for ethnicity misreport on death certificates. This figure compares non-Hispanic White and Hispanic rates for five age groupings: those 45 and younger, 45 to 64, 65-74, 75-84 and 85 and older. This comparison reveals higher rates of stroke mortality in US born Hispanic men and women at younger ages for most subtypes of stroke, the exception being ischemic stroke. These comparisons also show a mortality cross over which occurs around the age of 75 for US born Hispanics for most subtypes of stroke. The only exception to this cross over is in the rate of subarachnoid hemorrhage for US born Hispanic women.

Examination of place of death revealed that 87% of both US born Hispanics and non-Hispanic Whites died in an institution. 71% of US born Hispanic men died in a hospital compared 17 % who died in a nursing facility. For non-Hispanic White men, 60% died in a hospital versus 28% in a nursing

facility. 66% of US born Hispanic women died in a hospital compared to 21% who died in a nursing facility. For non-Hispanic White women, 48% died in a hospital while 40% died in a nursing facility. Log linear analysis of contingency tables comparing non-Hispanic Whites to US born Hispanics showed little change in the coefficient for acute stroke as underlying cause of death (β=-4.16, 95% CI -4.19,-3.79) after accounting for place of death outside of an institution (β=-3.99, 95% CI -4.23,-3.75).

Discussion

This study explored the degree to which the relatively lower stroke mortality of Hispanics compared to non-Hispanic Whites is explained by inaccuracies introduced through omission of nativity, imprecise measurement of cause of death and under-ascertainment of Hispanic ethnicity. These factors were examined by adjusting mortality rates for both misclassification of Hispanic ethnicity on death certificates and foreign versus US place of birth. Imprecision was examined through the calculation of rates for subtypes of stroke and comparison of place of death.

The over all rate of stroke mortality for Hispanic women remained lower than that for non-Hispanic White women after adjustment for nativity and misreport of Hispanic ethnicity. The lower stroke mortality for US born Hispanic men disappears after adjustment for nativity and misreport. Examination of death from subtype of stroke reveals a different pattern. Hispanic men and women have a higher rate of mortality from subarachnoid hemorrhage than do non-Hispanic Whites. In contrast, Hispanic men and women have lower

mortality rates from ischemic and chronic effects of stroke than do non-Hispanic Whites. Hispanics have greater odds of dying outside of an institution than non-Hispanic Whites. Additionally, when the place of death is not an institution the odds are more than three times higher for an underlying cause of death diagnosis to be chronic effects of stroke as opposed to acute stroke.

The clear mortality advantage for the foreign born Hispanics supports the notion of a Healthy Immigrant effect within the Hispanic population. This relative health advantage of the foreign born suggests that immigrants are selected to be healthier than the native born.

The majority of stroke deaths occurred in the chronic effects of stroke category. This has been noted previously by the CDC.[76, 77] Such a lack of specificity draws into question the accuracy of rates for those subtypes. Almost all of the stroke mortality advantage for Hispanics lay in the chronic category: other and ill defined stroke and late effects of stroke. These chronic effects leave a great deal of room for interpretation and correspondingly misinterpretation, and thus more prone to erroneous report. In contrast, diagnosis of more acute events is likely more accurate.

The association of place of death and acute versus chronic stratum was anticipated, as patients who die in an institution are more likely to receive a more accurate underlying cause of death diagnosis than those who die elsewhere. As such, rates derived from death in hospital are assumed to be more accurate. Out of hospital deaths, in contrast, receive more vague diagnoses which in turn lead to more questionable mortality rates. This study found higher rates of out of

health care facility mortality for Hispanics compared to non-Hispanic Whites which is consistent with other research.[107] However, adjusting for death outside of a health care facility resulted in no changes in the coefficients for acute stroke as underlying cause of death.

When acute subtypes of stroke are examined, Hispanics are more likely to die from subarachnoid hemorrhage than non-Hispanic Whites. Additionally, Hispanics are less likely to die from ischemic stroke. These findings are consistent with other studies.[97, 98] This difference in mortality is indicative of differences in the etiology of the underlying disease process for Hispanics and non-Hispanics Whites. While the prevalence of hypertension appear to be slightly lower in Hispanics compared to non-Hispanic Whites (25% and 27% respectively), Hispanics are less likely than Whites to be aware of their condition and significantly less likely to be under treatment or to have their condition under control.[108] It may be the lack of treatment and control of hypertension that contributes to their higher risk for this type of stroke.

Although the overall stroke mortality rate for US born Hispanic men is no different than that for non-Hispanic Whites, this rate is still lower than might be expected given their socioeconomic status. This advantage has been previously observed and called the *Hispanic Paradox*.[1] Several studies have suggested that this paradox is due either to ethnicity misclassification (and thus miscounting) of Hispanics or the contribution of healthy immigrants.[12, 73, 109] The current study supports the supposition that these factors explain part, but not all, of the stroke mortality advantage for Hispanics in the US.

Limitations

There are several limitations to this study. One limitation is the misreporting of age on death certificates, especially at older ages. Misstatement of age biases mortality estimates downward. Studies have found this to be true for non-Hispanic Blacks and non- Hispanic Whites.[71, 110-112] The extent to which this is an issue with Hispanics is not as well established. In this study, however, we pooled data for ages greater than 85 years which should minimize any biases.

Another potential limitation of this study is the complete misreport of underlying cause of death. As previously discussed, the internal vagaries introduced are problematic at the level of stroke subtype mortality estimation. However, these data cannot tell us the extent to which stroke attributable deaths are completely misclassified as another underlying cause. However, it is plausible that more accurate underlying cause of death diagnoses occur for those who die in institutions as opposed to outside of institutions.

Another limitation is in the heterogeneity of country of origin of the Hispanic population. There is evidence to suggest that different sub populations of Hispanics have different risk profiles and thus different patterns of mortality. Unfortunately there is no way to discern the origins of the US born population in vital statistics data (i.e., origins in Mexico, Puerto Rico, Cuba). Only the foreign born have indicators of origin country on their death certificates. Sub-type of

Hispanic origin could be assumed based on regional population estimates. For example, Hispanics of Mexican origin live primarily in the south west of the US, while Florida is the home to many Cubans, and the north east to many Caribbean Hispanics. The major drawback of this method is acquiring accurate denominator estimate from census data by Hispanic subgroup.

Due to the limitations imposed by the misreport of race/ethnicity in vital registration data, researchers have examined data from large, nationally representative survey samples, such as the National Health Interview Survey (NHIS) and the National Mortality Follow-up Survey (NLMS), and then link them to the National Death Index (NDI).[65, 73, 85, 86, 105, 113] The chief advantage of this approach is that race/ethnicity is self-reported, and thus not susceptible to the biases of a third party. However, these studies are limited in several ways. The nature of these samples results in very small numbers when examining cause-specific mortality along with sex, race/ethnicity and nativity, resulting in very broad confidence intervals for rate estimates. Additionally, these studies rely on linkage to the NDI, a linkage that has been questioned in regards to Hispanic immigrants.[12] The NDI has no facility to track return migrants whose death outside the United States would lead to understated mortality rates. In contrast to these studies, we examined vital statistics data directly and apply a correction for misreport of Hispanic ethnicity. The advantage of this process is that rates are based on the actual population at the time of the measure and thus less susceptible to return migration bias.

Conclusions

Misreport of Hispanic ethnicity on death certificates contributes to the perceived Hispanic stroke mortality advantage, more so for US born Hispanics than for the foreign born. When adjusted for misclassification the lower stroke mortality for Hispanic men disappears. Additionally, Hispanic men and women have higher rates of mortality attributed to subarachnoid hemorrhage than do non-Hispanic Whites. Part of the previously reported advantage is a combination of imprecise measurement and data quality. However, after accounting for these factors, an advantage still remains for Hispanic women.

Additionally, the high rates of stroke mortality for Hispanics at younger ages highlight an area of public health deserving of attention. More effort should be made to educate this segment of the population about the manageable risk factors as well as the warning signs of stroke to reduce stroke incidence and stroke mortality.

Chapter 4: Discussion

Overview

The apparent mortality advantage for Hispanics, termed the *Hispanic Paradox,* was first reported over 20 years ago.[1] In a review of the literature 20 years since, Franzini and colleagues conclude that the beneficial mortality profile is largely observed in infants and older adults.[12] they also conclude that the cause of this advantage is largely unknown. In another review Markides and Eschbach find consistent support in the literature for the mortality advantage but not for health status.[14] This finding that Hispanics do not consistently report better health but rather worse health is important because poor reported health is associated with increased mortality. However, despite this lower reported health status Hispanics have lower mortality rate. Lower stroke mortality rates have been reported for Hispanics in several studies. [12, 20, 31, 85]

Studies that have sought clarity in the complex relationship between the various explanatory factors have focused primarily on all cause mortality. Studies that have focused on stroke have done little to assess the impact of the many competing explanatory factors. We examined a small piece of the puzzle by looking at the contribution of the healthy migrant effect, misreport of ethnicity (data quality), and the vagaries introduced by cause of death coding (data quality).

Contribution of Healthy Immigrant Effect

Lower mortality patterns for immigrants compared to the US born have been found consistently in the literature.[84-86, 88-90, 103, 105, 114] This has

been termed the healthy immigrant effect. The healthy immigrant effect is apparent in the relatively better health of those who immigrate than those who stay in the origin country. It has also been observed that this effect diminishes over time as the immigrant becomes more acculturated to the host country. We assessed the impact of migrant status on stroke mortality using two different data sources (Chapter 2). The survey samples used both had a high proportion of immigrants: the Hispanic Established Population of the Epidemiologic Study of the Elderly which included immigrant Mexican Americans, and the East Boston Established population for the Epidemiologic Study of the Elderly which included immigrant Italian Americans. Significant differences in base line characteristics were found. In both samples immigrants were likely to be older, less educated, in poorer health, and to have had a hip fracture – all factors that would suggest higher risk of mortality in follow-up. The subsequent survival analyses revealed no significant relationship between immigrant status and stroke mortality or incident stroke after accounting for covariates.

This finding is somewhat in contrast to the mortality data reported in the literature where the foreign born have a stroke mortality advantage. This may be due to the nature of the data used and the inclusion of covariates in the survival analysis not usually used with mortality data. For example, compilation of mortality rates occasionally uses immigrant status as a stratum but rarely if ever also stratifies/controls for health conditions, behaviors, and health status.

The chief benefit of immigrant status appears to be surviving to older ages but doing so while in worse health. However, while there is no statistically

significant effect of immigrant status in the survival analyses, the lack of variation in the hazard ratio associated with immigrants suggests that there may still be an effect. If migrant status were explained by the covariates we would expect the ratio to move closer to 1.0. It does not. This suggests that either the models do not include enough covariates so as to explain the immigrant effect, or the immigrant effect is real – just not significant.

Finding the hazard ratios for the incident stroke data to be in different directions for Italian immigrants compared to Mexican immigrant may reflect profound differences in these two samples. The average time in the US for Italian immigrants was 55 years, placing average immigration to around 1927. These immigrants would then live through the great depression and the second World War. During the Great Depression and World War II, the US experienced a tremendous drop in immigration.

The Italian immigrants might have been escaping poor social, economic and health conditions in Italy. Such may be reflected in the lower hazard for incident stroke for the US born who may have benefited from the relative stability of US society. During the depression and war years these Italian immigrants would be competing with more established US born Italian Americans for resources such as food, employment and housing. Additionally, most of those in the East Boston sample were children when they immigrated. As such, hardships of the great depression and the war might have had greater consequences on their subsequent health. The cumulative effect of hardships during childhood has been proposed as major contributors to mortality and

morbidity in later life.[115-117] Individuals who have endured such hardships may be at greater risk for developing limitations of Activities of Daily Living (e.g., walking, eating dressing) or Instrumental Activities of Daily Living (e.g., shopping or cooking), as well as risk of depression and lower self-reported health status.

In contrast to the Italian Immigrants, the Mexican immigrants would have arrived in the US on average in the 1950's, during a period of relative prosperity. Additionally, the porous border between the US and Mexico may have made it easier to immigrate from Mexico or Central America. This relative ease of transit might have allowed individuals to immigrate who otherwise would not have survived the journey and who might not otherwise have been any healthier than those who remained behind. This lack of an effect of immigrant status in the Mexican immigrants is consistent with other research which has found that for this group there is little evidence to suggest that those who immigrate are any healthier than those who do not.[90]

What can not be ascertainedl from these data is whether or not the immigrants, either Italian or Mexican, were healthier than their US born counterparts when they immigrated. If they were healthier, any such benefit has dissipated with their duration of residence in the US. This fits in with findings from other studies which show that duration of residence for immigrants is related to worse health outcomes.[118-124] Immigrants are more likely are to become acculturated as time since immigration increases, adopting unhealthy behaviors and lifestyles common in the host country. The results of this adoption can lead to a health risk profile similar to or even worse than the native born.

Impact of data quality

Mortality rates are only as accurate as the counts in the numerator and denominator. Misreport of Hispanic ethnicity on death certificates undercounts Hispanics and thus artificially reduces mortality estimates for stroke. Additionally, diagnoses that are vague or too general can lead to misclassification of cause of death. In Chapter 4 I stratified by specific diagnoses (i.e., Ischemic, subarachnoid and intracerebral hemorrhage), immigrant status and then adjusted the Hispanic numerators for the proposed misreport of ethnicity.

The results of this study show that there is a Hispanic stroke mortality advantage only at older ages. At younger ages (<65 years) there is a pronounced and significant disadvantage for both men and women. This cross over is similar to that reported for non-Hispanic Blacks. Even after stratifying by immigrant status, sex, and stroke type, Hispanics have lower stroke mortality at older ages.

In the final stratified rates, many of the confidence intervals contained 1 showing no difference between Hispanics and non-Hispanic Whites. It is important to note that just because Hispanic mortality rates are no longer lower than non-Hispanic Whites, there still is evidence for the Hispanic Paradox. Given their socioeconomic status, Hispanics should have *higher* mortality rates from stroke. Thus, rates that are the same as non-Hispanic Whites are still paradoxical.

The reasons for the mortality advantage at older ages may be a selection effect. Hispanics who survive to older ages may simply be less susceptible to

stroke mortality compared to some other cause of death. Those most at risk, US born Hispanic males, are dying at younger ages. Thus, they cannot be part of the risk pool in the older population.

One issue that arises when examining Hispanic stroke mortality is the relative heterogeneity of the Hispanic population. Vital statistics data are inadequate by themselves to generate numerators for subgroups of Hispanics unless they were foreign born. However, studies that have looked at Mexican Hispanics and Caribbean Hispanics specifically have found that stroke incidence and mortality is similar between these two groups.[30, 32, 125]

The striking higher rates of stroke mortality for Hispanics at younger ages should prompt health care officials to target interventions to these younger age groups. Increased awareness of risk factors and methods of mitigating them would likely decrease the incidence of stroke in these age groups. Additionally, greater knowledge of the symptoms of a stroke will improve detection and decrease delay seeking health care interventions.

Significance and Future Direction

Debate surrounding the Hispanic Paradox for the last two decades is far from settled. Recent research has found sufficient evidence so as to question whether this beneficial mortality extends to all Hispanic sub-groups.[13, 73] However, the majority of research on the subject has found health advantages for Hispanics, particularly in regards to mortality. The competing explanatory theories paint a complex picture combining age, gender, Hispanic sub-group,

immigrant status, and social conditions. Despite the myriad theories, the causes of the Hispanic paradox remain obfuscated.

This dissertation used multiple data sources to examine lower Hispanic stroke mortality compared to non-Hispanic Whites. The principle findings of this research suggest that the lower stroke mortality of Hispanics may partially be due to the Healthy Immigrant effect, accuracy of cause of death reporting and misreport of ethnicity on death certificates. However, these factors do not tell the whole story. The general beneficial rate of stroke mortality in Hispanics at older ages may reflect a selection bias – premature mortality at younger ages has removed those at highest risk from the risk pool. However, this does not explain why older Hispanics who have higher rates of diabetes and incident stroke compared to non-Hispanic Whites, have lower rates of stroke mortality.

There are a couple of points that bear reflection regarding this examination of the Hispanic Paradox. First, this work did not explore the extent to which the Hispanic Paradox might have a social component that is unique to Hispanics. Franzini and colleagues suggest that social origins are likely.[12] However, they stress that as Hispanics become more acculturated some of this social benefit will erode, implying a sense of urgency to capture those cultural factors. Certainly studies such as the Hispanic EPESE could help shed light on these socio-cultural factors, but these are representative only of Mexican American living in the southwestern US. There is no useful comparison sample.

Second, the comparison group in this thesis has been non-Hispanic Whites. This is the most common comparison made. However, Markides and

Eschbach point out that the more appropriate comparison might be with non-Hispanic Blacks who share similar socioeconomic characteristic but have very different mortality outcomes.[14] Future research investigating the Hispanic Paradox should consider opportunities to examine the differences in social characteristics between Hispanics and non-Hispanic Blacks as predictors of health outcomes.

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VITA

Bret Thomas Howrey was born on September 29, 1968 in Houston, TX to Bobbie and Kent Howrey. After graduating high school from St. John's School in Houston, TX in 1987, Bret attended college at the University of Texas at Austin. He graduated in 1991 with two undergraduate degrees: a B.F.A from the College of Fine Arts and a B.A. from the Plan II honors program.

Following college, Bret designed and managed data bases for Duke University's recycling program. During this period he developed an interest in data systems and programming. He continued to work with data systems while assisting with collection management at the Harn Museum at the University of Florida in Gainesville, FL. While in Florida, Bret began working on interactive internet designs.

Returning to Texas, Bret began to work at M.D. Anderson Hospital in Houston, TX. While working on a prostate cancer research project he developed an interest in health care research. Bret was subsequently offered a position in the Office of Institutional Analysis at the University of Texas Medical Branch (UTMB) in Galveston, TX. This position afforded Bret the opportunity to continue developing his programming skills while also exposing him to statistical analysis methodology.

These experiences lead to Bret's interest in pursuing a Ph.D. in Health Services Research, part of the Preventive Medicine and Community Health program at the UTMB. Bret was awarded a pre-doctoral fellowship from the Sealy Center on Aging's Health of Older Minorities training grant. In 2007 Bret was awarded the best student poster award at the 11th Annual Forum on Aging

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