2022

Border Epidemiological Study of Aging: Understanding Disparities in Mortality and Morbidity Among Mexican Americans Along the Southern US Border

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BORDER EPIDEMIOLOGICAL STUDY OF AGING: UNDERSTANDING DISPARITIES IN MORTALITY AND MORBIDITY AMONG MEXICAN AMERICANS ALONG THE SOUTHERN UNITED STATES BORDER

A dissertation submitted in partial fulfillment of

the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

PUBLIC HEALTH

by

Wissam Al Khoury

2022

To: Dean Tomás R. Guilarte
R. Stempel College of Public Health and Social Work

This dissertation, written by Wissam Al Khoury, and entitled Border Epidemiological Study of Aging: Understanding Disparities in Mortality and Morbidity Among Mexican Americans Along the Southern United States Border, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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Date of Defense: November 4, 2022

The dissertation of Wissam Al Khoury is approved.

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Florida International University, 2022

ACKNOWLEDGMENTS

I would like to thank the members of my doctoral committee, Drs. Michael Anastario, Zoran Bursac and Timothy Hayes for their patience and intellectual contribution to this work. I am also indebted to my chair, doctor Elena Bastida for her patience, support, understanding and especially her scholarly contribution throughout my years at FIU. Her contribution to my intellectual and professional development will remain a constant and salient component of my life, particularly relevant is her contribution to this dissertation. I also thank FIU's graduate school and the Department of Health Promotion and Disease Prevention for their intellectual and financial support. Finally, and foremost, I would also like to thank my family, Salim Al Khoury, Samia Abboud and my sister, Grace Al Khoury for their unconditional love throughout my life. And last, but not least, I am very grateful for the assistance and support that I have received from Dr Susan Biersteker, Doctoral Coordinator, in the Department of Health Promotion and Disease Prevention during the last two years of my doctoral work.

ABSTRACT OF THE DISSERTATION

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This dissertation investigates the association between nativity, age at migration for the Mexican born, farmwork, neighborhood context and mortality over a 25-year period in a statistically representative sample of Mexican Americans aged 45 and older at baseline. Data from the Border Epidemiologic Study of Aging (BESA) were used to investigate mortality, health related and social factors in the study population. Analysis and discussion of the BESA data extend over three subsequent manuscripts that examine: a) differences in health trajectories and mortality for the Mexican born and US born; b) farmworker health; and c) impact of neighborhood security and family support on mortality. This analysis incorporates several existing theoretical explanations on migration and health to include the healthy migrant and its corollary, the Hispanic paradox. Results indicate that individuals who migrated to the United States during mid-adulthood have a significant lower risk of mortality compared to those who migrated

earlier in life. Moreover, being a farmworker increased one's risk of death, especially when spending more than 31 years in farm work. The most frequently reported causes of death for farmworkers were liver, renal, pulmonary disorders, and complications of diabetes. Finally, the third manuscript indicates very strong satisfaction among study participants when reporting on their neighborhood and their neighbors. We suggest that these findings, possibly directly or indirectly, may contribute to their overall level of life satisfaction which itself may contribute to positive health outcomes and longer life for the studied population.

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ABBREVIATIONS AND ACRONYMS

BESA	Border Epidemiological Study of Aging
BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
CVD	Cardiovascular Diseases
DSHS	Department of State Health Services
HR	Hazard Ratio
HRS	Health and Retirement Study
IADL	Instrumental Activities of Daily Living
IRB	Institutional Review Board
MRFIT	Multiple Risk Factor Intervention Trial
NDI	National Death Index
NHANES	National Health and Nutrition Examination Survey
NHIS	National Health Interview Survey
OR	Odds Ratio
SD	Standard Deviation
SSN	Social Security Number
SPSS	Statistical Package for the Social Sciences
SES	Socioeconomic Status
SLE	Stressful Life Events
SRH	Self-Rated Health
T2DM	Type 2 Diabetes Mellitus

U.S.	United States
WHI	Women Health Initiative
WHO	World Health Organization

CHAPTER I: INTRODUCTION

The opening chapter of this dissertation delineates the backdrop of the dissertation while also offering a basic theoretical and literature review that establishes the rationale for the research questions and hypotheses that are distinctly stated in each of the study's three manuscripts.

Specific Aims and Hypotheses

Each of the three papers is guided by its own set of hypotheses, all of which attempt to look into predictors of death in Mexican Americans over a 25-year period in a random probability sample of 1083 middle-aged and older Mexican Americans in Texas' Lower Rio Grande Valley.

Manuscript 1:

AIM 1: Identify differences in mortality outcomes between the US born and Mexican born. Based on existing literature, we pose:

Hypothesis a: There will be a higher mortality for the US born than the Mexican born when controlling for age, gender, SES, and self-reported health.

Hypothesis b: The younger the age at migration for those born in Mexico, the higher their mortality when compared to those who migrated at older ages.

Manuscript 2:

AIM 2: Estimate mortality among farmworkers and examine observed differences between this group and the larger non-farmworker Mexican Americans in the sample, while controlling for age at migration.

Hypothesis: 1 Mexican American farm workers die at younger ages than non - farmworkers in the sample on the average, when controlling for age, gender, self-reported health status and self-reported health conditions.

Hypothesis: 2 Mexican American farmworkers will experience greater number of hospitalizations on the average than non-farmworkers in the sample, when controlling for age, gender and income.

Objective 2a: Examine the association between years spent in farm-work and physical health for farmworkers in the study. It is hypothesized that the longer the years of farm work, the more the number of reported physical health problems, hospitalizations and the higher mortality, when controlling for age.

Objective 2.b: Examine life satisfaction and self-esteem among farmworkers, when controlling for years spent in farmwork, age and income.

Manuscript 3:

AIM 3: Examine the impact of a social receptive network and neighborhood conditions on mortality among Mexican Americans in the study.

Hypothesis a: Accessibility to a receiving network at migration mediates the proposed association for the life chances of the Mexican born on income, life satisfaction, education, reported illnesses, and mortality.

Hypothesis b: Neighborhood context and perceived neighborhood environment have a significant impact on mortality and morbidity for the studied population.

Methods

Below we provide a brief review of the parent study that generated the data for the research conducted in this dissertation.

The Border Epidemiological Study of Aging (BESA)

Study Design and Sample

Data are from the Border Epidemiological Study of Aging, known as BESA, a longitudinal study consisting of four waves conducted in South Texas from 1994 to 2006/07. This dissertation builds on previous findings by Bastida (2008). The entire sample was first reviewed for mortality in 2008 by requesting death certificates from the Texas Department of Vital Statistics for all participants who had been lost to follow up during the 2006/2007 Wave 4 data collection (Bastida, 2008). This first death certificate review yielded 127 deaths. Additional 12 years of survival follow up data was requested and received from the National Death Index (NDI) resulting in a total of 24 years of follow-up mortality and survival (1995-2019) (Jannadi, 2021).

The sampling frame for the BESA was drawn using census tract data from the 1990 US Census on the 40+ population of Mexican origin for all tracts in Hidalgo County, TX, and tracts within surrounding three counties (Cameron, Willacy and Starr) in a 25–30-mile radius of the Hidalgo County line. Besides the age stratum of 45+ and the Mexican American origin, census tracts were used as the strata to generate recruitment quotas to recruit the targeted population (Bastida, 2008). Hidalgo County is ranked 7th in populations size in the state of Texas, with a population of approximately 900,000, the surrounding counties are much smaller and only the bordering counties were used as stratum to generate the final sample. Sample recruitment for all census tracts in Hidalgo County were stratified by age and proportionally represented in the final sample (Bastida, 2008).

It is noted that the sampling frame was proportionally representative of the total number of census tract residents, 40 years or older of Mexican American origin, residing in those tracts, who at the initiation of the study five years later, would have reached the minimum age for sample selection. The sampling unit consisted of all households in the tract that were 40-year-old and older Mexican American in 1990. All households in the tract where at least there was one 40-year-old Mexican American household resident met the sampling frame specifications (Bastida, 2008).

For all urban tracts, streets were randomized and within streets, city blocks were further randomized. The total sample size for the tract was proportionally stratified, given the number of 40-year-olds that had resided in the tract in 1990; thus, sample sizes by tracts vary according to the total size of the population, stratified by age and ethnicity. It is also noted that counties along the Texas-Mexico border area densely populated by Mexican Americans, with Hidalgo County, at the center of the study, with a population that is 90% Mexican American in origin. Starr County is 99% Mexican American and Willacy and Cameron are about 87% Mexican American. The study took advantage of the density of the population that afforded a probability sample selection, otherwise the tracts would not have yielded large numbers (Bastida, 2002). A number table was used to select randomly the last digit of house numbers or apartment buildings that would be targeted for recruitment. At this level, sampling was with replacement, two additional digits were randomly drawn for replacement, these additional replacement numbers were used to either replace a number that did not exist on the block or for a refusal to participate in the study. This was necessary because street numbers vary by blocks. Two houses were selected for recruitment within each randomized block. For each tract, the

number of households targeted was established according to the estimated number of 40-year-old living on the tract in 1990 (Bastida et al., 2018).

The sampling frame was finalized in July 1994, with sample recruitment beginning in fall 1994. The total sample consisted of 1089 households with at least one resident 45, or turning 45 in 1995, years of age. No further randomization was implemented at the household. Households with more than one member eligible to participate were asked to choose who would volunteer to participate in the study. An effort was made early on to randomize all eligible members of the household, but householders met this effort with resistance. Consequently, the decision was made to allow all eligible participants to decide on who would volunteer. Thus, randomization stopped at the household level. Hence, participants represent a probability sample of households (Bastida, 2002)

Study Measures

Data collection began in 1995. Three consecutive waves were conducted between 1995 and the end of the last wave in 2006/07. Participants consented to respond to an in-home face-to-face interview in either Spanish or English. A two-hour IRB-approved survey questionnaire was administered in each wave of data collection. The survey instrument was reviewed by a panel of community residents and researchers. Additionally, a medical doctor reviewed the data in reference to prescription medications, family physician and laboratory work as well as verified all health reported data (Bastida et al., 2018).

Data Wave 1 (1995 – 1996)

Demographic and socioeconomic status (SES) questions were asked, e.g., age, date of birth, place of birth, time of immigration for those born outside the U.S., marital status, type of work/occupation done most of their lives, employment status, years of education, annual personal and household income, and literacy. Additionally, Wave 1 queried participants on living arrangements, physical and mental health conditions, prior hospitalizations, medications, instrumental and physical activities of daily living (ADLS), alcohol consumption, social support, life events, and religious attendance (Bastida, 1998). Moreover, the interviewer measured the height and weight of participants and assessed their mental capacity and physical functioning through a short questionnaire prepared for this purpose. Participants were asked about their willingness to be contacted for a second interview at a later time, which included their name, address, telephone number, and a second telephone number of a contact person who would know about them (Bastida, 1998).

Data Wave 2 (1998 – 1999)

Repeated questions from the first wave and added two new domains on sleep and acculturation with no additional new information requested. Similar to wave 1, participants were queried on their willingness to be interviewed at a later time, which included the name, address, and telephone number of a contact person (Jannadi, 2021).

Data Wave 3 (2002 – 2003)

Repeated second wave measurements and added new questions on physical activities, managing stress, and smoking. Again, willingness to be interviewed at a later time was recorded with corresponding contact person information (Bastida, 1998).

Data Wave 4 (2006 – 2007)

Repeated third wave measurements and included additional questions on lifestyle (changes in physical activities and eating) and neighborhood assessments. As in previous waves, questions about willingness to continue with the study and contact person were included (Jannadi, 2021).

Mortality Data (1995 – 2019)

Survival follow-up was assessed through three different methods. In 2008, death data were obtained from death certificates requested from the Texas Department of Health Services (TDSHS). In 2020, mortality data of the entire BESA sample were requested from the CDC through the records of the National Death Index.

Background

The proposed study is a longitudinal epidemiological study of middle age and older Mexican Americans along the US/Mexico border. Data for the proposed analysis were generated by The Border Epidemiological Study of Aging (BESA), a four-wave study began in 1995 (Bastida, 2008). Most participants in the BESA sample are native born, hence, the study's focus is not necessarily on migration. The original study obtained a representative sample of middle aged and older Mexican Americans. The sample size at baseline for the early cohort was n= 1133 with a later cohort added in 2002. When weighted (2008), the sample is representative of approximately 300,000 border residents, in the BESA age group and of Mexican origin (Bastida, 2008). The dependent variable or the outcome under study is mortality, various independent variables will be considered when examining their effect on this outcome. For now, given

the richness of the data, the approach to mortality has been limited to physical and mental health variables. I will examine several independent variables that can be used in understanding factors that may precipitate early mortality, while also examining those that appear to delay mortality in this large sample. My theoretical approach will be guided by the life-course framework, given that we will be investigating the outcomes and corollaries of life course as an accumulation of major "transitions" and their long-term impact over time.

Theoretical Framework and Brief Overview

The life course theory has six domains. These domains encapsulate major life course concepts. Among the latter and particularly applicable to this research are concepts such as life-history, life cycle, life span, maintenance and decline, and life cycle schemas. Secondary, but also applicable to this research, are other life course concepts, such as life history strategies, cohorts, contexts, social networks, generations, kinship networks, events, transitions and trajectories (Pablos-Méndez, 1994). The latter are exposures, experiences and factors that precipitate the health and healthcare issues of the population in question, as well as the systematic challenges that this groups faces. Life course theory complements convergence theory in further explaining the process by which non-native Mexican Americans have settled in the host country, became acculturated, and adopted the health behaviors of the majority population as Philip Yang and Shann Hwang suggest (Yang, Hwang, 2016). Consequently, their health eroded or improved to converge gradually with the majority profile (Teruya, Bazargan-Hejazi, 2013).

Analysis and discussion of the BESA data will extend over three subsequent manuscripts that will examine health trajectories and mortality differences between the Mexican born and the US born, farmworker health and impact of neighborhood security and family support respectively. This analysis will incorporate several existing theoretical perspectives on migration and health that aim to explain the healthy migrant paradox and other health outcomes in Mexican Americans; for example, the healthy migrant hypothesis and Hispanic paradox (Lady, Henning-Smith and Kun, 2018; Torres, 2014). For the non-native participants we will examine, to the extent possible, the existence or absence of receiving social networks in the US at the time of immigration; and whether existing social networks and received support at the time of immigration are associated with later health outcomes and mortality. Finally, I will examine possible trends among this population regarding those who report major health problems and the support and care they receive from relatives.

In sum, a brief overview of the border area indicates that "almost 30% of Mexican Americans in the border region live in rural areas and the average median income in the region is less than $15000" (Lady, Henning-Smith & Kun, 2018). Diabetes prevalence among Mexican Americans is greater than 30%, being the highest in the nation, following only the selected tribes of Native Americans with the highest prevalence, e.g., the Pima Indians of Arizona. The Mexican American population also has higher rates of poverty which when coupled with poor regional infrastructure in the communities or regions where most live, it is generally accepted that these contribute to health disparities. Furthermore, this population is "at an increased risk for non-communicable diseases and other causes of death (e.g., cancers, diabetes, liver diseases,

homicide and accidents). Moreover, the number of uninsured or under-insured in the border region is higher than national averages. Despite the above, we note that for the studied population, most had some form of health insurance, especially participants over 65 years who qualified for Medicare. However, for those who remain uninsured, barriers to care lead to fragmented, rather than coordinated, care" (Lady, Henning-Smith and Kun, 2018). Finally, "poverty rates along the border are twice as high as the national rate with many border Mexican residents living in unincorporated communities known as 'colonias,' that often lack adequate plumbing, electricity, and water treatment facilities" (Lady, Henning-Smith and Kun, 2018).

Previous studies explored the relationship between personal and spousal migration to the United States and later-life health of Mexican immigrants who returned to Mexico in the context of other social determinants of health across the life-course (Torres, 2014) and examined the role of health insurance in the propensity of doctor visits and hospitalizations among this population (Wong, Diaz, Higgins, 2006). Bastida examined subjective well-being and depression in this population (Cuellar, Bastida & Braccio, 2004) and explored persistent disparities in the use of health care along the US-Mexico border from an ecological perspective (Garcia C, Garcia M. A., & Hazuda, 2010). There have been several studies that looked at mortality as the outcome variable but none has assessed the various social, health and economic factors that contribute towards this outcome among this particular population in the approach adopted by each of the following three manuscripts. Moreover, whereby many studies looked at the general health status of the Mexican American population in the US in general, this study

specifically looks at this population along the southern US border. The Mexican American population along the southern US border remains understudied and numerous factors contributing to their deterioration of health and well-being remain unexplored rendering their investigation, particularly, the social and health determinants of mortality, crucial.

Moreover, because both age and cumulative advantage/disadvantage theories are inextricably tied to the aging process, they appear to have logical, theoretical, and empirical interconnections. Cumulative Advantage/Disadvantage (CAD) is a theory that treats people unevenly and partly, causes interindividual disparity and iniquitous feelings, and so raises doubts about the social legitimacy of existing social norms, at least indirectly (Dannefer, 2003).

CAD is described as a series of processes that can be experimentally identified and are based on general psychosocial and interactional dynamics. The involvement of "selection" and "socialization" factors in this process is clearly acknowledged. “The CAD perspective has a strong intellectual resonance with several other traditions of sociological theorizing that interpret differential individual outcomes as resulting, in substantial part, from the operation of social processes. Two such traditions are social reproduction theory (Bourdieu, 1990) and allocation-based theories (Reskin, 2003; Riley et al., 1972) that focus on the structuring of opportunity” (Dannefer, 2003).

Problem Statement

Multiple gaps are evident in the current literature on Hispanic health. The weight of the evidence on older Hispanic health is largely drawn from two large studies: The Hispanic EPESE and the SALSA studies (Espinoza, Jung, Hazuda, 2010; Meyer,

Geller, He, Gonzalez & Hinton, 2014) and from small cross-sectional studies (Graham, Stoebner-May, Ostir, Al Snih, Peek, Markides, & Ottenbacher, 2007; Daviglus, Talavera, Avilés-Santa et al., 2012). Mexican Americans along the southern US border have lower likelihood of receiving health care and have worse SES than Mexican Americans elsewhere. For example, this is a region that qualifies as a medical underserved area, precisely because of the limited number of medical professionals and other health care services in the region. Generally, the border region is known for low levels of education, income and employment, with counties in this region ranking among the most disadvantaged in the US. Among this group, farm workers constitute an at-risk population that has not been extensively studied, particularly longitudinally, as proposed here. The BESA dataset provides a very special opportunity to examine longitudinally the physical and mental health of farm workers in a large representative sample of the region's population. I propose to examine health and SES data for farmworkers that can provide an improved understanding of their mortality and morbidity.

Purpose of the Study

The BESA, as already noted, is a longitudinal epidemiological study of aging based on a representative sample of middle aged and older Mexican Americans on the US border. I propose to use mortality data for the sample which in 2019 indicated 24 years post baseline. There are seven data collection periods: four waves of in-person data collections, and mortality data collected in 2008, 2012 and 2020. In 2012 the entire sample was reached over the telephone to verify mortality and addresses. An intense mortality data search was just completed this past October through the National Data Index (NDI). The entire database, submitted to the NDI, has been verified to confirm all

deaths and cause of deaths. Given the availability of earlier and recent mortality updates by date and cause of death, I will use the completely revised and updated database to examine mortality outcomes for several interesting predictor variables.

Significance

This study is expected to expand understanding of health problems associated with work trajectories, particularly distinguishing between farm work and non-farm work. Since this is a longitudinal study, we propose to investigate expected associations between mortality and selected life trajectories, especially as these relate to work and earlier physical health conditions over a given period of time. Findings from this study are poised to contribute toward enhancing policy implementation for this population. Furthermore, findings from research on Mexican Americans have found that despite this population's low socioeconomic status, it tends to be healthier than non-Hispanic Whites (Derose, Bahney, Lurie & Escarce, 2009). At the same time, "many studies suggest that first-generation Mexican Americans have better health than their children" (Derose, Bahney, Lurie & Escarce, 2009). Understanding and recognizing the underlying variables that impact this group's health form the core of this study and hopefully should direct future policy corollaries.

Innovation

Although sociocultural variability in the Latino population has been previously addressed and their health and health care needs in the United States-México Border Region have been previously explored (McCoy, Williams, Atkinson, & Rubens, 2016), very few studies have investigated longitudinal associations between morbidity and mortality among this population over a 25-year period, especially with a representative

sample population aged 45+ at Wave 1. Moreover, in this study, work trajectories, particularly for farm workers will be prioritized in the analysis.

Previous studies have examined characteristics of migrant farmworkers (NAWS, 1997) and have explored the demographic and employment profile of United States farm workers (Thompson & Wiggings, 2002), but no previous studies have examined morbidity and mortality for farmworkers over a twenty-five-year period. The nature of this study - a longitudinal epidemiological study spanning over 25 years - makes it possible to account for changes in health and other conditions among middle-aged and older Mexican Americans along a continuum of 24 years. While previous studies have examined many of the conditions explored in the BESA study, they did not focus on the trajectory from middle age to the later years. Here lies the uniqueness of the BESA study in that it allows for the exploration of health trajectories, very much along the lines suggested by the life-course theory.

Data Analysis

We will examine data from the Border Epidemiological Study on Aging through the first four waves, starting with wave 1 (1995-1996) and survival outcome at 18 years in 2012 and at 24 years in 2020 (the latest revision of mortality data for the study). The baseline wave that was collected in 1995 and resulted in a final sample of 1133 households with a response rate of 89% in which there was at least one eligible participant per household, aged 45 or older. It should be noted that data were obtained through an in-person questionnaire schedule conducted at the participant's home.

Prior to analysis, the data will be evaluated for outliers by examining leverage indices for each individual and defining an outlier as a leverage score 4 times greater than

the mean leverage. Univariate normality will be evaluated using indices of skewness and kurtosis and anything above absolute value of 2 will predict violation of normality. Multivariate normality will be evaluated using Mardia's test and critical value of 1.96 or less will suggest normality. Missing data will be imputed using maximum likelihood procedures, assuming that missing data are 'Missing at Random'.

Bivariate analysis was performed to explore the difference between survival of and risk factors, for example, hospitalization in last 5 years, psychosocial factors, e.g., perceived health status, years spent in the US and place of birth, CESD depression scale, standardized question on life satisfaction and self-esteem, farm-work, years spent in farm-work, access to healthcare and socio-demographic, e.g., sex, marital status, income. Multivariable logistic regression is used to analyze independent association of risk factors, psychosocial and socio-demographic factors with age at death and cause of death. Also, the Mexican-born population is compared to that born in the US by examining the progression of health along a continuum of twelve years, beginning in 1996 and ending in 2012 using instrumental (control) variables in a bivariate probit model.

Since we are investigating predictors of mortality, survival analysis will be applied to analyze patterns as well as compare different survival time distributions. The Kaplan-Meier method is used to plot survival curves. These graphs will serve to test the proportional hazard assumption. Consequently, a Cox's Proportional Hazards Model including the covariables of interest is fitted using a step forward stepwise process, i.e., from a null model, all the covariates with $p < 0.05$ will be included in the model.

Impact

Using above theoretical framework to understand verified self-reported physical health outcomes - indicated by hospital discharge summaries, the 26 items OARS*[1] instrument, scales that measure physical and instrumental activities of daily living e.g., the DUKE Epidemiological Study of Aging … - across all four waves, will help us examine mortality and identify the most heightened and detrimental physical health factors encountered by this cohort. Moreover, by better understanding the contribution of years in a particular type of work on mental health (12 years) and mortality (25 years), we expect to make a contribution to the current academic and policy relevant discussion on health disparities. Particularly, important in this context are farmworkers' self-reported 'physical and mental health which have been understudied and thus in this manner this study, which spans over a period of 25 years, has the potential to contribute to the design of future interventions addressing the health of this particular population group. Finally, this study will make an important contribution to the current discussion on health disparities by providing twenty-five-year data that explores health and mortality for an important population group in the current discourse on health disparities. The latter, it is expected, would provide a greater insight on the health trajectories of this population group, central to the current discussion on health disparities.

[1] The Duke OARS (Older Americans Resources and Services) Program, developed at the Duke Center for the Study of Aging and Human Development, was specifically designed as a means of determining the impact of services and alternative service programs on the functional status of older persons. The resulting brief, valid, and reliable instruments have been used for purposes as varied as individual clinical assessment of personal functional status, surveys of the status of adult populations, assessment of service utilization and service requirements, longitudinal investigations in community, clinic and long-term care settings, and training of service providers.

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CHAPTER II: FIRST MANUSCRIPT

Country of Birth and Mortality

2.1. Introduction and Literature Review

Mexican Americans are demographically diverse and include native and foreign-born; additionally, the foreign-born account for a broad dispersion in years of residence in the United States. Over half the Mexican American population is native born and many trace their family histories to the old Southwest, prior to the "US Mexico War and the subsequent incorporation of these lands to the US" (Gonzalez-Barrera & Lopez, 2013). Investigating the health of this population is increasingly important given that currently they are the largest Hispanic population, representing 67% of all Hispanics in the US[1]. In the last decade, studies have explored variations that exist between the native-born Mexican origin population and recent and longtime immigrants in terms of health and mortality. This is particularly relevant to the US Mexico border, a region first settled in the early 1700s by Spanish and Mexican colonizers moving north and much later by the large westward movement of Southerners, Northerners and new European immigrants to the United States (Montejano, 1987). In 2022 Mexican Americans comprised nearly two-thirds of the U.S. Hispanic population and 11% of the U.S. population (Gonzalez-Barrera & Lopez, 2013). While many of the "new immigrants" who cross the border today settle well beyond the border, the border remains a place where both descendants of the early settlers and new immigrants reside.

Research interest for this study stems from the persistent observations on a mortality advantage for Mexican Americans (MA) when compared to non-MA, as well as

a mortality advantage among the foreign born when compared to the native born. Given their lower levels of education and income of the foreign born when compared to the native born, this study further corroborates research on this population and finds a more favorable mortality outcome than predictable, given their low socioeconomic condition within the US population (Arias, Eschbach, Schauman, Backlund, & Sorlie, 2010; Bond-Huie, Hummer, & Rogers, 2002; Patel, Eschbach, Ray, & Markides, 2004). The literature on the "immigrant health paradox" is contradictory when it comes to how elder immigrants' health compares to that of the native-born. On the one hand, immigrants have lower mortality and better health on most (but not all) health measures (Acevedo-Garcia & Bates, 2008; Hummer, Powers, Pullum, Gossman, & Frisbie, 2007; Jasso, Massey, Rosenzweig, & Smith, 2004; Markides & Gerst, 2011; Palloni & Morenoff, 2001; Riosmena & Dennis, 2012; Smith & Bradshaw, 2006). However, questions on their mortality advantage remain. Intergenerational research have consistently found lower mortality among Hispanic immigrants than among their children and grandchildren's generations over the last 20 years (Elo, Turra, Kestenbaum, & Ferguson, 2004; Goel, McCarthy, Phillips, & Wee, 2004; Hummer, Rogers, Nam, & LeClere, 1999; Markides & Coreil, 1986; Palloni & Arias, 2004). The mortality advantage among immigrants appears concentrated among the elderly (over 65) and those with lower socioeconomic status, with little or no advantage at higher socioeconomic levels, according to data from the 1997 National Health Interview Survey, which focuses on Mexican Americans as a group (Turra & Goldman, 2007).

Reviewing papers that examined the morbidity of this population, Mexican-origin immigrants aged 60 and above who arrived at the age of 20 and under had a greater cardiovascular death rate than those who arrived later in life (Eschbach, Stimpson, Kuo, & Goodwin, 2007). Increased rates of smoking, drinking, and a lack of physical activity have been linked to longer US residence and expected increased acculturation, which has resulted in the loss of the apparent immigrant advantage. According to studies on acculturation, the latter increases the prevalence of health risk behaviors and raises allostatic load, resulting in the loss of the immigrant health advantage. (Abraido-Lanza, Chao, & Florez, 2005; Finch & Vega, 2003; Kaestner, Pearson, Keene, & Geronimus, 2009; Kimbro, 2009). However, at least one study contradicts these findings, claiming that extended residence leads to better health among older Mexican-origin immigrants (González, Haan, & Hinton, 2001). González and colleagues observed that the health benefit among long-term residents results from higher socioeconomic status that comes with a longer work history in the United States (González et al., 2009). However, the latter was not observed in most studies that examined Mexican Americans.

Zoya Gubernskaya notes that inconsistencies in the results stem, at least in part, from reliance on age-adjusted estimates and underplaying disparities among the foreign born by arrival age. The degree of health selectivity upon arrival, the ability to maintain good health while in the United States, and the length of exposure to environmental conditions in countries of origin, all of which may have implications for maintaining good health in old age, are all defined and affected by age at migration, to varying extents (Gubernskaya, 2014). Children, brought by their parents, and middle-aged migrants are

more positively selected on health than young adult migrants who come to the United States primarily to enhance their economic circumstances. According to Gubernskaya, children and young adult immigrants, when compared to those who migrate later in life, are also more likely to have accumulated socioeconomic resources needed to maintain good health in later life. Longer exposure to poor environmental and health circumstances may have a negative influence on the health of the foreign-born who migrate to the US later in life (Gubernskaya, Zoya, 2014).

Thus, a vast body of work indicates that the length of time spent in the United States is linked to differing health levels both intragenerationally and intergenerationally. Immigrants appear to have a health advantage in general, which could be due to migration selectivity (Hummer, Powers, Pullum, Gossman, & Frisbie, 2007). This initial health advantage is gradually lost by this and following generations. However, limited research has looked at the impact of migration age on death over time. Findings from a paper by Ronald and Jacqueline Angel reveal that the immigrant generation is not a homogeneous mortality risk group. Individuals who immigrated to the United States as adults have a significantly reduced risk of death than those who immigrated as children or in their middle years (Angel, Angel, Lee, Markides, 1999). These disparities are not explained by chronic diseases or functional abilities. Hence, in this study, we examine mortality data on Mexican immigrants over a 25-year period in a probability sample of 1083 middle aged and older Mexican Americans in the Lower Rio Grande Valley of Texas. The aim of this study is to expand on current research on the positive mortality experiences reported for Mexican Americans and identify differences in mortality

outcomes between the US born and Mexican born. In this paper we organize the sample by age cohorts and birth nativity. Consequently, we will be investigating differences and similarities among above cohorts.

2.2. Methods

2.2.1. Study Design and Sampling

Data are from the Border Epidemiological Study of Aging, (BESA), a longitudinal design study consisting of four waves conducted in South Texas from 1994 to 2006/07. The first and last waves will be used in this analysis by looking at information on the study's sample collected in the fourth wave and mortality data and comorbidities collected in the fifth wave (2019 – 2020). A two-stage stratified random sampling was utilized in recruiting participants to the study. The initial sample yielded 1089 participants, 45 years or older, selected using tract data from the 1990 US Census to estimate the number of qualifying Mexican American adults 45 years and older in four counties along the Texas Mexico border in 1994 - 1995 (Hidalgo, Cameron, Willacy, and Starr) (Jannadi, 2021).

Besides the age stratum of 45+ and the Mexican American origin, census tracts were used as the strata to generate recruitment quotas. Sample recruitment for all census tracts were stratified by age and proportionally represented in the final sample.

2.2.2. Study Variables

Data collection began in 1995 followed by three consecutive waves conducted between 1995 and the end of the last wave in 2006/07. Participants consented to join an in-home face-to-face interview in either Spanish or English. In every wave, participants were administered a 2-hr general health questionnaire approved by a panel of community

residents and researchers. All health reported data were further verified by a medical doctor who reviewed the data with reference to prescription medications, family physician and laboratory work whenever included (Jannadi, 2021).

2.2.2.1. Independent Variables

Country of Birth

At the beginning of every data wave collection, participants were asked about their country of birth and other demographic information in order to verify their initial participation in the study. In this study, the question pertaining to country of birth was open ended.

Age at Arrival to the US

As with 'country of birth', 'age at arrival to the US' was also asked as an open-ended question. Since one of the exclusion criteria was being younger than 45 years of age, all answers ranged between 45 and 74 years.

2.2.2.2. Dependent Variable

Mortality

Survival follow-up was assessed through three different methods. In 2008, death data were obtained from death certificates requested from the Texas Department of Health Services (TDSHS). In 2020, mortality data of the entire BESA sample were requested from the CDC through the records of the National Death Index. Additionally, newspaper obituaries and/or phone calls were used to supplement and verify date and place of death. Survival time was measured in years starting with the date of baseline data

collection and ending with the death of the participant or end of follow up on December 31, 2019.

Morbidities: Diseases

Participants were asked if they were medically diagnosed with any of the following diseases: thyroid diseases, cancer, gastrointestinal diseases such as ulcer, cardiovascular diseases, diabetes or neuromuscular disorders such as Parkinson's diseases. Accordingly, the response was coded dichotomously as whether the participant was diagnosed with at least one of these diseases or none. All comorbidities were recorded by a clinical interviewer and further validated by a medical doctor who reviewed all prescribed medications respondents were taking at the time of the interview and their self-report of a chronic disease.

Cause of Death

Along with the collected mortality data for the complete BESA sample acquired from the CDC in 2020 via the National Death Index records, causes of death were also obtained in the form of ICD-10 codes.

2.2.3. Statistical Analysis

First, a descriptive statistical analysis was conducted for the sample and included gender, country of birth, age at death. Consequently, the population was stratified according to age at US arrival and age at beginning of wave 1.

Survival analysis was used to focus primarily on time to death. The most prevalent feature of survival analysis is that it uses "censored" data, in which the 'time to event' cannot be fully ascertained and instead indicates the time to event's lower limit. Time to event (death) was tracked. A variety of high-dimensional epidemiological

surveillance data have rapidly amassed as a result of the advent of high-throughput biological data capture, enabling for more tailored information to be utilized for detection and survival probability prediction. Two measures commonly used for epidemiological surveillance which are at the core of this study are morbidity and mortality. Provided that the assumptions of Cox regression are met in the study, this function will provide better estimates of survival probabilities and cumulative hazard than those provided by the Kaplan-Meier function.

2.3. Results

Table 2.1. Sex versus Country of Birth

Sex versus Country of Birth (Total Population)

			Country respondent was born in		Total
			Mexico	U.S.	
Sex	Male		174	239	413
		% within Sex	42.1%	57.9%	100.0%
		% within Country of Birth	28.8%	34.8%	32.0%
	Female		431	448	879
		% within Sex	49.0%	51.0%	100.0%
		% within Country of Birth	71.2%	65.2%	68.0%
Total		Count	605	687	1292
		% within Sex	46.8%	53.2%	100.0%
		% within Country of Birth	100.0%	100.0%	100.0%

This study aims at examining lifespan measures and discrepancies in morbidities among *Mexican Americans* who were born in Mexico and those born in the US.

Table 2.2- Age at Death versus Country of Birth

Descriptive Statistics

Country respondent was born in				Statistic	Std. Error
Age At Death	**Mexico**	**Mean**		**80.85**	.409
		95% Confidence Interval for Mean	**Lower Bound**	**80.05**	
			Upper Bound	**81.65**	
		5% Trimmed Mean		80.87	
		Median		**81.00**	
		Variance		81.853	
		Std. Deviation		9.047	
		Minimum		56	
		Maximum		105	
		Range		49	
	U.S.	**Mean**		**78.75**	.377
		95% Confidence Interval for Mean	**Lower Bound**	**78.01**	
			Upper Bound	**79.49**	
		5% Trimmed Mean		78.80	
		Median		**78.00**	
		Variance		82.575	
		Std. Deviation		9.087	
		Minimum		49	
		Maximum		106	
		Range		57	

Constructing the histograms for life expectancy, we realize that the median and mean ages for life spans of Mexican Americans born in Mexico are higher than those born in the US. Moreover, the lifespans of those born in Mexico follow a bell-shaped curve with the mode being around 83 years, whereas those born in the US have a mode around 70 years of age.

Consequently, we examined country of birth as a potential predictor of survival in this population. For this purpose, we used Cox-Regression Survival Analysis to examine whether respondents' country of birth, Mexico or US, is statistically significant regarding mortality, while controlling for age, sex, education level and SES. With a statistical significance being <0.05, the country the respondent was born in is statistically significant when examining survival and life expectancies between those born in the US or Mexico.

Results indicate lower mortality rate for men who immigrated from Mexico in the 1920s and 1930s when compared to those born in the US (that is those aged 55 - 74 at the time of wave 1, 1994-1995). Similarly, women who immigrated from Mexico and were 45 years and older in 1994-1995 have a better survival rate when compared to their US-born counterparts regardless of the age of arrival to the US.

In furthering the above analysis, study participants were stratified by age of arrival to the US. Five age groups were created, fifteen years apart: 0 to 15, 16 to 30, 31 to 45, 46 to 60 and 61 to 75 years of age. The results are tabulated as shown below (Tables 2 and 3). Mexican born male participants arriving in their middle years (31 – 45) and at older ages (61 – 75) had the longest life spans. Males who arrived younger than 16 and those who arrived between ages 46 and 60 had a worse survival outcome; interestingly, among the latter two age groups, those who survived had a longer life span. On the other hand, Mexican-born females who arrived between the ages of 16 – 45 years

had the best survival outcome, whereas the worst outcome was for women arriving younger than 16 and older than 60 years of age.

Expanding on this, we constructed a hazards ratio table that further built on those results. This table exhibits hazard models whereby mortality predictors were introduced in a stepwise fashion. The hazards ratios table at the end of the study shows that model 1 which includes the age at arrival variable, with US-born being the reference (in addition to demographics), immigrating between ages 31 - 45 decreases risk of death by 26%. Immigrating at 61 – 75 years of age decreases the risk of mortality by 32%. Model 2 adds education to the equation. In this model, having 5 or more years of education seems to decrease the risk of death by 15 percent.

In Model 3, SES (in the form of income) is added to the equation. Its introduction doesn't seem to have a significant impact on the associations exhibited in the first model. Model 4 introduces the prevalent chronic conditions (those reporting more than 1 major health disorder). When introduced, arrival during the ages 31 – 45 years becomes statistically insignificant. However, immigrant arriving at older ages still have a better mortality outcome.

Compared to the US-born Mexican American population, the mean and median ages at death for the Mexican-born were higher and the percent mortality among the Mexican-born was lower (better) as well.

In an effort to account for factors explaining the higher mortality rates among the US-born participants, we examined discrepancies in morbidities between the US and

Mexico-born (table 4). An independent Cox-Regression Survival Analysis for each disease controlling for age, sex, education level, country of birth, education level, general health status and SES was run for the entire sample. The top ten morbidities associated with mortality were selected and their prevalence compared between Mexican and US-born participants. US-born participants had significantly higher incidence rates of diabetes, cardiovascular diseases, speech impairment and paralysis than the Mexican born.

Further, we used correlation coefficient r to compare number of hospitalizations for participants born in the US to those born in Mexico and examined Pearson's r (0.022) but found no significant correlation in hospital admissions ($p= 0.58$).

We used Cox regression survival analysis to test whether age at arrival to the US is statistically significant for age at death while controlling for age, gender, educational level and SES.

The multivariable Cox proportional hazards regression model for the Mexican-born was statistically significant [HR:0.86, 95%: 0.012-1.23, $p < 0.001$] regarding age of arrival. Therefore, censoring for age at US-time-of-arrival and controlling for age, gender, educational level and SES, the risk of dying was significantly affected by age at which Mexican Americans arrived at the US (this correlation is discussed in the following paragraphs).

Furthermore, we extrapolated the analysis by extending the study's focus to a subcategory of the Mexican-born who came to the US at 10 and under. After filtering this

population, we matched it with respondents who were born in the US during the same years as the birth years of the Mexican born. Results indicate that those born in Mexico who immigrated to the US before the age of 10 had a significantly lower risk of death [HR:0.83, 95% CI: 0.78-0.93, $p < 0.05$].

2.4. Discussion

Results presented here corroborate earlier findings supporting a mortality advantage among foreign-born Mexican immigrants (Angel, Angel, Díaz, Venegas & Bonazzo, 2010; Hummer, Powers, Pullum, Gossman, & Frisbie, 2007). Extensive literature review search yielded only one paper by Bradshaw and Smith that alluded otherwise (Bradshaw, Smith, 2011). However, aside from Bradshaw and Smith's study, the Hispanic Paradox remains central in the conceptualization and explanation of the Hispanic mortality advantage, who, despite having lower average income and education, exhibit health outcomes that are "paradoxically" comparable to, or in some cases better than, those of their non-Hispanic White counterparts in the United States. As such, this study examined the Hispanic Paradox over a twenty-five-year period and concluded that Mexican Americans born in Mexico had longer life spans. Among those, men who arrived in their middle years (31- 45) and older (61 – 75) did the best.

Moreover, according to Setoguchi and Soko (2007), impact of repeated heart failure (HF) hospitalization on mortality remained understudied for a large community population with HF (Soko, 2007); however, in 2021, Blumer and colleagues examined the prognostic role of prior heart failure hospitalization among patients hospitalized for worsening chronic heart failure (Blumer et al., 2021). The impact of repeat

hospitalizations on hospitalization rates for selected conditions among adults with and without diabetes showed that the inclusion of repeat hospitalizations was a predictor of overall mortality (Benjamin, Wang, Geiss, Thompson, & Gregg, 2015). Given that the majority of incident diseases in this population were either cardiovascular or diabetes, we examined hospital overnight admissions within the last 12 months in each of the collected data waves (tables 7 and 8) but found no significant difference in overnight hospitalizations between participants born in Mexico or the US.

We probed further into the Hispanic Paradox by separately comparing participants who were ten and under at US arrival with those born in the US. We examined mortality over a 25-year period for both groups. This helped us answer the following question: Are individuals who came to the U.S. in childhood indistinguishable from the native born in terms of mortality over the 25-year study period? The reason we found this question important stems from previous findings that lead to suspect that those individuals who migrate later in life are somehow selected for longevity, but exactly how is not obvious as others have shown (Palloni & Morenoff, 2001). Still, this study supports existing findings, since those born in Mexico and arriving before the age of 10 manifest a statistically significant better life expectancy when compared to those born in the US during the same years. Another possible explanation is that those individuals with better longevity have overcome early life diseases and death.

This research examined mortality as the major dependent variable because unlike self-reported health and self-reported health conditions, mortality has the advantage of being equitably unambiguous in terms of measurement.

We attribute those differences in age-related mortality prospects to selection as well as acculturation and its correlates. Immigrants who arrive as children are chosen based on the traits of their parents and that's what is termed as the migrant advantage. Their parents, like the majority of young and middle-aged adults, have moved to the United States in quest of employment possibilities and hence they can be regarded as labor migrants. Labor migrants can be seen as migrants who are basically in good shape and fit enough to travel and work once they arrive. However, their occupations can be physically demanding, their pay low and likely to have no health insurance. Existing literature suggests that the longer a person is exposed to various forms of US acculturation, the more likely they are to acquire detrimental behaviors. Here the discussion can be expanded to include social reproduction theory (Bourdieu & Passeron, 1990) and allocation-based theories (Reskin, 2003). Despite the fact that social reproduction theory has paid little attention to human development and aging, the potential link is clear. If education, for example, is a resilient mechanism for reproducing class-based or other forms of inequality, then diverging interindividual trajectories that lead to increasing intracohort inequality have their origins in early childhood education-based stratification and, it can be hypothesized, continue to be amplified throughout life (Dannefer, 2003).

Hence, it is to no surprise that scholars, for example Bowles and Gintis (1976) have explicitly connected schooling and work as integrated elements in such a system of stratified social reproduction. In this paper, we examined schooling trajectories and results clearly showed that among the study population, those born in the US were significantly more educated (Table 14). As such, this difference in mortality outcomes among the relatively aging population can be attributed to the cumulative advantage/disadvantage (CAD) theory that goes hand-in-hand with life-course theory. This significant "heterogeneity discourse" remained primarily at the level of casual observation and, possibly, popular inspiration before the application of the CAD perspective in gerontology (Dannefer, 2003). In fact, it sparked little intellectual curiosity and resulted in little empirical inquiry (Bornstein & Smircana, 1982; Nelson & Dannefer, 1992).

Mexican American Mortality by Age Groups at Beginning of Study

			Country respondent was born in						**Total**	
			Mexico			**U.S.**				
Sex			**Mortality**		**Average Age at Death**	**Mortality**		**Average Age at Death**	**Mortality**	
Male	*Age Categories in Years at Beginning of Study (or the Equivalent Birth Decade)*	45 – 54 (1940s)	6	18.18%	67.33	15	16.48%	63.40	21	16.94%
		55 – 64 (1930s)	20	47.62%	72.20	30	51.72%	72.27	50	50.00%
		65 – 74 (1920s)	44	77.19%	81.73	55	90.16%	81.38	99	83.90%
Female	*Age Categories in Years at Beginning of Study (or the Equivalent Birth Decade)*	45 – 54 (1940s)	13	11.21%	66.15	19	13.67%	64.47	32	12.55%
		55 – 64 (1930s)	40	30.77%	73.23	43	41.35%	74.19	83	35.47%
		65 – 74 (1920s)	56	68.29%	84.36	88	77.88%	83.47	144	73.85%
Total	*Age Categories in Years at Beginning of Study (or the Equivalent Birth Decade)*	45 – 54 (1940s)	19	12.75%	66.53	34	14.78%	64.00	53	13.98%
		55 – 64 (1930s)	60	34.88%	72.88	73	45.06%	73.40	133	39.82%
		65 – 74 (1920s)	100	71.94%	83.20	143	82.18%	82.66	243	77.64%
	Total		179	38.91%	77.97	250	44.17%	77.42	429	44.81%

Table 2.3. Mortality stratified by Age Groups

Table 2.4. Age Upon Arrival versus Mortality and stratified by Sex - Crosstabulation

Age Upon Arrival vs Mortality vs Sex

Sex			*Mortality Status*				*Age At Death (yrs)*		
			Number of alive	**Number of deceased**	**Total**	**Percent Mortality**	**Mean**	**Median**	**Range**
Male	Age Upon Arrival (yrs)	0 -15	7	10	17	58.82%	83.90	82.50	23
		16 - 30	18	38	56	67.86%	78.97	80.00	38
		31 - 45	13	17	30	56.67%	78.00	79.00	33
		46 - 60	7	10	17	58.82%	84.40	85.00	16
		61 - 75	1	1	2	50.00%	74.00	74.00	0
	Total		46	76	122	62.23%	80.05	80.50	38
Female	Age Upon Arrival (yrs)	0 -15	29	34	63	53.97%	81.79	85.00	42
		16 - 30	72	39	111	35.14%	81.95	83.00	36
		31 - 45	45	42	87	48.28%	81.02	81.50	46
		46 - 60	16	18	34	52.94%	81.94	80.00	28
		61 - 75	2	4	6	66.67%	84.00	83.50	27
	Total		164	137	301	45.51%	81.69	83.00	46
Total	Age Upon Arrival (yrs)	0 -15	36	44	80	55.00%	82.27	85.00	42
		16 - 30	90	77	167	46.11%	80.48	82.00	39
		31 - 45	58	59	117	50.43%	80.15	80.00	46
		46 - 60	23	28	51	54.90%	82.82	83.50	28
		61 - 75	3	5	8	62.5%	82.00	82.00	27
	Total		210	213	423	50.35%	81.10	82.00	46

Table 2.5. US Born versus Mortality and Stratified by Sex

Mexican Americans US Born: Age Upon Arrival* Mortality* Sex Crosstabulation

	Mortality Status				*Age at Death*			
Sex	**Number of Alive**	**Number of Deceased**	**Total**	**Percent Mortality**	**Mean**	**Std. Deviation**	**Median**	**Range**
Male	95	121	216	56.02%	77.84	9.932	79.00	46
Female	167	198	365	54.25%	80.97	9.825	82.00	49
Total	262	319	581	54.91%	79.78	9.967	81.00	52

Table 2.6. Most Prevalent Chronic Diseases versus Country of Birth

	Mexican-Born		**US-Born**		**p-value (significance in difference)**
	Number of Participants with Disease	Percent of Mexican-Born Population	Number of Participants with Disease	Percent of US-Born Sample Population	
Diabetes	120	19.83471	149	21.6885	**0.048**
HBP	215	35.53719	240	34.9345	**0.689**
Cardiovascular	75	12.39669	97	14.11936	**0.039**
Stroke	19	3.140496	29	4.221252	**0.050**
Arthritis	214	35.3719	236	34.35226	**0.819**
Dermatological	40	6.61157	51	7.423581	**0.087**
Speech Impairment	5	0.826446	14	2.037846	**0.026**
Hearing Impairment	47	7.768595	51	7.823581	**0.981**
Glaucoma	28	4.628099	33	4.803493	**0.671**
Paralysis	24	3.966942	43	6.259098	**0.035**

Table 2.7. Hazards Ratio Table for Age of Arrival to US

Independent Variable	Model 1, Hazard Ratio (SE)	Model 2, Hazard Ratio (SE)	Model 3, Hazard Ratio (SE)	Model 4, Hazard Ratio (SE)
Age at Arrival to US (years)				
Less than 30	0.91 (0.07)	0.93 (0.07)	0.95 (0.06)	0.88 (0.10)
31 - 45	0.74* (0.05)	0.88* (0.07)	0.91 (0.07)	0.92 (0.08)
61 - 75	0.68* (0.04)	0.75* (0.06)	0.78* (0.08)	0.76* (0.09)
Demographics				
Age	1.81* (0.05)	1.55* (0.04)	1.73* (0.04)	1.75* (0.04)
Male	0.89* (0.07)	0.73* (0.08)	0.74* (0.07)	0.68* (0.05)
Education				
5 or more years of education		0.85* (0.03)	1.09 (0.06)	1.09 (0.06)
SES				
Less than $10,000			1.09 (0.06)	1.13 (0.07)
More than $10,000			0.99 (0.08)	1.08 (0.09)
Health/ Morbidities				1.21* (0.04)

*(The highlighted values have a p value < 0.01)

Table 2.8. Hospital Overnights in the Past 12 Months (Waves 1 and 2)

WAVE 1					WAVE 2				
		Country respondent was born in		Total			Country respondent was born in		Total
		Mexico	U.S.				Mexico	U.S.	
Hospital overnight in last 12 months	1 time	62	67	129	Hospital overnight in last 12 months	1 time	37	40	77
	2 times	14	16	30		2 times	13	9	22
	3 times	4	8	12		3 times	4	4	8
	4 times	1	2	3		4 times	0	5	5
	5 times	1	3	4		5 times	1	1	2
	6 or more times	1	1	2		6 or more times	2	3	5
Total		83	97	180			59	64	123

Table 2.9. Hospital Overnights in the Past 12 Months (Waves 3 and 4)

WAVE 3					WAVE 4				
		Country respondent was born in		Total			Country respondent was born in		Total
		Mexico	U.S.				Mexico	U.S.	
Hospital overnight in last 12 months	1 time	36	28	64	Hospital overnight in last 12 months	1 time	35	35	70
	2 times	11	7	18		2 times	15	17	32
	3 times	1	2	3		3 times	1	5	6
	4 times	0	1	1		4 times	0	2	2

	5 times	1	1	2		6 or more times	2	3	5
	6 or more times	0	1	1					
	no answer	1	1	2					
Total		50	41	91			53	62	115

Table 2.10. Country of Birth versus Mortality

Country Respondent Was Born In versus Death

			Mortality Status			Total
			Living	**Deceased**	**p- value (significance of difference)**	
Country respondent was born in	**Mexico**	Count	**16**	**22**	**0.0486**	**38**
		% within Country respondent was born in	**42.1%**	**57.9%**		**100.0%**
	U.S.	Count	**53**	**91**		**144**
		% within Country respondent was born in	**36.8%**	**63.2%**		**100.0%**
Total		Count	**69**	**113**		**182**
		% within Country respondent was born in	**37.9%**	**62.1%**		**100.0%**

Table 2.11. Causes of Death Among US-Born According to ICD Codes

ICD Code	*Frequency*	*Percent*	*Causes of Death Among US-Born*
A04.7	2	1.0	Enterocolitis due to Clostridium difficile
A41.2	1	.5	Sepsis due to unspecified staphylococcus
A41.9	15	7.4	Sepsis, unspecified
B94.8	1	.5	Sequelae of other specified infectious and parasitic diseases
C04.9	1	.5	Malignant neoplasm of floor of mouth
C14.0	1	.5	Malignant neoplasm of pharynx
C16.9	2	1.0	Malignant neoplasm of stomach
C18.9	4	2.0	Malignant neoplasm of colon
C22.9	3	1.5	Malignant neoplasm of liver and intrahepatic bile ducts
C24.9	1	.5	Malignant neoplasm of biliary tract
C25.9	2	1.0	Malignant neoplasm of pancreas
C34.9	4	2.0	Malignant neoplasm of bronchus and lung
C50.9	3	1.5	Malignant neoplasm of breast
C53.9	1	.5	Malignant neoplasm of cervix uteri
C54.1	1	.5	Malignant neoplasm of corpus uteri (endometrium)
C55	1	.5	Malignant neoplasm of uterus, part unspecified
C56	1	.5	Malignant neoplasm of ovary
C61	1	.5	Malignant neoplasm of prostate
C73	1	.5	Malignant neoplasm of thyroid gland
C79.5	1	.5	Secondary malignant neoplasm of bone and bone marrow
C80	1	.5	Malignant neoplasm, primary site unknown
C85.9	6	3.0	Non-Hodgkin lymphoma
C90.0	1	.5	Multiple myeloma
D13.4	1	.5	Benign neoplasm in Intrahepatic bile ducts
D68.9	1	.5	Coagulation defect, unspecified
E11.2	1	.5	Type 2 diabetes mellitus with kidney complications

E11.9	1	.5	Type 2 diabetes mellitus Without complications Controlled
E14.2	1	.5	Unspecified diabetes mellitus
E14.5	1	.5	Unspecified diabetes mellitus with peripheral circulatory complications
E14.9	8	4.0	Unspecified diabetes mellitus without complications
E46	1	.5	Unspecified protein-energy malnutrition
E78.0	1	.5	Pure hypercholesterolaemia
E78.5	4	2.0	Unspecified diabetes mellitus
E87.2	1	.5	Acidosis
E88.9	2	1.0	Metabolic disorder, unspecified
F01.9	2	1.0	Vascular dementia, unspecified
F03	16	7.9	Unspecified dementia
G12.2	1	.5	Motor neuron disease, multiple sclerosis
G21.9	1	.5	Secondary parkinsonism
G30.1	1	.5	Alzheimer disease with late onset
G30.9	8	4.0	Alzheimer's disease, unspecified
G93.4	1	.5	Encephalopathy, unspecified
I05.9	1	.5	Mitral valve disease, unspecified
I10	1	.5	Essential Hypertension
I11.0	1	.5	Hypertensive heart disease with (congestive) heart failure
I21.9	26	12.9	Acute Myocardial Infarction (ST Elevation, STEMI)
I25.0	1	.5	Atherosclerotic cardiovascular disease
I25.1	9	4.5	Chronic Ischemic Heart Disease of Native Coronary Artery
I25.5	2	1.0	Ischemic Cardiomyopathy
I25.8	1	.5	chronic ischaemic heart disease
I25.9	1	.5	Ischaemic heart disease (chronic), unspecified
I34.0	1	.5	Mitral (valve) insufficiency
I35.0	1	.5	Nonrheumatic Aortic Valve Stenosis
I50.0	7	3.5	Heart Failure
I51.9	1	.5	Cardiomyopathy
I61.9	2	1.0	Intracerebral haemorrhage, unspecified

I62.9	1	.5	Intracranial haemorrhage (nontraumatic),
I64	2	1.0	Cerebral Infarction
I67.8	1	.5	Acute cerebrovascular insufficiency
I69.4	1	.5	Sequelae of stroke, not specified as haemorrhage or infarction
I70.9	1	.5	Generalized and unspecified atherosclerosis
J18.9	2	1.0	Pneumonia, unspecified organism
J44.0	1	.5	Chronic obstructive pulmonary disease with (acute) lower respiratory infection
J44.1	1	.5	Chronic obstructive pulmonary disease with (acute) exacerbation
J44.9	1	.5	Chronic obstructive pulmonary disease, unspecified
J45.9	1	.5	Unspecified asthma
J69.0	7	3.5	Aspiration pneumonia
K56.2	1	.5	Volvulus
K70.3	1	.5	Alcoholic cirrhosis of liver
K74.6	2	1.0	Fibrosis and cirrhosis of liver
K81.0	1	.5	Pulmonary oedema
K92.2	1	.5	Gastrointestinal haemorrhage,
M86.9	1	.5	Osteomyelitis
N18.0	2	1.0	Chronic kidney disease
N18.5	1	.5	Chronic kidney disease, stage 5
N18.9	1	.5	Chronic kidney disease, unspecified
N19	1	.5	kidney failure
N39.0	2	1.0	Urinary tract infection
R62.8	1	.5	lack of expected normal physiological development, failure to thrive
W06	1	.5	Fall involving bed
W19	1	.5	Unspecified fall, slipping
X09	1	.5	Burning, Incineration, Smoke Inhalation
X59.0	1	.5	Exposure to unspecified factor causing fracture
Y84.8	1	.5	
Total	202	100.0	

Table 2.12. Causes of Death Among Mexican-Born According to ICD Codes

ICD Code	*Frequency*	*Percent*	*Causes of Death Among Mexican Born*
A41.9	7	4.5	Sepsis, unspecified
B78.7	1	0.6	Disseminated strongyloidiasis
C14.0	1	0.6	Malignant neoplasm of pharynx
C16.9	1	0.6	Malignant neoplasm of stomach
C22.1	1	0.6	Cholangiocarcinoma
C23	1	0.6	Malignant neoplasm of gallbladder
C25.9	2	1.3	Malignant neoplasm of pancreas
C34.9	3	1.9	Malignant neoplasm of bronchus and lung
C50.9	1	0.6	Malignant neoplasm of breast
C56	1	0.6	Malignant neoplasm of ovary
C71.9	2	1.3	Malignant neoplasm of brain
C79.5	1	0.6	Secondary malignant neoplasm of bone and bone marrow
C80	1	0.6	Malignant neoplasm, primary site unknown
C85.9	2	1.3	Non-Hodgkin lymphoma
C91.1	1	0.6	Lymphoid leukaemia
C97	1	0.6	Malignant neoplasms of independent (primary) multiple sites
D43.2	2	1.3	Neoplasm of Brain
D46.9	2	1.3	Myelodysplastic syndrome (Preleukemia)
D64.9	2	1.3	Anaemia, unspecified
E10.9	1	0.6	Type 1 diabetes mellitus without complications
E11.2	1	0.6	Type 2 diabetes mellitus with kidney complications
E11.9	2	1.3	Type 2 diabetes mellitus Without complications Controlled

E14.2	1	0.6	Unspecified diabetes mellitus
E14.5	1	0.6	Unspecified diabetes mellitus with peripheral circulatory complications
E14.9	4	2.5	Unspecified diabetes mellitus without complications
E87.2	2	1.3	Acidosis
E88.9	1	0.6	Metabolic disorder, unspecified
F01.9	1	0.6	Vascular dementia, unspecified
F03	1	0.6	Unspecified dementia
F05.1	1	0.6	Delirium superimposed on dementia
G20	1	0.6	Parkinson disease
G30.9	15	9.6	Alzheimer's disease, unspecified
G93.1	1	0.6	Anoxic brain damage, not elsewhere classified
I10	2	1.3	Essential Hypertension
I21.9	21	13.4	Acute Myocardial Infarction (ST Elevation, STEMI)
I25.1	9	5.7	Chronic Ischemic Heart Disease of Native Coronary Artery
I31.9	1	0.6	Cardiac tamponade, Pericarditis (chronic)
I38	1	0.6	Endocarditis, Valve Unspecified
I46.9	1	0.6	Cardiac arrest, unspecified
I50.0	5	3.2	Heart Failure
I50.9	1	0.6	Heart failure, unspecified
I60.9	1	0.6	Nontraumatic subarachnoid hemorrhage, unspecified
I61.9	1	0.6	Intracerebral haemorrhage, unspecified
I62.9	1	0.6	Intracranial haemorrhage (nontraumatic),
I64	5	3.2	Cerebral Infarction
I69.4	1	0.6	Sequelae of stroke, not specified as haemorrhage or infarction
I71.4	1	0.6	aneurysm and dissection

I95.9	1	0.6	Hypotension, unspecified
J18.9	4	2.5	Pneumonia, unspecified organism
J44.0	2	1.3	Chronic obstructive pulmonary disease with (acute) lower respiratory infection
J44.9	6	3.8	Chronic obstructive pulmonary disease, unspecified
J80	1	0.6	Adult respiratory distress syndrome
J81	1	0.6	Pulmonary oedema
J84.1	1	0.6	Pulmonary fibrosis, unspecified
K55.9	1	0.6	Vascular disorder of intestine (Ischemic enteritis)
K66.0	1	0.6	Peritoneal adhesions
K70.3	1	0.6	Alcoholic cirrhosis of liver
K72.9	1	0.6	Hepatic failure with coma
K74.6	3	1.9	Fibrosis and cirrhosis of liver
K76.9	1	0.6	Liver Disease
K81.0	1	0.6	Pulmonary oedema
M06.9	1	0.6	Rheumatoid arthritis
N18.5	5	3.2	Chronic kidney disease, stage 5
N18.9	1	0.6	Chronic kidney disease, unspecified
N28.8	1	0.6	Other specified disorders of kidney and ureter
N28.9	1	0.6	Disorder of kidney and ureter, unspecified
R54	1	0.6	Senility
V27.4	1	0.6	Motorcycle driver injured in collision with fixed or stationary object in traffic accident
V29.0	1	0.6	Motorcycle rider injured in other and unspecified transport accidents
W19	1	0.6	Unspecified fall, slipping
X74	1	0.6	Intentional self-harm by other and unspecified firearm and gun discharge.
Y83.9	1	0.6	Surgical procedure, unspecified with complication

Table 2.13. Summary of Death-causing Diseases

Summary:	*US-Born (%)*	*Mexico-Born (%)*
Infections	9.4	5.1
Cancers	18.3	15.9
Diabetes	8.4	6.4
Dementia/Alzheimer's	14.9	12.7
CVD	30.2	33.1
Pulmonary	6.4	9.6
Liver Diseases	1.5	4.5
Renal Disorders	3.5	5.1

Table 2.14. Educational Level versus Country of Birth

Country of Birth		*Mexico*	*U.S.*
educational level	0	59 (9.8%)	34 (5%)
	1 - 6	410 (68.2%)	228 (33.6%)
	7 - 12	104 (17.3%)	260 (38.3%)
	Post-high school	28 (4.6%)	156 (23.00%)
Total		601	678

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CHAPTER III: SECOND MANUSCRIPT

Farm-work and Mortality

Abstract

Background: Despite a recent surge in knowledge about Mexican American farm workers, little is known about the health of this population.

Purpose: This paper examines mortality among Mexican American farmworkers. It also explores the impact of years spent in farmwork on prevalent morbidities on this population.

Methods: Mexican American farmworkers' health and mortality was assessed by analyzing data collected from a longitudinal study, part of a larger study - the Border Epidemiological Study of Aging, (BESA). This is a longitudinal design study consisting of four waves conducted in South Texas from 1994 to 2006/07. In 2019, this study was completed by factoring in a fifth wave that collected and examined all causes of mortality.

Results: Results show that farmworkers are at a significantly increased risk for worse mortality and morbidity outcomes. Among farmworkers, those who were male and born in the US fared the worst. Years spent in farmwork also contributed to worse health outcomes, analyzed separately through a Cox Regression survival analysis [HR:1.32, 95%CI: 1.12-1.45, $p < 0.05$]. Data suggest that farmworkers are more likely to develop cardiovascular disorders, kidney disease and diabetes when compared to non-farmworkers in the sample ($p<0.05$). However, aside from diabetes, complications from above conditions though elevated among this population, were not associated with

mortality. Instead, the farmworker population in the study were more likely to die from kidneys, liver, and pulmonary diseases.

Conclusion: Mexican American farmworkers are essential to agriculture in the United States, and actions are needed to protect this vulnerable population.

3.1. Introduction and Literature Review

Farmworkers are a unique population within rural communities and are often overlooked and undercounted. There are over 1.1 million farmworkers in the United States (Economic Research Service, 2022). While comprehensive data on migrant and seasonal farmworkers are lacking, the 2015–2016 National Agricultural Workers Survey found 68% of farmworkers were men and the average age was 38 years. Over 80% identify as Latino or Hispanic. Farmworkers' median personal income reported for the prior year were in the range of $17,500 to $19,999, average educational attainment was the eighth grade, and 40% of farmworkers were living away from their immediate family at the time of the interview (Hernandez & Gabbard, 2018). However, even though farmworkers in the US are predominantly adult men (Arcury & Quandt, 2007), the BESA sample is predominantly female.

The US-Mexico border region offers a unique social, demographic and political context that shapes the health of its residents as well as serves as a microcosm of migration health challenges facing an increasingly mobile and globalized world (Rosales, de Zapien, Chang, Ingram, Fernandez, Carvajal, & Staten, 2017). The history of Mexican origin migrant farm workers can be dated back to the 1940s, following the implementation of the Bracero Program that offered Mexican migrants a temporary

contract to work on U.S farms through 1964 (González & Loza, 2016; Mize, 2016). According to several studies, farmworkers have high levels of chronic diseases such as diabetes and respiratory problems, are at risk for infectious diseases, and experience among the highest incidences of occupational injuries (Rosales, 2012). Farm workers bear a disproportionate burden of poverty and ill health and additionally face significant occupational hazards (Rosales, 2012). Previous studies have been conducted on farmworkers' health yet no in-depth longitudinal examination has been conducted examining Mexican American farmworkers' mortality over a period of time. There have been a number of cross-sectional studies of migrant health but few longitudinal studies were identified. Many studies in the past have focused on the wellbeing (e.g., health and illness) of migrant farm workers from the epidemiological perspective (e.g., Castañeda et al., 2015; Dodd et al., 2016; Mucci, Traversini, Giorgi, Tommasi, De Sio, & Arcangeli, 2020). "Approximately 4.2 million migrant and seasonal farmworkers and their families work in the United States, and 1.6 million are classified as migrants. Migrant farmworkers are known to have more health problems than the general population, and they lack dependable access to health care services" (Mucci, Traversini, Giorgi, Tommasi, De Sio, & Arcangeli, 2020). In approaching this examination, we first review the social context of this specific population and then examine the clinical aspects. Invisibility of farmworkers within institutions, such as health care, the educational system, social services, domestic violence shelters, and churches contribute to illness among farmworkers (Bail, Foster, Dalmida, Kelly, Howett, Ferranti, & Wold, 2012). Previous studies on farmworkers have investigated their workplace as a source of environmental exposures that lead to injury and illness while others focused on the

workplace as a source of stressors that can contribute to short- and long-term illnesses and injuries. Such stressors include repetitive work, piece-rate work, arbitrary supervision, and low-skilled work (Arcury & Quandt, 2007). Approximately half (55.3%) of farmworkers reported using US health care in 2010 (Hoerster, Mayer, Gabbard, Kronick, Roesch, Malcarne, & Zuniga, 2011). Several factors seem to be independently associated with health care utilization at the individual level (gender, immigration and migrant status, English proficiency, transportation access, health status, and non-US health care utilization), geographical location (proximity to US–Mexico border), and at the policy level (insurance status and workplace payment structure) (Hoerster, Mayer, Gabbard, Kronick, Roesch, Malcarne, & Zuniga, 2011). In the past, farmworkers' illnesses were attributed to their inescapable exposure to pesticides, especially five organophosphates routinely sprayed on crops (Leibson & Lifshitz, 2008). Pesticide use in the USA peaked in 1981, then trended downward, driven by technological innovations and other factors. “Many pesticides still widely used in the USA, at the level of tens to hundreds of millions of pounds annually, have been banned or are being phased out in the EU, China and Brazil. Of the pesticides banned in at least two of these nations, many have been implicated in acute pesticide poisonings in the USA and some are further restricted by individual states” (Donley, 2019). Studies on pesticide poisoning also attributed sex/gender variation in their results. Two studies found that the incidence of a pesticide exposure event was lower for women than men (Bell et al., 2006; Kachaiyaphum et al., 2010). A 2013 study found that farmworkers and non-farmworkers frequently had detections for organophosphates and pyrethroid pesticide urinary metabolites. “Detections of bisdithiocarbamate urinary metabolites were less frequent,

but substantial among the non-farmworkers. The concentrations of organophosphate, bis-dithiocarbamate, and pyrethroid pesticide urinary metabolites were high for farmworkers and non-farmworkers compared to National Health and Nutrition Examination Survey results" (Arcury et al., 2016).

Bell and colleagues report that among men, increased pesticide application days per year, not removing work boots while entering home, and not wearing personal protective equipment increased the risk of an exposure event and its related health symptoms (Bell et al., 2006). All studies have shown sex/gender differences between exposure and cancer diagnosis. In their research in rural South Korea, Lee and colleagues found that as regional farm exposure (i.e. number of farm households, farm size, crop type) increased, men showed higher cancer mortality of the esophagus, stomach, brain and leukemia, while women had elevated cancer mortality for esophageal and stomach cancers (Lee et al., 2008). Differences were also noted for men and women on the tasks involved. Lee et al. (2008) noted an increase in risk of brain cancer among men who used pesticides. Expanding on the above, Lee at al found that increasing farming index mortality of esophageal, stomach and brain cancer was significantly elevated for men, and of esophageal and stomach cancer for women, whereas the standardized mortality ratios for colorectal and gall bladder cancers were inversely associated with farming (Lee at al., 2008). In another study that looked at "295 agricultural workers, acute kidney injury (AKI) after a summer work shift was detected in 35 (11.8%)" (Leibson & Lifshitz, 2008). The cumulative incidence of AKI after a single day of summer agricultural work was found alarming due to an increased risk of long-term kidney damage and mortality

(Moyce, Joseph, Tancredi, Mitchell, & Schenker, 2016). Acute Kidney Injury (AKI) can also be exacerbated by heat and dehydration. A 2015 study with farmworkers in North Carolina observed that a third (35.6%) of the 235 farmworkers reported heat illness while working outside, and 13.9% while working inside. Factors associated with heat illness while working outside included working in wet clothes and shoes, harvesting and topping tobacco, and spending after-work time in an extremely hot house (Arcury et al., 2016). Moreover, a consistent risk factor for mesoamerican nephropathy (a type of chronic kidney disease) appears to be heavy manual labour in extreme heat (Wesseling, Crowe, Hogstedt, et al., 2014). A longitudinal study done in northwest Mexico found that the estimated glomerular filtration rate (eGFR) in migrant and seasonal farmworkers (MSFWs) decreased significantly from pre-harvest (125 ± 13.0 mL/min/1.73 m2) to late harvest (109 ± 13.6 mL/min/1.73 m2) ($p < 0.001$), while no significant change was observed in office workers (Lopez-Galvez et al., 2021). Research conducted with farmworkers in Guatemala examined more closely factors affecting renal function among this population. The authors collected demographic and biological data for 330 sugarcane cutters at the beginning and end of the harvest and found a decline in kidney function. This indicated that both occupational and behavioral factors play significant roles in declines in kidney function (Butler-Dawson et al., 2018).

In one of the few longitudinal studies done on this population, logistic regression models showed that working in an occupation with a higher share of immigrants is associated with higher odds of poor physical and psychological health. This relationship is more pronounced among native-born workers than among foreign-born workers.

Second, this same study proposed two explanations for the association between occupational segregation and health: "(1) workers with less human capital are typically sorted into culturally devalued occupations with a higher concentration of immigrants, and (2) occupations with a higher percentage of immigrants generally have relatively poor work environments" (Qian & Fan, 2016).

In a study conducted by the University of Texas at El Paso in 2003, migrant workers from The National Agricultural Workers Survey (NAWS) were found to be "knowledgeable about symptoms of pesticide exposure, and over half reported experiencing these symptoms during their years of work in agriculture. About one fifth of the sample also reported being injured while working in agriculture. Subjects' nutritional status was suboptimal; they ate high fat diets with few fruits and vegetables, and their mean BMI was in the overweight range. This degree of overweight and obesity is especially significant in a population that is engaged in hard physical labor and suggests that subjects were eating a diet very high in calories. The fact that subjects sought health care on both sides of the US/Mexico border reflects their binational existence. Similar to the results of national surveys, such as the NAWS, few workers had health insurance and a small percentage had Medicare or Medicaid. Most subjects paid for their health care out of pocket" (Sapbamrer & Nata, 2003). Another study from North Carolina found low to moderate levels of knowledge about colorectal, breast, and testicular cancer among farmworkers. Compared to non-farmworkers, farmworkers had similar levels of knowledge about breast and testicular cancer, but slightly lower knowledge about colorectal cancer ($p = 0.0087$) (Furgurson, Sandberg et al., 2019).

Furthermore, a study of self- and physician-assessed health for Mexican Americans showed a great deal of disagreement between the respondents and the physicians, particularly for those who were interviewed in Spanish. For this group, the physicians assessed 80% as being in excellent or very good health. But only 15% of the respondents considered their health to be excellent over very good (Angel & Guarnaccia, 1989). The Spanish speaking respondents also reported higher levels of depression, a pattern possibly related to the lack of separation between psychological and physical senses of self. In this population, high levels affective distress are interpreted as a sign of negative physical health. In addition to ailments recognized by biomedicine, Mexican tradition recognizes a number of folk illnesses, such as susto mal puesto , and nervios. These folk illnesses have psychological symptoms. It has been suggested that since treatment for folk illnesses may be in the hands of folk healers, fewer of them may come to the attention of biomedical mental health providers (Schreiber & Homiak, 1981).

A study by Claudia Saenz at the University of Texas at El Paso studied predominantly middle-aged Hispanic border farmworkers and found this population to have a potential risk for STI's and unintended pregnancy. It also indicated that the prevalence of lifetime and recent cervical cancer screening, and to a lesser extent, breast cancer screening, was higher than that reported for many other farmworker groups. In contrast, the low prevalence of prostate screening among mostly middle-aged male group was a concern (Saenz, 2010). Another study conducted in Guatemala found that

occupational and behavioral factors played a significant role in declines in kidney function among farmworkers (Butler-Dawson et al., 2018).

Farmworkers are also disproportionately affected by emerging threats, including climate change and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Given the global COVID-19 epidemic, there are little data on the impact of COVID-19 on morbidity and mortality among migrants specifically, but migrants living in refugee camps, detention centers and reception centers are at particularly high risk for COVID-19 exposure (Greenaway et al., 2020). COVID-19 has emerged in a world tightly connected by local and international population movements, with more people moving for work, education and family reasons, tourism and survival than ever in the past (Skeldon, 2018). Migrants are a heterogenous population that may have various health needs and face barriers to care that differ by migrant type, entitlement to care and stage along the migration journey (Greenaway et al., 2020). Globally, migrant workers have faced a disproportionate social and economic impact from the pandemic (Guadagno, 2020). In fact, COVID-19 cases have been increasing exponentially among migrant labor camps, some of which exclusively house Hispanic workers who are part of the federal H-2A temporary work visa program (Quandt et al., 2020).

Despite the above identified health problems, farmworkers also experience lower incidence rates in some health disorders. A study performed on 272 farmworkers and non-farmworkers in North Carolina evaluated the variability in the prevalence of epicondylitis, rotator cuff syndrome, low back pain, and lower extremity pathology

among immigrant Latino farmworkers and non-farmworkers. It found that the prevalence of musculoskeletal disorders (MSD) among Latino manual workers is high compared to other workers in similar occupations. Non-farmworkers (49%) had a higher prevalence of MSDs than farmworkers (35%). Epicondylitis (20.2%) and rotator cuff syndrome (19.1%) were most prevalent (Mora, 2016).

3.2. Methods

3.2.1. Study Design and Sampling

Data for the analysis presented here are from the Border Epidemiological Study of Aging, (BESA), a longitudinal design study consisting of four waves conducted in South Texas from 1994 to 2006/07. The first and last waves will be used in this analysis by looking at information on farmworkers collected in the fourth wave as well as mortality data and comorbidities collected in the mortality analysis in 2020. A two-stage stratified random sampling was utilized in recruiting participants to the study. The initial sample yielded 1089 participants, 45 years or older, selected using tract data from the 1995 US Census to estimate the number of qualifying Hispanic adults 45 years and older in four counties along the Texas Mexico border (Hidalgo, Cameron, Willacy, and Starr).

Besides the age stratum of 45+ and the Mexican American origin, census tracts were used as the strata to generate recruitment quotas. Sample recruitment for all census tracts were stratified by age and proportionally represented in the final sample. For analytic purposes, 240 participants were included from the initial sample who indicated farmwork as the major occupation during wave 1 of the study. Exclusion criteria was as follows: (1) not being a farmworker or (2) loss of follow up in the last wave or missing

data. Thus, for this study, only farmworkers are included which made up 20% of the entire sample.

3.2.2. Study Variables

Data collection began in 1995 followed by three consecutive waves conducted between 1995 and the end of the last wave in 2006/07. Participants consented to join an in-home face-to-face interview in either Spanish or English. In every wave, participants were administered a 2-hr general health questionnaire approved by a panel of community residents and researchers. All health reported data were further verified by a medical doctor who reviewed the data with reference to prescription medications, family physician and laboratory work whenever included.

3.2.2.1. Independent Variables

Years Spent in Farm-work

Years spent in farm-work is a variable that was collected by asking participants to write down the number of years spent in farm-work. The "0 - 10" category was used as a reference group in the regression analysis.

3.2.2.2. Dependent Variable

Mortality

Survival follow-up was assessed through three different methods. In 2008, death data was obtained from death certificates requested from the Texas Department of Health Services (TDSHS). In 2020, mortality data of the entire BESA sample were requested from the CDC through the records of the National Death Index. For participants with incorrect or missing Social Security Numbers (SSN), obituaries news and/or phone calls were used to obtain date of death and assess their vital status. Survival time was

measured in years starting with the date of baseline data collection and ending with the death of the participant or end of follow up on December 31, 2019.

Morbidities

Participants were asked if they were medically diagnosed with any of the following diseases: thyroid diseases, cancer, gastrointestinal diseases such as ulcer, cardiovascular diseases, diabetes or neuromuscular disorders such as Parkinson's diseases. Accordingly, the response was coded dichotomously as whether the participant was diagnosed with at least one of these diseases or none. All comorbidities were recorded by a clinical interviewer and further validated by a medical doctor who reviewed all prescribed medications respondents were taking at the time of the interview and their self-report of a chronic disease.

Cause of Death

Along with the collected mortality data for the complete BESA sample that was acquired from the CDC in 2020 via the National Death Index records, causes of death were also obtained in the form of ICD-10 codes.

3.2.2.3. Covariates

Age, sex, marital status, and country of birth

Age at baseline was treated as a continuous variable in the logistic regression analysis. Sex was coded as male or female. Marital status was coded as married or not married. Country of birth was self-reported and coded as U.S. or Mexico.

Income

Annual participant income was self-reported at baseline in 1995 and coded as less than $7000 and $7000 or higher. *Education:* participants were asked about years of

formal education. Responses were coded as having some college education (13 years or more) or not having a college education (less than 13 years).

Years in the United States

For the Mexican born, years of residence in the United States were coded as follows: being a U.S. resident for less than 20 years and 20 years or more of residency in the U.S.

3.2.3. Statistical Methods

In univariate analysis, Chi-square test was used to examine the relationship between selected study variables and incident mortality. For multivariable analysis, a binary logistic regression model was applied to assess the association between independent variables and mortality adjusting for study covariates. Crosstabulation (in the form of Chi-square) was then used to investigate level of education versus mortality. Mediation effect of years spent in farmwork was tested using Model 4 in SPSS's PROCESS. The final regression model was adjusted for baseline sex, age, years in the US, education, income, perceived health status, country of birth and all independent variables. All the tests were two-tailed with a significance level alpha set at 0.05. IBM SPSS software version 26 was used to analyze the data (IBM Corporation).

3.3. Data Analysis

The BESA sample had a total of 240 farmworkers, 68% female and 32% male. At the time the fifth wave of data collection (2019), nearly 57% of this population was deceased. Cox Regression survival model indicated that all of the following variables: sex, age, country of birth, general health status and years spent in farmwork were

statistically significant for all our sample. Moreover, after controlling for the above variables, just being a farm worker was statistically significant in terms of mortality and was strongly positively correlated with mortality given a 95% confidence interval. Furthermore, in general, males, older aged participants, those born in the US and those who reported worse general health status were at a higher risk of death.

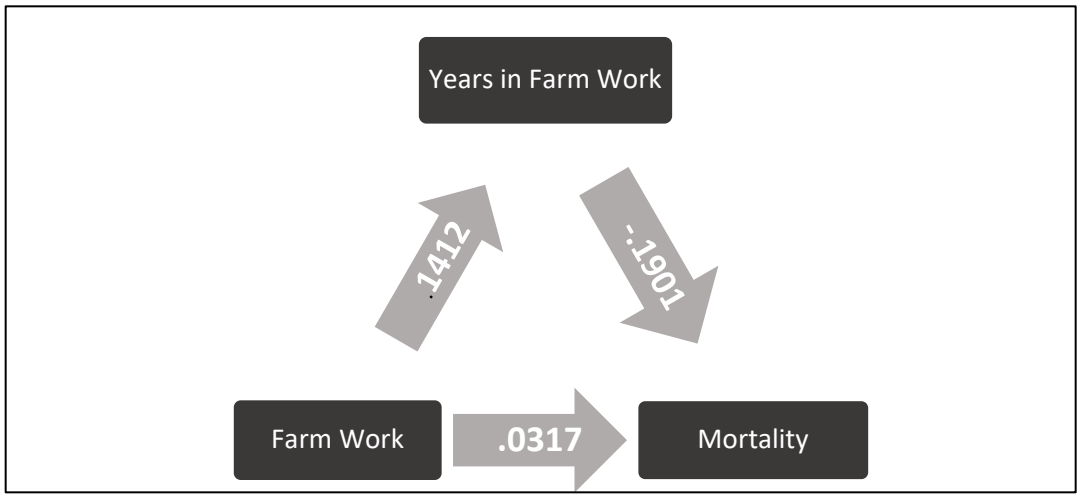
Further examining years spent in farmwork, 32% spent 11- 20 years and 27% spent between 31- 45 years, with only 19% of this population spending less than 10 years in farmwork. Most male farmworkers reported over 20 years of farmwork, while most female farmworkers tend to spend between 16 and 20 years in farmwork. Subsequently, we looked at how years spent in farm work may have an impact on mortality, controlling for being a farm worker, age, gender, country of birth, education level, general health status and SES. Cox Regression model showed that years spent in farmwork was statistically significant and positively related to mortality, given 95% confidence interval [HR:1.32, 95%CI: 1.12-1.45, $p < 0.05$].

Table 3.1 – Years Spent in Farm Work versus Mortality
Years Spent in Farm-work vs Mortality (A Gendered Approach)

Sex			**Mortality Status**		**Total**
			living	***deceased***	
Male	Years Spent in Farm-working	0 -10	0	2	2
		11 - 20	2	5	7
		21 - 30	1	5	6
		31 - 45	4	10	14
	Total		7	22	29
Female	Years Spent in Farm-working	0 -10	11	9	20
		11 - 20	7	21	28

		21 - 30	8	10	18
		31 - 45	8	8	16
	Total		34	48	82
Total	Years Spent in Farm-working	0 -10	11	11	22
		11 - 20	9	26	35
		21 - 30	9	15	24
		31 - 45	12	18	30
	Total		41	70	111

Figure 3.1 - Mediation Effect by Years of Farmwork



To check any significant mediation effect of years spent in farm-work in the survival analysis of years spent in farm-work, we used Model 4 in SPSS's PROCESS. The mediation model was applied to explain the relationship between the antecedent (farm work, the predictor variable) and outcome (mortality). In this model, we hypothesize that the effect of the predictor variable (years spent in farmwork) upon the outcome operates, fully or in part, through an intervening or mediator variable. Examining the indirect effect of farm work on mortality, we notice that the range between the upper and lower Bootstrap Confidence Intervals contains zero, which renders this mediation effect non-significant given this confidence interval. Moreover, looking at

the R-squared measure of the model, we realize that the variables in this model only explain about 9% of the variability in the outcome scores.

We examined the educational level of our farmworker population. The highest grade reached was 12 and twenty two percent (52) stopped at grade 3. Only three were high-school graduates.

To further as well as strengthen our results, we investigated the hazards ratios concerned with years spent at farm work, compounded with other health-outcome variables. Results were tabulated whereby mortality predictors were introduced in a stepwise fashion. Model 1 includes years spent in farmwork variable, with non-farm workers being the reference (in addition to demographics). In this model, spending 31 – 45 in farm work increases risk of death by 24%.

Model 2 adds education to the equation. In this model, education doesn't seem to affect the association between years spent in farm work and mortality. In Model 3, SES (in the form of income) is added to the equation. Its introduction also doesn't seem to have a significant impact on the associations exhibited in the first model. Model 4 introduces the prevalent chronic conditions (those reporting more than 1 major health disorder). When introduced, having spent 31 – 45 years farmwork remains statistically significant. However, this is not true for less years spent in fam work.

Next, we examined the comorbidities and investigated which ones are more prevalent among farm workers. For that purpose, we employed crosstabulation along with their Chi-Squared Tests. We could deduce that farmworkers seem to be at a significantly higher risk of having the following health problems compared to their non-farm-work counterparts: cardiovascular disorders, renal diseases, arthritis, diabetes.

In order to confirm above results, a Cox regression model was run for each health disorder independently from each other (along with the covariates to be controlled). This resulted in a more accurate outcome since interactions between comorbidities within the same equation were avoided. This further identified stroke, cardiovascular diseases and diabetes as the three most significant diseases associated with mortality among farmworkers.

Consequently, the association between all-time morbidities and death among this population was investigated, and we found that farmworkers, when compared with non-farmworkers, report more liver, renal and pulmonary disorders as well as complications of diabetes. On the other hand, non-farmworkers report more cancers, cardiovascular disorders, and infections.

Table 3.2 - Discrepancies in Morbidities between Farm Workers and Non-farm Workers

Morbidities Correlated with of Death	Farmworkers (%)	Non-Farmworkers (%)
Infections	6.97	7.45
Cancers	13.96	17.25
Diabetes	10.47	7.85
Dementia/Alzheimer's	10.47	14.12
Cardiovascular	30.26	32.94
Pulmonary (COPD/ Pneumonia)	10.47	6.67
Liver (Cirrhosis)	5.815	3.14
Renal	5.815	3.92

Finally, mortality and morbidities among this population was assessed (Tables 1 through 3) by examining the causes of death written as ICD-10 codes on discharge summaries of actual hospitalizations. According to the latter, most frequently reported causes of death for farmworkers were from liver, renal, pulmonary disorders, and complications of diabetes. On the other hand, cancers, dementia/Alzheimer's,

cardiovascular disorders, and infections were reported most often in discharge summaries of non-farmworkers.

2.4. Discussion

The results presented here should be considered in the same context as the data that were collected. This study focuses on microlevel, intermediate, and meso-level social processes, as well as the quantitative data sources that may be used at each level.

Above results indicate that being a farmworker is a significant factor in yielding a worse mortality and morbidity outcome; among farmworkers, those who are male, of older age and born in the US did worst. Years spent in farmwork also contributed to worse health outcomes and this was analyzed separately through a Cox Regression survival analysis [HR:1.32 (0.07), CI: 95%, $p < 0.05$]. Data analysis suggest that farmworkers are more likely to develop cardiovascular disorders, renal diseases and diabetes when compared to non-farmworkers in the sample. However, aside from diabetes related conditions, these conditions were not listed as causes of death that were specifically elevated among this population. Instead, farmworkers studied here were more likely to die from renal, liver and pulmonary diseases.

The best way to understand this study's findings is to understand the dynamics behind the lifestyles of the farm work population. This population has its own social hierarchy and is defined by variables that are unique to it. Discrepancies in health care were not confined to socioeconomic position in this population. Ethnicity, geography, and insurance status are all factors that might have a negative impact on a community's

health. Because of "over representation of racial and ethnic minority employees in a hazardous industry, absence of occupational safety and health initiatives," the authors of the Kresge report (2012) observed health inequalities among migrant farmworkers (p. 17). Critical theory aimed to explain not just the workings of modern societies, but also their human and social consequences as well as their underlying conflicts. The preservation of stratification hierarchies was underlined by Bourdieu in particular as part of a long-term and systematic complex of "social reproduction" processes (1990, p. 139). Such a concept ran opposed to the educational principles of equal opportunity and merit-based incentives that were sympathetically viewed by certain leading voices of the functionalist tradition, particularly in the United States (Parsons, 1951; Parsons & Platt, 1973; Turner, 1960). Despite the fact that the social reproduction viewpoint has paid little attention to human growth and aging, the potential relationship is clear. If education, for example, is a resilient mechanism for reproducing class-based or other regimes of inequality, then diverging interindividual trajectories that lead to increasing intracohort inequality have their origins in early childhood education-based stratification and, it can be hypothesized, continue to be amplified throughout life. Hence, education is pivotal in determining one's health outcomes and therefore, we analyzed the educational background of this population. None of them went beyond high school and most of them stopped at grade 3. Research indicates that adults with higher educational attainment live healthier and longer lives compared to their less educated peers (Zajacova & Lawrence, 2018). Moreover, research that examined the impact of educational attainment on health outcomes in moderate to severe chronic kidney disease found a "significant trend ($P < 0.001$) toward increased vascular risk with decreasing levels of education. Participants

with no formal education were at a 46% higher risk of vascular events (relative risk [RR], 1.46; 95% CI, 1.14-1.86) compared with participants with tertiary education" (Morton, DPhil et al., 2016).

Differences in gender and differences in years spent in farmwork also set farmworkers in this study on different trajectories. The significance of behavioral, legal, political, and other aspects of institutional life—dimensions that are completely independent of individual worker characteristics—is therefore understood to have an influence on parameters like wages, job security, and access to health care. From the standpoint of Cumulative Advantage/Disadvantage theory, such sectoral inequalities in the organization of labor may easily be linked to divergence in wages and pension accumulations as workers age (Crystal, Shea, & Reyes, 2017), as well as divergence in other job-related consequences including health and access to health care (e.g., Carr, 2012; Mirowsky & Ross, 2008). The idea of labor market segmentation differs from neoclassical economic theory, which assumes the presence of a unified labor market with unrestricted competition between buyers and suppliers.

Table 3.3 – Causes of Death Among Farmworkers

ICD	Frequency	Percent	Cause of Death
A04.7	1	1.163	Enterocolitis due to Clostridium difficile
A41.9	5	5.814	Sepsis, unspecified
C16.9	1	1.163	Malignant neoplasm of stomach
C18.9	1	1.163	Malignant neoplasm of colon
C22.9	1	1.163	Malignant neoplasm of liver and intrahepatic bile ducts
C25.9	1	1.163	Malignant neoplasm of pancreas
C34.9	1	1.163	Malignant neoplasm of bronchus and lung
C50.9	1	1.163	Malignant neoplasm of breast
C56	1	1.163	Malignant neoplasm of ovary
C80	1	1.163	Malignant neoplasm, primary site unknown
C90.0	1	1.163	Multiple myeloma
C97	1	1.163	Malignant neoplasms of independent (primary) multiple sites
D13.4	1	1.163	Benign neoplasm in Intrahepatic bile ducts
D43.2	1	1.163	Neoplasm of Brain
E11.9	2	2.326	Type 2 diabetes mellitus Without complications Controlled
E14.5	1	1.163	Unspecified diabetes mellitus with peripheral circulatory complications
E14.9	3	3.488	Unspecified diabetes mellitus without complications
E78.5	2	2.326	Unspecified diabetes mellitus
E87.2	1	1.163	Acidosis
F01.9	2	2.326	Vascular dementia, unspecified
F03	3	3.488	Unspecified dementia
G30.9	4	4.651	Alzheimer's disease, unspecified
I10	1	1.163	Essential Hypertension
I21.9	12	13.953	Acute Myocardial Infarction (ST Elevation, STEMI)

I25.1	4	4.651	Chronic Ischemic Heart Disease of Native Coronary Artery
I25.5	1	1.163	Ischemic Cardiomyopathy
I35.0	1	1.163	Nonrheumatic Aortic Valve Stenosis
I38	1	1.163	Endocarditis, Valve Unspecified
I50.0	1	1.163	Heart Failure
I60.9	1	1.163	Nontraumatic subarachnoid hemorrhage, unspecified
I64	4	4.651	Cerebral Infarction
J18.9	1	1.163	Pneumonia, unspecified organism
J44.0	1	1.163	Chronic obstructive pulmonary disease with (acute) lower respiratory infection
J44.1	1	1.163	Chronic obstructive pulmonary disease with (acute) exacerbation
J44.9	5	5.814	Chronic obstructive pulmonary disease, unspecified
J45.9	1	1.163	Unspecified asthma
K70.3	2	2.326	Alcoholic cirrhosis of liver
K72.9	1	1.163	Hepatic failure with coma
K74.6	1	1.163	Fibrosis and cirrhosis of liver
K76.9	1	1.163	Liver Disease
M86.9	1	1.163	Osteomyelitis, unspecified
N18.0	1	1.163	Chronic kidney disease
N18.5	1	1.163	Chronic kidney disease, stage 5
N18.9	1	1.163	Chronic kidney disease, unspecified
N28.8	1	1.163	Other specified disorders of kidney and ureter
N28.9	1	1.163	Disorder of kidney and ureter, unspecified
V29.0	1	1.163	Driver injured in collision with other and unspecified motor vehicles in nontraffic accident
W19	1	1.163	Unspecified fall, slipping
X59.0	1	1.163	Exposure to unspecified factor causing fracture
Y84.8	1	1.163	Abnormal reaction of the patient, or of later complication
Total	86	100	

Table 3.4 – Causes of Death Among Non-farmworkers

ICD	Frequency	Percent	Cause of Death
A04.7	1	0.392	Enterocolitis due to Clostridium difficile
A41.2	1	0.392	Sepsis due to unspecified staphylococcus
A41.9	15	5.882	Sepsis, unspecified
B78.7	1	0.392	Disseminated strongyloidiasis
B94.8	1	0.392	Sequelae of other specified infectious and parasitic diseases
C04.9	1	0.392	Malignant neoplasm of floor of mouth
C14.0	1	0.392	Malignant neoplasm of pharynx
C16.9	2	0.784	Malignant neoplasm of stomach
C18.9	2	0.784	Malignant neoplasm of colon
C22.1	1	0.392	Cholangiocarcinoma
C22.9	2	0.784	Malignant neoplasm of liver and intrahepatic bile ducts
C23	1	0.392	Malignant neoplasm of gallbladder
C25.9	3	1.176	Malignant neoplasm of pancreas
C34.9	6	2.353	Malignant neoplasm of bronchus and lung
C50.9	3	1.176	Malignant neoplasm of breast
C53.9	1	0.392	Malignant neoplasm of cervix uteri
C54.1	1	0.392	Malignant neoplasm of corpus uteri (endometrium)
C55	1	0.392	Malignant neoplasm of uterus, part unspecified
C56	1	0.392	Malignant neoplasm of ovary
C61	1	0.392	Malignant neoplasm of prostate
C71.9	2	0.784	Malignant neoplasm of brain
C73	1	0.392	Malignant neoplasm of thyroid gland
C79.5	2	0.784	Secondary malignant neoplasm of bone and bone marrow
C80	1	0.392	Malignant neoplasm, primary site unknown
C85.9	7	2.745	Non-Hodgkin lymphoma

C91.1	1	0.392	Lymphoid leukaemia
D43.2	1	0.392	Neoplasm of Brain
D46.9	2	0.784	Myelodysplastic syndrome (Preleukemia)
D64.9	2	0.784	Anaemia, unspecified
D68.9	1	0.392	Coagulation defect, unspecified
E10.9	1	0.392	Type 1 diabetes mellitus without complications
E11.2	2	0.784	Type 2 diabetes mellitus with kidney complications
E11.9	1	0.392	Type 2 diabetes mellitus Without complications Controlled
E14.2	3	1.176	Unspecified diabetes mellitus
E14.5	1	0.392	Unspecified diabetes mellitus with peripheral circulatory complications
E14.9	9	3.529	Unspecified diabetes mellitus without complications
E46	1	0.392	Unspecified protein-energy malnutrition
E78.0	1	0.392	Pure hypercholesterolaemia
E78.5	1	0.392	Unspecified diabetes mellitus
E87.2	2	0.784	Acidosis
E88.9	1	0.392	Metabolic disorder, unspecified
F01.9	1	0.392	Vascular dementia, unspecified
F03	14	5.490	Unspecified dementia
F05.1	1	0.392	Delirium superimposed on dementia
G12.2	1	0.392	Motor neuron disease, multiple sclerosis
G20	1	0.392	Parkinson disease
G21.9	1	0.392	Secondary parkinsonism
G30.1	1	0.392	Alzheimer disease with late onset
G30.9	16	6.275	Alzheimer's disease, unspecified
G93.1	1	0.392	Anoxic brain damage, not elsewhere classified
G93.4	1	0.392	Encephalopathy, unspecified
I05.9	1	0.392	Mitral valve disease, unspecified

I10	2	0.784	Essential Hypertension
I11.0	1	0.392	Hypertensive heart disease with (congestive) heart failure
I21.9	32	12.55	Acute Myocardial Infarction (ST Elevation, STEMI)
I25.0	1	0.392	Atherosclerotic cardiovascular disease
I25.1	14	5.490	Chronic Ischemic Heart Disease of Native Coronary Artery
I25.5	1	0.392	Ischemic Cardiomyopathy
I25.8	1	0.392	chronic ischaemic heart disease
I25.9	1	0.392	Ischaemic heart disease (chronic), unspecified
I31.9	1	0.392	Cardiac tamponade, Pericarditis (chronic)
I34.0	1	0.392	Mitral (valve) insufficiency
I46.9	1	0.392	Cardiac arrest, unspecified
I50.0	11	4.314	Heart Failure
I50.9	1	0.392	Heart failure, unspecified
I51.9	1	0.392	Cardiomyopathy
I61.9	3	1.176	Intracerebral haemorrhage, unspecified
I62.9	2	0.784	Intracranial haemorrhage (nontraumatic),
I64	3	1.176	Cerebral Infarction
I67.8	1	0.392	Acute cerebrovascular insufficiency
I69.4	2	0.784	Sequelae of stroke, not specified as haemorrhage or infarction
I70.9	1	0.392	Generalized and unspecified atherosclerosis
I71.4	1	0.392	aneurysm and dissection
I95.9	1	0.392	Hypotension, unspecified
J18.9	4	1.568	Pneumonia, unspecified organism
J44.0	2	0.784	Chronic obstructive pulmonary disease with (acute) lower respiratory infection
J44.9	2	0.784	Chronic obstructive pulmonary disease, unspecified
J69.0	7	2.745	Aspiration pneumonia
J80	1	0.392	Adult respiratory distress syndrome

J81	1	0.392	Pulmonary oedema
K55.9	1	0.392	Vascular disorder of intestine (Ischemic enteritis)
K56.2	1	0.392	Volvulus
K66.0	1	0.392	Peritoneal adhesions
K74.6	4	1.568	Fibrosis and cirrhosis of liver
K81.0	2	0.784	Acute cholecystitis
K92.2	1	0.392	Gastrointestinal haemorrhage,
M06.9	1	0.392	Rheumatoid arthritis
N18.0	1	0.392	Chronic kidney disease
N18.5	5	1.960	Chronic kidney disease, stage 5
N18.9	1	0.392	Chronic kidney disease, unspecified
N19	1	0.392	kidney failure
N39.0	2	0.784	Urinary tract infection
R54	1	0.392	Senility
R62.8	1	0.392	lack of expected normal physiological development, failure to thrive
W06	1	0.392	Fall involving bed
W19	1	0.392	Unspecified fall, slipping
X09	1	0.392	Burning, Incineration, Smoke Inhalation
Y83.9	1	0.392	Surgical procedure, unspecified with complication
Total	255	100.0	

Table 3.5 - Summary of The Above 2 Tables

Causes of Death	**Farmworkers (%)**	**Non-Farmworkers (%)**
Infections	6.97	7.45
Cancers	13.96	17.25
Diabetes	10.47	7.85
Dementia/Alzheimer's	10.47	14.12
Cardiovascular	30.26	32.94
Pulmonary (COPD/ Pneumonia)	10.47	6.67
Liver (Cirrhosis)	5.815	3.14
Renal	5.815	3.92

Table 3.6 - Hazards Ratio for Years Spent in Farm Work versus Mortality

Independent Variable	Model 1, Hazard Ratio (SE)	Model 2, Hazard Ratio (SE)	Model 3, Hazard Ratio (SE)	Model 4, Hazard Ratio (SE)
Years Spent in Farm Work				
0 - 10	0.96 (0.05)	0.93 (0.04)	0.95 (0.05)	0.88 (0.05)
11 - 20	0.95 (0.04)	0.98 (0.08)	0.96 (0.07)	0.94 (0.06)
21 - 30	1.05(0.04)	1.06 (0.06)	1.05 (0.08)	1.12 (0.09)
31 - 45	1.24* (0.05)	1.15 (0.03)	1.05 (0.02)	1.34* (0.05)
Demographics				
Age	1.66* (0.04)	1.65* (0.04)	1.72* (0.15)	1.78* (0.20)
Male	0.90 (0.06)	0.81 (0.08)	0.78 (0.07)	1.32* (0.05)
Education				
Highschool education and more		1.00 (0.11)	1.07 (0.09)	1.18 (0.12)
SES				
Less than $10,000			1.00 (0.03)	1.09 (0.06)
More than $10,000			0.89 (0.07)	0.81 (0.13)
Health/ Morbidities				1.29* (0.10)

**(The highlighted values have a p value < 0.05)*

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CHAPTER IV: THIRD MANUSCRIPT

Impact of a Receptive Network and Neighborhood Context on Mortality

4.1. Introduction and Literature Review

It is well known in the epidemiological literature that health is correlated to people's socioeconomic status (SES) and lifestyle. Indeed, SES has a significant impact on people's physical health (Wang & Geng, 2019). Previous research on income and health has been extensively explored in the epidemiological literature (e.g., Arpey, Gaglioti, & Rosenbaum, 2017; MacIntyre et al., 1998). Lower socioeconomic status (SES) is a determinant of many of the health problems that emerge at older ages. Interestingly, lower SES (defined by wealth) is "related to accelerated decline over 6 to 8 years in 16 outcomes from physical, sensory, physiological, cognitive, emotional, and social domains, independently of diagnosed health conditions, self-rated health, education, and other factors" (Steptoe & Zaninotto, 2020). Furthermore, it "provides evidence for the pervasive role of social circumstances on core aging processes and suggests that less affluent sectors of society age more rapidly than more privileged groups" (Steptoe & Zaninotto, 2020). Despite recent developments, the real association between economic disparity and individual health conditions remains under investigation. It should be emphasized that any discussion of inequality and health, in general, cannot be divorced from the fundamental question of "inequality of what?" (Kawachi, 2000; Sen, 1992). There is no definite answer; however, a myriad of explanations has been suggested (Kawachi., 2000; Subramanian & Kawachi, 2004).

Conceptualizations of social capital have been suggested to explain different outcomes across individual-SES and income-inequality research. Researchers have proposed utilizing social capital to better understand how economic inequality and health inequalities are linked (Subramanian & Kawachi, 2004; Yamaguchi, 2014). The notion of social capital offers an intriguing lens through which one can integrate existing information about social aspects into health concerns; moreover, social capital can help us better understand how social situations affect health (Berkman et al., 2000, Yamaguchi, 2014).

This study aims at examining the impact of social networks, neighborhood bonds, and neighborhood context on health outcomes and mortality among Mexican Americans. Hence, social capital is not measured directly in this paper but rather the propensity to develop and procure it. This in turn can be invested in leveraging one's lifestyle and life trajectory. Therefore, it is important to first define social capital. As Yamaguchi (2014) noted, "all the definitions do seem to be relational and multidimensional, and researchers tend to divide the concept into two types". Social capital is first defined as an aggregate of the individual (Bourdieu & Chamboredon, 1991; Bourdieu, 1988) and second, as resources collectively possessed (Putnam, 1995, 2000). James et al. (2001) and Yamaguchi (2014) defined social capital as "resources in social relationships" that include "mutual trust, a sense of reciprocal obligation, and civic participation aimed at benefiting the group or community as a whole".

Realizing the significance of social networks and relationships, the National Institutes of Health report "Toward Higher Levels of Analysis: Progress and Promise in Research on Social and Cultural Dimensions of Health" (Mansyur et al, 2009) delineated an ecological and multilevel national research agenda and advocated for increased exploration and evaluation at the “group, network, neighborhood, and community levels”.

When examining population and community health, social networks cannot be examined and understood without considering neighborhood context and the milieu within which those social networks exist. The influence of neighborhood context on residents’ health has been critical in developing the field of population health and health disparities research during the last two decades. Residential environments may interact additively or interactively with individual- and household-level variables to considerably improve the ability to explain variance in health outcomes and/or risk factors, opening up new paths for health-promoting interventions. (Clarke, Morenoff, & Debbink, 2013). Interestingly, social context can have grave ramifications on the quality of individual lives (Bleich, Jarlenski, Bell, & LaViest, 2012; Brooks-Gunn, Duncan, Lebanov, & Sealand, 1993; Duncan, Connell, & Klebanov, 1997; Duncan & Raudenbush, 1999; Jencks & Mayer, 1990; Sampson, Morenoff, & Gannon-Rowley, 2002; Turner, Ellen, O’Leary, & Carnevale, 1997).

In this study, the impact of social receptive networks and neighborhood conditions on mortality will be examined on the studied population. Particularly, we intend to examine how accessibility to a receiving network upon migration mediates the proposed association for the life chances of Mexican born immigrants on income, life

satisfaction, education, health reported illnesses, and mortality. We will also investigate the impact of neighborhood context and perceived neighborhood environment on mortality and morbidity of Mexican Americans in South Texas.

4.2. Methods

4.2.1. Study Design and Sampling

Data are from the Border Epidemiological Study of Aging, (BESA), a longitudinal design study consisting of four waves conducted in South Texas from 1994 to 2006/07. The first and last waves will be used in this analysis by examining information from the sample population collected in the fourth wave as well as mortality data and comorbidities collected in the fifth wave. A two-stage stratified random sampling was utilized in recruiting participants to the study. The initial sample yielded 1089 participants, "45 years or older, selected using tract data from the 1990 US Census to estimate the number of qualifying Mexican American adults 45 years and older in four counties along the Texas Mexico border in 1994 - 1995 (Hidalgo, Cameron, Willacy, and Starr)" (Jannadi, 2021).

Besides the age stratum of 45+ and the Mexican American origin, census tracts were used as the strata to generate recruitment quotas. Sample recruitment for all census tracts were stratified by age and proportionally represented in the final sample.

4.2.2. Study Variables

Data collection began in 1995 followed by three consecutive waves conducted between 1995 and the end of the last wave in 2006/07. Participants consented to join an in-home face-to-face interview in either Spanish or English. In every wave, participants were administered a 2-hr general health questionnaire approved by a panel of community

residents and researchers. All health reported data were further verified by a medical doctor who reviewed the data with reference to prescription medications, family physician and laboratory work whenever included (Jannadi, 2021).

4.2.2.1. Independent Variables

English Literacy and Education

A set of survey questions investigated English literacy. Participants were asked if they speak/read/write English (No, Yes); if yes, how much (Likert scale: 0, a lot, some, a little). Moreover, participants were asked for years spent in education, ranging from 0 to 20. Although this variable is not associated with neighborhood conditions, it helps us attain an idea about the sample population's academic background in order to better understand the results.

Home Conditions

A set of questions investigated participants' home and residential conditions. They were asked if they live in their own home (no/yes), who do they live with (alone, with spouse, with spouse/family, only relatives, only friends, relatives and friends); if they live in a home, an apartment, a duplex, a project, a retirement community or a mobile home. Participants were also asked if the place was owned or rented and if rented, if they received rental assistance.

Satisfaction with housing conditions, neighborhood and family's responsiveness to their needs

Participants were asked about their satisfaction with their housing conditions and their neighborhood; answers were on a Likert scale that ranged from 'very satisfied' to 'very unsatisfied'. Satisfaction was also measured regarding their family's

responsiveness to their needs. Answers were also on a Likert scale that ranged from 'Never' to 'Always'.

Care by family/friends

Participants were asked if in their opinion, when needed:

a) *your children would care for you at home* (no/yes)

b) your friends and neighbors would check on you at home (no/yes)

c) you would be willing to move with your children (no/yes)

d) a trained person would care for you (no/yes)

e) a family member would care for you at home(no/yes), and

f) *your neighbor would watch out for your property* (Never, Rarely, Sometimes, Most of the time, Always).

Health Care

Participants were asked if they receive the services they needed from their physicians ('Never' through 'Always') and whether the time spent with the physician was well spent.

Neighborhood

a) Sidewalk Characteristics

Participants were asked about their neighborhoods' sidewalks and walking areas (quality, cleanliness, general condition, presence of recreation installations, maintenance).

b) Neighborhood dogs

Participants were asked about the presence of loose dogs and whether they were a major problem for their general well-being (Yes, No).

c) Streetlights

Participants were asked about the condition of their neighborhood streetlights (excellent, good, ordinary, bad).

d) Neighborhood Security

Participants were asked about the level of perceived neighborhood security (extremely secure, secure, somewhat secure, insecure).

e) Neighborhood Traffic

Participants were asked whether their neighborhood traffic was heavy, moderate or light.

f) Cleanliness, hygiene and general features

Participants were asked if there is debris on the street or the sidewalks, water filled deposits, abandoned tires in the street, tires filled with water, stray dogs, standing water and whether streets are paved. All answers were either Yes or No.

Location

a) *Distance from major sites*

Participants were also asked if they live within 10 minutes of their grocery stores, pharmacy, doctor's office, medical center, agricultural land and irrigation canals (Answers were Yes/No); and, if they live near the Mexico-USA border and at what distance.

b) *Living near undesirable sites*

Participants were asked if they live close to city dumps, noisy factories, chemical plants or gas drilling sites.

4.2.2.2. Dependent Variable

Mortality

Survival follow-up was assessed through three different methods. In 2008, death data were obtained from death certificates requested from the Texas Department of Health Services (TDSHS). In 2020, mortality data of the entire BESA sample were requested from the CDC through the records of the National Death Index. Additionally, newspaper obituaries and/or phone calls were used to supplement and verify date and place of death. Survival time was measured in years starting with the date of baseline data collection and ending with the death of the participant or end of follow up on December 31, 2019.

4.3. Data Analysis

We conducted a descriptive analysis that examined English proficiency and general educational background. It proceeds to examine neighborhood and living conditions that could impact one's health as indicated by the literature. Frequency tables and Chi-square tests were first conducted followed by a stepwise Cox regression that eliminated the variables that were least associated with mortality within a 95% confidence interval. As such, a survival (time to death) analysis was conducted, controlling for the covariates (age, sex, country of birth, education level, SES, general health status).

4.4. Results

The analysis first examines the educational background of the population. An overwhelming 84.7% of those born in Mexico have a 6th grade education or less whereas those born in the US had noticeably better education. Twenty one percent of the latter had some post high school education compared to 2.5% of their Mexican-born counterparts. Mortality was significantly inversely proportional to years spent in education with a p value less than 0.05. However, even though percent mortality was less for the more educated, the less educated were dying at an older age. Results are shown in tables (1) and (2). Seventy percent of the entire population speaks English very well, while 63.1% reads English and 59% write English very well.

Living conditions were then investigated. Almost 90% of participants lived in their own homes and from these, 21% lived alone, whereas most lived with a spouse and/or a family member. Very few lived in apartments, projects, retirement communities or mobile homes. Moreover, 91% of the population owned their homes. Among those who rent, 22.1% receive aid in paying their rent; 87.2% of the population reported to be very satisfied with their housing conditions and 89.4% reported to be very satisfied with their neighborhoods. Moreover, 54.3% of the study's respondents reported children took care of them at home, 21.3% have friends and neighbors checking on them at their home and only 11.3% live in nursing homes. Furthermore, 81.7% of the population have a trained person taking care of them and 97% reported that their family would take care of them if necessary. In fact, 71.7% reported being always satisfied with their family's responsiveness to their needs. Also, 63.4% of participants think that their neighbors

always watch for their property, while 20.9% think that their neighbor watches most of the time. A cox regression model was then employed to gradually filter out the variables that were most significant regarding mortality. Results indicated that neighborhood satisfaction as well as having friends and neighbors checking on them at home were the most significant [HR:0.76, 95%CI: 0.70-0.84, $p < 0.05$]. However, after controlling for the covariates (sex, age, country of birth, education, SES, general health status) in the survival analysis, 'friends and neighbors checking on you at home' was significantly associated with a lower mortality rate ($p= 0.028$).

In order to discern whether their living areas or neighborhoods affect mortality, a stepwise logistic regression was performed that included all the different counties found to be significantly associated with higher mortality. Among those, neighborhood conditions were examined. Only 40% of participants reported their neighborhoods had sidewalks and only 27% indicated recreation installations were present. In fact, less than 50% of the population reported that their neighborhoods were a good place to walk. Moreover, 75% of the sampled population reported that the sidewalks were not well-kept. Even worse, 93% of the population indicated that streetlights were not in an excellent condition and 20% of the sample indicated that streetlights were poor. Loose dogs however were not reported to be a major problem. Moreover, only 4% reported that their neighborhoods were insecure and vehicle traffic was mostly moderate to light. Additionally, 56.3% reported that they live within 10 minutes by car from grocery stores and 55.3% indicated that they live within 10 minutes by car from a pharmacy. Also, 38.2% indicated that the pharmacy is within a walking distance of their homes with no

obstacles. Moreover, more than half the participants indicated that they live within 10 minutes driving distance from their doctor's office and medical center. Very few live near agricultural lands (11.5%) or near an irrigation canal (6.2%). Still, 52% live near the US Mexico border and most of them (35.3%) live within 6 – 10 miles from the border or more than 20 miles away from the border (26.9%). Interestingly, less than 1% of the population lives near factories, biochemical plants, hazardous sites or city dumps and only 2.4% live near a gas drilling site.

4.5. Discussion

This study shows clearly that Mexican Americans born in the US had a much better education level than those born in Mexico. Despite this, data analysis shows that having more years in education did not translate into longer lifespans. This further supplements observations in the first two papers of this dissertation whereby the Hispanic Paradox was clearly noteworthy in explaining the mortality differences among this study's population. Another explanation for this would be assimilation theory. A group assimilates into another over time, gradually acquiring cultural similarities. When viewing immigrant families through the perspective of this theory, one may observe generational transitions in which the immigrant generation initially exhibits cultural differences before assimilating to some extent to the prevailing culture. Barbara Zsembik and Daniel Llanes from the University of Florida found that "generational status significantly affects educational outcomes, though the specific pattern is outcome specific". The number of years of completed schooling increases sharply between the immigrant and second generation and levels off in the third generation. "The proportion of Mexican Americans completing high school increases with successive generations of

U.S. residence. College completion peaks in the second generation, and declines in the third generation" (Zsembik & Llanes, 1996).

Data from the fourth wave shows that street and sidewalk conditions were not optimal. However, neighborhood hygiene and security were deemed to be good. Neighborhood conditions gravely affect residents' general health and well-being. For example, a study done on Mexican Americans in the southwestern United States showed that "baseline cognitive function and rates of cognitive decline varied significantly across US Census tracts. Respondents living in economically disadvantaged neighborhoods experienced significantly faster rates of cognitive decline than those in more advantaged neighborhoods. Odds of incident cognitive decline decreased as a function of neighborhood percentage of Mexican American residents and increased with neighborhood economic disadvantage" (Sheffield & Peek, 2009).

Moreover, data presented here have found that satisfaction with the neighborhood and having friends and neighbors checking on you at home were significantly associated with better mortality outcomes ($p=0.028$, CI= 95%). In fact, 89.4% of the study's population indicated that they were very satisfied with their neighborhoods and 21.3% think that their friends and neighbors would check on them at home. Interestingly, 84.3% of this population also report that their neighbors watch for their property. According to social isolation, a person's social relationships are a major predictor of mortality, comparable to traditional clinical risk factors. "Socially isolated men and women had worse unadjusted survival curves than less socially isolated individuals. Cox models revealed that social isolation predicted mortality for both

genders, as did smoking and high blood pressure" (Pantell, Rehkopf et al., 2013). This study's findings are also supported by the work of Seeman's research whereby she argues that social ties and integration have significant benefits to one's health outcomes (Seeman, 1996). Seeman also indicates that the "social environment could play an important role in future health promotion efforts for older adults, although careful consideration of both potentially positive as well as negative social influences is needed" (Seeman, 1996).

Results presented here indicate very strong satisfaction among study participants when reporting on their neighborhood and their neighbors. We suggest that these findings, possibly directly or indirectly, may contribute to their overall level of life satisfaction which itself may contribute to positive health outcomes.

4.6. Appendix

Table 4.1 – Education versus average age at death

	Educational Degree Level	Average Age at Death
Education (Grade attained by categories)	0 - 6	81.34446
	12	75.93902
	13 - 20	74.69853

Table 4.2 – Education versus country of birth versus mortality

		Country of Birth vs Education Level vs Mortality							
		MEXICO				**USA**			
		Mortality		Total	% Mortality	Mortality		Total	% Mortality
		living	deceased			living	deceased		
Education Categories	0 to 6	193	219	412	53.16%	70	179	249	71.88 %
	7 to 11	33	21	54	38.89%	61	71	132	53.79 %

12	7	1	8	12.50%	39	33	72	45.83 %
13 to 20	7	5	12	41.67%	89	33	122	27.05 %
Total	240	246	486	50.62%	259	316	575	54.96 %

Table 4.3 – Neighborhood Conditions

Neighborhood Conditions	**Participants responding with 'Yes'**	**Neighborhood Conditions**	**Participants responding with 'Yes'**
Neighborhood has sidewalks	59%	Lives within 10 minutes by car from doctor's office	54.0%
Neighborhood has recreation installation	27.1%	Doctor's office within walking distance	37.1%
Neighborhood is a good place to walk	48.6%	Lives 10 minutes away from medical center	46.6%
Sidewalks are well-kept	25.3%	Medical center within walking distance	30.8%
Sidewalks are in fair condition	19.0%	Lives near agricultural land	11.5%
Sidewalks are in poor condition	4.10%	Lives near irrigation canal	6.20%
Sidewalks are not maintained at all	2.10%	Lives near a river	4.30%

Loose dogs are a major problem	1.40%	Lives near Mexico-USA border	52.0%
Loose dogs are a problem	3.70%	Debris in street	1.70%
Loose dogs are not a major problem	20.1%	Debris on the sidewalks	1.80%
Loose dogs are not a problem at all	31.7%	Water filled deposits	1.60%
Streetlights are excellent	6.90%	Abandoned tires in the street	0.80%
Streetlights are good	40.2%	Tires filled with water	1.60%
Streetlights are ordinary	43.2%	Stray dogs	1.70%
Streetlights are bad	19.0%	Standing water	2.50%
Neighborhood is extremely secure	6.60%	Streets are paved	12.2%
Neighborhood is secure	72.9%	City dump nearby	1.10%
Neighborhood is somewhat secure	26.0%	Lives near noisy factories	0.70%
Neighborhood is insecure	3.70%	Lives near chemical manufacturing	0.40%

Neighborhood traffic is heavy	10.2%	Lives near where chemicals sold	0.20%
Neighborhood traffic is moderate	49.8%	Lives near gas drilling site	2.40%
Neighborhood traffic is light	48.1%	Lives in an old average class home	35.6%
Lives within 10 minutes by car from groceries	56.3%	Lives in a new average class home	9.30%
Lives within 10 minutes b car from pharmacy	55.3%	Lives in an old neighborhood for working class	43.7%
Pharmacy within walking distance	38.2%	Lives in a new neighborhood for working class	4.50%
Lives in large and small homes, under construction	4.20%	Large house and well kept	41.7%
Large house and unkept	4.40%	Small and simple but well kept	40.2%
Small and simple unkept	15.7%	Completely built house	91.7%
Outside the city limit, out in the country	8.10%	House is in a subdivision	60.0%

Table 4.4 – Place of Residential

Do you live in your home?

		Valid Percent
Valid	no	10.1
	yes	89.9
	Total	100.0

Table 4.5 – People Whom Participant Live With

Who do you live with?

		Valid Percent
Valid	alone	20.9
	with spouse only	25.8
	with spouse and family	37.8
	only relatives	13.4
	only friends	.5
	with relatives and friends	.1
	other	1.5
	Total	100.0

Table 4.6 – Type of Housing

Live in a/an....

		Valid Percent
Valid	home	90.1
	apartment	4.2
	duplex	.1
	projects	1.6
	retirement community	.7
	mobile home	3.3
	Total	100.0

Table 4.7 – House owned vs Rented

Is the place owned or rented

		Valid Percent
Valid	owned by you	90.8
	rented	9.2
	Total	100.0

Table 4.8 – Reception of Aid in Rent Payment

Do you receive aid in paying rent

		Valid Percent
Valid	no	77.9
	yes	22.1
	Total	100.0

Table 4.9 – Satisfaction with House

Satisfaction with house

		Valid Percent
Valid	very satisfied	87.2
	somewhat satisfied	11.1
	not very satisfied	1.4
	very unsatisfied	.3
	Total	100.0

Table 4.10 – Satisfaction with Neighborhood

Satisfaction with neighborhood

		Valid Percent
Valid	very satisfied	89.4
	somewhat satisfied	9.7
	not very satisfied	.9
	Total	100.0

Table 4.11 – Whether Children Care for Parents at Home

Children care for you at home

		Valid Percent

Valid	no	45.7
	yes	54.3
	Total	100.0

Table 4.12 – Whether Friends and Neighbors Check on the Participant

Friends and Neighbors check on you at home

		Valid Percent	Cumulative Percent
Valid	no	78.7	78.7
	yes	21.3	100.0
	Total	100.0	

Table 4.13 – Whether Family Offers Care

Would family care for you if necessary

		Valid Percent
Valid	no	3.0
	yes	97.0
	Total	100.0

Table 4.14 – Satisfaction with Family Responsiveness

Satisfied with family's responsiveness

		Valid Percent
Valid	Never	6.3
	Rarely	.2
	Sometimes	1.6
	Most of the time	20.2
	Always	71.7
	Total	100.0

Table 4.15 – Whether Participant Thinks Neighbor Watches for His/her Property

Think neighbor watches out for your property?

		Valid Percent
Valid	Never	2.6
	Rarely	1.6
	Sometimes	11.4

Most of the time	20.9
Always	63.4
Total	100.0

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CHAPTER V: CONCLUSION

As previously stated, one of the most economically depressed areas in the country is the Texas Rio Grande Valley (RGV) region, home to the studied population in this paper (Ryabov & Merino, 2017). This dissertation examined mortality and morbidity for the studied population, residents of the U.S.–Mexico border, which, as already noted, is a medically neglected and disadvantaged region (Bastida et al., 2008; Salinas, 2013). The biologist and Nobel Laureate, Szent-Györgyi (1972) once said "innovation is seeing what everybody has seen and thinking what nobody has thought". In public health this commences with improved understanding of the link between theory, research, and practice. Hence, this study which mainly draws from life-course theory, adds to the existing literature on the Hispanic American population, which constitutes the largest minority population in the United States, by highlighting their increased risk for diabetes, cardiovascular diseases and end-stage renal diseases. Data presented here build on previous studies conducted on the BESA population which indicated that Mexican Americans in the lower Rio Grande Valley of Texas have a higher prevalence of diabetes and obesity (Bastida & Pagán, 2002; Fisher-Hoch et al., 2010). Interestingly, the latter findings support and expand on prior findings that pertain to the general health of this population such as those presented by Yracheta (2015).

This dissertation began with an analysis on mortality and morbidities for the BESA sample by comparing outcomes between those born in the US with those born in Mexico. This first study indicates that foreign-born Mexican immigrants have a significant mortality advantage. In fact, both median and mean ages for life spans of

Mexican Americans born in Mexico are higher than for those born in the US. This is not new, but a recurring finding in nearly all mortality studies on Mexican Americans. However, as noted earlier in this dissertation, this study investigated longitudinal associations between morbidity and mortality among this population over a 25-year period with a representative sample, aged 45+ at Wave 1. Hence, this study examined and followed a younger population than used in other studies. As such, extrapolating the Hispanic Paradox to a younger population beginning during middle age and not at 65 is what sets this research apart.

The second study delves into the health of farmworkers in this population. Results showed that farmworkers are at a significantly increased risk for worse mortality and morbidity outcomes. Among farmworkers, those who were male and born in the US fared the worst. Years spent in farmwork also contributed to worse health outcomes. Data suggest that farmworkers are more likely to develop cardiovascular disorders, kidney disease and diabetes when compared to non-farmworkers in the sample ($p<0.05$). However, aside from diabetes, complications from above conditions though elevated among this population, were not associated with mortality. Instead, the farmworker population in the study were more likely to die from kidneys, liver, and pulmonary diseases.

According to several studies (Haan, Kaplan, & Camacho,1987; Anderson et al, 1997; Pickett & Pearl, 2001; Diez Roux, Merkin, Arnett, et al, 2001), there is a gradient influence of community socioeconomic status, with greater rates of illness and death in

areas that are economically underprivileged and less educated. The third study indicates that Mexican Americans born in the US had higher levels of education than Mexican Americans born in Mexico. However, the statistical analysis reveals that more years spent in school did not necessarily result in longer lifespans. Results from the third manuscript support findings from the first two studies in this dissertation, that uphold the Hispanic Paradox in explaining a mortality advantage among the Mexican American population. Moreover, data presented in the third study found that satisfaction with neighborhood and having friends and neighbors checking on you at home were significantly associated with better mortality outcomes. After investigating a set of neighborhood variables, satisfaction with their neighborhoods of residence and their neighbors play a significant role in future attempts to promote older individuals' health.

Research presented here has limitations. It is an observational longitudinal study of Mexican Americans that required repeated observations of (more or less) the same variables over a period of 25 years. Even though the population is all Mexican Americans, we cannot assume they all share the same local environmental and sub-cultural characteristics or that they are fully comparable to Mexican Americans in other studies e.g., California. Although identifying patterns is the aim of longitudinal studies, inaccurate data gathering may result in erroneous interpretations of reported behaviors and health variables. Moreover, longitudinal studies in general offer a factor of unpredictability and this study is no exception, especially when it comes to loss of participant follow-up.

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