The Dissertation Committee for Sanggon (Sang Gon) Nam Certifies that this is the approved version of the following dissertation:

Obesity, Diabetes, and Disability in Older Mexican Americans, 1993-2011

Committee:

Kyriakos Markides, Ph.D., Supervisor

Soham Al Snih, M.D., Ph.D.

Raymond Palmer, Ph.D.

M. Kristen Peek, Ph.D.

Melanie de Boer, Ph.D.

Dean, Graduate School

Obesity, Diabetes, and Disability in Older Mexican Americans, 1993-2011

by

Sanggon (Sang Gon) Nam

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Dedication

For the four women of my life:

To

Aeja Cho, my mother

Jungwon Kim, my wife

Hawon Nam and Hajin Nam, my daughters

Mom, you are what I am; Jungwon, you are my life; Daughters, you are my future.

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Obesity, Diabetes, and Disability in Older Mexican Americans, 1993-2011

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Increases in obesity have been observed in both men and women, for all age groups and major ethnic groups, and at all educational levels. However, in Mexican Americans, the increased level of obesity only partially accounts for their higher prevalence of diabetes compared with non-Hispanic Whites. These high rates of both obesity and diabetes are also related to higher levels of disability in older Mexican Americans. Much of the previous research about associations between obesity, diabetes, and disability has focused on cross-sectional or short-term longitudinal studies of non-Hispanic populations to explain disparities by age, gender, and nativity. There have only been a few long-term longitudinal studies that have looked at obesity, diabetes, and disability among older Mexican Americans. Using data from the Hispanic Established Population for the Epidemiological Study of the Elderly (Hispanic EPESE) from baseline (1993-1994) to wave seven (2010-2011), this proposed study seeks to determine the effect of age, gender, and nativity differences on the relationship between obesity, diabetes, and disability among older Mexican Americans. This study found that the effect of obesity was less likely to have ADL disability as compared to non-diabetes among Mexico-born participants, and the effect of diabetes was less likely to have ADL disability as compared to non-diabetes among the young old group (65-74). In addition, subjects with obesity and diabetes were more likely to develop more ADL disability over time compared to subjects with diabetes only and subjects without obesity and diabetes. However, the development of ADL disability did not vary significantly across time between subjects with both obesity and diabetes compared to subjects with obesity only.

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INTRODUCTION

Older Americans aged 65 and over are a rapidly expanding population. According to a report by the Administration on Aging (AOA), the older adult population (≥65) in the United States was estimated to number 40 million in 2008, and is expected to more than double (to 88.5 million) by 2050 (AOA, 2010). As the aging population grows, the provision of healthcare will become a major challenge for the US health system, which must address the tasks of helping older adults to live longer, and to live longer without chronic diseases and functional dependence.

Hispanics are currently the nation's largest minority group, with a total population estimated at 50.4 million in 2010. This group is the most rapidly growing racial/ethnic group in the US. In 2010, 16.3% of the total US population in 2010 reported that they were of Hispanic origin (Humes et al., 2011). There were 2.7 million older Hispanics in 2008, with this number expected to grow to 17 million by 2050. Thus, it is critically important to address common health issues in this group. By 2019, older Hispanics will become the largest minority population in the United States among all older adults greater than 65 years of age (AOA, 2010).

Mexican Americans live longer than other groups, but they also live with more chronic conditions and disabilities as compared to other racial/ethnic groups (Markides & Coreil, 1986; Markides & Eschbach, 2005; 2011). Their overall mortality is similar to or better than that of the non-Hispanic white population, even though their socioeconomic circumstances (lower income and fewer years of formal education) are similar to those of the non-Hispanic black population, who have a poorer health profile on average than non-Hispanic whites (Markides & Coreil, 1986; Markides & Eschbach, 2005; 2011).

However, Mexican Americans have higher rates of Type 2 diabetes mellitus, obesity, and disability on average, and relatively lower rates of health insurance coverage and physician and hospital use (Andersen, et al., 1981; Angel & Angel, 1996; Markides, et al., 1997; Franzini, 2001; Markides & Eschbach, 2011). Further, older Mexican Americans are likely to have higher risks of obesity, diabetes, and disability compared to other racial/ethnic groups (Black, Ray, Markides et al., 1999; Ostir, et al., 2000; Al Snih, et al., 2005; Markides, et al., 2013).

RESEAERCH SIGNIFICANCE

The prevalence of obesity in the United States has been dramatically increasing, so much so that it has been described as an epidemic (Arterburn, et al., 2004; Ogden, et al., 2006). Approximately 26 million people in the US had diabetes (19 million diagnosed and an estimated 7 million undiagnosed) during 2010 (CDC, 2011). Meanwhile, obesity and diabetes are known to be major causes of disability (CDC, 2010). Studies have consistently shown that obesity is associated with an increased risk of diabetes (Ford, et al., 1997; Resnick, et al., 2000), and both conditions are also associated with an elevated risk of disability in older adults (Ford, et al., 1997; Resnick, et al., 2000; CDC, 2010; CDC, 2011). The dramatic increase in obesity rates among Mexican Americans likely contributes to a higher prevalence of diabetes and disability in that population (Markides & Eschbach, 2011).

Although Mexican Americans enjoy better life expectancy and general health advantages, they experience much higher rates of disability as compared to other racial/ethnic groups, partly as a result of poverty, obesity, and diabetes as they age (Markides & Coreil, 1986;

Markides & Eschbach, 2005; 2011). This paradox may find its explanation in the immigration patterns of many Mexican Americans. Immigrant men are more likely to be selected for better health than immigrant women (Markides, et al., 2007). It is possible that in the older Mexican American cohorts, men immigrate for reasons related to their occupation, while women tend to immigrate to be with family (Markides, et al., 2007). However, research addressing the issue of gender and nativity differences in health has been insufficient.

The health advantages in gender and nativity among older Mexican Americans due to occupation carries over to the relationship between obesity, diabetes, and disability. Obesity and diabetes are critical risk factors for disability, particularity among women and older adults, and especially among Mexican Americans, who have a higher prevalence of obesity and obesity-related diseases (Ogden, et al., 2006; Markides, & Eschbach, 2011; Markides, et al., 2013). Thus, for older Mexican Americans as compared to other racial/ethnic groups, obesity and diabetes are expected to be associated with greater disability among women and the US-born population as compared to men and the foreign-born population.

However, the association between obesity, diabetes, and functional disability among older Hispanic Americans has received little attention in the literature (Visser, et al., 1988; Bannerman, et al., 2002; Al Snih, et al., 2005). Few studies have considered racial/ethnic differences in terms of the link between obesity, diabetes, and disability across time. Many previous studies investigating disparities by age, gender, and nativity in the associations between obesity, diabetes, and disability are cross-sectional or short-term longitudinal studies of non-Hispanic populations. There have been few long-term longitudinal studies that examine the relationship of obesity and diabetes with disability among older Mexican Americans.

PURPOSE OF THE STUDY

In order to address gaps in the research, this study examines age, gender, and nativity differences in the associations of obesity and diabetes with disability among older Mexican Americans over time. Specifically, this study explores age, gender, and nativity differences in the relationship between obesity and disability and in the relationship between diabetes and disability across seventeen-years of a longitudinal survey administered to older Mexican Americans. This study is widely known as the Hispanic Established Populations for the Epidemiological Study of the Elderly (Hispanic EPESE).

SPECIFIC AIMS

Aim I: Obesity and Disability

Determine age, gender, and nativity differences in the relationship between obesity and disability in older Mexican Americans over 17 years of follow-up.

Representative Hypotheses

1a. Obesity will be associated with greater disability (ADL) among the older (>=75) group when compared with the young old (65-74).

1b. Obesity will be associated with greater disability (ADL) in women compared to men.

1c. Obesity will be associated with greater disability (ADL) in US-born compared to foreign-born.

Aim II: Diabetes and Disability

Determine age, gender, and nativity differences in the relationship between diabetes and disability in older Mexican Americans over 17 years of follow-up.

Representative Hypotheses

2a. Diabetes will be associated with greater disability (ADL) in the older (>=75) group when compared with the young old (65-74)

2b. Diabetes will be associated with greater disability (ADL) in women compared to men.

2c. Diabetes will be associated with greater disability (ADL) in US-born compared to foreign-born.

Aim III: Obesity, Diabetes, and Disability

Determine the effect of obesity and diabetes on disability in older Mexican Americans over 17 years of follow-up.

Representative Hypotheses

3a. Subjects with obesity only will be more likely, over time, to develop ADL disability than subjects without obesity and diabetes.

3b. Subjects with diabetes only will be more likely, over time, to develop ADL disability than subjects without obesity and diabetes.

3c. Subjects with obesity and diabetes will be more likely, over time, to develop ADL disability than subjects with obesity only, subjects with diabetes only, and subjects without obesity and diabetes respectively.

STRUCTRE OF THE DISSERTATION

The structure of the dissertation is presented as follows. Chapter 2 provides a general literature review in the relationship between obesity, diabetes, and disability overtime among older Mexican Americans. It also discusses the disablement process model as the disability framework for this study. Chapter 3 describes the study sample, measures, and data analysis methods used to address each of the specific Aims. Chapters 4, 5, and 6 provide the results of the analyses of specific Aims I, II, and III. The last chapter 7 includes a discussion and summary of results, strengths and limitations of the dissertation, and possible future research.

Chapter 2: BACKGROUND

OBESITY

Definition

Obesity is generally defined as “excessive deposition of fat in the body” (Bray, 1987, p.15) and as an abnormally high proportion of body fat that negatively affects health (World Health Organization [WHO], 1998). Obesity is a condition of excess body weight, and is classified as a disease, International Classification of Disease code E66 (WHO, 1997a).

Measurement of Obesity

Obesity is often measured by Body Mass Index (BMI), which is the ratio of weight to height (weight in kg divided by height in m^2), based on the standards of the National Heart Lung Blood Institute (NHLBI). The BMI measure consists of four official categories, including underweight (<18.5), normal (18.5 to 24.9), overweight (25.0 to 29.9), and obese (≥ 30.0) (NHLBI, 2002). Additionally, obesity has been categorized as follows: class I obese (30.0 to 34.9), class II obese (35.0 to 39.9), and class III extreme obesity (> 40.0) (NHLBI, 2002).

Epidemiology of Obesity

Increases in obesity have been observed in both men and women, in all age groups, major ethnic groups, and at all educational levels (Wang, & Beydoun, 2007). The US Census Bureau has shown that the prevalence of obesity in adults aged 60 and older increased from 32%

in 2000 to 37.4% in 2010, and the prevalence of normal weight among adults aged 60 and older decreased from 30.6% in 2000 to 26.7% in 2010 (Humes, et al., 2011). This increase in obesity rates among older adults may stem from increasingly sedentary lifestyles, dietary changes, and age-associated alterations in the metabolic rate (Jensen, & Rogers, 1998).

The prevalence of obesity varies substantially by racial/ethnic group. Mexican Americans have a higher prevalence of obesity than do non-Hispanic Whites (Flegal, et al., 2012). Findings from the Hispanic EPESE comparing two separate representative samples of older Mexican Americans showed an increase in the prevalence of obesity (BMI >30) from 20.3% in 1993–1994 to 28.9% in 2004–2005 (Beard, et al., 2009).

Consequences of Obesity

Obesity is associated with increased incidence of various diseases, including type 2 diabetes, high blood pressure, high total cholesterol, high levels of triglycerides, liver disease, gallbladder disease, sleep apnea, respiratory problems, osteoarthritis, infertility, coronary heart disease, stroke, endometrial cancer, breast cancer, colon cancer, and mental health problems (Ferraro, et al., 2002; Weil, et al., 2002; Cossrow, & Falkner, 2004; CDC, 2011).

Obesity in the older population increases rates of disability as a result of related chronic conditions. Obesity-related disability includes limitations in the activities of daily living (ADL) and in the instrumental activities of daily living (IADL) (Himes, 2000; Al Snih, et al., 2007).

Previous studies have consistently suggested a strong positive relationship between obesity and increased disability longitudinally, while results of cross-sectional studies have been inconsistent (Visser, et al., 1988; Galanos, et al., 1994; Ferraro, et al., 2002; Sturm, et al., 2004;

Visscher et al., 2004; Reynolds, et al., 2005; Wilkins & de Groh, 2005; Wu, et al., 2007; Al Snih et al., 2007; Lang et al., 2008; Walter et al., 2009; Wee, et al., 2011).

The 20-Year Panel Study of data from the National Health and Nutrition Examination Survey I (NHANES I) and its Epidemiologic Follow-Up Study (NHEFS), 1971–1992, investigated whether BMI increases the possibility of disability among adults aged 25 to 74 (Ferraro, et al., 2002). The panel showed that obesity as measured by BMI was related to increased upper and lower body disability over time in a curve-linear relationship (Ferraro, et al., 2002).

Al Snih and colleagues (2007) found that a BMI of 24 was the threshold for the association between obesity and disability, with increased incidence of disability below and above that point describing a J-shaped curve. Using the EPESE and Hispanic EPESE data for their study, they also showed that obesity is closely associated with disability but less associated with mortality over time (Al Snih, et al., 2007).

Reynolds and her colleagues (2005), using the Asset and Health Dynamics Among the Oldest Old (AHEAD) survey, 1993–1998, estimated life expectancy, active life expectancy and disabled life expectancy among older Americans 70 and older. They found that older obese men and women are likely to have a higher possibility of becoming disabled, and that obesity has a negative effect on disability in older adults (Reynolds, et al., 2005).

This consistent link between obesity and disability over time is also shown to be true in research conducted in other countries. The longitudinal Rotterdam Study in the Netherlands showed a much higher 6-year incidence of disability among the overweight and obese older population (Walter, et al., 2009). A cross-sectional study using the 2003 Canadian Community Health Survey (CCHS) and the longitudinal 1994/95 through 2002/03 National Population

Health Survey (NPHS) also suggested that obesity was a predictor of higher ADL and IADL disability (Wilkins & de Groh, 2005).

These consistent findings apply particularly to older people, women and Mexican Americans. Older adults who are overweight and obese live longer but have some degree of disability in their oldest age compared to normal BMI subjects (Al Snih, et al., 2007). Although women live longer, disabled life expectancy is significantly longer for obese older women at age 70 (Reynolds, et al., 2005). Further, Al Snih and her colleagues show these consistently robust associations between obesity and disability over time apply to African Americans and Mexican Americans (Al Snih, et al., 2007).

Although obesity is a risk factor for disability, particularly among women, older adults, and especially minority groups, which have a higher prevalence of obesity and obesity-related diseases (Ogden, et al., 2006), there have been few longitudinal studies of the effect of obesity on disability in older people, women, and Mexican Americans.

DIABETES

Definition

Diabetes is a disease characterized by high levels of blood glucose due to defects in insulin production, insulin action, or both (Centers for Disease Control and Prevention [CDC], 2004). It is usually believed that both genetic and environmental factors cause diabetes, but the causes of diabetes remain unknown (American Diabetes Association [ABA], 2011). Type II diabetes can be prevented by diet and exercise. Diabetes is one of the major chronic diseases necessitating self-management and ongoing medical care to avoid complications (ABA, 2012).

Measurement of Diabetes

Type II diabetes is usually diagnosed via a fasting plasma glucose test (FPG>126) or a hemoglobin A1c test (A1c>6.5) (ABA, 2011). In addition, people with mid-range elevated glucose levels (pre-diabetes) have a higher risk for developing diabetes (100<FPG>126) (ABA, 2011).

Epidemiology of Diabetes

Diabetes is most prevalent among adults aged sixty five and over, with numbers estimated to be near 11 million (27% of older adults) (CDC, 2011). Diabetes is associated with heart disease and stroke, and is the seventh leading cause of death in the United States (CDC, 2011). A recent Center for Disease Control and Prevention (CDC) statistical report indicated that Mexican Americans have a higher prevalence of diabetes (15.3%) than Non-Hispanic blacks (14.6%) or non-Hispanic whites (9.9%) (Fryar, et al., 2010).

The high prevalence of diabetes among Mexican Americans has in part been the result of higher obesity rates (Mokdad, 2000). The prevalence of obesity has increased significantly (8.6 %) in older Mexican Americans aged 75 and over, between the baseline measure of the Hispanic EPESE (1993–1994) to the fifth wave (2004–2005) (Beard, et al., 2009). Because obesity increases the risk of Type 2 diabetes, the dramatic increase of obesity among Mexican Americans has contributed to the higher prevalence of diabetes in this population.

Mexican Americans have a higher prevalence of diabetes than do non-Hispanic black and non-Hispanic white persons. This higher prevalence of diabetes is associated with an increased risk of functional disability in the Hispanic population (Markides et al., 1996; Markides, and Eschbach, 2005; 2011; Markides et al., 2013). Although previous research has suggested that diabetes is significantly associated with disability in the older Hispanic population, there is little research that examines the impact of diabetes on disability over the long term. Thus, there is a need for research designed to investigate longitudinally the effect of diabetes on disability and functional limitations in older Mexican Americans.

Consequences and Comorbidity of Diabetes

Diabetes is one of the primary risk factors for functional disabilities, particularly among women, older population, and especially minority groups, which have a higher prevalence of obesity and obesity-related disease (Ogden et al., 2006; CDC, 2011; Markides et al., 2012). Rates of functional disabilities are much higher for people with diabetes than those without diabetes, and diabetics are more likely to use mobility aids than non-diabetics (Sinclair, et al., 2008).

The higher prevalence of diabetes is associated with an increased risk of functional disability in the Hispanic population. Because diabetes is known to be a critical predictor of functional disability, a portion of the increase in ADL and IADL is attributed to the higher prevalence of diabetes among older Americans (Sinclair, et al., 2008).

Several cross-sectional studies have found that diabetes is significantly associated with increased prevalence of functional disability (de Grauw, et al., 1999; Gregg, et al., 2002; Sinclair, et al., 2008). Gregg and his colleagues, using the third National Health and Nutrition Examination Survey (NHANES III) from 1988 to 1994 of Americans aged 60 years and older, found that with increasing age older women with diabetes are more likely to experience disability, cardiovascular heart disease, severe visual impairment, and depressive symptomatology as they age (Gregg, et al., 2002).

Significant associations have emerged between diabetes and functional status, particularly in relation to cardiovascular morbidity among diabetes patients aged less than 85 years (de Grauw, et al., 1999). According to Grauw and colleagues, subjects with diabetes have more than twice the probability of functional impairment (OR=2.46; 95% CI=1.5-4.1). Another cross-sectional study analyzing the NHANES 1999–2006 survey of the population aged 60 years and over showed diabetes to be significantly associated with a higher probability of ADL disability after adjustment for demographic factors (OR=2.53, 95% CI=1.98-3.24) (Kalyani et al., 2010).

Some studies have explored the associations between diabetes and disability among older women and older Mexican Americans (Stefano, et al., 2002; Rodríguez-Saldaña, et al., 2002; Wu, et al, 2003; Al Snih, et al., 2005). Stefano and colleagues, using the Women's Health and Aging Study of 1,002 women aged 65 and over, found that older women with diabetes have a greater prevalence of ADL disability (OR=1.61, 95% CI = 1.06-2.43) and mobility disability (OR = 1.85, 95% CI 1.12–3.06) (Stefano, et al., 2002).

According to studies of older Mexican Americans, diabetes is associated with disability in this group as well (Rodríguez-Saldaña, et al., 2002; Wu, et al, 2003; Al Snih, et al., 2005). A 7-year longitudinal study (1993–1994 to 2000–2001) of data from the Hispanic EPESE found that older Mexican Americans with diabetes were more than twice as likely to have lower body limitation ADL (hazard ratio (HR) = 2.05, 95% confidence interval (CI) = 1.58-2.67) as compared to subjects without diabetes, after controlling for relevant covariates (Al Snih, et al., 2005). This study proposed that older Mexican Americans with diabetes have a higher possibility of lower-body ADL and mobility limitations longitudinally.

Although diabetes, like obesity, is a critical risk factor for disability, particularly among women, older adults, and especially minority groups (particularly, Mexican Americans), which have a higher prevalence of obesity and obesity-related diseases (Ogden, et al., 2006; Markides, et al., 2013), little is known about differences by age, gender, and nativity in terms of the impact of diabetes on disability longitudinally.

DISABILITY

Definition

Disability is a multi-dimensional process that can include both progression and recovery, described by the World Health Organization (WHO) website as follows:

"Disabilities is an umbrella term, covering impairments, activity limitations, and participation restrictions. Impairment is a problem in body function or structure; an activity limitation is a difficulty encountered by an individual in executing a task or action; while a participation restriction is a problem experienced by involvement in life situations.[1]"

Thus disability is a complex phenomenon, reflecting an interaction between features of a person's body and features of the society in which he or she lives (WHO, 2012).

Previous research has shown that disability is not a status but a process, having a trajectory of functional outcomes over time (Verbrugge & Jette, 1994). The process view of

[1] Health Topic: Disabilities (2003). WHO website: Retrieved January 15, 2013, from http://www.who.int/topics/disabilities/en/

disablement is based on these two widely used definitions of disability as a multi-dimensional and ongoing process (Verbrugge & Jette 1994).

Conceptual Frameworks

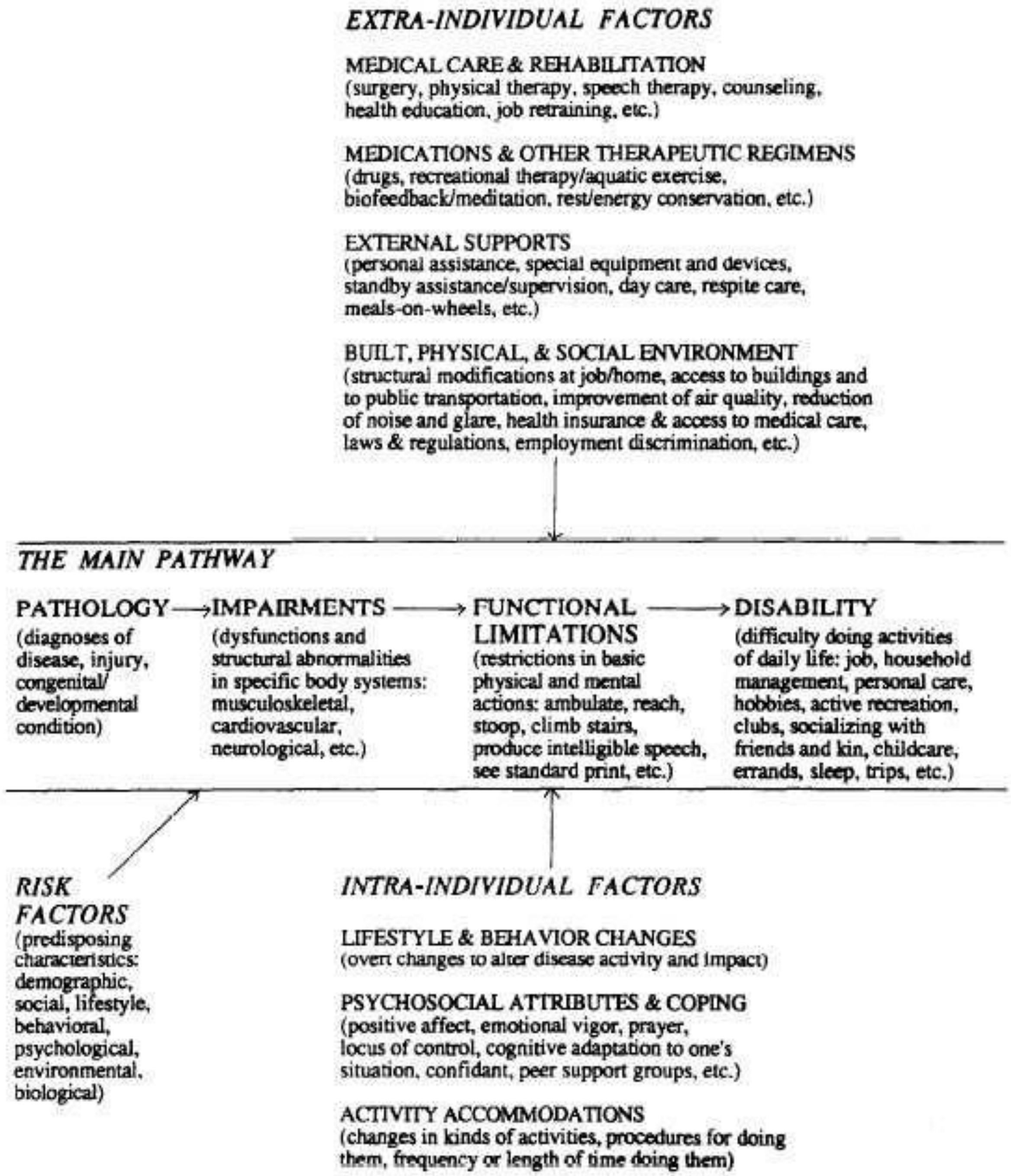
Disablement, including chronic and acute conditions, is a process that may be described via a pathway in terms of the consequences of pathology for physical functioning (Verbrugge & Jette, 1994). *Disablement* refers to the impact of chronic and acute conditions on functioning in specific body systems and on a person's ability to act in a necessary, usual, and expected, personally-desirable way in his/her society (Verbrugge & Jette, 1994). *Process* refers to the dynamics of disablement over time, with factors consisting of the main pathological pathway and the "direction, pace, and pattern of change" in the disablement process (Verbrugge & Jette, 1994, p. 3).

Figure 2.1 shows the disablement process model suggested by Verbrugge and Jette (1994), depicting the main pathway from pathology and disablement, consisting of risk factors; extra-individual factors (1. medical care & rehabilitation, 2. medications & other therapeutic regimens, 3. external supports, and 4. the built, physical, & social environment); and intra-individual factors (1. life style & behavior changes, 2. psychosocial attributes & coping, and 3. activity accommodations) (Verbrugge & Jette, 1994).

In this model, functional limitation relies on individual physical health, while disability is a type of social process or behavior pattern stemming from acute and chronic diseases or impairment (Verbrugge & Jette, 1994). The extra-individual factors and intra-individual factors may increase or decrease the speed of the process along the disablement pathway (Verbrugge & Jette, 1994).

In the main pathway of the disablement process model, chronic pathology occurs when normal physiological processes are interrupted by disease, injury, or a congenital/developmental condition, resulting in impairments that create critical abnormalities in physical, mental, or social functioning (Verbrugge & Jette, 1994). Functional limitations restrict daily life (i.e. the ability to ambulate, reach, stoop, climb stairs, and produce intelligible speech) by limiting physical or mental processes necessary for navigating the physical and social environment in daily activities (Verbrugge & Jette, 1994). Thus, disability from functional limitations refers to any difficulty in performing activities of daily living because of physical problems (Verbrugge & Jette, 1994).

Figure 2.1 The Disablement Process Models by Verbrugge and Jette (1994)



Reprinted from Social Science & Medicine, 38(1), Verbrugge, L. M., & Jette, A.M.

The Disablement Process, p. 1-14, Figure 2. Copyright (1994), with permission from Elsevier.

Epidemiology of Disability

Disability in older Americans is among the more significant public health concerns. Chronic disability affects older adults by producing financial strain, lower quality of life, loss of independence, loss of the sense of being of use to others, and increased risk of mortality (Jang, et al., 2009; Marengoni, et al., 2009). Although disability rates have been decreasing among older Americans since the 1980s (Freedman, et al., 2002; Crimmins, 2004; Freedman, et al., 2007; Manton, 2008), the rate of disability has increased in the young old (age 60–69) due to increased levels of obesity (Sturm, et al., 2004; Ogden, et al., 2006).

Increased rates of obesity at younger ages tend to cause higher rates of disability because older adults are living with diabetes for longer periods of time (Sturm, et al., 2004; Ogden, et al., 2006). Recent evidence has suggested that the prevalence of ADL, IADL, and mobility limitations has significantly increased among the young old, non-whites, and the obese population (Seeman, et al., 2010).

According to the 2000 U.S. Census, older Mexican Americans have higher rates of disability than whites, but lower rates than blacks (Markides, et al., 2007). Comparing two periods, the baseline (1993–1994) and wave five (2004-2005) of the Hispanic EPESE data, the prevalence of ADL and IADL among older Mexican Americans aged 75 and over increased from 29.5% to 41.5% and from 77.3% to 80.1%, respectively (Beard, et al., 2009).

Moreover, differences exist in the rates of disability by gender and nativity in older Mexican Americans due to migration selection (Markides, et al., 2007; Nam, et al., 2013). Previous research has consistently shown that foreign-born immigrants are less likely to report experiencing disabilities and more likely to report better health than their US-born counterparts

(Cho, Frisbie, Hummer et al., 2004; Haan, Mungas, & Gonzalez, 2003; Markides & Eschbach, 2011).

OLDER MEXICAN AMERICANS

The Hispanic Paradox

The Hispanic Epidemiologic Paradox, described over two decades ago, describes a situation wherein Hispanic people living in the Southwestern part of the US appear to have an overall health profile similar to or better than that of non-Hispanic Whites, even though the socioeconomic circumstances of Hispanics are more similar to those of non-Hispanic Blacks (Markides & Coreil, 1986).

Markides and Coreil (1986) have suggested that certain cultural practices, strong family support, and selective migration may underlie the low infant mortality, the high overall life expectancy, the lower mortality from cardiovascular diseases, and the lower mortality from certain major cancers of this population (Markides & Coreil, 1986; Hayes-Bautista, 1992; Vega & Amaro, 1994). Despite these advantages, Hispanic populations on the border experience more diseases that affect quality of life, such as diabetes, infectious diseases, and parasitic diseases (Markides & Coreil, 1986).

More recently the literature has suggested a mortality advantage among the various Hispanic subpopulations—an advantage most evident among immigrants and widest in old age (Markides & Eschbach, 2005). Markides and Eschbach have argued that the bulk of the evidence has continued to support a mortality advantage for Mexican Americans at a minimum, and that the mortality advantage continuing into old age was possibly due to the misclassification of

Hispanic ethnicity, the healthy immigrant effect, a salmon bias, and certain features of Hispanic culture (Markides & Eschbach, 2005).

The healthy immigrant effect is one of the most feasible explanations for the Hispanic Paradox, because the immigrant mortality advantage is not confined to Hispanic immigrants, but has been observed among other immigrant groups in the United States as well as in Canada and Australia (Cunningham, et al., 2008; Markides & Eschbach, 2011). Regardless of racial or ethnic background, new immigrants have better health outcomes and lower mortality risks than their native-born counterparts (Markides & Eschbach, 2011).

The healthy immigrant effect has been found to affect mortality primarily, providing first generation immigrants with a longer life expectancy, but it has been observed that it may not provide a similar advantage with regard to other health indicators or general health (Stephen, et al., 1994; Singh, 2001; Cho, et al., 2004; Crimmins, et al., 2007; Eschbach, et al., 2007). Regardless of racial or ethnic background, new immigrants have better health outcomes and lower mortality risks than their native-born counterparts in the United States, Canada, and Australia (Markides & Eschbach, 2011).

Age, Gender, and Nativity Differences

Diabetes is an ongoing health concern, particularly for women, older adults, and especially Mexican Americans, who have a higher prevalence of obesity and obesity-related diseases (Ogden, et al., 2006; Markides, et al., 2013). Bringing the Hispanic Paradox to this context, nativity is another factor supporting the hypothesis concerning gender differences in migration selection, at least among older Mexican Americans (Markides, et al., 2007; Markides & Eschbach, 2011). The motivation of migration for foreign-born Mexican American men has generally been a voluntary quest for work, while women migrants more often follow their spouses and families (Markides, et al., 2007; Markides & Eschbach, 2011). Thus, the health advantage exists among Mexican-American men but not among Mexican-American women.

To investigate obesity, diabetes, and disability, particularly among older Mexican Americans, age, gender, and nativity differences should be considered in the context of the special immigrant pattern suggested by the Hispanic Paradox. Simply, it is expected that obesity and/or diabetes will be associated with greater disability in older Mexican Americans, and particularly in older people (aged 75 and over), women, and US-born immigrants as compared to the young old (aged 65–74), men, and foreign-born immigrants. However, little is known about this seldom-studied association between obesity, diabetes, and disability over time as it varies by age, gender, and nativity. Further, there have been few comparisons between groups (subjects with obesity, subjects with diabetes, and subjects with both) as their situation changes over time.

Chapter 3: METHODS

This study will examine age, gender, and nativity differences in the relationship between obesity, diabetes, and disability in older Mexican Americans throughout 17 years of follow-up. Analyses will first assess whether there is an association between obesity (measured by BMI) and disability and between diabetes and disability. The analyses will also assess the effect of obesity and diabetes, together, on disability.

DATA

The Hispanic Established Population for the Epidemiological Study of the Elderly (Hispanic EPESE), an on-going population-based study, was funded in 1992 by the National Institute of Aging. The Hispanic EPESE was modeled after the previous Established Populations for Epidemiologic Studies of the Elderly (EPESE) studies conducted in the 1980s in North Carolina, rural Iowa, New Haven, and East Boston (Cornoni-Huntley, et al., 1993) focusing on elderly non-Hispanic Whites and African Americans.

The Hispanic EPESE subjects consisted of 3,050 Mexican Americans aged 65 and older who were first interviewed during 1993–1994. Subjects for this study lived in five southwestern states (Texas, California, Colorado, New Mexico, and Arizona). While the previous EPESE studies had been conducted in restricted geographic areas, the Hispanic EPESE was generalizable to approximately 500,000 older Mexican Americans residing in the Southwest in 1993–1994 using multistage area cluster probability sampling, with 1990 US Census tracts serving as the primary sampling units. The primary objectives of the Hispanic EPESE were to investigate the prevalence of physical health conditions, selected medical conditions, mental health conditions, and physical impairments, in order to examine their associations, predict mortality, examine changes in health characteristics longitudinally, and compare the results with similar data for other populations.

Seven waves of data to date have been collected (1993-1994, 1995-1996, 1998-1999, 2000-2001, 2004-2005, 2007-2008, and 2010-2011).The baseline of the Hispanic EPESE was conducted with in-home interviews in Spanish or English and limited medical assessments. There was an 83% response rate among the 3,050 participants. At baseline (1993-1994), 2,873 participants were interviewed in person and 177 (5.8%) by proxy. In the second wave (1995-1996), 2,296 subjects were re-interviewed in person and 143 by proxy. In the third wave (1998-1999), 1,836 participants were re-interviewed in person and 145 by proxy. In the fourth wave (2000-2001), 1,581 subjects were re-interviewed in person and 101 by proxy.

During the fifth wave in 2004-2005, a representative sample of 902 Mexican Americans from the same region was added to the study. This gave a total of 2069 subjects aged 75 and over, including 1,167 of the original subjects who were re-interviewed (1,074 in person and 49 by proxy). The new subjects were added to the original surviving cohort using similar area probability sampling procedures. Both cohorts received identical evaluations at their baseline.

However, this proposed study will use only the original cohort for the 17 years follow up study. In the sixth wave (2007), 1,383 subjects were re-interviewed in person and 159 by proxy. In the seventh wave (2010-2011), 995 subjects were re-interviewed in person and 84 by proxy. Table 3.1 shows the seven data collections, numbers of subjects, number interviewed by proxy, and number deceased, refused, and not located.

Table 3.1. Descriptive Characteristics of the Participants at Each Interview for the Hispanic EPESE (1993-1994 to 2010-2011)

Wave	Year	Total	Proxy+[2]	Deceased	Refused	Not Located	Age
I	1993-4	3050	177				65+
II	1995-6	2439	143	241	109	261	67+
III	1998-9	1981	145	432	122	274	70+
IV	2000-1	1682	101	290	133	272	72+
V	2004-5	1167	93	504	139	277	75+
Added Sample							
	2004-5	902	49	--	--	--	75+
Combined 2069							
VI	2007	1542	159	418	157	368	78+
VII	2010-1	1079	84	374	121	264	80+

Limitations of the Hispanic EPESE

One limitation of the Hispanic EPESE for this proposal is that diabetes, disability, and other major variables were self-reported. There was a potential for recall bias, particularly for older adult subjects. However, previous studies have demonstrated a positive concordance between self-reported medical conditions and disability with medical chart reviews (Haapanen, et al., 1997).

Although most of variables in the Hispanic EPESE questionnaires were the same for each wave in which they were included, some information, important to the goals of this study, was

[2] proxy informants were family members of the missing subject

not obtained for every wave. For example, waist circumference (WC) was measured only at the baseline and the second wave, so variations in WC could not be determined across time. In addition, no household income information was reported in wave 4.

Strengths of the Hispanic EPESE

The Hispanic EPESE is the largest cohort of 3,050 older Mexican Americans generalizable to approximately 500,000 Mexican Americans aged 65 and older residing in the Southwest in the US, and it features a long period of follow-up. Above all, one of the biggest strengths of the Hispanic EPESE data is its prospective collection and data analysis for a large sample (Ottenbacher, et al., 2009) encompassing 17 years.

The survey design allows for the examination of prevalence, incidence, and changes in health outcomes as well as mortality. Notably, the Hispanic EPESE has repeatedly and consistently measured obesity (measured by BMI), diabetes, ADL disability, and other major health variables in every wave, allowing determination of the impacts of obesity and diabetes on disability over time.

MEASURES

Independent variables at baseline, through the 7th follow-up interview.

A) Sociodemographic factors

1. Age as a continuous and categorical variable: young old (65-74) and the older group (>=75).
2. Gender (female vs. male).

3. Marital status (married vs. separated, divorced, widowed, or never married).
4. Years of formal education (<8 vs. ≥8).
5. Nativity (foreign-born vs. US-born).
6. Household income (<$15,000 vs. ≥$15,000).
7. Living arrangements (living alone vs. living in a household with two or more people).
8. Time in years

B) <u>Medical Conditions</u>

Medical conditions and obesity are associated with disability in old age. The most prevalent medical conditions associated with disability are arthritis (Al Snih, et al, 2000; Dunlop, et al, 2005), cancer (Serraino et al., 2001; Amemiya et al., 2007), stroke (Ekstam, et al., 2007), heart disease (Guccione, et al., 1994), and hip fracture (Guccione, et al., 1994). Previous studies have shown that these medical conditions are possible risk factors for disability in the older population.

The following six medical conditions were assessed by asking whether participants had ever been told by a physician that they had any of the following: (1) Arthritis, (2) Stroke, (3) Heart attack, (4) Hypertension, (5) Hip fracture, and (6) Cancer.

C) <u>Obesity</u>

Obesity is usually identified based on the presence of a high proportion of body fat to lean body mass, or a body mass index (BMI) of 30 kg/m^2 or higher. Participants will be grouped according to the following standards of the National Institute of Health (NIH, 2002) (<18.5 = underweight, 18.5–24.9 = normal weight, 25.0–29.9 = overweight,

≥30.0 = obesity). For the analyses, based on the baseline of the Hispanic EPESE, participants with BMI < 18.5 (underweight) will be excluded because underweight people represent a quite small portion (n=51 (1.8%)) of the total ample (N=3,050). A BMI of 18.5 to 24.9 kg/m^2 (normal weight) will be used as the reference category.

D) Diabetes

Diabetes was assessed in two ways: (1) based on the subject's answer to the question, "Have you ever been told by a doctor that you have diabetes, sugar in your urine, or high blood sugar?" or (2) based on whether the subject was found to be on hypoglycemic drugs after inspecting the list of medications he or she had taken in the two weeks prior to the interview.

E) Depressive Symptoms

A high level of depressive symptoms was measured with the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1997). A person with a CES-D score ≥ 16 was considered to have a high level of depression (Boyd, et al., 1982).

F) Cognitive Function

Cognitive function was assessed using the Mini-Mental State Examination (MMSE) (Folstein, et al., 1975; Bird, et al., 1987). Scores ranged from 0 to 30. Lower scores on the MMSE represented low cognitive functioning or impairment (Barberger-Gateau, et al. 1992).

Dependent variables measured at 2nd, 3rd, 4th, 5th, 6th, and 7th follow-up interview.

Disability

Disability was assessed using a modified version of the Katz Activities of Daily Living (ADL) scale (Branch, et al., 1984). Interviewers asked whether participants had experienced difficulty or required assistance performing the following seven activities: walking across a small room, bathing, personal grooming, dressing, eating, getting in and out of bed, and using the toilet. ADL disability was dichotomized as "no help needed" versus needing help with or unable to perform one or more of the seven ADL activities. Participants who reported difficulty in performing one or more the seven ADL activities were considered ADL disabled. Participants who reported any ADL limitations (n=421 (13.8%)) in the baseline were excluded from the analysis.

DATA ANALYSIS

All baseline subjects who remained in the study through all seven follow-up interviews will be included in the analysis.

Overall Approach

The T-test and ANOVA was used to examine the distribution of the continuous variables by obesity, diabetes, and disability. The chi square was applied to examine the distribution of the categorical variables by obesity, diabetes, and disability. For Aims I, II and III, the Generalized Estimating Equations (GEE) was used to determine age, gender, and nativity differences in the relationship between obesity and disability, and diabetes and disability respectively in older Mexican Americans throughout 17 years of follow-up.

The GEE is an extension of the Generalized Linear Model (GLM) for longitudinal data analyses with quasi-likelihood estimation, allowing the mean of a population to rely on a linear predictor through a nonlinear link function (Liang & Zeger, 1986; Zeger & Liang, 1986). The GEE includes the marginal expectation (for an individual response or that of the average population sharing the same covariates) as a function of independent variables and other covariates (Liang & Zeger, 1986; Zeger & Liang, 1986).

All variables were analyzed as time-dependent covariates except for age, gender, education, and nativity. In the GEE procedure, regression coefficients and their variances are estimated constantly based on weak assumptions concerning the actual correlation in observations by a subject (Liang & Zeger, 1986; Zeger & Liang, 1986).

All analyses were adjusted for the complex survey design of the Hispanic EPESE using two-sided 0.05 alpha levels and N = 3,050 total sample size, by performing the POWER procedure in SAS statistical program (SAS Institute Inc., Cary, NC) (Shah et al., 1993). The Hispanic EPESE had 3,050 participants at the baseline, 2,438 in Wave 2, 1,980 in Wave 3, 1,682 in Wave 4, 1,092 in Wave 5, 921 in Wave 6, and 659 in Wave 7. Obviously, these populations constitute a large enough sample to allow for detection of very small associations and correlations (for the logistic regression, sample size = 700, β=0 (α = 0.05, two-sided), 81% power and odd ratio = 1.25; sample size = 700, β=0 (α = 0.05, two-sided), 86% power and odd ratio = 1.30). [3]

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[3] Power computations and statements generated by the program nQuery advisor 7.0 (Janet D. Elashoff. **nQuery Advisor User's Guide**. Los Angeles: Dixon Associates, 1995).

The SAS system version 9.2 was employed to analyze the data using PROC GENMOD for the main analyses of Aim I, II, and III (SAS: SAS Institute Inc., Cary, NC). The selected alpha level for statistical significance will be 0.05.

Specific Aims Analysis

Aim 1: Obesity and Disability

To determine age, gender, and nativity differences in the relationship between obesity and disability in older Mexican Americans over 17 years of follow-up.

Research Hypotheses:

1a. Obesity will be associated with greater disability (ADL) among the older (>=75) group when compared with the young old (65-74).

1b. Obesity will be associated with greater disability (ADL) in women compared to men.

1c. Obesity will be associated with greater disability (ADL) in US-born compared to foreign-born.

Specific Aim #1 Analyses

The GEE procedure was used to test the association between obesity and disability over time. Several models were conducted to test the hypotheses for Specific Aim 1. All variables were analyzed as time-dependent except for age, gender, education, and nativity. There are five hierarchical models to test the associations between obesity and disability overtime varying by age, gender, and nativity.

Model 1 includes time, age, gender, nativity, and obesity. Model 2 includes marital status, education, household income, living arrangement, diabetes, arthritis, stroke, heart attack, hypertension, hip fracture, cancer, CES-D, and MMSE along with the variables in Model 1. Model 3 includes an interaction of age, obesity, and time along with the variables in Model 2. Model 4 includes an interaction of gender, obesity, and time along with the variables in Model 2. Model 5 includes an interaction of nativity, obesity, and time along with the variables in Model 2.

- *Model 1: Y = time + age + gender + nativity + obesity*
- *Model 2: Y = time + age + gender + nativity + obesity + marital status + education + language of interview + income + living arrangement + diabetes + 6 medical conditions + CES-D + MMSE*
- *Model 3: Y = time + age + gender + nativity + obesity + marital status + education + language of interview + income + living arrangement + diabetes + 6 medical conditions + CES-D + MMSE +* ***age*obesity*time***
- *Model 4: Y = time + age + gender + nativity + obesity + marital status + education + language of interview + income + living arrangement + diabetes + 6 medical conditions + CES-D + MMSE +* ***gender*obesity*time***
- *Model 5: Y = time + age + gender + nativity + obesity + marital status + education + language of interview + income + living arrangement + diabetes + 6 medical conditions + CES-D + MMSE +* ***nativity*obesity*time***

- 6 medical conditions = arthritis, stroke, heart attack, hypertension, hip fracture, and cancer

-All variables are time-varying variables except age, gender, nativity, and education.

Aim 2: Diabetes and Disability

To determine age, gender, and nativity differences in the relationship between diabetes and disability in older Mexican Americans over 17 years of follow-up.

Research Hypotheses:

2a. Diabetes will be associated with greater disability (ADL) in the older (>=75) group when compared with the young old (65-74)

2b. Diabetes will be associated with greater disability (ADL) in women compared to men.

2c. Diabetes will be associated with greater disability (ADL) in US-born compared to foreign-born.

Specific Aim #2 Analyses

The GEE procedure was used to test the association between diabetes and disability over time. Several Models were conducted to test the hypotheses. All variables were analyzed as time-dependent except for age, gender, education, and nativity. There are five hierarchical models for the associations between diabetes and disability overtime varying by age, gender, and nativity.

Model 1 includes time, age, gender, nativity, and diabetes. Model 2 includes marital status, education, household income, living arrangement, obesity, arthritis, stroke, heart attack, hypertension, hip fracture, cancer, CES-D, and MMSE along with the variables in Model 1. Model 3 includes an interaction of age, diabetes, and time along with the variables in Model 2. Model 4 includes an interaction of gender, diabetes, and time along with the variables in Model

2. Model 5 includes an interaction of nativity, diabetes, and time along with the variables in Model 2.

- *Model 1: Y = time + age + gender + nativity + diabetes*
- *Model 2: Y = time + age + gender + nativity + diabetes + marital status + education + language of interview + income + living arrangement + diabetes + 6 medical conditions + CES-D + MMSE*
- *Model 3: Y = time + age + gender + nativity + diabetes + marital status + education + language of interview + income + living arrangement + obesity + 6 medical conditions + CES-D + MMSE +* ***age*diabetes*time***
- *Model 4: Y = time + age + gender + nativity + diabetes + marital status + education + language of interview + income + living arrangement + obesity + 6 medical conditions + CES-D + MMSE +* ***gender*diabetes*time***
- *Model 5: Y = time + age + gender + nativity + diabetes + marital status + education + language of interview + income + living arrangement + obesity + 6 medical conditions + CES-D + MMSE +* ***nativity*diabetes*time***

- 6 medical conditions = arthritis, stroke, heart attack, hypertension, hip fracture, and cancer
-All variables are time-varying variables except age, gender, nativity, and education.

Aim 3: Obesity, Diabetes, and Disability

To determine the effect of obesity and diabetes on disability in older Mexican Americans over 17 years of follow-up.

Research Hypotheses:

3a. Subjects with obesity only will be more likely, over time, to develop ADL disability than subjects without obesity and diabetes.

3b. Subjects with diabetes only will be more likely, over time, to develop ADL disability than subjects without obesity and diabetes.

3b. Subjects with obesity and diabetes will be more likely, over time, to develop ADL disability than subjects with obesity only, subjects with diabetes only, and subjects without obesity and diabetes respectively.

Specific Aim #3 Analyses

The GEE procedure was used to test the association between obesity, diabetes, and disability over time. Several Models were conducted to test the hypotheses. All variables were analyzed as time-dependent except for age, gender, education, and nativity. In order to determine the comparisons obesity and/or diabetes to associate with disability, a 2x2 table was created for obesity and diabetes comparisons at baseline (Table 3.2). There are four groups; subject with no obesity and diabetes, subjects with obesity only, subjects with diabetes only, and subjects without obesity using subject with no obesity and diabetes as a reference group. The group comparison variable used for the longitudinal analysis on ADL disability was non-time varying component.

Table 3.2. Obesity and Diabetes Comparisons by 4 Groups

		Obesity	
		No (Non-obesity)	Yes (Obesity)
Diabetes	No (Non-Diabetes)	Normal (Reference)	Obesity Only
	Yes (Diabetes)	Diabetes Only	Both Obesity and Diabetes

Several Models were conducted to test the hypotheses for Specific Aim III. Model 1 includes time, and the 4 groups. Model 2 includes age, gender, and nativity along with the variables in Model 1. Model 3 includes marital status, education, household income, living arrangement, arthritis, stroke, heart attack, hypertension, hip fracture, cancer, CES-D, and MMSE along with the variables in Model 2. Model 4 includes interactions between groups and time along with the variables in Model 3.

- *Model 1: Y = time + 4 groups*
- *Model 2: Y = time + 4 groups + age + gender + nativity*
- *Model 3: Y = time + 4 groups + age + gender + nativity+ marital status + education + language of interview + income + living arrangement + 6 medical conditions + CES-D + MMSE*
- *Model 4: Y = time + 4 groups + age + gender + nativity + marital status + education + language of interview + income + living arrangement + 6 medical conditions + CES-D + MMSE +* ***4 groups*time***

-4groups = (no obesity + no diabetes: reference group) + (no obesity + diabetes) + (obesity + no diabetes) + (both obesity + diabetes)

-All variables are time-varying variables except age, gender, nativity, and education.

Table 3.3 presents descriptive characteristics of older Mexican Americans at baseline from the Hispanic EPESE, 1993–1994. Of the total 3,050 original participants, 1,818 were young old people (65–74, 62.9%), while 1,132 were 75 or older (37.1%). Fifty eight percent were women, Fifty six percent were born in the US, and forty four percent were born in Mexico. The mean BMI was 27.8 kg/m^2, with 1.8% of subjects being underweight, 28.5% normal weight, 39.7% overweight, and 30.0% obese. A total of 23.9% of participants had diabetes, and 11.5% had one or more ADL disability (any ADL).

Table 3.3 Descriptive Characteristics of Older Mexican Americans at baseline (1993-1994) from the Hispanic EPESE (N=3050)

Predictor Varibales		Mean (SD) or N (%)
Age MEAN (SE)		73.6 (6.8)
	young old (65-74)	1818 (62.9)
Age, N (%)	older (>=75)	1132 (37.1)
Gender	Male	1291 (42.3)
	Female	1759 (57.7)
Marital Status	Married	1693 (55.5)
	Not Married	1357 (44.5)
Education Mean		4.8 (3.9)
	<8 years	2367 (77.6)
	≥8 years	683 (22.4)
Nativity	Mexico-Born	1344 (44.1)
	US-Born	1704 (55.9)
Language of Interview	English	676 (22.2)
	Spanish	2374 (77.8)
Household income	<$15,000	2210 (81.3)

	≥$15,000	510 (18.7)
Living Arrangement Mean (SE)		2.6 (1.6)
	living alone	640 (21.0)
	living with two or more	2410 (79.0)
Arthritis		1137 (40.1)
Stroke		165 (5.8)
Heart attack		297 (10.5)
Hypertension		1662 (58.3)
Hip fracture		95 (3.3)
Cancer		152 (5.3)
CES-D Mean		9.9 (9.5)
	CES-D<16	2135 (76.1)
	CES-D=>16	669 (23.9)
MMSE Mean		24.7 (4.7)
	MMSE >=21	2403 (84.3)
	MMSE < 21	449 (15.7)
BMI Mean (SE)		27.8 (5.3)
	18.5>BMI	51 (1.8)
	18.5<=BMI<25	785 (28.5)
	25<=BMI<30	1095 (39.7)
	BMI ≥30	828 (30.0)
Diabetes		683 (23.9)
AnyADL Disability		421 (13.8)

SE-=Standard Error, CES-D = Center for Epidemiologic Studies Depression Scale, MMSE = Mini Mental State Examination, BMI= Body Mass Index, ADL = Activities of Daily Living.

Table 3.4 shows the descriptive characteristics of older Mexican Americans at each wave of the Hispanic EPESE, 1993-2011.

Table 3.4 Descriptive Characteristics of Subjects at Each Wave of the Hispanic EPESE (1993-1994 to 2010-2011)

		Baseline	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7
Total (N)		3050	2438	1980	1682	1092	921	659
Gender	male	1291 (42.3)	1014 (41.6)	799 (40.4)	648 (38.5)	404 (37.0)	325 (35.3)	220 (33.4)
	female	1759 (57.7)	1424 (58.4)	1181 (59.6)	1034 (61.4)	688 (63.0)	596 (64.7)	439 (66.6)
Age	mean (se)	73.6 (6.8)	75.5 (6.6)	77.9 (6.1)	79.5 (5.7)	82.1 (4.9)	83.6 (4.6)	86.0 (3.9)
	young old (65-74)	1818 (62.9)	1274 (52.3)	694 (35.1)	351 (20.9)	1 (0.1)	0	0
Age CAT, N (%)	older (75-84)	1132 (37.1)	1164 (47.7)	1286 (64.9)	1331(79.1)	1091(99.9)	921 (0)	659 (0)
Marital Status	married	1693 (55.5)	1294 (53.1)	964 (48.8)	766 (45.5)	452 (41.5)	343 (37.2)	200 (30.4)
	not Married	1357 (44.5)	1141 (46.9)	1012 (51.2)	916 (54.5)	638 (58.5)	578 (62.8)	458 (69.6)
Education Mean		4.8 (3.9)	4.8 (3.9)	4.8 (3.9)	4.9 (3.9)	5.0 (3.8)	5.0 (3.9)	4.9 (3.9)
	<8	2367 (77.6)	1898 (77.8)	1532 (77.4)	1294 (76.9)	838 (76.7)	701 (76.1)	507 (76.9)
	≥8	683 (22.4)	540 (22.2)	448 (22.6)	388 (23.1)	254 (23.3)	220 (23.9)	152 (23.1)
Nativity	Mexico-Born	1344 (44.1)	1089 (44.7)	859 (43.4)	713 (42.4)	471 (43.1)	395 (42.9)	273 (45.2)
	US-Born	1704 (55.9)	1348 (55.3)	1120 (56.6)	969 (57.6)	621 (56.9)	526 (57.1)	331 (54.8)
Household income	<$15,000	2210 (81.3)	1803 (79.3)	1363 (75.9)	Not collected	248 (25.5)	201 (25.8)	208 (33.9)
	≥$15,000	510 (18.7)	471 (20.7)	431 (24.1)		725 (74.5)	579 (74.2)	406 (66.1)
Living Arrangement	mean (se)	2.6 (1.6)	2.6 (1.6)	2.5(1.5)	2.39 (1.5)	2.41 (1.5)	2.35 (1.5)	2.43 (1.6)
	living alone	640 (21.0)	548 (22.5)	487 (24.6)	454 (26.9)	298 (27.3)	259 (28.4)	197 (32.2)
	living with two or more	2410 (79.0)	1890 (77.5)	1493 (75.4)	1228 (73.1)	794 (72.7)	654 (71.6)	415 (67.8)
	arthritis	1137 (40.1)	1091 (44.9)	976 (49.5)	915 (54.6)	648 (60.6)	577 (63.3)	441 (67.7)

	stroke	165 (5.8)	243 (9.9)	127 (6.4)	91 (5.4)	79 (7.2)	36 (3.9)	75 (11.4)
Medical Conditions	heart attack	297 (10.5)	235 (9.6)	160 (8.1)	113 (6.7)	68 (6.2)	33 (3.5)	63 (9.5)
	hypertension	1662 (58.3)	1392 (57.1)	1184 (59.8)	949 (59.1)	711 (65.1)	531 (69.8)	489 (74.3)
	hip fracture	95 (3.3)	44 (1.8)	57 (2.8)	56 (3.3)	37 (3.4)	26 (2.8)	41 (6.2)
	cancer	152 (5.3)	174 (7.1)	136 (6.8)	109 (6.4)	71 (6.5)	70 (7.6)	73 (11.1)
CES-D Mean		9.9 (9.5)	7.09 (8.4)	8.40 (8.9)	7.10 (7.5)	9.58 (8.9)	9.35 (8.9)	10.84 (9.3)
	<16	2135 (76.1)	1933 (86.3)	1478 (82.5)	1361 (87.1)	837 (78.9)	628 (77.4)	482 (73.2)
	=>16	669 (23.9)	308 (13.7)	314 (17.5)	201 (12.9)	223 (21.1)	184 (22.6)	177 (26.9)
MMSE Mean		24.7 (4.7)	23.42 (5.1)	21.06 (7.2)	20.94 (7.1)	21.13 (7.1)	19.98 (8.9)	21.02 (7.4)
	28 -30	991 (34.8)	649 (28.7)	403 (21.5)	314 (19.8)	218 (19.9)	208 (23.7)	121 (19.8)
	24 -27	780 (27.3)	445 (19.7)	315 (16.8)	265 (16.6)	185 (16.9)	125 (14.2)	148 (24.3)
	0 -23	1081 (37.9)	1165 (51.6)	1157 (61.7)	1010 (63.6)	689 (63.2)	545 (62.1)	341 (55.9)
BMI Mean		27.8 (5.3)	27.88 (5.3)	28.28 (5.5)	27.95 (5.4)	27.61 (5.1)	26.99 (5.3)	27.40 (5.1)
	18.5>BMI	51 (1.8)	38 (1.8)	29 (1.8)	27 (2.1)	16 (1.7)	25 (3.1)	12 (2.4)
	18.5<=BMI<25	785 (28.5)	599 (28.4)	438 (26.7)	365 (28.2)	284 (30.8)	291 (36.4)	150 (29.5)
	25<=BMI<30	1095 (39.7)	815 (38.6)	609 (37.2)	487 (37.7)	349 (37.8)	294 (36.8)	213 (41.9)
	BMI ≥30	828 (30.0)	657 (31.2)	563 (34.3)	414 (32.0)	274 (29.7)	189 (23.7)	133 (26.2)
Diabetes		683 (23.9)	678 (27.8)	577 (29.1)	537 (31.9)	348 (32.0)	312 (34.0)	227 (34.4)
Any ADL Disability		421 (13.8)	383 (15.7)	459 (23.3)	420 (25.2)	365 (33.4)	478 (51.9)	342 (51.9)

SE-=Standard Error, CES-D = Center for Epidemiologic Studies Depression Scale, MMSE = Mini Mental State Examination, BMI= Body Mass Index, ADL = Activities of Daily Living.

Chapter 4: Specific Aim I Results

Chapter 4, 5, and 6 provide the results for the analyses for specific aims I, II, and III. Chapter 4 describes the relationship between age, gender, and nativity with obesity (overweight and obesity) and disability in older Mexican Americans over seven waves of follow-up. Three hypotheses were suggested to investigate whether obesity is associated with disability varying by age, gender, and nativity. Obesity will be associated with greater ADL disability; 1) among the older (75+) group when compared with the young old (65-74), 2) in women compared to men, and 3) in U.S-born compared to Mexico-born.

Figure 4.1 represents percentages of those experiencing ADL disability by age group for each wave of the Hispanic EPESE (1993–1994 to 2010-2011). Between 1993-1994 and 2010-2011, the prevalence of ADL disability increased from 13.8% (baseline) to 51.9% (Wave 7). The percentage of ADL disability among the young old gradually increased while the percentage of ADL disability decreased among the older group due to old age (mortality). At baseline (1993–1994). The percentage of ADL disability is 36.1% for the young old and 63.9% for the older old among ADL subjects. At Wave7, the percentage of ADL disability is 82.8% for the young old and 17.2% for the older old among ADL subjects.

Figure 4.1. Percentage of ADL Disability by Age Category at Baseline in the Hispanic EPESE (1993–1994 to 2010-2011)

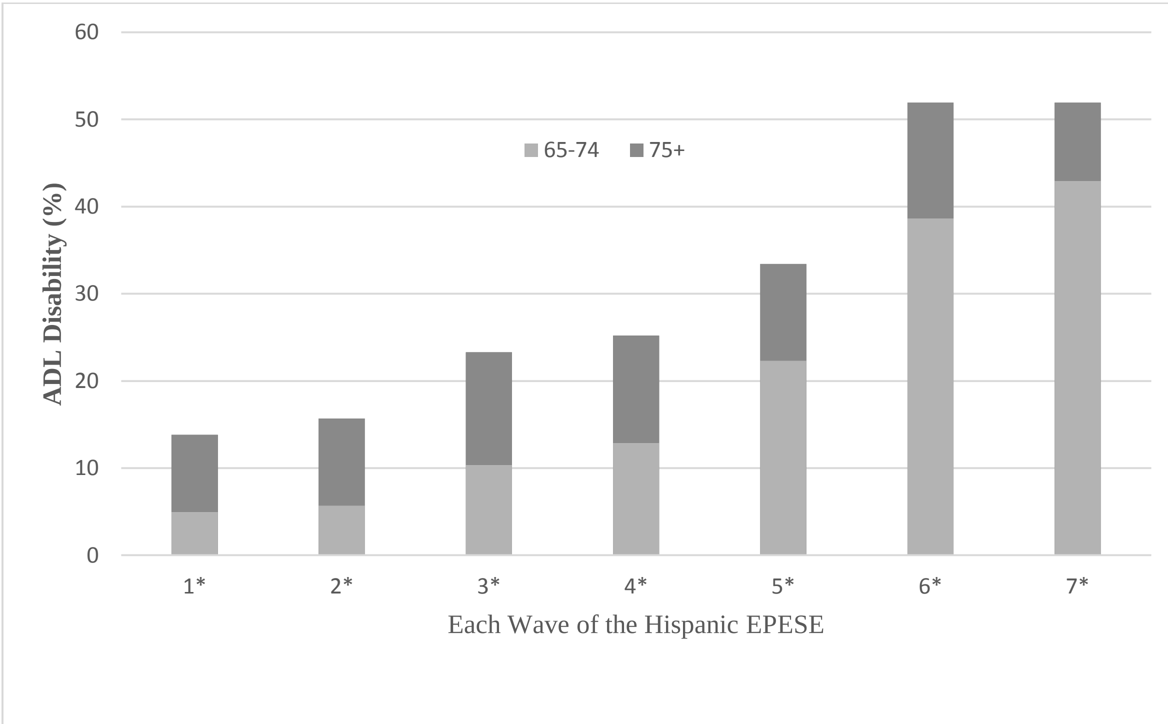


Figure 4.2 represents the percentages of those with ADL disability by gender for each wave of the Hispanic EPESE (1993–1994 to 2010-2011). Overall, female participants experienced more ADL disability than male participants. The percentage of ADL disability for males is 35.87% and 64.13% for females at baseline (1993–1994), and 27.19% and 72.81% for male and female ADL disabled subjects at Wave 7 (2010-2011).

Figure 4.2. Percentages of ADL Disability by Gender in the Hispanic EPESE (1993–1994 to 2010-2011)

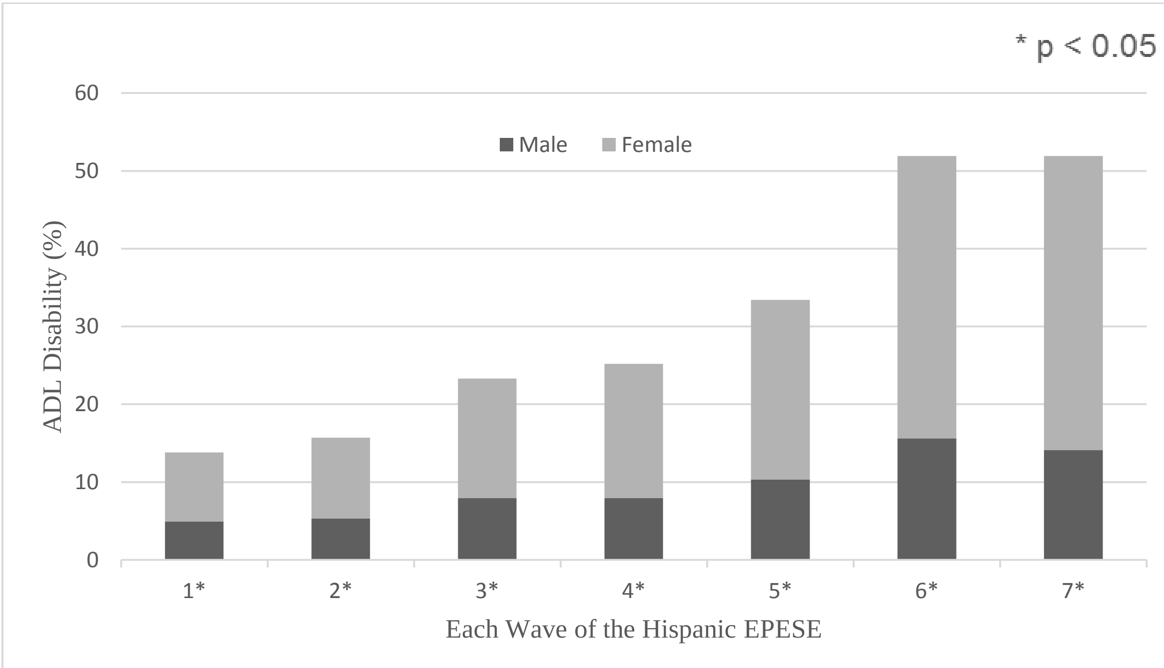
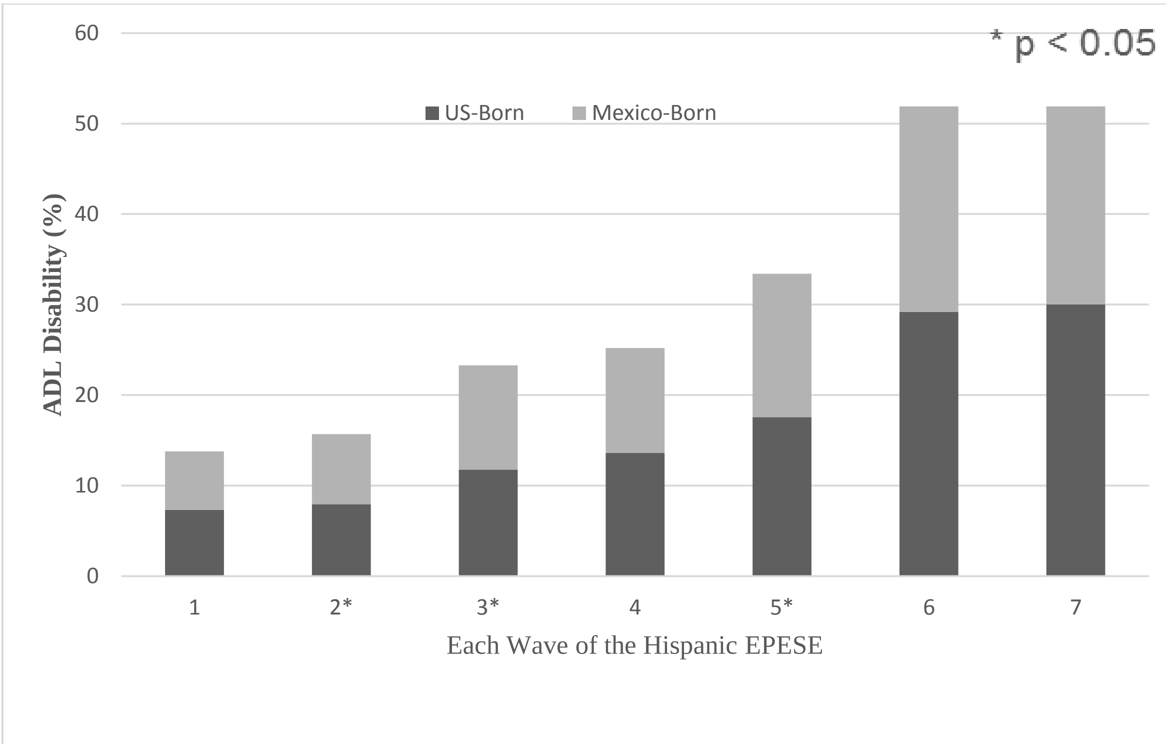


Figure 4.3 represents the percentages of those with ADL disability by nativity (U.S.-born vs. Mexico-born) in each of the Hispanic EPESE waves (1993–1994 to 2010-2011). Although there are inconsistencies in terms of nativity, participants born in the U.S. always outnumber those born in Mexico at each wave of the Hispanic EPESE. The percentage of those with ADL disabled subjects in the U.S-born population range from 50.54 % (Wave 3) to 57.80% (Wave 7).

Figure 4.3. Percentages of ADL Disability by Nativity in the Hispanic EPESE (1993–1994 to 2010-2011)



AIM I RESULTS

Figure 4.4 presents the percentages for each of the BMI categories (normal, overweight, and obesity) at each wave of the Hispanic EPESE (1993–1994 to 2010-2011). At baseline (1993–1994), 32.95% are normal weight, 38.37% are overweight, and 28.68% are obese. The percentage of the obese subjects range from 28.49 % at Wave 2 and 41.59% at Wave 4.

Figure 4.4. Percentages of BMI Category in the Hispanic EPESE (1993–1994 to 2010-2011)

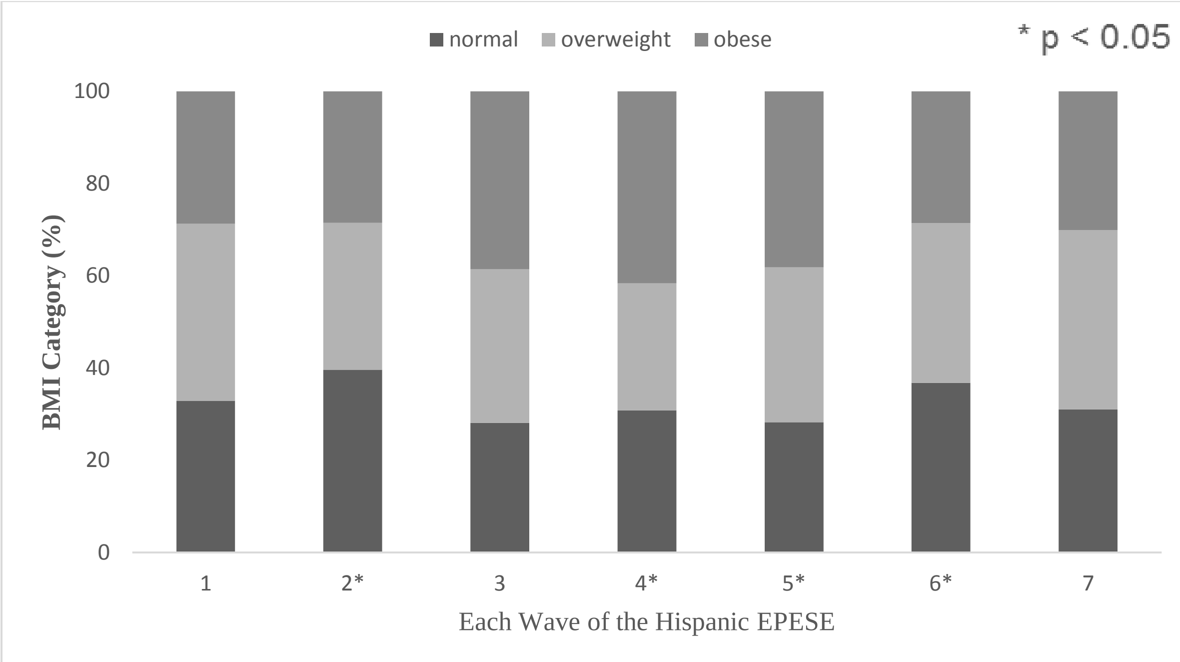


Figure 4.5. Percentages of ADL Disability and BMI Mean in the Hispanic EPESE (1993–1994 to 2010-2011)

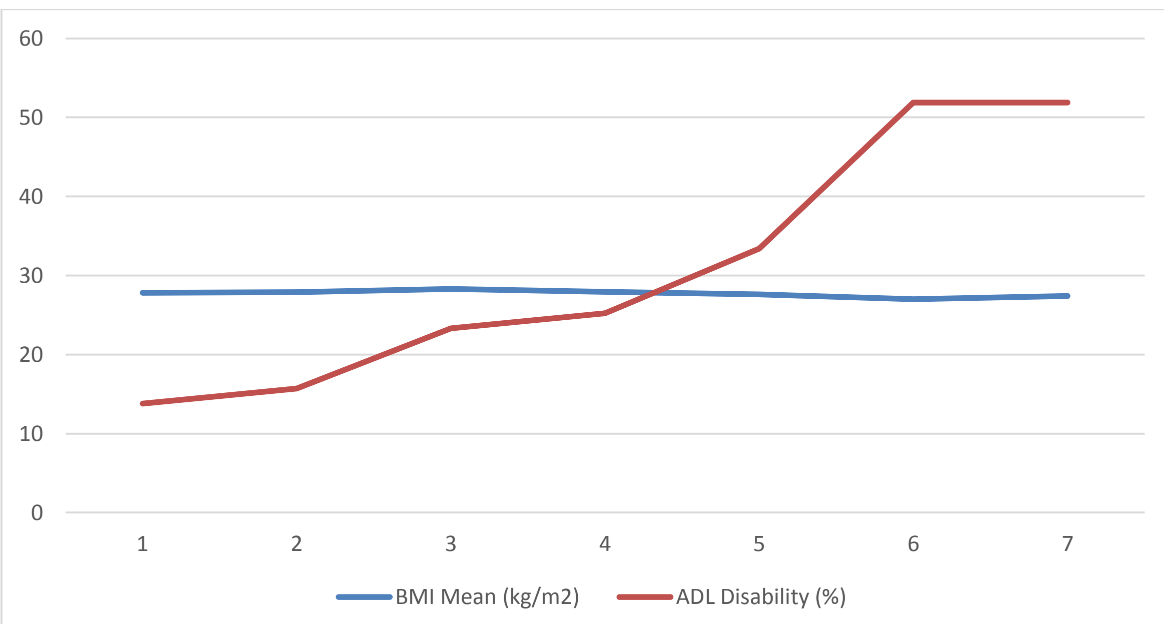


Figure 4.5 presents the percentages of ADL disability and mean BMI in the Hispanic EPESE (1993–1994 to 2010-2011). The percentages of ADL disability increased from 13.8% at baseline to 51.9% at Wave 7. Conversely, mean BMI (kg/m^2) stayed relatively flat. Mean BMI ranged from 26.99 (Wave 6) at its lowest BMI to 28.22 (Wave 3) at its highest.

Hypothesis 1a

Hypothesis 1a was that obesity (overweight and obesity) would be associated with greater ADL disability among the older (75+) group in comparison to the young old (65–74). The GEE results for ADL disability as a function of obesity by age, gender, and nativity over the 17-year period is provided in Table 4.2.

The analysis showed that older adults and women were more likely to develop disability over the 17-year timeframe. In addition, Model 1 shows that the odds of experiencing ADL disability at each wave as a function of being overweight (BMI of 25.0–29.9) were 0.81 (95% CI, 0.69-0.93). Thus, being overweight compared to normal weight associated with a 19 % decreased odds of developing disability over time.

To further examine this aim, Models 3-5 show the interaction effects that were tested for age, gender, nativity, and obesity over time on disability. An interaction effect between age, overweight (BMI of 25.0–29.9), and time (OR = 0.90; 95% CI, 0.83-0.99) was significant in Model 3 after controlling for marital status, education, household income, living arrangements, diabetes, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE. This finding suggests that the effect of being overweight on disability may vary significantly by age over time. To ease the interpretation of the interaction effect, I stratified the analyses by age. However, the results of the stratified analyses did not show significant effects of weight on disability over time for either age group (results not shown). Therefore, Hypothesis 1a was refuted because the findings did not show that weight (being overweight and/or obese) was associated with greater ADL disability by age. Moreover, the direction of the association between overweight (BMI of 25.0–29.9) and disability by age was opposite of the hypothesized direction of association.

Hypothesis 1b

Hypothesis 1b was that obesity (overweight and obesity) would be associated with greater ADL disability in women compared to men shown in Table 4.2. The analysis showed in this table that women were more likely to develop disability over the 17-year time frame. In addition, Model 1 shows that the odds of experiencing ADL disability at each wave as a function of women were 1.44 (95% CI, 1.23-3.35). Thus, women compared to men associated with a 44% increased odds of developing disability over time.

To further examine this aim, Model 4 shows the interaction effects that were tested for gender and obesity over time on disability. An interaction effect between gender, obesity (BMI $\geq$ 30), and time (OR = 1.11; 95% CI, 1.03-1.21) was significant in Model 4 after controlling for marital status, education, household income, living arrangements, diabetes, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE. This finding suggests that the effect of obesity on disability over time may vary significantly by gender. To ease the interpretation of the interaction effect, I stratified the analyses by gender. However, the results of the stratified analyses did not show significant effects of weight on disability over time for either gender (results not shown).

Therefore, Hypothesis 1b was refuted because the findings did not show that weight (being overweight and/or obese) was associated with greater ADL disability among women as compared to the men.

Hypothesis 1c

Hypothesis 1c was that obesity (overweight and obesity) would be associated with greater ADL disability in U.S.-born as compared to foreign-born persons shown in Table 4.2. In all Models, nativity was not associated with ADL disability, at each wave (intercept).

An interaction effect between age, obesity (BMI $\geq$ 30), and time (OR = 1.12; 95% CI, 1.03-1.22) was significant in Model 5 after controlling for marital status, education, household income, living arrangements, diabetes, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE. This finding suggests that the effect of obesity (BMI $\geq$ 30) on disability over time may vary significantly by nativity. To ease the interpretation of the interaction effect, I stratified the analyses by nativity. The results of the stratified analyses showed significant effects of obesity (BMI $\geq$ 30) on disability over time for Mexico-born participants (OR=1.17; 95% CI, 1.01-1.36) suggesting that the effect of obesity on disability was 17% more likely to have ADL disability over time significantly as compared to normal weight among Mexico-born participants (results not shown).

Thus, Hypothesis 1c was partially supported in the interaction between nativity, obesity (BMI ≥ 30), and time. Because the interaction effect between nativity, obesity (BMI ≥ 30), and time was significant while the interaction effect between nativity, overweight (BMI ≥ 25.0–29.9), and time was not.

Frequency of BMI and Status

Table 4.1 shows cross-tabulation for BMI and status at each interview for older Mexican Americans (1993-1994 to 2010-2011). At baseline (1993-1994), 2,769 participants were interviewed with BMI information. In the second wave (1995-1996), 2,029 subjects were re-interviewed in person and 167 by proxy, and 453 subjects were re-interviewed in person and 80 by proxy in the seventh wave (2010-2011).

Table 4.1. Cross-tabulation for BMI and Status at Each Interview for the Hispanic EPESE (1993-1994 to 2010-2011)

Wave	Year	Total	Proxy+	Deceased	Refused	Not Located	Age
I	1993-4	2769					65+
II	1995-6	2196	167	175	101	244	67+
III	1998-9	1674	163	261	64	72	70+
IV	2000-1	1363	97	134	54	59	72+
V	2004-5	908	122	233	36	89	75+
VI	2007	711	91	119	29	48	78+
VII	2010-1	533	80	173		68	80+

*BMI <18.5 were excluded at baseline.

SUMMARY AIM I

This chapter has illustrated that weight (overweight and obesity) was not associated with greater ADL disability by age (Hypothesis 1a), by gender (Hypothesis 1b) or by nativity (Hypothesis 1c). However, it was determined that the effect of obesity was less likely on ADL disability as compared to non-diabetes among Mexico-born participants, an association in the opposite direction of that hypothesized.

Table 4.2. The General Estimate Equations Models for ADL Disability as a Function of Obesity over Seventeen-Year Period among Older Mexican Americans (1993–1994 to 2010-2011).

		Model 1 OR (95 % CI)	Model 2 OR (95 % CI)	Model 3 OR (95 % CI)	Model 4 OR (95 % CI)	Model 5 OR (95 % CI)
Time		1.62 (1.56-1.68)	1.57 (1.50-1.64)	1.59 (1.52-1.66)	1.52 (1.45-1.60)	1.54 (1.47-1.61)
Age	Young old (65-74)	1.00	1.00	1.00	1.00	1.00
	Older (>=75)	2.85 (2.42-3.35)	2.53 (2.11-3.03)	2.93 (2.29-3.76)	2.51 (2.09-3.01)	2.54 (2.11-3.05)
Gender	Male	1.00	1.00	1.00	1.00	1.00
	Female	1.44 (1.23-1.68)	1.15 (0.95-1.39)	1.16 (0.96-1.39)	1.02 (0.80-1.28)	1.16 (0.96-1.39)
Nativity	Mexico-Born	1.00	1.00	1.00	1.00	1.00
	US-Born	1.06 (0.91-1.23)	0.95 (0.80-1.12)	0.95 (0.81-1.12)	0.96 (0.81-1.12)	0.82 (0.65-1.02)
BMI category	18.5<=BMI<25	1.00	1.00	1.00	1.00	1.00
Overweight	25<=BMI<30	0.81 (0.69-0.93)	0.82 (0.68-0.97)	0.92 (0.74-1.13)	0.77 (0.61-0.97)	0.78 (0.63-0.96)
Obesity	BMI ≥30	1.03 (0.87-1.22)	0.98 (0.80-1.18)	1.04 (0.83-1.31)	0.74 (0.56-0.97)	0.82 (0.65-1.03)
Age*Overweight*Time				0.90 (0.83-0.99)		
Age*Obesity*Time				0.95 (0.84-1.06)		

Gender*Overweight*Time	1.02 (0.95-1.09)	
Gender*Obesity*Time	1.11 (1.03-1.21)	
US-Born*Overweight*Time		1.03 (0.95-1.10)
US-Born*Obesity*Time		1.12 (1.03-1.22)

Model 2, 3, 4 & 5: Controlled for marital status, education, household income, living arrangement, diabetes, 6 medical conditions (arthritis, stroke, heart attack, hypertension, hip fracture, and cancer), CES-D, and MMSE

OR= Odds Ratio, CI= Confident Interval, BMI = Body mass index

Overweight = BMI of 25 <30 kg/m^2

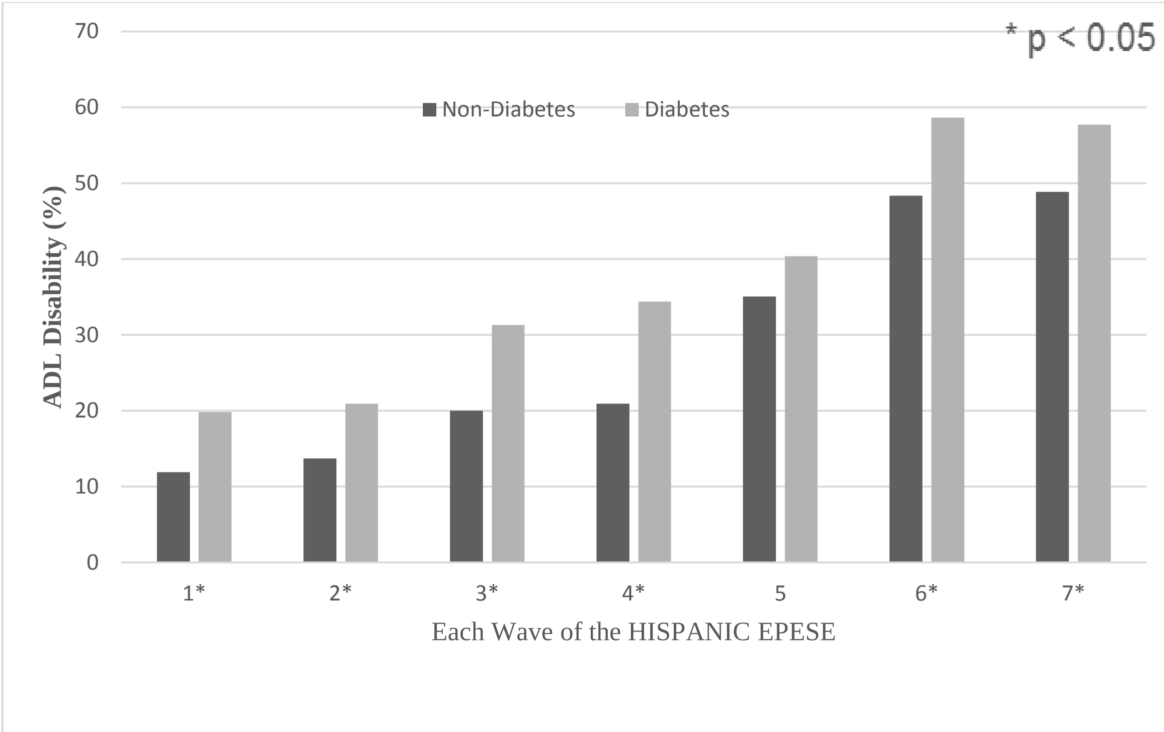
Obesity = BMI ≥30 kg/m^2

Chapter 5: Specific Aim II Results

Chapter 5 shows the results for aim II which tested the interaction between age, gender, nativity, and diabetes with time on ADL disability in older Mexican Americans. Three hypotheses are proposed to investigate whether the association between diabetes and disability would vary by age, gender, and nativity. The proposed hypotheses will test the association between diabetes and greater ADL disability; 2a) among the older (75+) group when compared with the young old (65-74), 2b) in women compared to men, and 2c) in the U.S.-born compared to Mexico-born.

Figure 5.1 shows the percentages of diabetes population with ADL disability at each wave of the Hispanic EPESE (1993-1994 to 2010-2011). The proportion of non-diabetes and diabetes population with ADL increased over time. The percentage of non-diabetes participants with ADL disability is 11.93% (baseline) at its lowest and 48.84% (Wave 7) at its highest, and the percentages of diabetes participants with ADL disability is 19.84% (baseline) at its lowest and 57.71% (Wave 7) at its highest.

Figure 5.1. Percentages of Diabetes with ADL Disability in the Hispanic EPESE (1993–1994 to 2010-2011)



AIM II RESULTS

Hypothesis 2a

Hypothesis 2a was that diabetes would be associated with greater ADL disability among the older (75+) group as compared to the young old (65–74). Table 5.2 presents the results of the GEE for ADL disability as a function of diabetes over a seventeen-year period of follow-up among older Mexican Americans. Upon analysis, the odds of experiencing ADL disability at each wave (intercept) as a function of diabetes were found to be significant in all Models: 1.80 (95% CI, 1.41-2.28) in Model 1 and, 1.72

(95% CI, 1.23-2.41) in Model 2. Model 3, 4, and 5 tested for the interaction effect between age, gender, and nativity, and diabetes with time.

The analysis showed in this table that older adults were more likely to develop disability over the 17-year time frame. In addition, Model 1 shows that the odds of experiencing ADL disability at each wave as a function of diabetes were 1.80 (95% CI, 1.41-2.28). Thus, diabetes compared to non-diabetes associated with an 80% increased odds of developing disability over time.

To further examine this aim, Models 3-5 show the interaction effects that were tested for age, gender, nativity, and diabetes over time on disability. An interaction effect between age, diabetes, and time (OR = 0.86; 95% CI, 0.78-0.95) was significant in Model 3 after controlling for marital status, education, household income, living arrangements, diabetes, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE. This finding suggests that the effect of diabetes on disability over time may vary significantly by age. To ease the interpretation of the interaction effect, I stratified the analyses by age. The results of the stratified analyses showed significant effects of diabetes on disability over time for the young old aged 65-74 group (OR = 0.90; 95% CI, 0.82-0.99) suggesting the effect of diabetes was 10% less likely to have ADL disability as compared to non-diabetes only among the young old group (results not shown).

However, hypothesis 2a was refuted because the direction of the association between diabetes and disability by age was opposite (OR = 0.86; 95% CI, 0.78-0.95) the hypothesized direction of association.

Hypothesis 2b

Hypothesis 2b was that diabetes would be associated with greater disability (ADL) in women as compared to men shown in Table 5.2. In Model 1, it emerged that women were more likely to experience increased ADL disability as compared to men (OR=1.42; 95% CI, 1.24-1.64) at each wave (intercept). However, no significant association emerged in Model 2 after controlling for marital status, education, household income, living arrangements, obesity, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE.

No interaction effect emerged between gender, diabetes, and time (OR = 1.03; 95% CI, 0.96-1.10) in Model 4 after controlling for marital status, education, household income, living arrangement, diabetes, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE.

The interaction term was not significant (1.03 95% CI, 0.96-1.10). To interpret the interaction term, I stratified the analyses by gender. The results of the stratified analyses did not show significant effects of diabetes on disability over time for either gender group (results not shown).Thus, Hypothesis 2b was refuted.

Hypothesis 2c

Hypothesis 2c was that diabetes would be associated with greater ADL disability in U.S.-born as compared to foreign-born persons. No significant association was found at each wave (intercept) between nativity and disability shown in Table 5.2.

No interaction effect emerged between nativity and diabetes over time (OR = 0.99; 95% CI, 0.93-1.07) in Model 5 after controlling for marital status, education, household income, living arrangements, obesity, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE, suggesting that diabetes among US-born participants had 0.99 times the odds of becoming ADL disabled over time compared to foreign-born, however, the association was not statistically significant.

The interaction term was not significant (OR = 0.99; 95% CI, 0.93-1.07). To interpret the interaction term, I stratified the analyses by nativity. The results of the stratified analyses did not show significant effects of diabetes on disability over time for either nativity group (results not shown).Thus, Hypothesis 2c was refuted.

Frequency of Diabetes and Status

Table 5.1 shows cross-tabulation for diabetes and status at each interview for older Mexican Americans (1993-1994 to 2010-2011). At baseline (1993-1994), 3,039 participants were interviewed with diabetes information. In the second wave (1995-1996), 2,137 subjects were re-interviewed in person and 260 by proxy, and 504 subjects were re-interviewed in person and 98 by proxy in the seventh wave (2010-2011).

Table 5.1. Cross-tabulation for Diabetes and Status at Each Interview for the Hispanic EPESE (1993-1994 to 2010-2011)

Wave	Year	Total	Proxy+	Deceased	Refused	Not Located	Age
I	1993-4	3039					65+
II	1995-6	2397	260	234	108	258	67+
III	1998-9	1899	253	377	75	87	70+
IV	2000-1	1602	195	238	68	72	72+
V	2004-5	1102	192	404	61	115	75+
VI	2007	798	126	194	32	63	78+
VII	2010-1	602	98	224		91	80+

SUMMARY AIM II

This chapter has illustrated that diabetes was not associated with greater ADL disability by age (Hypothesis 2a), by gender (Hypothesis 2b) or by nativity (Hypothesis 2c). However, it was determined that the effect of diabetes was less likely to have ADL disability as compared to non-diabetes among the young old group (65-74), an association in the opposite direction of that hypothesized.

Table 5.2. The General Estimate Equations Models for ADL Disability as a Function of Diabetes over Seventeen-Year period among Older Mexican Americans (1993–1994 to 2010-2011).

		Model 1 OR (95 % CI)	Model 2 OR (95 % CI)	Model 3 OR (95 % CI)	Model 4 OR (95 % CI)	Model 5 OR (95 % CI)
Time		1.54 (1.50-1.59)	1.57 (1.50-1.64)	1.59 (1.52-1.65)	1.56 (1.49-1.63)	1.57 (1.50-1.64)
Age	Young old (65-74)	1.00	1.00	1.00	1.00	1.00
	Older (>=75)	3.53 (3.06-4.07)	2.53 (2.11-3.03)	2.88 (2.35-3.54)	2.53 (2.11-3.04)	2.53 (2.11-3.03)
Gender						
	Male	1.00	1.00	1.00	1.00	1.00
	Female	1.42 (1.24-1.64)	1.15 (0.95-1.39)	1.15 (0.95-1.38)	1.11 (0.91-1.36)	1.15 (0.96-1.39)
Nativity						
	Mexico-Born	1.00	1.00	1.00	1.00	1.00
	US-Born	1.13 (0.98-1.29)	0.95 (0.81-1.12)	0.96 (0.81-1.13)	0.95 (0.81-1.12)	0.96 (0.79-1.15)
Diabetes		1.80 (1.41-2.28)	1.72 (1.23-2.41)	1.85 (1.53-2.24)	1.51 (1.19-1.90)	1.62 (1.33-1.97)
Age*Diabetes*Time				0.86 (0.78-0.95)		
Gender*Diabetes*Time					1.03 (0.96-1.10)	

US-born* Diabetes*Time	0.99 (0.93-1.07)

Model 2, 3, 4 & 5: Controlled for marital status, education, household income, living arrangement, diabetes, 6 medical conditions (arthritis, stroke, heart attack, hypertension, hip fracture, and cancer), CES-D, and MMSE

OR= Odds Ratio, CI= Confident Interval, BMI = Body Mass Index

Chapter 6: Specific Aim III Results

Chapter 6 shows the results for aim III which determined the effect of obesity and diabetes on disability in older Mexican Americans over seventeen-year of follow-up. Three hypotheses investigated whether subjects with obesity and diabetes were more likely, over time, to develop ADL disability compared to subjects with obesity only, subjects with diabetes only, and subjects without obesity or diabetes.

Table 6.1 shows the descriptive statistics of older Mexican Americans by obesity and diabetes at baseline (1993–1994). Of the 2,716 original participants, 56.19 % of the young old (65–74) were in Group 1 (no obesity & no diabetes) and 72.29% were in Group 4 (obesity and diabetes) while of the older group (75+) 32.10% were in Group 2 (obesity only) and 42.76% were in Group 3 (diabetes only). The mean BMIs (kg/m^2) were 22.69 for Group 1, 30.07 were for Group 2, 22.72 for Group 3, and 30.75 Group 4. Percentages of participants having one or more ADL disability (any ADL) ranged from 7.65% (Group 2) to 17.24% (Group 3).

Frequency of Disability and Status

Table 6.2 shows cross-tabulation for disability and status at each interview for older Mexican Americans (1993-1994 to 2010-2011). At baseline (1993-1994), 3,041 participants were interviewed with disability information. In the second wave (1995-1996), 2,133 subjects were re-interviewed in person and 259 by proxy, and 505 subjects were re-interviewed in person and 98 by proxy in the seventh wave (2010-2111).

Table 6.1. Descriptive Characteristics of Older Mexican Americans by Group at Baseline from the Hispanic EPESE (N=2,716)

		Group1	Group2	Group3	Group4
	N (%)	646 (23.78)	1427 (52.54)	145 (5.34)	498 (18.34)
	Age MEAN (SE)	74.52 (0.28)	72.68 (0.16)	73.93 (0.54)	72. 17 (0.25)
Age*	Young old (65-74)	363 (56.19)	969 (67.90)	83 (57.24)	360 (72.29)
N (%)	Older (75+)	283 (43.81)	458 (32.10)	62 (42.76)	138 (27.71)
Gender	Male	285 (44.12)	579 (40.57)	64 (44.14)	206 (41.37)
N (%)	Female	361 (55.88)	848 (59.43)	81 (55.86)	292 (58.63)
Nativity	Mexico-Born	289 (44.81)	629 (44.11)	61 (42.07)	199 (39.96)
N (%)	UB-Born	356 (55.19)	797 (55.89)	84 (57.93)	299 (60.04)
	BMI Mean (SE)*	22.69 (0.06)	30.07 (0.11)	22.72 (0.12)	30.75 (0.22)
	Any ADL Disability* N (%)	60 (9.33)	109 (7.65)	25 (17.24)	64 (12.85)

Note: * $p < 0.05$
'N' varies due to missing data. Chi-square tests were used.
SE=Stand Error, ADL=Activities of Daily Living

Group1= No Obesity and No Diabetes
Group2 =Obesity Only
Group3 =Diabetes Only
Group4 =Both Obesity and Diabetes

Table 6.2. Cross-tabulation for ADL Disability and Status at Each Interview for the Hispanic EPESE (1993-1994 to 2010-2011)

Wave	Year	Total	Proxy+	Deceased	Refused	Not Located	Age
I	1993-4	3041					65+
II	1995-6	2392	259	232	107	257	67+
III	1998-9	1899	253	377	75	84	70+
IV	2000-1	1594	192	236	68	72	72+
V	2004-5	1098	192	393	60	114	75+
VI	2007	800	126	195	34	63	78+
VII	2010-1	603	98	225		92	80+

AIM III RESULTS

Hypothesis 3a, 3b, and 3c

The hypotheses were that participants with obesity only (3a) and diabetes only (3b) would be more likely, over time, to develop ADL disability than participants without obesity and diabetes respectively. Hypothesis 3c was that participants with obesity and diabetes would be more likely, over time, to develop ADL disability than participants with obesity only, participants with diabetes only, and participants without obesity and diabetes.

As shown Table 6.3, in Model 1, it emerged that participants with diabetes only (OR=1.97; 95% CI= 1.39 - 2.80) had 1.97 times the odds of becoming ADL disabled, and that participants with both obesity and diabetes (OR=1.70; 95% CI= 1.35 – 2.12) and had 1.70 times the odds of becoming ADL disabled as compared to those who were not obese or diabetic respectively. However, participants with obesity only (OR=0.83; 95% CI= 0.68 - 1.00) had 0.83 times the odds of becoming disabled ADL disability as compared to participants without obesity and diabetes.

In Model 2, it emerged that those with both obesity and diabetes (OR=2.14; 95% CI= 1.71 - 2.68) had 2.14 times odds of becoming ADL disabled, and that subjects with diabetes only (OR=2.00; 95% CI= 0.99 – 3.99) were 100% more likely to become ADL disabled significantly as compared to those who were not obese or diabetic, after controlling for age, gender, and nativity.

In Model 3, it emerged that the diabetes-only group (OR=2.07; 95% CI= 1.37 – 3.14) and those with both obesity and diabetes (OR=1.83; 95% CI= 1.43 - 2.35) were significantly more likely to experience higher ADL disability (2.07 times odds of becoming ADL disabled and 1.83 times odds of becoming ADL disabled respectively) as compared to those who were not obese or diabetic, after controlling for age, gender, nativity, marital status, household income, living arrangements, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE.

In Model 4, interaction effects between diabetes-obesity groups and time were tested after controlling for age, gender, nativity, marital status, household income, living arrangements, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE, however, no significant interaction effects were found between groups over time.

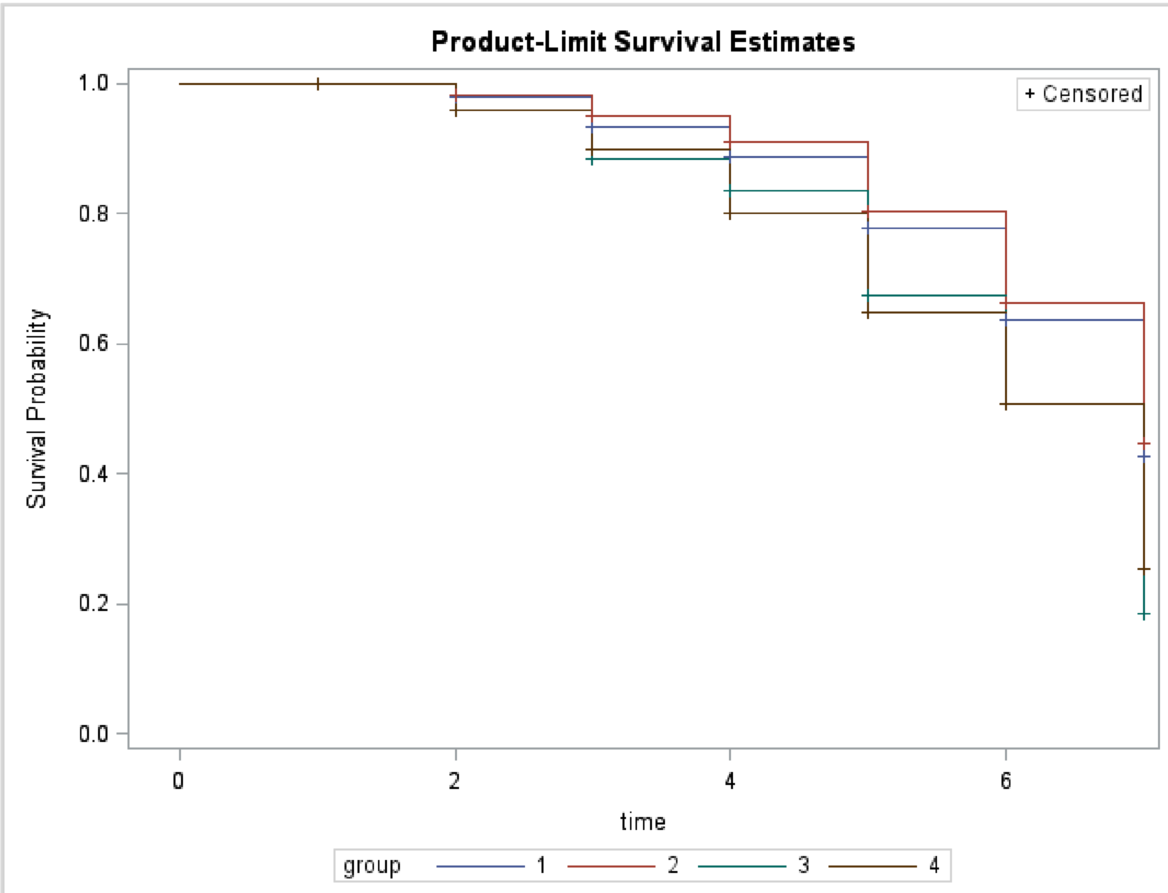
Participants with obesity only were less likely to experience ADL disability as compared to those without obesity and diabetes. Thus, Hypothesis 3 was partially supported for participants with diabetes only and participants with both obesity and diabetes.

Figure 6.1 shows the unadjusted disability survival curve of older Mexican Americans by group over seven waves for 17 years. The survival curve using discrete time-hazard models was estimated with maximum likelihood methods to predict the likelihood of participants becoming ADL disabled during each wave, comparing participants with obesity only (group 2), to participants with diabetes only (group 3), and participants with both obesity and diabetes (group 4) and, as a reference group, participants with no obesity and no diabetes (group 1) over time.

Based on this survival curve, participants in the obesity-only group (Group 2) were less likely to become ADL disabled of all groups, including the no-obesity / no-diabetes group. By contrast, the diabetes-only group (Group 3) was the most likely to become disabled through Wave 4 (2000–2001), and the obesity-and-diabetes group (Group 4) was the most likely to be become ADL disabled from Wave 4 (2000-2001) to Wave 6 (2007-2008). The diabetes-only group (Group 3) was the most likely to become ADL disabled from Wave 6 (2007-2008) to Wave 7 (2010-2011).

Approximately 17 % of the participants with both obesity and diabetes, 24 % of those with diabetes only, 42% of those with no obesity and no diabetes, and 45% of those with obesity were still not disabled after 17 years of follow-up. This pattern clearly demonstrates the protective effect of obesity for older adults over a long period of time.

Figure 6.1. Disability Survival Curve of Older Mexican Americans over 17 Years (N=2,716, Unadjusted Model).



SUMMARY AIM 3

This chapter has discussed results showing that participants with obesity and diabetes were more likely, over time, to develop more ADL disability as compared to participants with diabetes only and those without obesity and diabetes. However, the development of ADL disability did not vary significantly over time between participants with both obesity and diabetes as compared to participants with obesity only.

Table 6.2. The General Estimate Equations Models for ADL Disability as a Function of Obesity and Diabetes over a Seventeen -Year Period among Older Mexican Americans (1993-1994 to 2010-2011).

		Model 1 OR (95 % CI)	Model 2 OR (95 % CI)	Model 3 OR (95 % CI)	Model 4 OR (95 % CI)
Time		1.60 (1.55-1.65)	1.71 (1.65-1.76)	1.64 (1.57-1.70)	1.60 (1.47-1.73)
(Non-obese & Non-diabetes)		1.00	1.00	1.00	1.00
(Obese only)		+0.83 (0.68-1.00)	0.88 (0.59-1.31)	0.95 (0.78-1.16)	0.88 (0.59-1.31)
(Diabetes only)		1.97 (1.39-2.80)	+2.00 (0.99-3.99)	2.07 (1.37-3.14)	+2.00 (1.00-4.00)
(Both obesity & diabetes)		1.70 (1.35-2.12)	2.14 (1.71-2.68)	1.83 (1.43-2.35)	+1.55(0.97-2.46)
Age	Young old (65-74)		1.00	1.00	1.00
	Older (>=75)		3.35 (2.85-3.93)	2.66 (2.23-3.17)	2.65 (2.22-3.16)
Gender	Male		1.00	1.00	1.00
	Female		1.43 (1.23-1.67)	1.21 (1.01-1.46)	1.21 (1.01-1.45)

Nativity	Mexico-Born	1.00	1.00	1.00
	US-Born	1.09 (0.94-1.26)	0.97 (0.83-1.14)	0.97 (0.82-1.14)
(Obese only)*Time				1.02 (0.93-1.12)
(Diabetes only)*Time				1.01 (0.83-1.22)
(Both obesity & diabetes)*Time				1.06 (0.93-1.19)

Model 3 & 4: Controlled for marital status, education, household income, living arrangement, 6 medical conditions (arthritis, stroke, heart attack, hypertension, hip fracture, and cancer), CES-D, and MMSE

OR= Odds ratio, CI= Confident Interval

+ P < 0.10

Chapter 7: Summary and Discussion

The purpose of this study was to examine age, gender, and nativity differences in the relationship between obesity and diabetes as well as the relationship between diabetes and disability over seventeen years of research concerning older Mexican Americans in the United States.

AIM I DISCUSSION

Three hypotheses were tested to investigate whether obesity would be associated with disability varying by age, gender, and nativity under Aim I. Obesity was expected to be associated with greater ADL disability: 1a) among the oldest old (75+) group as compared to the young old (65–74), 1b) in women as compared to men, and 1c) in US-born as compared to foreign-born persons.

The analyses showed that age, gender, and obesity (overweight and obesity), but not nativity were associated with ADL disability. Testing for the interaction effect between obesity and time it was found that the effect of obesity (BMI $\geq$ 30) on disability was 17% more likely to have ADL disability over time significantly among Mexico-born participants, after controlling for marital status, education, household income, living arrangements, obesity, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE.

These findings were consistent with those of previous research in several respects. First, gender was found to be associated with obesity and disability. Specifically, Mexican-American women have been found to experience higher obesity rates (Ogden, et al., 2006). Recent studies have asserted that Mexican-American men enjoy certain health advantages in general, but not Mexican-American women (Markides, et al., 2007; Nam, et al., 2013). Gender differences have been observed via migration selection, at least among older Mexican Americans (Markides, al., 2007; Markides, & Eschbach, 2011). The motivation to migrate for foreign-born Mexican American men has been to look for jobs, while women have more often followed their spouses and families regardless of their health status or motivational factors (Markides, al., 2007; Markides, & Eschbach, 2011). In addition, according to a recent unpublished manuscript (Nam, et al.,, 2013), Mexico-born men aged 75 and older were less likely to report ADL disability as compared to US-born men and women and Mexico-born women after adjusting for all other variables. That study suggested that Mexico-born men experienced less disability than US-born men, while the opposite was true for women, given a significant interaction effect between gender and nativity on ADL disability among Mexican Americans aged 75 and over (Nam, et al., 2013). Although the associations found herein have indicated a health advantage for Mexican-American men, they did not explain why increased rates of obesity have been observed across time, but did add to the literature concerning the immigration effect on disability and mortality.

Second, this study found nativity to be associated with obesity and disability. Previous research has suggested that immigrants in several countries were less likely to experience disability than native-born persons from the same countries of origin (Wilknins, 1996; Haan, et al., 2003; Cho, et al., 2004; Biddle, et al., 2007; Markides, & Wallace, 2007; Markides, & Eschbach, 2011). Studies have shown that Mexican Americans (regardless of whether they were foreign-born or native-born) have higher rates of diabetes, obesity, disability, and are more sedentary as compared to white persons (Haan, et al., 2003; Markides &Wallace, 2007).

Third, relationship between age, obesity and disability was the same with previous literature. Previous research has suggested a strong association between obesity and disability in this age group (Visser, et al., 1988; Galanos, et al., 1994; Ferraro, et al., 2002; Visscher, et al., 2004; Sturm, et al., 2004; Reynolds, et al., 2005; Wilkins & de Groh, 2005; Wu, et al., 2007; Al Snih, et al., 2007; Lang, et al., 2008; Walter et al., 2009; Wee et al., 2011). Al Snih and her colleagues found a BMI of 24 or below to be associated with greater disability and mortality, and BMIs greater than 24 to be associated with increased disability, in a J-shaped curve (Al Snih, et al., 2007). However, the present seventeen-year longitudinal study has shown that overweight had protective effects against disability over time in older adults (75+) as compared to the young old group (65–74).

A recent fourteen-year study of data from the Hispanic EPESE, 1993–1994 to 2007, suggested that obesity (BMI of 30–35) is only marginally associated with disability, and that overweight (BMI of 25 <30) and excess obesity (BMI ≥35) were not associated with ADL disability (Markides, et al., 2013). However, the present seventeen-year longitudinal study showed that overweight ((BMI of 25.0–29.9) had protective effect against disability over time for adults aged 75 and over as compared to the young old group (aged 65–74).

This study has several implications for the effects of obesity on disability and mortality. First, associations between obesity and disability alone cannot explain that relationship. Although strong links have emerged between obesity and medical conditions, obesity has been found to have a protective effect from increased risk of mortality among obese patients diagnosed with heart failure and coronary artery disease (Curtis, et al., 2005). In other words, not only does obesity lead to increased risk of disability, it also protects against mortality among those who have experienced potentially disabling health events (Grabowski, et al., 2005).

Second, BMI may not be the best measurement of adiposity, not only for the general population (Visscher, et al., 2001) but also for older Mexican Americans (Markides, et al., 2013). BMI has often been examined at only one point in time in studies describing the relationship between BMI and disability. Recently, waist circumference (WC) has been combined with BMI to measure obesity and obesity-related comorbidities (Janssen, et al., 2005; Guallar-Castillon, et al., 2007; Nam, et al., 2012).

However, capturing the complexity of weight changes over the life course of an individual is impossible using a single measurement. Weight history, including periods of weight gain and duration of obesity, should be considered, together with variations by age, birth cohort, and socioeconomic status (Koster, et al., 2006). In addition, since body composition varies by age, BMI as an indicator cannot reflect specific types of adiposity in older persons. Moreover, due to changing body composition, aging modifies both the numerator of a BMI measurement (weight) and the denominator (height) (Zamboni, et al., 2005).

AIM II DISCUSSION

Three hypotheses were tested to investigate whether diabetes would be associated with disability in combination with age, gender, and nativity. Diabetes was expected to be associated with greater ADL disability: 2a) among the older (75+) group as compared to the young old (65–74), 2b) in women as compared to men, and 2c) in US-born as compared to foreign-born persons.

This dissertation showed age and diabetes were associated with ADL disability over time, but gender and nativity were not associated with ADL disability over time. Considering the interaction effects between time and diabetes, the effect of diabetes was 10% less likely to have ADL disability as compared to non-diabetes only among the young old group (65-74), but the association was in the opposite direction than hypothesized. Although the analyses showed that all three hypotheses for Aim II were rejected, an unexpected reverse result emerged: that diabetes was associated with less disability over time among the young old (65–74).

These findings are similar to those of previous studies in several aspects. This study found age and diabetes to be highly associated with disability. Among older Americans, diabetes is known to be a critical predictor of functional disability, and a portion of the increase in ADL and IADL disability has been attributed to the higher prevalence of diabetes (de Grauw, et al., 1999; Gregg, et al., 2002; Sinclair, et al., 2008).

However, differences also emerged between this and previous studies. First, diabetes was not found to be associated with disability by gender and nativity, unlike the findings of previous studies. According to existing literature, diabetes is a primary risk factor for functional disability, particularly among women, older adults, and Mexican Americans, who have a higher prevalence of obesity and obesity-related diseases than other groups (Ogden, et al., 2006; CDC, 2011; Markides, et al., 2013). Several previous studies have shown significant associations between diabetes and disability among older women and older Mexican Americans (Stefano, et al., 2002; Rodríguez-Saldaña, et al., 2002; Wu, et al, 2003; Al Snih, et al., 2005). However, the results of this study show either no or weak associations between diabetes and disability by gender and nativity.

Second, the present study found that the effect of diabetes was 10% less likely to have ADL disability as compared to non-diabetes among the young old group (65-74), a relationship in the reverse direction of that hypothesized, and in contrast with the findings of previous literature. Obviously, diabetes is one of the most prevalent diseases among older Americans (CDC, 2011). However, this study showed that for the population studied, the effect of diabetes was 10% less likely to have ADL disability as compared to non-diabetes among the young old group aged 65-74 compared to people without diabetes. This may be possible selection of the diabetes-favored sample considering their relatively young old age.

These differences carry several possible implications. First, diabetes has an earlier onset of disease on average, around age 45 and over. Non-Hispanic black persons (late 30s) and Hispanics (early 30s) have an even earlier onset of diabetes (CDC, 2008). Thus, people aged 65 and over with diabetes in this cohort may have been selected by attrition in favor of diabetes survival. Older people with diabetes may decrease risky health behaviors (drinking, smoking, and physical inactivity) based on greater diabetes awareness, thus explaining lower ADL disability among the selected group of diabetes survivors. Older people with diabetes are more likely to report their health as poor or bad, but may maintain their health under worse circumstances given their diabetes, precisely because of their diabetes awareness.

Second, this dissertation study did not cover the synergistic effect of the relationship between diabetes and high depressive symptomatology as these affect disability. Much research has suggested that diabetes combined with high depressive symptomatology affects health outcomes, including disability (Black, 2003; Lin, et al., 2004; Lin, et al., 2008; Markides, et al., 2013). A seven-year study using the Hispanic EPESE, 1993–1994 to 2000–2001, showed synergistic effects between diabetes and high depressive symptomatology as measured by the Center for Epidemiologic Studies Depression Scale (CESD) on disability among older Mexican Americans over time (Black, et al., 2003). This study, although it did find that diabetes and depressive symptomatology were associated with ADL disability, did not investigate any combined synergistic effects of those factors. Thus, this synergistic effect should be considered in terms of their impact on disability in terms of age, gender, and nativity over time in future studies.

AIM III DISCUSSION

Three hypotheses were tested in this study to investigate whether 3a) participants with obesity only, 3b) participants with diabetes only, and 3c) participants with both obesity and diabetes would be more likely, over time, to develop ADL disability than participants without obesity or diabetes.

The analyses showed that those with diabetes only and those with both obesity and diabetes were more likely to experience higher ADL disability as compared to those who did not have obesity and diabetes. Moreover, older Mexican Americans with both obesity and diabetes were more likely to experience increased ADL as compared to participants without obesity and diabetes. However, participants with obesity only had 0.83 times the odds of becoming ADL disabled only in the unadjusted model (Model 1; OR=0.83; 95% CI= 0.68 - 1.00). However, no interaction effect over time was found for any of these groups.

These findings are consistent with those of previous research in showing that people who have diabetes are more likely to experience disability (Ogden, et al., 2006;

Sinclair, et al., 2008; CDC, 2011; Markides, et al., 2013). This study showed that in the population studied, people with diabetes only and people with obesity and diabetes were more likely to experience ADL disability than participants without obesity and diabetes, in harmony with the findings of previous research.

However, some of the present findings are inconsistent with those of previous research. Obesity has been found to be a major risk factor for disability among older adults (Himes, 2000; Jenkins, 2004; Reynolds, et al., 2005; Himes, & Reynolds, 2012). The findings herein suggested that participants with obesity were less likely to experience increased ADL disability than participants with diabetes only, participants without obesity and diabetes, and even participants without obesity and diabetes at each wave, but not over time.

This association was attenuated by age, gender, nativity, marital status, household income, living arrangements, hypertension, heart attack, stroke, cancer, arthritis, hip fracture, CES-D, and MMSE. Thus, the findings of this study showed that obesity may be protective effect of increased disability for the studied population. Some previous research examining osteoporosis and mortality among obese older adults have shown that obesity may have a positive impact on the health of older adults, in what has been called the "obesity paradox" (DiPietro, et al., 1993; Osher, & Stern, 2009).

Future studies should examine the mechanisms governing the relationship between obesity, diabetes, and disability in older adults in the context of other medical conditions, including depressive symptomatology and cognitive impairment, together with the effect of time. These mechanisms cannot be fully examined on their own, as mentioned above. For example, although obesity is associated with medical conditions, it has been shown to have a protective effect against increased risk of mortality among obese patients diagnosed with heart failure and coronary artery disease (Curtis, et al., 2005). It appears that obesity not only leads to increased risk of disability, but also protects against mortality among those who have experienced potentially disabling health events (Grabowski, et al., 2005). Thus, obesity, diabetes, and other conditions, should be considered as time-dependent variables when studying disability.

STRENGTHS AND LIMITATIONS

Strengths of the study

This study has shown that it is possible to examine the association between obesity and diabetes on disability longitudinally using the Hispanic EPESE data. The design of the Hispanic EPESE allows for examination of prevalence, incidence, and changes in health outcomes as well as mortality. Notably, the Hispanic EPESE has repeatedly and consistently measured obesity (measured by BMI), diabetes, ADL disability, and other major health variables in every wave, allowing determination of the impacts of obesity and diabetes on disability over time. There is much research that covers obesity, diabetes, and disability; however, the Hispanic EPESE is one of the earliest and longest-running studies dealing with older Mexican Americans in the United States.

In addition, the Hispanic EPESE study a large cohort of 3,050 older Mexican Americans, is generalizable to approximately 500,000 Mexican Americans aged 65 and older residing in the southwest of the United States, and features a long period of follow-up. Above all, one of the most substantial strengths of the Hispanic EPESE data is its prospective collection and data analysis for a large sample (Ottenbacher, et al., 2009) encompassing seventeen years.

Limitations of the Study

Although most of the items on the Hispanic EPESE questionnaires were the same for each wave in which they were included, some information important to the goals of this study was not obtained in each wave. For example, waist circumference (WC) was measured only at baseline and the second wave. Household income was not measured at the fourth wave.

Moreover, disability, diabetes, medical conditions, and many other variables were self-reported. Subjectivity and recall could constitute biases in this study, particularly for older adult participants who may have cognitive impairment, and be unable to respond to questions accurately. However, previous research has indicated an acceptable level of concordance between self-reported medical conditions and disability with medical chart reviews (Haapanen, et al., 1997).

Further, a bias may subsist in the selection of healthy survivors among the participants in the Hispanic EPESE. As mentioned above, older people with certain diseases, including obesity and/or diabetes, may tend to decrease risky health behaviors (drinking, smoking, and physical inactivity) based on their disease awareness and health knowledge, and lower ADL disability could result, particularly based on the selective survival of diabetes. Older people with diseases may be likely to report their health as poor or bad, but may maintain their health under the worse circumstances of their diseases precisely because of their disease awareness. Notably, participants' mean age in the seventh wave (2011) of the Hispanic EPESE was 86, much higher than the US life expectancy in 2011 of around 78 (Hoyert & Xu, 2012).

Additionally, this dissertation did not use Multiple Imputation Methods (MIM) (Schafer, 1997) to discuss attrition and missing data. Because the use of MIM is often misunderstood, these procedures are regarded to bias or impose "unfair" parameter estimates (Palmer & Royall, 2010). However, the appropriate employment of missing data procedure provides the use of all the available data. In addition, it approaches closer to parameter estimates for the true population parameters than data are merely discarded (Schafer & Graham, 2002; Palmer & Royall, 2010). Further, Multiple imputation has currently described as state-of-the art (Schafer and Graham, 2002; Graham, 2009). Thus, this MIM should be used in future research particularly in longitudinal studies of aging (Palmer & Royall, 2010).

FUTURE STUDIES

First, further research is necessary which examines the effect of underweight (BMI <18.5) on disability among older Mexican Americans. Because the underweight population at baseline of the Hispanic EPESE were excluded from this analysis, this study did not investigate the effect of underweight on disability, since the main goal was to examine the effect of obesity on ADL disability. Previous studies have shown that underweight is frequently associated with higher mortality in older adults (Grabowski & Ellis, 2001; Berraho, et al., 2010). However, underweight populations may not experience an increased mortality risk directly due to their BMI status, but may have underlying conditions that affect both their BMI, their mortality risk (Landi, et al., 2000) and frailty (Heiat, et al., 2001). It seems reasonable to expect that future studies will show that underweight older women will be more likely to experience increased disability as compared to underweight older men.

Second, researchers would do well to examine the effect of BMI and WC on disability among older Mexican Americans. BMI (BMI: weight in kg divided by height in m^2) has often been criticized as an inadequate measure of obesity, specifically among older people. Although BMI is a useful surrogate measure of total adiposity, BMI classification is also significantly influenced by gender and ethnicity (Dixon, 2010). A high WC has been found to be associated with higher disability and mortality rates after adjustment for high BMI risk (Janssen, et al., 2005). Recently, waist circumference (WC) has been combined with BMI to measure obesity and obesity-related comorbidities. Current guidelines recommend measuring WC in persons with a BMI between 25 and 35 kg/m^2 and using the cutoff points to define abdominal obesity and to identify persons at risk for disease. It has been found that a WC of 102 cm in men and 88 cm in women are risk factors for obesity-related disease (NHLBI, 2002). For example, in a prospective cohort study of elderly Spanish persons, WC had a predictive effect for disability after two years (Guallar-Castillon, et al., 2007). However, although the WC cutoff points (102cm in men and 88 cm in women) indicate excess adiposity for adults, they lack sufficient validity as indicators of disability and mortality (National Institutes of Health (NIH), 2000; World Health Organization (WHO), 1997b). Consequently, considering WC alone, or together with BMI, would be a better predictor of disability and mortality in the elderly population than considering BMI alone (Nam, et al., 2012). WC and BMI as a combined obesity marker for the older population could offer a measurement for use in research regarding mechanisms linking obesity to disability.

Third, as mentioned above, this dissertation study did not examine the synergistic effect of the relationship between diabetes and high depressive symptomatology as both conditions affects disability. This study, although it did find that diabetes and depressive symptomatology were associated with ADL disability, did not investigate any combined synergistic effect of these factors. Thus, these synergistic effects should be considered in terms of their impact on disability by age, gender, and nativity over time in future studies.

This future study's aims and hypotheses will be below;

Aim I: Underweight and Disability

To determine the effect of underweight, measured by BMI (Body Mass Index) on disability in older Mexican Americans over 17 years of follow-up.

Research Hypotheses:

1a. Underweight will be associated with greater ADL disability among the older (75+) group when compared with the young old (65-74).

1b. Underweight will be associated with greater ADL disability in women compared to men.

1c. Underweight will be associated with greater ADL disability in US-born compared to foreign-born.

Aim II: BMI, WC, and Disability

To determine the effect of body mass index (BMI) and waist circumference (WC) on disability in older Mexican Americans over 17 years of follow-up.

Research Hypotheses:

2a. Higher BMI and WC will be independently associated with greater ADL disability among the young old (65-74) group when compared with the older (75+) group.

2b. Higher BMI and WC will be independently associated with greater ADL disability in women compared to men.

2c. Higher BMI and WC will be independently associated with greater disability in US-born compared to foreign-born.

Aim III: Synergistic Effects between Diabetes and Depressive Symptomatology and Disability

To determine the synergistic effect between diabetes and high depressive symptomatology on disability in older Mexican Americans over 17 years of follow-up.

Research Hypotheses:

3a. Synergistic effect between diabetes and high depressive symptomatology will be associated with greater ADL disability among the older (75+) group when compared with the young old (65-74).

3b. Synergistic effect between diabetes and high depressive symptomatology will be associated with greater ADL disability in women compared to men.

3c. Synergistic effect between diabetes and high depressive symptomatology will be associated with greater ADL disability in US-born compared to foreign-born.

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Vita

Sanggon (Sang Gon) Nam was born on May 27, 1975 in Gumi, Korea to Jung-Tae Nam and Ae-Ja Cho. He and his brother grew up in Seoul, Korea. He earned a Bachelor of Science degree in Communication and Culture (double major) from Handong Global University in 2002. He received his Masters of Sociology (Minor in Statistics) from Clemson University, SC in 2007, and then moved to Galveston, Texas to pursue a PhD in Preventive Medicine and Community Health from the University of Texas Medical Branch at Galveston (UTMB).

His research interests include health disparities in minority aging, global obesity, disability & mortality among older adults. He has studied various factors affecting obesity, disability, and mortality among older minority adults, specifically, Mexican-American, African-American, and Latin American and the Caribbean. He has presented his research at the annual meeting of the American Public Health Association, the Gerontological Society of America's, and Annual National Student Research Forum. He acted as the vice-President for the Preventive Medicine and Community Health Graduate Student Organization in 2011-2012

Education

B.A., Mass Media and Communication (Double Major), Feb 2002, Handong Global University, Pohang, Korea

M.S., Sociology (Minor in Statistics), Aug 2007, Clemson University, Clemson, SC

Publications

Do, T.N., **Nam, S.** (2011). Knowledge, Awareness and Medical Practices of Asian Americans/Pacific Islanders on Chronic Hepatitis B Infection: Review of Current Psychosocial Evidence. *Health and Social Welfare Review,* 31 (3). 341-364.

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Nam, S. (2013). Effects of Social Support and Spirituality on Weight Loss for Rural African-American Women. *ABNF Journal* (In Press)

Permanent address: 507 Camden Yards Way, Cary, North Carolina 27519

This dissertation was typed by Sanggon Nam