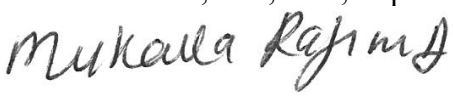
The Dissertation Committee for Mandi Lynn Sonnenfeld Certifies that this is the approved version of the following dissertation:

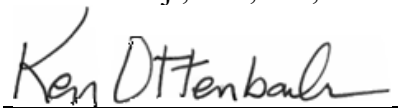
Vision Impairment and Health Outcomes among Older Mexican Americans: Findings from the Hispanic Established Population for the Epidemiologic Study of the Elderly

Committee:

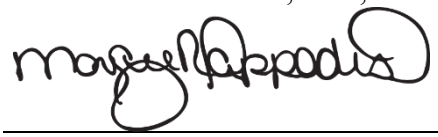
Soham Al Snih, MD, PhD, Supervisor



Mukaila Raji, MD, MS, FACP



Kenneth Ottenbacher, PhD, OTR



Monique Pappadis, Med, PhD

Timothy Reistetter, PhD, OTR, FAOTA

Vision Impairment and Health Outcomes among Older Mexican Americans: Findings from the Hispanic Established Population for the Epidemiologic Study of the Elderly

by

Mandi Lynn Sonnenfeld, MOT, BS

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Dedication

This dissertation is dedicated to my three children (Samantha, Shelby, and Sophia), my husband Jereme, my father Tom Holt, and my mother Carol Holt.

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Vision Impairment and Health Outcomes among Older Mexican Americans: Findings from the Hispanic Established Population for the Epidemiologic Study of the Elderly

Publication No._____

Mandi Lynn Sonnenfeld, PhD

The University of Texas Medical Branch, 2022

Supervisor: Soham Al Snih, MD, PhD

Background: Vision impairment (VI) is one of the most common conditions in older adults. It is associated with negative health outcomes leading to disability and decreased quality of life. **Objectives:** To examine 1) predictor factors of VI; 2) the effect of VI on physical and cognitive function, frailty, disability, and falls; and 3) VI as predictor of eye and health care utilization among older Mexican Americans over time. **Design:** Longitudinal study. **Participants:** Mexican Americans aged 70 years and older (N=1,979) from the Hispanic Established Population for the Epidemiologic Study of the Elderly (1998-2016). **Measures:** Included self-reported VI as the independent variable; physical and cognitive function, modified frailty phenotype, disability, falls, and health care utilization as outcome variables; and socio-demographics, social isolation, smoking status, body mass index, comorbidities, depressive symptoms, and hearing impairment as covariates. **Analysis:** Generalized estimating equation models were performed to estimate the odds ratio of health outcomes and health care utilization. **Results:** Percent of VI ranged from 3.7% to 4.3% for near vision impairment (NVI), 12.9% to 27.8% for

distant vision impairment (DVI), and 13.7% to 27.6% for VI (NVI or DVI). Predictors of NVI, DVI, and VI were time (years), lower Mini Mental State Exam score, depressive symptoms, and hearing impairment. Spanish interview was a predictor of NVI only. Over time, participants with cognitive impairment and frailty had greater odds of reporting DVI and VI (NVI or DVI) than those without VI; those with limitations in instrumental activities of daily living had greater odds of reporting NVI, DVI, and VI (NVI or DVI) than those without VI; those with limitations in activities of daily living had greater odds of reporting VI than those without VI; and those who reported falls had greater odds of reporting NVI and VI (NVI or DVI) than those without VI. Those with VI had greater odds of having medical doctor visits and been hospitalized than those without VI.

Conclusions: VI among older Mexican Americans was high and is a strong independent predictor of cognitive impairment, frailty, disability, and falls. These findings suggest that current vision health disparities exist among older Mexican Americans.

Table of Contents

LIST OF TABLES ..... **XI**

LIST OF FIGURES ..... **XV**

LIST OF ABBREVIATIONS ..... **XVI**

CHAPTER 1 ..... **1**

Background and Significance 1

Vision Impairment Definition 2

Epidemiology of Vision Impairment 2

Factors Associated with Vision Impairment 5

- Age… 5
- Sex… 6
- Education 6
- Nativity 7
- Language of Interview 7
- Social Isolation 7
- Depressive Symptoms 8
- Multimorbidity 8

Vision Impairment and Health Outcomes 9

- Physical Function 9
- Cognitive Function 10
- Frailty 11
- Disability 12
- Falls 15

Vision Impairment and Health and Eye Care Utilization 17

Specific Aims 19

- Specific aims and hypotheses 19

CHAPTER 2 ..... **21**

Methods 21

Conceptual Framework 21
Measures 25
Statistical Analysis 34

CHAPTER 3 ..... **41**

The Overall Sample 41

Data Source 41
Study Sample of H-EPESE Survey 41
Study Population 42
Baseline Sample 43
Linkage of the H-EPESE to CMS Files 45

CHAPTER 4 ..... **47**

Aim 1 Results 47

Percent of Vision Impairment Over Time 47
Analyses For Overall Sample 48
Analyses For Near Vision Impairment 50
Analyses For Distant Vision Impairment 52
Analyses For Vision Impairment (Near or Distant) 53
Longitudinal Analyses For Near Vision Impairment 55
Longitudinal Analyses For Distant Vision Impairment 57
Longitudinal Analyses For Vision Impairment (Near or Distant) 59
Analysis of moderator effects 61

CHAPTER 5 ..... **63**

Aim 2 Results 63

Physical Function Impairment 65
Cognitive Impairment 73
Frailty 82

IADL Disability 89
ADL Disability 98
Falls 107
Analysis for moderator effects 114
Analysis for mediator effects 115

CHAPTER 6 117

Aim 3 Results 117

Health Care Utilization 119
Eye Care Utilization 124

CHAPTER 7 134

DISCUSSION 134

Conclusion 141
Limitations of the Study 143
Strengths of the Study 143
Future Research Implications 144

APPENDIX 146

Medicare Dataset Codes 146

International Classification of Diseases (ICD)-9 Vision Diagnosis Codes 146
Provider Visit 159
Diagnostic/Therapeutic Procedure 160

REFERENCES 161

VITA 181

LIST OF TABLES

Table 2.1 Operationalized variables for the HEPESE data set Wave 3 to Wave 9.

Table 2.2 Operationalized variables from the CMS data sets.

Table 3.1 Sample of H-EPESE at each follow-up wave (N=3050).

Table 3.2 Sample of H-EPESE at each follow-up wave used for this research study (N=1979).

Table 3.3 Baseline characteristics of the sample by excluded and included participants.

Table 4.1 Descriptive baseline characteristics for sample among older Mexican Americans included for final analysis (N=1501).

Table 4.2 Descriptive baseline characteristics by near vision impairment among older Mexican Americans (N=1501).

Table 4.3 Descriptive baseline characteristics by distant vision impairment among older Mexican Americans (N=1501).

Table 4.4 Descriptive baseline characteristics by vision impairment (near or distant) among older Mexican Americans (N=1501).

Table 4.5 Generalized estimating equation models for Near VI among older Mexican Americans over 18 years of follow-up (N=1295).

Table 4.6 Generalized estimating equation models for Distant VI among older Mexican Americans over 18 years of follow-up (N=1295).

Table 4.7 Generalized estimating equation models for VI (Near or Distant) among older Mexican Americans over 18 years of follow-up (N=1295).

Table 4.8 Generalized estimating equation models for Near and Distant VI by diabetes among older Mexican Americans over 18 years of follow-up (N=1295).

Table 5.1 Baseline descriptive characteristics of the sample by physical function impairment among older Mexican Americans (N=1485).

Table 5.2 Generalized estimating equation models for physical function impairment (SPPB < 7) among older Mexican Americans as a function of near vision impairment over 18 years of follow-up (N=1032).

Table 5.3 Generalized estimating equation models for physical function impairment (SPPB < 7) among older Mexican Americans as a function of distant vision impairment over 18 years of follow-up (N=1032).

Table 5.4 Generalized estimating equation models for physical function impairment (SPPB < 7) among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1032).

Table 5.5 Baseline descriptive characteristics of the sample by cognitive impairment among older Mexican Americans (N=1501).

Table 5.6 Generalized estimating equation models for cognitive impairment (MMSE < 21) among older Mexican Americans as a function of near vision impairment over 18 years of follow-up (N=1010).

Table 5.7 Generalized estimating equation models for cognitive impairment (MMSE < 21) among older Mexican Americans as a function of distant vision impairment over 18 years of follow-up (N=1010).

Table 5.8 Generalized estimating equation models for cognitive impairment (MMSE < 21) among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1010).

Table 5.9 Baseline descriptive characteristics of the sample by frailty among older Mexican Americans (N=1218).

Table 5.10 Generalized estimating equation models for frailty among older Mexican Americans as a function of near vision impairment over 18 years of follow-up (N=1072).

Table 5.11 Generalized estimating equation models for frailty among older Mexican Americans as a function of distant vision impairment over 18 years of follow-up (N=1072).

Table 5.12 Generalized estimating equation models for frailty among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1072).

Table 5.13 Baseline descriptive characteristics of the sample by IADL disability among older Mexican Americans (N=1493).

Table 5.14 Generalized estimating equation models for IADL disability among older Mexican Americans as a function of near vision impairment over 18 years of follow-up (N=1058).

Table 5.15 Generalized estimating equation models for IADL disability among older Mexican Americans as a function of distant vision impairment over 18 years of follow-up (N=1058).

Table 5.16 Generalized estimating equation models for IADL disability among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1058).

Table 5.17 Baseline descriptive characteristics of the sample by ADL disability among older Mexican Americans (N=1500).

Table 5.18 Generalized estimating equation models for ADL disability among older Mexican Americans as a function of near vision impairment over 18 years of follow-up (N=1316).

Table 5.19 Generalized estimating equation models for ADL disability among older Mexican Americans as a function of distant vision impairment over 18 years of follow-up (N=1316).

Table 5.20 Generalized estimating equation models for ADL disability among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1316).

Table 5.21 Baseline descriptive characteristics of the sample by falls among older Mexican Americans (N=1219).

Table 5.22 Generalized estimating equation models for falls among older Mexican Americans as a function of near vision impairment over 14 years of follow-up (N=851).

Table 5.23 Generalized estimating equation models for falls among older Mexican Americans as a function of distant vision impairment over 14 years of follow-up (N=851).

Table 5.24 Generalized estimating equation models for falls among older Mexican Americans as a function of vision impairment (near or distant) over 14 years of follow-up (N=851).

Table 5.25 Generalized estimating equation models significant interaction models for ADL disability among older Mexican Americans over 18 years of follow-up.

Table 5.26 Generalized estimating equation models significant mediation models for ADL disability among older Mexican Americans over 18 years of follow-up.

Table 6.1 H-EPESE baseline descriptive characteristics of the sample by medical doctor visits and hospital stay among older Mexican Americans (N=1483).

Table 6.2 H-EPESE generalized estimating equation models for health care utilization among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1483).

Table 6.3 H-EPESE moderator analysis – depressive symptoms moderating the relationship between vision impairment (near or distant) and hospital stay.

Table 6.4 Prevalence of eye diseases at interview date (wave 5) and one year later.

Table 6.5 Unadjusted rate of outpatient visits to optometrist or ophthalmologist the year following the interview date (wave 5).

Table 6.6 Adjusted odds ratios of visiting an optometrist or ophthalmologist in outpatient settings the year following the interview date (wave 5).

Table 6.7 Unadjusted rate of diagnostic and therapeutic vision services utilization the year following the interview date (wave 5).

Table 6.8 Adjusted odds ratios of utilizing a diagnostic or therapeutic vision service the year following the interview date (wave 5).

Table A.1 ICD-9 Vision Diagnosis Codes in Medicare Provider and Analysis Review (MedPAR) Files, Carrier Claims, and Outpatient Standard Analytic Files (OutSAFs).

Table A.2 Healthcare Common Procedure Coding System (HCPCS) Codes in Medicare Carrier Line file for outpatient/office visit to provider with specialty "18" for "Ophthalmology" and “41” for "Optometrist".

Table A.3 Healthcare Common Procedure Coding System (HCPCS) Codes in Medicare Carrier Line and Outpatient Revenue Center files.

LIST OF FIGURES

Figure 1.1 Prevalence Rates for Low Vision by Age and Race in the United States.

Figure 1.2 Prevalence Rates of Low Vision by Gender in the United States.

Figure 1.3 Prevalence Rates of Low Vision by Race in the United States.

Figure 2.1 National Institute on Aging Health Disparities Framework, 2015.

Figure 2.2 Vision Impairment Framework on the Health of Older Adults (Swenor et al., 2020).

Figure 2.3 Vision impairment conceptual model for older Mexican Americans.

Figure 2.4 Social isolation as moderator in the relationship between vision impairment and health outcomes.

Figure 2.5 Depressive symptoms as mediator in the relationship between VI and outcomes**.**

Figure 4.1 Percent of vision impairment over time.

Figure 5.1 Flowchart of sample selection for Aim 2a.

Figure 5.2 Flowchart of sample selection for Aim 2b.

Figure 6.1 Flowchart of sample selection for Aim 3.

LIST OF ABBREVIATIONS

AAO	American Academy of Ophthalmology
ADL	Activities of Daily Living
ADAMS	Aging, Demographics, and Memory Study
AMD	Age-related Macular Degeneration
ANOVA	Analysis of Variance
AOA	American Optometric Association
ARED	Age-related eye diseases
BSF	Beneficiary Summary File
BMI	Body Mass Index
BRFSS	Behavioral Risk Factor Surveillance System
BS	Bachelor of Science
CCW	Chronic Condition Warehouse
CDC	Centers for Disease Control and Prevention
CES-D	Center for Epidemiologic Studies Depression Scale
CI	Confidence Interval
CIND	Cognitive Impairment No Dementia
CLHLS	Chinese Longitudinal Healthy Longevity Survey
CMS	Centers for Medicare and Medicaid Services
COVID-19	Coronavirus 2019
DUA	Data Use Agreement
DV	Dependent Variable

DVI	Distant Vision Impairment
ER	Emergency Room
ELSA	English Longitudinal Study of Ageing
FFS	Fee-for-service
GEE	Generalized Estimating Equation
GSBS	Graduate School of Biomedical Sciences
HCHS/SOL	Hispanic Community Health Study/Study of Latinos
HCPCS	Healthcare Common Procedure Coding System
HR	Hazard Ratio
HRS	Health and Retirement Study
H-EPESE	Hispanic Established Population for the Epidemiologic Study of the Elderly
IADL	Instrumental Activities of Daily Living
IAPB	International Agency for the Prevention of Blindness
ICD	International Classification of Diseases
ICPSR	Inter-University Consortium for Political and Social Research
IDF	International Diabetes Federation
IOM	Institute of Medicine
IRF	Inpatient Rehabilitation Facility
IV	Independent Variable
Kg	Kilograms
LE	Lower Extremity
LIADL	Lawton Instrumental Activities of Daily Living Scale

LOS	Length of Stay
LALES	The Los Angeles Latino Eye Study
m	meters
MCBS	Medicare Current Beneficiary Survey
MDS	Minimum Data Set
MedPAR	Medicare Provider Analysis and Review
M	Meters
MD	Medical Doctor
MFMER	Mayo Foundation for Medical Education and Research
MMSE	Mini Mental State Examination
MOT	Master of Occupational Therapy
MI	Mississippi
NASEM	National Academies of Sciences, Engineering, and Medicine
NACDA	National Archive of Computerized Data on Aging
NCOA	National Council on Aging
NEI	National Eye Institute
NHANES	National Health and Nutrition Examination Survey
NHATS	National Health and Aging Trends Study
NHIS	National Health Interview Survey
NIA	National Institute on Aging
NIH	National Institutes of Health
NLTCS	Longitudinal analysis of the National Long-Term Care Survey
NPI	National Provider Identification Standard

NVI	Near Vision Impairment
NC	North Carolina
No.	Number
N	Number of samples
OR	Odds Ratio
OUTSAF	Outpatient Standard Analytical File
PIN	Personal Identification Number
POS	Provider of Service File
PHD	Doctor of Philosophy
RCT	Randomized Control Trial
SAS	Statistical Analysis Software
SCCPHS	Stockholm County Council Public Health Surveys
SD	Standard Deviation
SKI	Smith Kettlewell Institute Study
SNAC	Swedish National Study on Aging and Care
SNF	Skilled Nursing Facility
SPPB	Short Physical Performance Battery
TSHA	Toledo Study for Healthy Aging
ULF	Living Conditions Survey
UPIN	Unique Provider Identification Number
U.S.	United States
UTMB	University of Texas Medical Branch
VI	Vision Impairment

WHAS	Women's Health and Aging Study
WHO	World Health Organization

CHAPTER 1

Background and Significance

Vision impairment (VI) has been identified among the top 10 disabilities for adults aged 18 years and older (CDC, 2001). Older adults with VI are more vulnerable to negative outcomes such as depression (Noran et al., 2009), cognitive deficits (Swenor et al., 2018; Zheng et al., 2018), disability (Haegele et al., 2018), decreased social engagement (Resnick et al., 1997), decreased self-efficacy (Haegele et al., 2018), increased number of comorbidities (Buttery et al., 2015), falls (Klein et al., 2003a) and frailty (Gonzales-Turin et al., 2021). According to the World Health Organization (WHO), one billion persons worldwide have a preventable VI (WHO, 2020a). In the United States (U.S.), 4.2 million Americans had a VI (Varma et al., 2016) and it is estimated that by 2050 this number double to 8 million (Varma et al., 2016).

The highest prevalence of VI has been reported for non-Hispanic whites (2.20%), followed by Hispanics (1.70%), non-Hispanic blacks (1.20%), and other races (1.50%) (National Eye Institute (NEI), 2019a). However, the largest population with low vision is expected to shift to Hispanic men over the next few decades (American Academy of Ophthalmology (AAO), 2020). Hispanics are a rapidly developing segment of older adults in the U.S., with older Mexican Americans comprising the largest portion of U.S. Hispanics (64.1%) (Lopez, 2015). Older Mexican Americans have a high prevalence of type 2 diabetes which is one of the risk factors for developing of VI (Al Snih et al., 2015). Their low access to medical care and low health literacy affects their ability to manage complex conditions (Pérez-Escamilla et al., 2010; Velasco-Mondragon et al., 2016). The overall goal of this proposal research is to examine VI and related health outcomes; and health and eye care utilization among older Mexican Americans over 18 years of follow-up.

Vision Impairment Definition

According to the WHO, low vision is visual acuity less than 6/18 (‹20/60) and equal to or better than 3/60 (‹20/400) in the better eye with best correction even after treatment (WHO, 2020b). Whereas the U.S. NEI defines VI and low vision as the best-corrected visual acuity less than 6/12 (‹20/40) in the better-seeing eye (excluding those who were categorized as being blind (‹20/200) by the U.S. definition.) (NEI, 2019b; NEI, 2019c). The NEI continues to describe the category of "all vision impairment" to include both low vision and blindness (NEI, 2019c). In the U.S., any person with vision that cannot be corrected to better than 20/200 in the best eye, or who has 20 degrees or less of visual field remaining, is considered legally blind (American Optometric Association (AOA), 2020). Despite the above definitions obtained, there is not a generally accepted definition for vision loss (National Federation of the Blind, 2019).

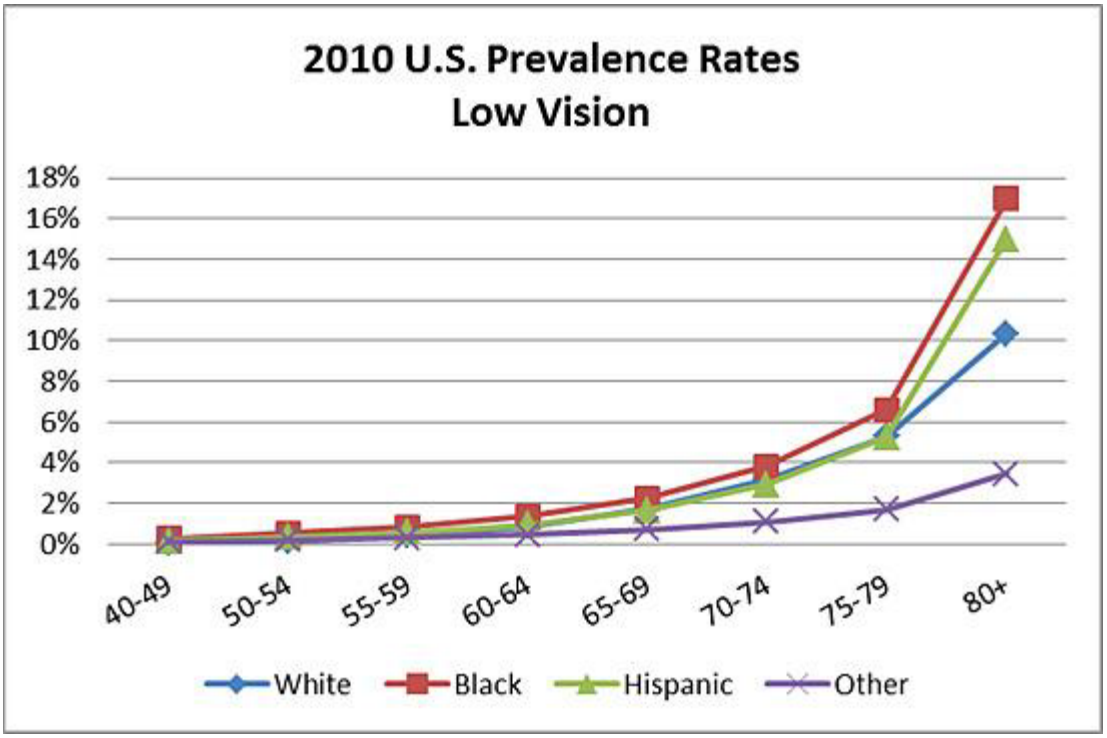
Epidemiology of Vision Impairment

According to the WHO, one billion persons worldwide have a preventable VI (WHO, 2020). In the U.S., 4.2 million Americans had a VI (Varma et al., 2016). It is estimated that by 2050 this number is expected to double to 8 million (Varma et al., 2016). Among the adult population living in the U.S., the yearly economic burden of major vision problems is more than $145 billion (Centers for Disease Control and Prevention (CDC), 2020). Based on the 2011 U.S. population, older adults aged 65 years and older had $800 million direct costs related to undiagnosed vision loss (CDC, 2020), indirect costs of $25.6 billion related to productivity loss, and informal care/nursing home costs of $21.5 billion (CDC, 2020).

In 2019, the NEI partnered with Prevent Blindness America using the 2010 U.S. Census population data set to obtain prevalence rates (NEI, 2019f). The prevalence of low vision by age

varies from 1.54% among those aged 40-64 years to 24.54% among those aged 65 years and older (Figure 1.1) (NEI, 2019d). Females were more likely to report low vision (63%) when compared to males (37%) (Figure 1.2) (NEI, 2019a). The highest prevalence of VI has been reported for non-Hispanic whites (2.20%), followed by Hispanics (1.70%), non-Hispanic blacks (1.20%), and other races (1.50%) (Figure 1.3) (NEI, 2019a). However, the largest population with low vision is expected to shift to Hispanic men over the next few decades (AAO, 2020).

Figure 1.1 Prevalence Rates for Low Vision by Age and Race in the United States.



Courtesy: National Eye Institute, National Institutes of Health (NEI/NIH). National Eye Institute (NEI) National Institutes of Health (a). (July 17, 2019). Low vision data and statistics: 2010 prevalence rates of low vision by race. Website: https://www.nei.nih.gov/learn-about-eye-health/resources-for-health-educators/eye-health-data-and-statistics/low-vision-data-and-statistics

Figure 1.2 Prevalence Rates of Low Vision by Gender in the United States.

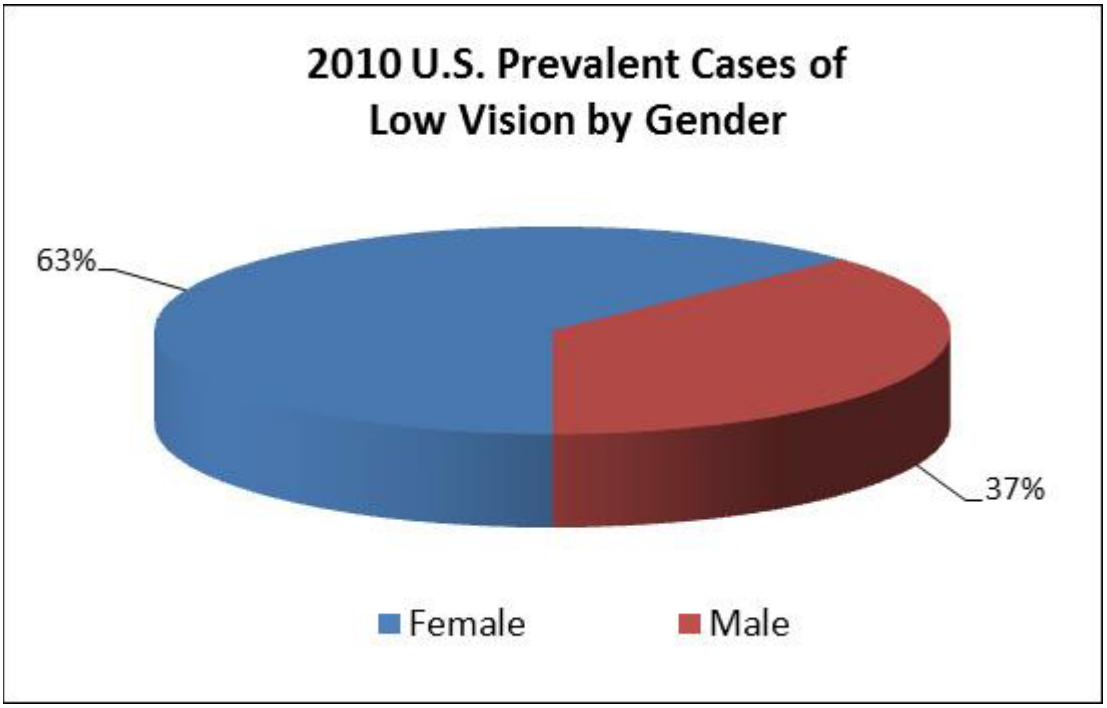


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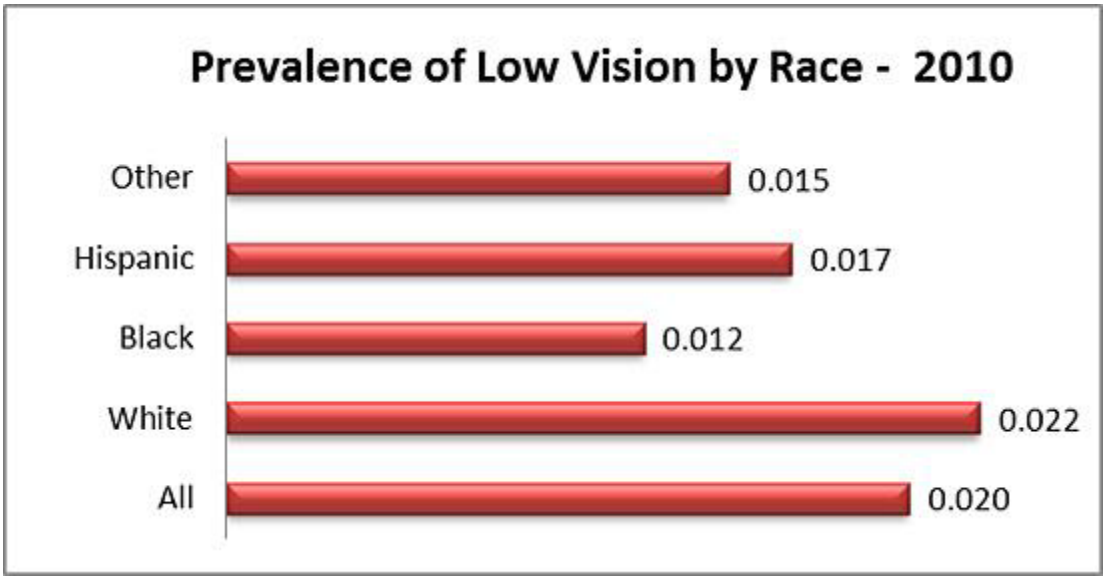
Figure 1.3 Prevalence Rates of Low Vision by Race in the United States.



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Hispanics have particularly high rates of diabetes, which is associated with diabetic eye disease, a treatable cause of VI (National Institutes of Health (NIH), 2016a). Diabetic retinopathy is believed to cause blindness in 18.4 percent of Hispanics who are legally blind (NVISION, 2020). Approximately 8 out of 10 Hispanics with glaucoma are not aware that they have it (NEI, 2019e). The NEI reports that Hispanics are not getting regular dilated eye exams (NEI, 2019e).

In 2019, the state with the highest number of individuals that reported a visual disability was California (approximately 800,000), while Texas was the second highest (approximately 700,000) (National Federation of the Blind, 2019). Vermont, Wyoming, and North Dakota reported the lowest individuals with a disability (approximately 14,000) (National Federation of the Blind, 2019).

Factors Associated with Vision Impairment

AGE

Older age has been shown to be associated with VI over time. Evans et al. using data from a large cluster randomized trial from the Medical Research Council general practice research framework in Britain found that VI was significantly associated with increased odds ratio (OR) among individuals aged 80-84 years (OR=2.04, Confidence Interval (CI) 1.80-2.33), 85-89 years (OR=4.65, CI 3.88-5.56), and 90 years or greater (OR=8.88, CI 7.11-11.07) (Evans et al., 2002). Klein et al. using the Beaver Dam Eye study of 4,295 individuals aged 43 to 86 found a five-year incidence of 1.4% for VI in participants aged 50-54 that increased to 14.7% in participants 85 years and older (Klein et al., 2013). Using U.S. population estimates and projections from the census data, Varma et al. determined the prevalence estimates from population-based studies conducted in the U.S. and found that in 2015, the prevalence of VI was 50% among persons aged 80 years

and older (1.61 million/3.22 million) followed by 24% among persons aged 70-79 years (Varma et al., 2016).

SEX

Female sex has been shown to be associated with VI. Aljied et al. using the Comprehensive Cohort of the Canadian Longitudinal Study on Aging of 30,107 participants, found that females had significantly increased rates of VI when compared to males (6.0% vs. 5.6%) (Aljied et al., 2018). Using the Los Angeles Latino Eye Study (LALES) of 6,137 participants with completed ophthalmic evaluation Varma et al., found that females had significantly increased rates of VI when compared to males (3.5% vs. 2.3%) (Varma et al., 2004). Cross sectional analysis of the 2008 Spanish Survey on Disability, Personal Autonomy, and Dependency Situations found that females were 1.6 times more likely to have VI when compared to males (Rius et al., 2018). Longitudinal analysis of participants in the Beaver Dam Eye Study indicated that women were consistently more likely than men to report VI over a 20 year follow up period (Klein et al., 2013).

EDUCATION

Several studies have indicated that lower levels of education are significantly associated with higher prevalence of VI (Livingston et al., 1997; Ulldemolins et al., 2012). Tielsch et al. using The Baltimore Eye Survey of 5,300 participants found that higher number of years of schooling completed was associated with lower prevalence of VI (Tielsch et al., 1991). Using a sample of 31,044 participants from the 2002 National Health Interview Survey (NHIS), Ryskulova et al. found that individuals with less than a high school education had higher odds (OR=7.74, 95% CI 1.47-2.05) of VI when compared to participants with a bachelor's degree or higher (Ryskulova et al., 2008).

NATIVITY

Being foreign-born has been found to be associated with VI. Liang et al. using the Stockholm County Council Public Health Surveys (SCCPHS) in Sweden (2006, 2010, and 2014) among adults aged 65 years and older, found that being foreign-born increased the prevalence of VI when compared to Sweden born participants (Liang et al., 2018). Cross-sectional analysis of the 2003-2008 National Health and Nutrition Examination Survey (NHANES) found that foreign-born participants who wear corrective lenses had less odds (OR=0.68, 95% CI 0.48-0.97) of having 20/40 or better vision when compared to U.S. born participants (Wilson et al., 2014). In this same study, foreign-born participants who did not wear corrective lenses had less odds (OR=0.54, 95% CI 0.39-0.74) of having 20/40 or better vision when compared to U.S. born participants (Wilson et al., 2014). Further research is needed for longitudinal analysis of VI and nativity status for older adults.

LANGUAGE OF INTERVIEW

An important determinant of health care access and health is whether a language barrier exists (Zheng et al., 2012). Eye care treatment acceptability, appropriateness, and engagement ability with a health care provider could be affected by communication barriers (Hamm et al., 2021). For defeating the language barrier, Nesher et al. found that when performing visual field testing, use of a recorded explanation in the patient's native language can be used for patient instruction (Nesher et al., 2001). Language of interview indicates English proficiency and is helpful for the timely occurrence of eye diagnosis and eye treatment. English proficiency is important because language barriers affect the ability to provide quality healthcare (Al Shamsi et al. 2020).

SOCIAL ISOLATION

Social isolation has been described by the National Institute on Aging (NIA) as the objective physical separation from other people (living alone) (NIA, 2019). Whereas the NIA described loneliness as the subjective distressed feeling of being alone or separated (NIA, 2019). Cross-sectional analysis of the WHO Study on Global Ageing and Adult Health dataset in Ghana found that older adults with VI were significantly more likely to have social isolation when compared to older adults without VI (Tetteh et al., 2020). Coyle et al. using the 1999-2008 NHANES survey found that individuals with poor self-reported vision had increased risk of social isolation (OR=1.53, 95% CI 1.08-2.16) when compared to individuals with good self-reported vision (Coyle et al., 2017).

DEPRESSIVE SYMPTOMS

Several studies have found that high depressive symptoms are associated with VI. Cross-sectional studies have determined an association between depression and VI exists (Van der Aa et al., 2015; Park et al., 2015; Zhang et al., 2013; Garin et al., 2014). Choi et al. found among 5,846 from the Korean National Health Insurance database that visually impaired participants had a hazard ratio (HR) of 1.15 (p-value=0.036) of developing depression over 11 years of follow-up (Choi et al., 2018). Heesterbeek et al. examining 540 older adults with VI from a prospective cohort study randomized control trial (RCT) found an incidence of depressive symptoms of 21% (Heesterbeek et al., 2017).

MULTIMORBIDITY

Multimorbidity has been found to be associated with VI over time. Court et al. in a cross-sectional study using 291,169 older adults from the data from Primary Care Clinical Informatics Unit at the University of Aberdeen found that participants with VI were significantly more likely to have more comorbidities when compared to participants without VI (Court et al., 2014). In another cross-sectional study, Garin et al. examining 4,583 adults aged 50 years and older found

that those with stroke had greater odds of near vision impairment (NVI) (OR=3.01, 95% CI 7.86-4.87) (Garin et al., 2014) while those with arthritis (OR=1.79, 95% CI 1.46-2.21), stroke (OR=1.59, 95% CI 1.05-2.42), and diabetes (OR=1.27, 95% CI 1.01-1.60) had greater odds of distant vision impairment (DVI) (Garin et al., 2014). Garin et al. also found that both NVI (OR=1.69, 95% CI 1.27-2.24 and DVI (OR=1.75, 95% CI 1.38-2.23) were associated with increased number of comorbidities (Garin et al., 2014).

Vision Impairment and Health Outcomes

PHYSICAL FUNCTION

Physical function is important because it is associated with several health outcomes including independence, quality of life, falls, hospitalization, chronic disease, and premature death (Penn State College of Medicine, 2020). It is essential to study and score physical function performance because it can be used in clinical practice for identification of early stages of functional decline (Freiberger et al., 2012). The Short Physical Performance Battery (SPPB) is an assessment tool used to evaluate lower extremity (LE) function among older adults (Westman, 2017) and SPPB scores are strongly correlated with measures of physical fitness in older adults (Simonsick et al., 2001). As individuals age, physical activity and functional fitness is reduced equally for both males and females (Milanović et al., 2013).

Several studies have indicated that VI is associated with decreased physical function among older adults (Salive et al., 1994; West et al., 2002a; Klein et al., 2003a; Brown et al., 2014; Hajek et al., 2016). A cross-sectional analysis conducted among 782 older adults found that decreased vision function (acuity, contrast sensitivity, effects of illumination level, contrast on glare on acuity, visual fields with and without attentional load, color vision, temporal sensitivity, and the impact of dimming light on walking ability) was related to decrease physical functional ability scores (self-reported mobility, tandem balance, chair rise, and observed walking) (West et

al., 2002a). In a longitudinal study of 9 years of follow-up, Hajek et al. found that those with self-reported VI experienced greater decline in physical function frequency scores in activities such as walking and gardening (Hajek et al., 2016). A current research gap exists in identifying whether VI leads to physical function impairment among the older Mexican American older adults.

Physical inactivity is a major cause of chronic disease (Booth et al., 2012) and disability (IOM, 1990). Increasing physical activity as we age has several health benefits. Feter et al. using the English Longitudinal Study of Ageing (ELSA) data set found that even low levels of physical activity decreased the risk of development of dementia (Feter et al., 2021). Regular physical activity can decrease the risk of development of several chronic diseases (cardiovascular disease, diabetes, cancer, hypertension, obesity, depression, and osteoporosis) and premature death (Warburton et al., 2006). Non-Hispanic blacks and Hispanics were more inactive during their leisure time than were non-Hispanic whites (Marshall et al., 2007).

COGNITIVE FUNCTION

As individuals age, brain structural changes occur and cognitive function changes occur, however attention and memory are the most common cognitive domains affecting by the aging process (Glisky et al., 2007). Hale et al. using the Health and Retirement Study (HRS) from 1998-2014 of 29,304 participants found that at 70 years of age, approximately two out of three Americans experience signs of cognitive impairment (Hale et al., 2020a). In another study using the HRS from 1996-2014 of 32,784 participants, Hale et al. found that Latinas had the highest increased odds of dementia (OR=1.79, 95% CI 1.39-2.29) followed by white men (OR=1.31, 95% CI 1.13-1.51), white women (OR=1.29, 95% CI 1.13-1.48) and black men (OR=1.24, 95% CI 1.06-1.45) (Hale et al., 2020b). Díaz-Venegas et al. using the 2010 HRS data set found that Hispanic older adults had lower cognitive function when compared to non-Hispanic whites, however this was primarily due to differences in educational attainment (Díaz-Venegas et al., 2016). Gupta, using the Behavioral Risk Factor Surveillance System (BRFSS) (2015-2018) data

set found racial/ethnic demographic trends exists for experiencing subjective cognitive decline with a greater proportion of Hispanics and blacks in the coming years when compared to whites (Gupta, 2021).

Various studies have found that VI is associated with cognitive function (Lin et al., 2004; Reyes-Ortiz et al., 2005; Harrabi et al., 2015; Hajek et al., 2016; Vu et al., 2020). For example, in a cross-sectional study, Harrabi et al. found that age-related eye disease is associated with lower cognitive function in a sample of 428 older adults (Harrabi et al., 2015). Furthermore, longitudinal studies indicated that VI onset leads to cognitive impairment among 2,394 older adults in Germany after 9-years of follow-up (Hajek et al., 2016). Four-year follow up of 6,112 American older women living in four metropolitan areas found that VI increased the odds of cognitive impairment (OR = 1.78, 95% CI 1.21-0.61) (Lin et al., 2004). Reyes-Ortiz et al. found that NVI predicted cognitive decline in a sample of 2,140 older Mexican Americans over 7 years of follow-up, however DVI was not associated with cognitive decline (Reyes-Ortiz et al., 2005). Garin et al. using the COURAGE in Europe project data set performed cross-sectional analysis and found that both NVI and DVI were associated with worse cognitive functioning (Garin et al., 2014). Longitudinal analysis of 351 older adults using the Aging, Demographics, and Memory Study (ADAMS) over a mean follow-up time of 4.1 years found among those with VI an elevated hazard of dementia (HR=1.63, 95% CI 1.04-2.58) and the hazard of transitioning from normal cognition to Cognitive Impairment No Dementia (CIND) was elevated (HR=1.86, 95% CI 1.09-3.18) (Ehrlich et al., 2021).

FRAILTY

Numerous population-based cross-sectional studies have found an association between low vision and frailty among older adults (Jiao et al., 2020; Klein et al., 2003; Lee et al., 2020; Varadaraj et al., 2019). For example, the most recent findings from the NHANES (1999-2006) study showed that older adults with visual uncorrected refractive error were 1.4 times more likely

to have pre-frailty and 3.2 of having frailty than those without frailty (Lee et al., 2020). Swenor et al. using the NHANES data set from 1992-2002 found that older adults with low vision were 3.2 times more likely to be prefrail and 3.7 times more likely to be frail (Swenor et al., 2020). In another study of 9,996 hospitalized elderly Chinese patients found that those with low vision were 1.14 times more likely to have frailty than those without frailty (Jiao et al., 2020).

Several population-based longitudinal studies have found that low vision predicted frailty in older adults (Liljas et al., 2017; Swenor et al., 2020; Gonzales-Turin et al., 2021). For example, findings from the Women's Health and Aging Studies (WHAS) showed that non-frail older aged 70 to 79 who reported moderate/severe VI were 3.5 times more likely to develop frailty over 3-years of follow-up than those without frailty (Swenor et al., 2020). Liljas et al. using the ELSA data set found that those with poor vision had an increased odds of prefrailty or frailty over 4 years of follow-up (2.07 and 3.24, respectively) (Liljas et al., 2017). Gonzales-Turin et al. using the Toledo Study for Healthy Aging (TSHA) examined VI as predictor of worsening frailty status and found that those who were non-frail were at 2.5 times of becoming frail, 2.1 times of transitioning from pre-frail to frail, and 3.2 times to transitioning from robust to frail over 5 years of follow-up (Gonzales-Turin et al., 2021).

DISABILITY

The WHO describes disability as the interaction between individuals with a health condition and personal/environmental factors (WHO, 2021a). Disability among instrumental activities of daily living (IADL) and activities of daily living (ADL) tasks have been shown to be associated with increased morbidity and increased mortality among individuals (Millán-Calenti et al., 2009). In 1950, Sidney Katz first described the term ADLs as a collection of skills that described fundamental tasks required to independently care for oneself, such as eating, bathing, and mobility (Edemekong et al., 2021). IADLs are a collection of skills or activities that allow an individual to live independently in the community, such as meal preparation, cleaning,

transportation, laundry, and money management (Guo et al., 2021). Furthermore, low vision has a significant impact on all aspects of daily life (Smallfield et al., 2020) and detrimental effects on older adults' independence (Liu & Chang, 2020).

Instrumental Activities of Daily Living

In Sweden, Parker et al. using the annual Living Conditions Survey (ULF) from 1980-2005 found that IADL disability (cleaning, shopping, and preparing food) decreased over time among participants aged 65-79 years however, IADL disability increased for ages 80-84 years (Parker et al., 2008). Chatterji et al. found that similarities across countries exist for persons aged 70 years and older showing increases in IADL limitations with increased age, however IADL disability was not increased for persons aged below 70 years (Chatterji et al., 2015). Chan et al. using the Kaiser Healthy Aging and Diverse Life Experience cohort for older adults found that black race/ethnic group participants were at increased risk for IADL disability when compared to Asian, Latino, and white race/ethnic groups (Chan et al., 2021).

Lam et al. using the Salisbury Eye Evaluation found that VI predicted an increased difficulty in performing IADLs (telephone management, light housework/yardwork, heavy housework/yardwork, meal preparation, money management, and shopping) only among men over 3 years of follow-up (Lam et al., 2013). Hochberg et al. performed a RCT of 131 adults aged 60 to 80 years and found that vision loss in age-related macular degeneration (AMD) and glaucoma are associated with limitations in meal preparation, grocery shopping, and out-of-home transportation (Hochberg et al., 2012). Brown et al. examined the functional complaints of new low vision in the Low Vision Rehabilitation Outcomes Study and found that reading, driving, and doing out-of-home activities as the most reported difficulties among 819 older adults (Brown et al., 2014).

A systematic review performed by Taylor et al. revealed that AMD negatively impacts mobility, face recognition, perception of scenes, computer use, meal preparation, shopping,

cleaning, watching television, reading, driving and, in some cases, self-care (Taylor et al., 2016). In a longitudinal analysis, Lam et al. found that VI predicted decreased independence with IADLs for men and women over three-year follow-up (Lam et al., 2013). Peres et al. using the French Three-City Cohort study found that both near and distance visual loss predicted greater functional decline over 8 years of follow-up in at least one of eight IADLs (telephone use, shopping, transportation, medication management, money management, homework, meal preparation, laundry) (Peres et al., 2017).

Kee et al., using the population-based longitudinal study on neuroprotective model for healthy longevity among Malaysian older adults found that NVI was associated with higher IADL disability using the Lawton Instrumental Activities of Daily Living Scale (LIADL) (Kee et al., 2021). Naël et al. using the Three City Alienor population-based study data set in France found that IADL disability was associated with VI as low as 2/25-20/32 for distance visual acuity in the better seeing eye (Naël et al., 2017).

Activities of Daily Living

ADL disability studies among most high-income countries have found ADL disability rates are decreasing however, the evidence has also been inconsistent (Chatterji et al., 2015). For example, in Spain, Sjölund et al. found that disability among activities of daily living increases with older age with the highest incidence in ADL disability being among females aged 84 years and older (Sjölund et al., 2015). In Sweden, Parker et al. using the annual ULF from 1980-2005 found that ADL disability decreased among both men and women aged 65 years and older (Parker et al., 2008). Thus, additional research is needed to understand whether ADL disability rates are increasing or decreasing among different countries and populations.

Brenner et al. using the National Health and Aging Trends Study (NHATS) data set found that blacks and Hispanics had more difficulty in ADLs compared to whites (Brenner et al., 2018). Nam et al. using the Hispanic Established Population for the Epidemiologic Study of the Elderly

(H-EPESE) study of older Mexican Americans found that foreign-born men reported less ADL disability than U.S. born counterparts and foreign-born women were more likely to report ADL disability than foreign-born men (Nam et al., 2015).

Previous literature supports VI as a strong predictor of IADL disability. However, the literature is inconclusive on whether VI is a strong predictor of ADL disability. For example, Lam et al. using the Salisbury Eye Evaluation found that VI predicted increased difficulty in performing ADLs (bed transfer, dressing, bathing/showering, toileting, and eating) among men and women over 3 years of follow-up (Lam et al., 2013). Progressive decline in vision was significantly associated with an increased risk of ADL disability (OR = 3.09, 95% CI 2.46–3.89) during a twelve-year follow-up period in older Chinese adults using the Chinese Longitudinal Healthy Longevity Survey (CLHLS) (Cao et al., 2021). However, Peres' et al. using the French Three-City Cohort study found that vision loss did not predict increased difficulty with ADL tasks of transferring and toileting over 8 years of follow-up (Peres et al., 2017). Furthermore, Peres et al. found that NVI only was associated with difficulty in ADL tasks of bathing and dressing (Peres et al., 2017).

FALLS

The WHO describes a fall as a health event or condition that has a potential to cause injury, and there has been much discussion about what constitutes a fall and the events that lead to it (WHO, 2021a). Current literature defines a fall as "inadvertently coming to rest on the ground, floor or other level, excluding intentional change in position to rest in furniture, wall or other objects" (Yoshida, 2016).

Worldwide, falls are the second leading cause of unintentional injury deaths (WHO, 2021a). Every 29 minutes an older adult dies following a fall (National Council on Aging (NCOA), 2012). In the U.S., falls are the leading cause of death resulting in unintentional injury

(NCOA, 2016). Trends over time regarding falls and injury, also indicate a problem. The unintentional fall death rate in 2005 was approximately 43.0 deaths per 100,000 population and it rose steadily to approximately 58.0 deaths per 100,000 in 2014 (CDC, 2016).

Risk factors related to falls and injury have been researched previously. The NIH states several possible risk factors of falling including muscle weakness in the legs, poor balance and gait, postural hypotension, slower reflexes, sensory problems, and vision deficits relating to the environment (NIH, 2016b). Additionally, falling once doubles your chances of falling again (O'Loughlin et al., 1993). Individuals with dementia fall twice as often as cognitively intact people and are more likely to have injurious falls, female sex is a risk factor for falls in cognitively intact older people, as the number of risk factors increase occurrences of falls also increase, and the prevalence of falls increases for those aged 85 years and older (Taylor et al., 2012). Falls are a significant public health problem causing a decrease in independence for older adults (Burns et al., 2016).

Cross-sectional analysis indicates that VI is significantly associated withs falls due to lower visual acuity, impaired visual field, decreased contrast sensitivity, and cataracts (Boptom et al., 1998). Moreira et al. using the Frailty in Brazilian Older People Study found that VI was associated with fear of falling in non-diabetic older adults (Moreira et al., 2017). In Ethiopia, institutional-based cross-sectional analysis indicated that VI was significantly associated with self-reported fall occurrence (OR=3.21, 95% CI 1.11-9.29) (Gashaw et al., 2020).

In the Swedish National Study on Aging and Care (SNAC), VI was a significant predictor of falls over 3 and 6 years of follow up (OR = 2.29, 95% CI 1.28–4.09) (Moller et al., 2012). In the American city of Beaver Dam Wisconsin study, Klein et al. found that adults aged 43 to 86 years with poor visual function had increased risk of falls (OR = 2.02, 95% CI 1.13-3.63) and those

with the poorest category of best-corrected visual acuity had a higher incidence of fear of falling (OR = 2.95, 95% CI 1.52-5.70) over 5 years of follow-up (Klein et al., 2003a).

Vision Impairment and Health and Eye Care Utilization

According to the International Agency for the Prevention of Blindness (IAPB), 90% of vision loss is avoidable (IAPB, 2020). The WHO urge that individuals suffering from VI should receive superior eye care interventions without enduring financial distress (WHO, 2019c). For example, eye care inclusion in national health plans is encouraged (WHO, 2019c). Analysis of health care benefits related to VI is an integral step towards achieving this goal.

The four types of age-related eye diseases (ARED) that are commonly associated with VI among older adults are cataracts, glaucoma, AMD, and retinopathy (Salm et al., 2006). A cataract is a disease of the eye in which the normally clear lens has opacified which obscures the passage of light (Nizami & Gulani, 2021) and can increase difficulty with tasks such as reading, driving a car, and identification of facial expressions (Mayo Clinic, 2021). Risk factors for cataract include increasing age, female sex, poor education, lower socioeconomic status, excessive exposure to sunlight, diabetes, hypertension, obesity, low BMI, smoking, heavy alcohol consumption, prolonged use of corticosteroid medications, history of eye inflammation, eye injury, and eye surgery (Mayo Clinic, 2021; Vîrgolici & Popescu, 2006). Treatment of cataract is surgery and is the most effective and only approved intervention regardless of etiology (Moshirfar et al., 2021). Regular eye exams can be helpful with detection of cataracts at early stages (Mayo Clinic, 2021).

Vision loss and blindness can be caused by glaucoma (NEI, 2021a) and is the leading cause of irreversible vision loss worldwide (Weinreb et al., 2014). Glaucoma is a group of eye diseases that damage the optic nerve located in the back of the eye and is usually due to expressive pressure on the eye (CDC, 2021). Risk factors for glaucoma include increased age, frailty, myopia,

obstructive sleep apnea syndrome, and pseudoexfoliation syndrome (McMonnies et al., 2017). A yearly regular dilated eye exam is very important because it is the only way to diagnose glaucoma (CDC, 2021; NEI, 2021a) and 40% of the optic nerve can be damaged before an individual experience symptoms of vision impairment (National Council for the Blind of Ireland (NCBI), 2022). Early treatment is essential because it can stop additional damage to the eye and provide vision protection (NEI, 2021a). Following diagnosis and treatment, prognosis for glaucoma is good because decreasing intraocular pressure can prevent additional visual field loss (Dietze et al., 2022).

The eye disease AMD can cause blurring of central vision due to age related damage to the light-sensitive tissue known as the macula (part of the retina), that controls the sharpness of vision when looking straight-ahead (NEI, 2021b). AMD affects 170 million individuals worldwide and 11 million individuals are affected by AMD in the U.S. (Pennington & DeAngelis, 2016). Several demographic and environmental risk factors have been identified including individuals aged 85 years and older, smoking, higher BMI, lower education, comorbidities (hypertension, diabetes, Alzheimer's disease, Parkinson's disease, and chronic kidney disease) (Heesterbeek et al., 2020). Interestingly, the recent Coronavirus 2019 (COVID-19) pandemic has increased the use of telemedicine for the diagnosis of AMD and holds high potential for the treatment of individuals that have limited health care access, including remote evaluation of the and home-based remote monitoring for individuals with increased risk for AMD (Armstrong & Miller, 2022).

Diabetic retinopathy is the ARED that is most familiar to public health professionals due to state diabetes programs initiatives to increase eye examination rates for diabetic individuals (Ghodes et al., 2005). According to the International Diabetes Federation (IDF), in 2045 the worldwide population of individuals with diabetes is expected to grow to 700 million (Teo et al., 2021). Diabetic retinopathy occurs with diabetes and causes damage to the blood vessels of the retina (NEI, 2003). It is essential to have early detection and timely intervention is a key for diabetic retinopathy to decrease risk of blindness (Shukla & Tripathy, 2021). Risk factors include smoking, pregnancy, hypertension, and longer diabetes disease (Breazzano, 2020).

Morse et al. using Medicare data from 2008-2014, found among 6,165 older adults that those with severe vision loss had significantly longer length of stay (OR = 1.04, 95% CI 1.06-1.41), higher readmission rates (OR = 1.22, 95% CI 1.06-1.41) and higher health care costs (OR = 1.12, 95% CI 1.06-1.18) (Morse et al., 2019). Those with vision loss who were hospitalized had an addition of $500 million annually health care costs than those without vision loss (Morse et al., 2019). In another research study, Bal et al. found that time to first hospitalization were significantly higher for Medicare recipients with VI (HR=1.14, 95% CI 1.05-1.23) over a 3-year follow-up period (Bal et al., 2017). Longitudinal analysis of the National Long-Term Care Survey (NLTCS) linked with the 1994-1999 Medicare data set found that regular eye examinations are protective for vision decline and functional status decline with ADLs and IADLs (Sloan et al., 2005).

Specific Aims

SPECIFIC AIMS AND HYPOTHESES

Specific Aim 1

To examine the predictor factors of VI in older Mexican Americans over time.

> ***Hypothesis 1a.*** Older age, female sex, low education, foreign-born, social isolation, and high depressive symptoms will be associated with VI over time.
>
> ***Hypothesis 2b.*** Older Mexican Americans with multimorbidity will be at greater risk of vision impairment than those without multimorbidity.

Specific Aim 2

To examine the effect of VI on physical and cognitive function, frailty, disability, and falls among older Mexican Americans over time.

Hypothesis 2a. Older Mexican Americans with VI will be more likely to experience greater decline in physical and cognitive function over time compared to those without VI.

Hypothesis 2b. Older Mexican Americans with VI will be more likely to experience greater odds of frailty, disability, and falls over time compared to those without vision impairment.

Hypothesis 2c. Older Mexican Americans with VI and high social isolation will have greater odds of frailty, disability, and falls than those with vision impairment and low social isolation over time.

Hypothesis 2d. High depressive symptoms will mediate the relationship between VI and physical and cognitive function, frailty, disability, and falls over time.

Specific Aim 3

To determine the effect of VI on health care utilization and the factors associated with eye care utilization among older Mexican Americans over time.

Hypothesis 3a. Older Mexican Americans with VI will have greater medical doctor visits and hospitalizations compared to those without VI.

Hypothesis 3b. Low education, foreign-born, and Spanish language of interview will be associated with lower eye care utilization among older Mexican Americans over time.

Hypothesis 3c. Older Mexican Americans with dual enrollment (Medicare and Medicaid) will have more access to eye care utilization compared to those without dual enrollment (Medicare and Medicaid).

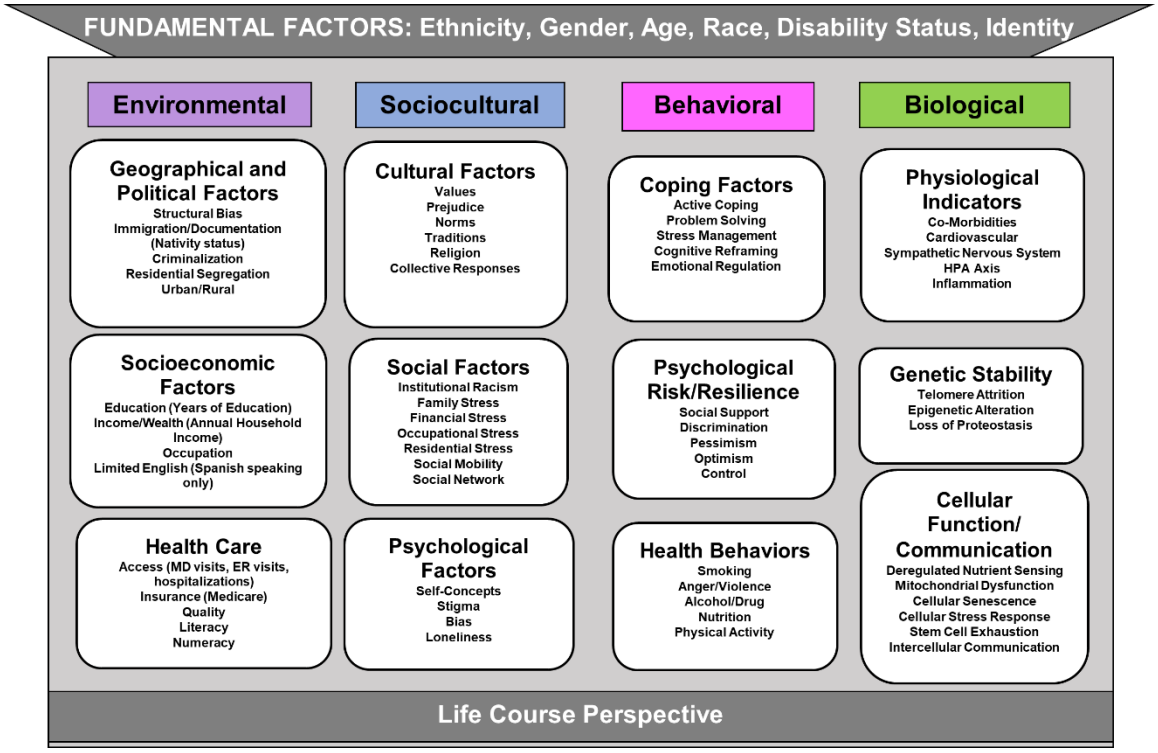
CHAPTER 2

Methods

CONCEPTUAL FRAMEWORK

The major goal of this proposal is to assess the contribution of VI to health outcomes and health care utilization among older Mexican Americans. Two primary frameworks were used to create the conceptual model used to guide these analyses: (1) the NIA health disparities research framework (Figure 2.1) and (2) the VI framework proposed by the Swenor et al. (Figure 2.2). The NIA Health Disparities framework was used because it has an age-related, multidimensional approach across the life course for health disparities research (Hill et al., 2015). This framework was useful for gap identification of health disparities research related to four primary categories: (1) environmental, (2) sociocultural, (3) behavioral, and (4) biological (Hill et al., 2015). Under each of the four primary categories, there are different levels of analyses described in this framework that were integrated into this research project (Hill et al., 2015). For example, within the environmental category, the following variables were used to analyze the socio-economic factors among older Mexican Americans: (1) education, (2) income/wealth, (3) and limited English (Hill et al., 2015).

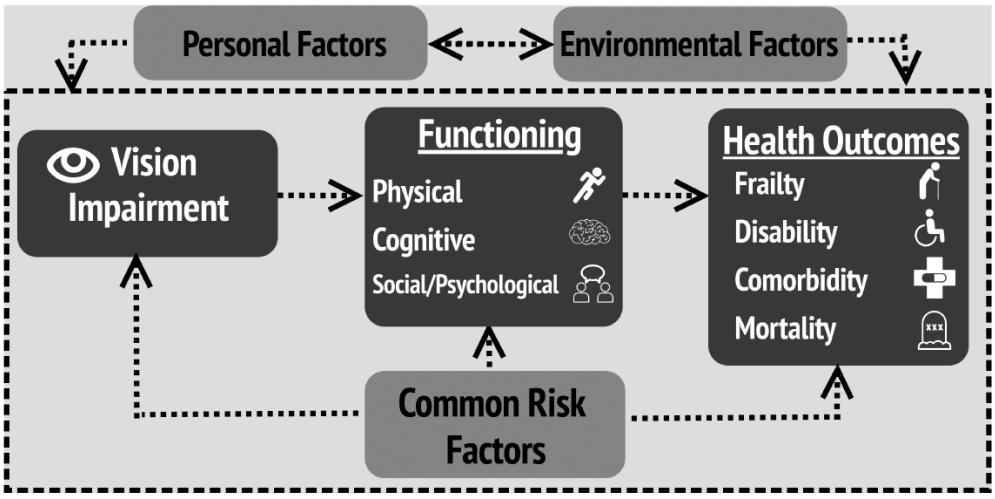
Figure 2.1 National Institute on Aging Health Disparities Framework, 2015.



Source: Hill, C., Pérez-Stable, E., Anderson, N., & Bernard, M. (2015). The National Institute on Aging Health Disparities Research Framework. Ethnicity & Disease, 25(3), 245–254. https://doi.org/10.18865/ed.25.3.245

In 2020, Swenor et al. proposed a conceptual framework relating to the impact of VI on the health of older adults (Swenor et al., 2020). This framework was used for conceptual model creation of our proposal because it integrates the concepts of ophthalmology, disability, and geriatrics (Swenor et al., 2020). The main pathway of the VI framework describes how VI influences multiple functional domains that increase the likelihood of negative health outcomes (Swenor et al., 2020). This framework was preferred because it presents important contributors to aging successfully (physical, cognitive, psychological, and social functioning) that can be either direct effects, indirect or mediating effects, or moderating effects of VI on functioning (Swenor et al., 2020). This model integrates the health outcomes of frailty, disability, and comorbidity that are related to this specific research project (Swenor et al., 2020).

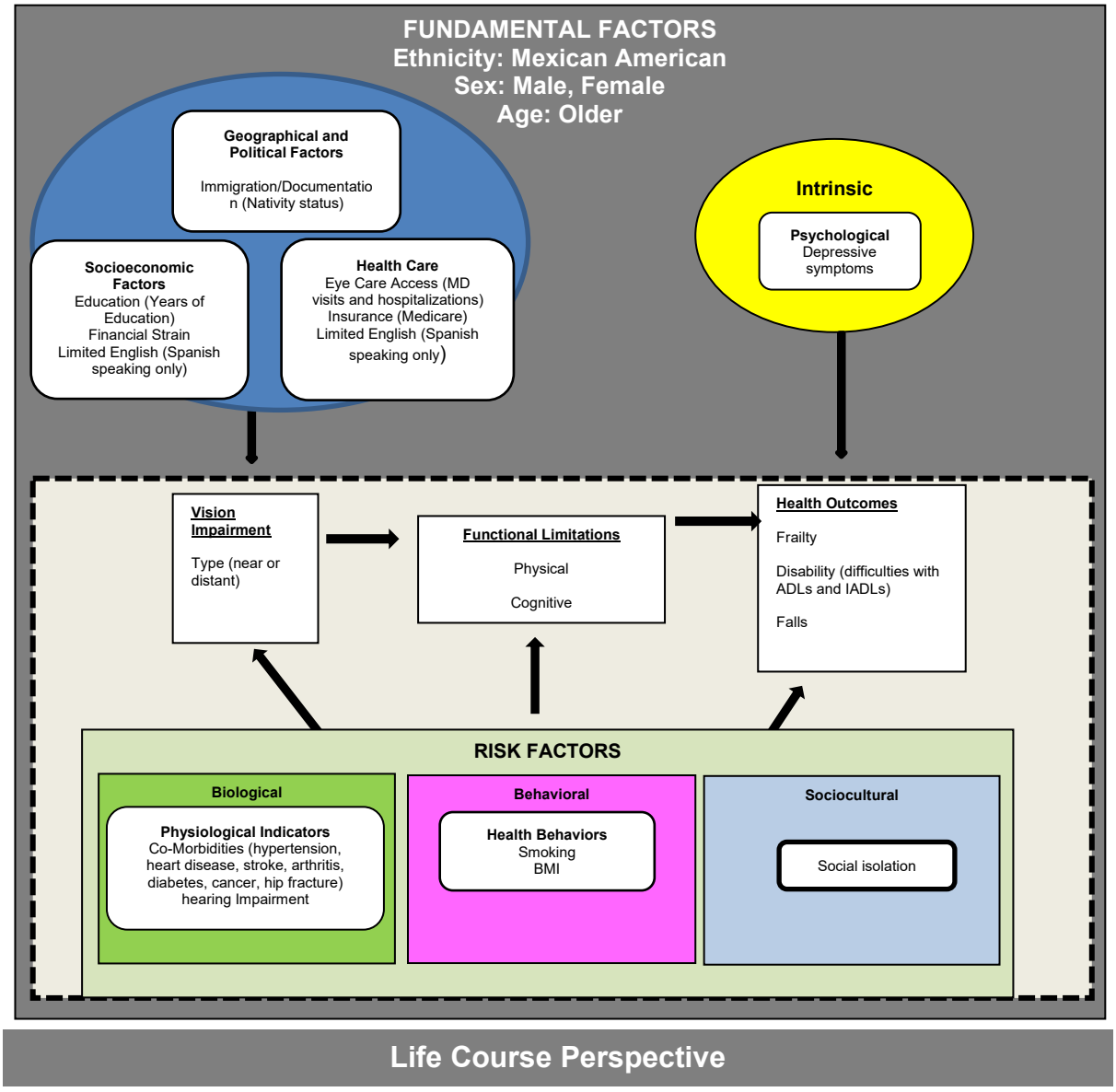
Figure 2.2 Vision Impairment Framework on the Health of Older Adults (Swenor et al., 2020).



Source: Swenor, B. K., Lee, M. J., Tian, J., Varadaraj, V., & Bandeen-Roche, K. (2020). Visual Impairment and Frailty: Examining an Understudied Relationship. J Gerontol A Biol Sci Med Sci, 75(3), 596-602. doi:10.1093/gerona/glz182

The above two models were integrated, modified, and used to guide all analyses (Figure 2.1 and Figure 2.2) (Swenor et al., 2020) (Hill et al. 2015). The main pathway of my proposed research includes the following: 1) VI type, (2) functional limitations (physical and cognitive), and (3) health outcomes (frailty, disability, and falls). The proposed research included primary domains relating to the NIA health disparities research framework that are located external to the main pathway (Hill et al., 2015). The first domain is biological including physiological indicators such as comorbidities (hypertension, heart disease, stroke, arthritis, diabetes, cancer, hip fracture). The second domain is behavioral including health behaviors such as smoking and BMI. The third domain is sociocultural and includes social isolation. The fourth domain is environmental and includes the following: (1) geographical and political factors – nativity status, (2) socioeconomic factors – education, income, and Spanish speaking only, and (3) health care – eye care access and Spanish speaking only. The fifth domain is intrinsic factors including psychological such as depression and is also located external to the main pathway. This domain integrated the external personal factor that was described in the original VI framework (Swenor et al., 2020). These domains and factors were analyzed in this research project (Figure 2.3).

Figure 2.3 Vision impairment conceptual model for older Mexican Americans.



MEASURES

Primary Independent Variable: Vision Impairment

VI was assessed by self-report of near or distant vision difficulty. Distant vision was assessed with the following question: “When wearing your glasses/contacts can you see well enough to recognize a friend across the street or across the room?” with a possible response of “yes”, “no”, and “do not know”. Near vision was assessed with the following question: “When wearing your glasses/contacts, can you see well enough to recognize a friend who is at arm’s length away?” with a possible response of “yes”, “no”, and “do not know”. These questions were similar to those used in the BRFSS data set for assessment of VI (McGwin et al., 2010) (Chou et al., 2012) (CDC, 2022).

Outcome Variables

PHYSICAL FUNCTION

Physical function was assessed with the SPPB which include three tests: (1) timed 8-foot walk, (2) timed repeated chair stands, and (3) standing balance (Guralnik et al., 1994). These tests were summed to obtain an overall score of 0 to 12 (Markides et al., 2001; Panas et al., 2014). A score of 12 indicated high physical performance function and a score of 0 indicated low physical function (Guralnik et al., 1994).

COGNITIVE FUNCTION

Cognitive function was assessed using the Mini Mental State Examination (MMSE) to obtain knowledge of orientation, registration, attention and calculation, recall, and language (Folstein et al., 1975). The maximum score on the MMSE is 30. The previously established cutoff of < 21 points on the MMSE among older Mexican Americans indicates

cognitive impairment (Raji et al., 2004; Downer et al., 2019). The test takes approximately 5 to 10 minutes to complete.

FRAILTY

Frailty was measured using a modified frailty phenotype. The original Frailty Phenotype (Fried et al., 2001) measured frailty by meeting three out of five criterion: weakness (low grip muscle strength), low energy, slowness (slow walking speed), low physical activity, and/or unintentional weight loss. A validation of the frailty phenotype was performed with the H-EPESE study to identify those participants with low physical activity (Li et al., 2019). Participants with three or more positive criterion were considered "frail", one or two criterion were "pre-frail", and none criterion were "non-frail". For our study, participants with three or more positive criterion were categorized as score=1, two or less criterion were categorized as score=0.

Exhaustion was measured with two items from the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977). (1) "I felt that everything I did was an effort" and (2) "I could not get going". The items asked, "How often in the last week did you feel this way?" 0 = rarely or none of the time (< 1 day), 1 = some or little of the time (1–2 days), 2 = a moderate amount of the time (3–4 days), or 3 = most of the time (5–7 days). Participants answering 2 or 3 to either of these 2 items were categorized as positive for the exhaustion criterion (score=1).

Unintentional weight loss was measured in pounds. Weight loss > 10 pounds calculated as the difference between weight measured in the previous wave and weight measured in the current wave (score=1).

Weakness was measured with the handheld dynamometer (Jamar Hydraulic Dynamo-meter Number (No.) 5030 J1; Ja.A. Preston Corporation, Jackson, Mississippi (MI). Participants unable to perform the handgrip strength test or were in the lowest 20% after adjusting for sex and BMI, calculated by kilograms (kg)/meters $(m)^2$ were considered positive for the weakness criterion (score=1).

Slowness was measured with time to walk 8-feet. Participants unable to perform the 8-feet walk test or were in the lowest 20% after adjusting for sex and height were considered positive for the slowness criterion (score=1).

Low physical activity was assessed with the answer "no" to the question "Can you walk half a mile without help?" adjusted by sex (score=1).

IADL DISABILITY

IADL disability was assessed using a modified LIADL scale (Lawton et al., 1969). A series of questions asking, "at the present time, do you need help from another person or special equipment or a device for" the ability to use the telephone, driving, grocery shopping, meal preparation, light housework, taking medicine, and money management, The response options are "yes", "no", and "do not know". IADL disability was defined as difficulty in performing one or more of the seven IADL activities.

ADL DISABILITY

ADL disability was assessed using a modified Katz-7 ADL index (Katz-6) (Katz et al., 1963). A series of questions asking "at the present time, do you need help from another person or special equipment or a device for" the ability to bath, dress, toilet, transfer, eat,

walk across the room and groom. The response options are “yes”, “no”, and “do not know”. The Katz-6 ADL Index was modified by replacing incontinence with grooming task. ADL disability was defined as difficulty in performing one or more of the seven ADL activities.

FALLS

Falls were assessed with the following question: “During the past 12 months, how many times did you fall and land on the floor or ground?” with response options of “none”, “1 time”, “2 times”, “3+ times”, and “do not know”. Fall status was categorized as having no falls and having one or more falls.

HEALTH CARE UTILIZATION

Hospitalizations were assessed with the following question: “In the last 12 months, did you experience an illness or injury (get sick or get hurt) that required staying overnight or longer in a hospital (not a nursing home)?” with response of “yes” or “no”. Medical doctor (MD) visits were assessed with the following question: “Not including any overnight stays in a nursing home or hospital, in the past 12 months, have you visited with a medical doctor?” with response of “yes” or “no”.

EYE CARE UTILIZATION

The primary variables in the Centers for Medicare and Medicaid (CMS) data set that were linked to the H-EPESE data set were eye exam, provider service visits (optometrist and ophthalmologist), and dual enrollment (Medicare and Medicaid) (Table 2.2). Eye care utilization was defined as utilizing a diagnostic or therapeutic vision services in the year following the date of interview at wave 5.

Covariates

Socio-demographics

Socio-demographics: age, sex, marital status [married vs. not married (separated, divorced, widowed, never married, common law/just living together)], nativity (U.S. vs. foreign born), language of interview (English vs. Spanish), years of formal education, and financial strain. Financial strain was assessed by the following question: "How much difficulty do you have in meeting monthly payments on your bills?" with response options of "a great deal", "some", "a little", "none", "don't know", and "refused". Participants who answered, "a great deal" and "some" were categorized as having financial strain.

Social Isolation

Social isolation was assessed with the following question: "How many people live in this household?" with response options of "lives alone", "two people in house", and "three or more people in house". Social isolation was defined as participants who responded, "lives alone". This definition is reflective of the NIA description of social isolation for the assessment of the sociocultural level of analysis (NIA, 2019) (Glover et al., 2021).

Smoking Status

Smoking status was assessed with the following question: "Do you smoke cigarettes now?" with response options of "yes", "no", and "do not know".

Body Mass Index

BMI was calculated as weight kg/height m^2.

Medical Conditions

Medical conditions were assessed by a series of questions asking "have you been told by a doctor that you had" arthritis, cancer, diabetes, heart attack, hip fracture, hypertension, or stroke. The WHO described multimorbidity as having the coexistence of two or more chronic conditions in the same individual (WHO, 2016). Thus, for the purposes of this study, multimorbidity was defined as having 2 or more for medical conditions of arthritis, cancer, diabetes, heart attack, hip fracture, hypertension, and stroke.

Depressive Symptoms

Depressive symptoms were assessed using the 20-item CES-D scale (Radloff, 1977). The total sum score range on the CES-D is 0 to 60 (Radloff, 1977). The previously established cutoff of ≥ 16 points on the CES-D indicates high depressive symptoms (Himmelfarb et al., 1983; Lyness et al., 1997; Gerst et al., 2010).

Hearing Impairment

Hearing impairment was assessed with the following question: "Can you usually hear and understand what a person way without seeing his face if that person talks in a normal voice to you in a quiet room" with response options "yes", "no", and "do not know". These questions were similar to those used in the NHIS data set for the assessment of hearing impairment (CDC, 2015).

Table 2.1 presents the operationalized variables used from the H-EPESE data set (wave 3 to wave 9). Table 2.2 presents the operationalized variables used from the CMS data sets.

Table 2.1 Operationalized variables for the H-EPESE data set Wave 3 to Wave 9.

Variable	Description	Type
Independent Variable		
Vision Impairment Perception	Difficulty vs. no difficulty	Categorical
Dependent Variables		
Physical function	SPPB Score	Continuous
Cognitive function	Total MMSE Score: <21 impaired vs. ≥ 21 not impaired	Categorical
Frailty	Frail vs. not frail	Categorical
IADL disability	Limitations one or more IADL activities	Categorical
ADL disability	Limitations one or more ADL activities	Categorical
Falls	One or more falls in the last 12 months	Categorical
MD visits	One or more MD visits in the last 12 months	Categorical
Hospitalization	One or more hospitalization in the last 12 months	Categorical
Covariates		
Sex	Female vs. male	Categorical
Age	Age in years	Continuous

Marital Status	Married vs. not married	Categorical
Nativity	U.S. born vs. Foreign born	Categorical
Language of Interview	Spanish vs. English	Categorical
Education	"What is the highest grade or year of regular school that you have completed?"	Continuous
Financial Strain	Difficulty paying monthly bills	Categorical
Social isolation	Lives with family vs. alone	Categorical
Medical conditions	Self-reported arthritis, cancer, diabetes, heart attack, hip fracture, hypertension, or stroke	Categorical
Depressive symptoms	Total CES-D Score: CES-D <16 vs. CES-D ≥ 16	Categorical
BMI	Total BMI: weight kg/m2 BMI Categories: Underweight <18.5), Normal (18.5 to <25), Overweight (25 to <30), Obese Category 1 30 to <35, and Obese Category 2 (≥35)	Continuous and Categorical
Smoking	Current smoker, yes vs. no	Categorical
Hearing Impairment	Difficulty vs. no difficulty	Categorical

Table 2.2. Operationalized variables from the CMS data sets.

Variable	**Description**	**Source**
Participant ID	**MCBS:** SAS CODE = BENE_ID, Description =The unique CCW identifier for a beneficiary.	MCBS MEDPAR

	MedPAR: SAS CODE = BENE_ID, Description =The unique CCW identifier for a beneficiary.	
Participant ID Linkage	**Carrier Base/Line/Demo Claim File:** SAS Code = DSYSRTKY, Description = This field contains the key to link data for each beneficiary across all claim files. **Outpatient Base/Condition Code/Occurrence Code/ Value Code/Revenue Center/Demo Claim File:** SAS Code = DSYSRTKY, Description = This field contains the key to link data for each beneficiary across all claim files.	Carrier OUTSAF
Dual Eligibility for Medicare and Medicaid	**MCBS:** SAS CODE = DUAL_MO, Description = This variable is the number of months during the year that the beneficiary was dually eligible (i.e., he/she was also eligible for Medicaid benefits).	MCBS
Vision Provider Service Visits	**Carrier Line Claim File:** SAS CODE = HCFASPCL, Description = CMS (previously called HCFA) specialty code used for pricing the line-item service on the non-institutional claim. Assigned by the Medicare Administrative Contractor (MAC) based on the corresponding provider identification number (performing NPI or UPIN), CMS Provider Specialty Code: 40 = Opthalmologist, 41 = Optometry SAS CODE = SRVC_CNT, Description = The count of the total number of services processed for the line item on the non-institutional claim. SAS Code = TYPSRVCB, Description = Code indicating the type of service, as defined in the CMS Medicare Carrier Manual, for this line item on the non-institutional claim, Response Q = Vision items or services SAS CODE = BETOS, Description = The Berenson-Eggers type of service (BETOS) for the procedure code based on generally agreed upon clinically meaningful groupings of procedures and services. This field is included as a line item on the non-institutional claim, Carrier Line-Item NCH Betos Code: M5C = Specialist – Opthalmology, **Outpatient Base Claim File:** SAS CODE = AT_PHYSN_SPCLTY_CD, Description = This variable is the code used to identify the CMS specialty code	Carrier MCBS OUTSAF

	corresponding to the attending physician, Response 18 = Opthalmology services SAS CODE = OT_PHYSN_SPCLTY_CD, Description = The code used to identify the CMS specialty code corresponding to the other physician. Response 18 = Opthalmology services **Outpatient Revenue Center File:** SAS CODE = REV_CNTR_RNDRNG_PHYSN_SPCLTY_CD Description = The code used to identify the CMS specialty code of the rendering physician/practitioner, Response 18 = Opthalmology services **MCBS File:** Includes name and type of dental, vision, and/or hearing care providers, dates of visits, services performed and/or medical equipment purchased (e.g., glasses, hearing aids), and medicines prescribed during the visits. **h**ttps://www.cms.gov/research-statistics-data-and-systemsresearchmcbsquestionnaires/2020-questionnaires	
Eye Exam	**Carrier Line Claim File:** **Eye Exam:** CPT (Level 1 HCPCS) Eye Exam Codes 92002, 92004, 92012, and 92014; all eye codes 92002 to 92014; Evaluation and Management E/M codes 99212 to 99215	Carrier OUTSAF

STATISTICAL ANALYSIS

Descriptive analyses using frequency, percent, mean, median, standard deviation and/or interquartile range was interpreted and reported. The continuous variables were assessed to determine normal or non-normal distribution. Median and inter-quartile range was reported for variables with a non-normal distribution. Mean and standard deviation was reported for those variables with a normal distribution. Differences among groups were examined with Chi-square tests or Fisher Exact tests for categorical variables and Student T-test and analysis of variance (ANOVA) for continuous variables. Generalized estimating equation models using the GENMOD procedure in SAS were used to estimate the odds ratio (OR) and 95% confidence interval (CI) of cognitive and function impairment, IADL and ADL disability, frailty, falls, and health care utilization (hospitalization and medical doctor visits). The models used a logit link binomial

distribution and autoregressive correlation structure to account for repeated measures of participants with appropriate covariance matrix. All variables were analyzed as time varying (with the potential to change over time), except for sex, education, and nativity. The covariance matrix for GEE models were chosen based on the Akaike information criterion and Bayesian information criterion values. All the analyses were performed using Statistical Analysis Software (SAS) 9.4 (SAS Institute, Cary, North Carolina (NC)).

Statistical Analysis for Aim 1

Aim 1: To examine the predictor factors of VI in older Mexican Americans over time.

> **Hypothesis 1a**. Older age, female sex, low education, foreign-born, social isolation, and high depressive symptoms will be associated with VI over time.
>
> **Hypothesis 1b.** Older Mexican Americans with multimorbidity will be at greater risk of VI than those without multimorbidity.

Methods: Chi-square and t-test were used to test the descriptive characteristic of the sample by VI at baseline. Generalized estimation equation (GEE) models using the GENMOD procedure in SAS were used to estimate the OR and 95% CI of VI over 18 years as a function of sociodemographic factors, smoking status, comorbidities, BMI, cognitive function, high depressive symptoms, and hearing impairment. The models used a logit link binomial distribution and autoregressive correlation structure to account for repeated measures of participants. All variables were analyzed as time varying (with the potential to change over time) except for sex, education, and nativity. Participants with VI at baseline were excluded. Interaction terms between sociodemographic factors, comorbidities, BMI, cognitive function, high depressive symptoms, and hearing impairment were performed.

To test hypothesis 1a. The GEE modeling with the autoregressive correlation structure was used to estimate the OR and 95 % CI of VI over time as a function of sociodemographic factors controlling for all covariates.

To test hypothesis 1b. The GEE modeling with the autoregressive correlation structure was used to estimate the OR and 95% CI of VI over time as a function of multimorbidity controlling for all covariates.

Statistical Analysis for Aim 2

Aim 2: To examine the effect of VI on physical and cognitive function, frailty, disability, and falls among older Mexican Americans over time.

Hypothesis 2a. Older Mexican Americans with VI will be more likely to experience greater decline in physical and cognitive function over time compared to those without VI.

Hypothesis 2b. Older Mexican Americans with VI will be more likely to experience greater odds of frailty, disability, and falls over time compared to those without VI.

Hypothesis 2c. Older Mexican Americans with VI and high social isolation will have greater odds of frailty, disability, and falls than those with VI and low social isolation over time.

Hypothesis 2d. High depressive symptoms will mediate the relationship between VI and physical and cognitive function, frailty, disability, and falls over time.

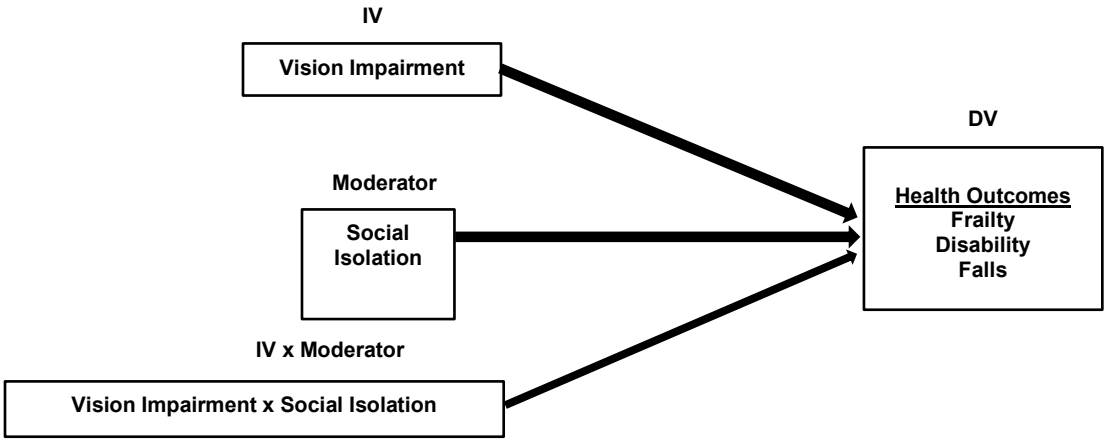
Methods: T-test, ANOVA, and Chi-square tests were used to test the differences of cognitive and physical function, frailty, ADL/IADL disability, and falls by VI at baseline. General Estimating Equation (GEE) with logit link for a binomial distribution and the appropriate working covariance structure to account for repeated measures of participants were used to estimate the OR and 95 % CI of disability, frailty, and falls as a function of VI controlling for sociodemographic factors and comorbidities over time. All variables were analyzed at time varying except for sex, education, and nativity. The sample size for each outcome excluded those participants who had the outcome present at baseline.

To test hypothesis 2a. GEE models using the GENMOD procedure in SAS was used to estimate the OR and 95 % CI of physical and cognitive function impairment over time as a function of VI controlling for all covariates.

To test hypothesis 2b. GEE models using the GENMOD procedure in SAS was used to estimate the OR and 95 % CI of frailty, ADL/IADL disability, and falls as a function of VI over time controlling for all covariates.

To test the moderator effect (hypothesis 2c. – Figure 2.4) of social isolation between VI and outcomes (frailty, IADL/ADL disability, and falls), interaction terms between VI and social isolation were conducted (Figure 2). Two models were performed for each outcome. Model 1 included VI, social isolation, and the interaction term between VI and social isolation. Model 2 included age, sex, nativity, marital status, education, income, smoking, BMI, comorbidities, and depressive symptoms along with the variables in Model 1**.** If the OR for the interaction term (VI*social isolation) was significant, this indicated moderation effect.

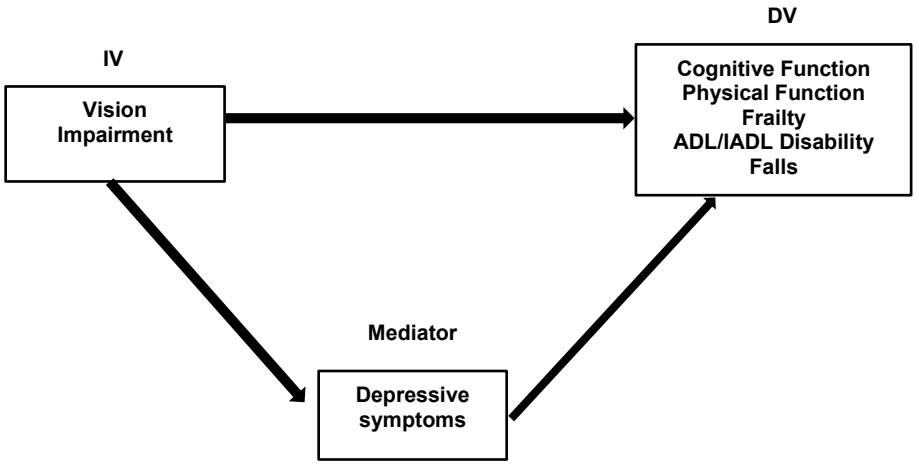
Figure 2.4 Social isolation as moderator in the relationship between vision impairment and health outcomes.



Note: IV=independent variable; DV=dependent variable

To test the mediator effect (hypothesis 2d – Figure 2.5). The four-step method proposed by Baron and Kenny (Figure 3) was used to test the mediating effect of depressive symptoms (hypothesis 2.d) on the relationship between VI and cognitive and physical function, frailty, ADL/IADL disability, and falls. The GEE models were used to estimate the OR of the outcomes (Baron et al., 1986).

Figure 2.5 Depressive symptoms as mediator in the relationship between VI and outcomes.



Note: IV=independent variable; DV=dependent variable

Statistical Analysis for Aim 3

Aim 3: To determine the effect of VI on health care utilization and the factors associated with eye care utilization among older Mexican Americans over time.

Hypothesis 3a. Older Mexican Americans with VI will have greater medical doctor visits and hospitalizations compared to those without VI.

Hypothesis 3b. Low education, foreign-born, and Spanish language of interview will be associated with lower eye care utilization among older Mexican Americans over time.

Hypothesis 3c. Older Mexican Americans with dual enrollment (Medicare and Medicaid) will have more access to eye care utilization compared to those without dual enrollment (Medicare and Medicaid).

Methods: For this aim, data from the H-EPESE survey was linked to the CMS files at wave 4 of the HEPESE dataset linked with the CMS files (2000-2016). Descriptive statistics were performed to test the differences of medical doctor visits and hospitalizations. GEE with logit link for a binomial distribution and the appropriate working covariance structure were used to estimate the OR of any hospitalization and any medical doctor visits. The Medicare Provider Analysis and Review (MEDPAR) (inpatient), Outpatient Standard Analytical File (OUTSAF) (outpatient), and Carrier files were used to estimate the prevalence of ocular diagnosis (e.g. glaucoma, cataracts, macular degeneration – Appendix Table A.1) by VI. Prevalence of eye disease at the time of the interview at wave 5 and year after the interview (wave 6) are provided. Descriptive statistics were used to provide the percent of socio-demographics and comorbidities by providers (optometrist

and ophthalmologist – Appendix Table A.2). Logistic regression analyses were used to estimate the adjusted OR of visiting an optometrist or ophthalmologist provider in the outpatient settings the year following the interview data at wave 5. Unadjusted rate of diagnostic and therapeutic vision services use was provided for any and each eye disease by socio-demographic characteristics and comorbidities. Logistic regression analyses were performed to estimate the adjusted OR for utilizing a diagnostic or therapeutic vision service. See Appendix Table A.3 for diagnostic and therapeutic vision services.

To test hypothesis 3a. GEE models were used to estimate the OR of medical doctor visits and any hospitalization.

To test hypothesis 3b. Logistic regression analysis were used to estimate the OR of eye care utilization as a function of education, language of interview, and nativity one year after wave 5 interview e controlling for age, sex, dual enrollment (Medicare and Medicaid), and comorbidities.

To test hypothesis 3c. Logistic regression analysis were used to estimate the OR of eye care utilization as a function of Medicare and Medicaid dual enrollment one year after wave 5 interview e controlling for socio-demographics and comorbidities.

CHAPTER 3

The Overall Sample

DATA SOURCE

This research study used data from the H-EPESE data set linked with CMS files. The H-EPESE provides basic information on socio-demographics, health and psychosocial characteristics, and health care needs of 3,050 Mexican Americans aged 65 and older originally interviewed in 1993/1994. Nine waves of data have been collected (1993/94-2016).

STUDY SAMPLE OF H-EPESE SURVEY

Participants were originally selected from five Southwestern states (Arizona, California, Colorado, New Mexico, and Texas) using area probability sampling procedures. In the first stage, counties were selected if at least 6.6% of the population was of Mexican American ethnicity. The second stage involved the selection of 300 randomly chosen census tracts. The third stage involved the selection of randomly selected blocks within each census tract. At the third stage, one or two additional blocks were added to obtain at least 400 households within each sampling unit. The fourth stage involved in-home assessments (up to four interviews per household) on socio-demographics, health conditions, and psychosocial characteristics of the subjects or their proxy. In addition, anthropometric measures, blood pressure, and physical function measures of subjects' upper and lower body strength were obtained. The sampling procedure assured a sample that was generalizable to approximately 500,000 older Mexican Americans living in the Southwest. The response rate at baseline was 83%. In-home interviews were conducted in Spanish or English depending on the respondent's preference. In 2004/2005 a new cohort of 902 participants aged 75 years and older were added to the survivors of the original cohort (N=1676) who were also 75 year and older. The interview and questionnaires contents were the same as those used in the original

cohort. The H-EPESE data set was created and made available to the public by the Inter-University Consortium for Political and Social Research (ICPSR) (NACDA, 2020). Table 3.1 shows the number of subjects during the nine waves of data collection. The present research will be using data from wave 3 (hereafter referred as baseline) to wave 9 since the questions related to vision impairment were consistently asked from wave 3 to wave 9. Self-reported vision impairment was not assessed in wave 1 and wave 2.

Table 3.1 Sample of H-EPESE at each follow-up wave (N=3050).

Status	**Baseline 1993-1994**	**Wave 2 1995-1996**	**Wave 3 1998-1999**	**Wave 4 2000-2001**	**Wave 5 2004-2005**	**Wave 6 2006-2007**	**Wave 7 2010-2011**	**Wave 8 2012-2013**	**Wave 9 2016**
Sample Size	3050	2435	1979	1676	1166	921	659	451	283
Interviewed in person	2734	2163	1715	1468	964	746	544	332	185
Assisted Proxy	139	129	119	109	109	78	94	76	98
Proxy only	177	143	145	99	93	97	21	43	0
Refused, alive	_____ __	109	123	131	140	103	57	23	5
Cumulative Deaths	_____ __	219	636	915	1410	1702	2036	2265	2528
Deaths (new wave – previous wave)	_____ __	219	417	279	495	292	334	229	263

STUDY POPULATION

Data was collected for vision impairment starting at Wave 3. Thus, for this research study, data from Wave 1 and Wave 2 was not analyzed. The baseline sample (Wave 3) included 1,979 participants of which 1715 were interviewed in person, 119 participants were proxy assisted, and 145 participants were proxy only. Out of the baseline sample, a total of 267 participants were

followed-up until Wave 9 and a total of 1,588 cumulative deaths were indicated. Table 3.2 shows the number of participants during each wave of data collection used for the present research study.

Table 3.2 Sample of H-EPESE at each follow-up wave used for this research study (N=1979).

Status	Wave 3 1998-1999	Wave 4 2000-2001	Wave 5 2004-2005	Wave 6 2006-2007	Wave 7 2010-2011	Wave 8 2012-2013	Wave 9 2016
Sample Size	1979	1597	1115	868	617	422	267
Interviewed in person	1715	1404	922	705	508	308	171
Assisted Proxy	119	104	104	73	89	72	96
Proxy only	145	89	89	90	20	42	0
Refused, alive	____	68	90	70	48	19	22
Cumulative Deaths	____	238	643	903	1186	1374	1588
Deaths (new wave – previous wave)	_____	238	405	260	283	188	214
Loss to Follow-up	____	78	131	138	176	164	102

BASELINE SAMPLE

The baseline sample included 1501 participants and excluded 478 participants due to missing vision impairment or covariate information. Table 3.3 indicates baseline characteristics of the sample by excluded and included. Excluded participants were significantly more likely to be older, not married, have less years of education, higher financial strain, conducted the interview in English, report more comorbidities (heart attack, hip fracture, and stroke), NVI, DVI, VI (near or

distant), and high depressive symptoms, and have lower mean BMI and lower MMSE score when compared to participants included in the study.

Table 3.3 Baseline characteristics of the sample by excluded and included participants.

Characteristics	Excluded N (%)	Included N (%)	P-Value
Total, n(%)	478 (24.15)	1501 (75.85)	
Age, Mean ± SD	80.5 ± 7.14	77.17 ± 5.48	<0.0001
Sex (female)	282 (59.00)	898 (59.83)	0.7471
Married	193 (40.72)	770 (51.30)	<0.0001
Education (years), Mean ± SD	4.51 ± 4.07	4.95 ± 3.88	0.0365
Financial Strain	169 (62.83)	804 (53.56)	0.0049
Nativity (US born)	262 (54.93)	857 (57.10)	0.4052
Spanish Interview	321 (67.15)	1080 (71.95)	0.0446
Lives with Family	358 (77.32)	1119 (74.55)	0.2273
Hypertension	236 (50.54)	726 (48.37)	0.4131
Arthritis	213 (45.51)	763 (50.83)	0.0445
Cancer	34 (7.20)	94 (6.26)	0.4691
Diabetes	144 (30.13)	433 (28.85)	0.5923
Heart Attack	25 (9.53)	85 (5.66)	0.0031
Hip Fracture	29 (6.12)	26 (1.73)	<0.0001
Stroke	65 (13.74)	48 (3.20)	<0.0001
BMI, Mean ± SD	26.51 ± 5.64	28.45 ± 5.50	<0.0001
MMSE (total), Mean ± SD	14.16 ± 9.79	22.77 ± 5.27	<0.0001
Depressive symptoms (CES-D ≥ 16)	83 (28.62)	231 (15.39)	<0.0001
Current Smoking	45 (9.72)	142 (9.46)	0.8682
Hearing Impairment	144 (31.30)	334 (22.25)	<0.0001
Near Vision Impairment Only	39 (8.76)	56 (3.73)	<0.0001
Distant Vision Impairment Only	115 (25.50)	194 (12.92)	<0.0001
Vision Impairment (Near or Distant)	119 (26.39)	206 (13.72)	<0.0001

Abbreviations: SD=standard deviation, US=United States, BMI=body mass index, MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

LINKAGE OF THE H-EPESE TO CMS FILES

Information for the H-EPESE participants was linked with the CMS files (e.g., Medicare Provider Analysis and Review (MedPAR) files) using individual identifiers consistent across datasets and determined by CMS. All linkages were done by CMS or their designated contractor and followed the CMS and the Health Insurance Portability and Accountability Act of 1996 guidelines and requirements as outlined in the Data Use Agreement (DUA). Medicare files were obtained for the H-EPESE participants from wave 4 to wave 9 (2000 to 2016). The data obtained are from the Beneficiary Summary File (BSF), MedPAR file, OUTSAF file, Carrier file (Physician/Supplier Part B File), and Provider of Service File (POS). Below are brief descriptions of each CMS dataset. Beneficiary's unique identifier in the CMS BSF was used to match participants in the H-EPESE survey and obtain information on physician visits, acute hospitalizations, and eye care utilization.

Medicare Beneficiary Summary File (MBSF). This file contained demographic and enrollment information about each beneficiary enrolled in Medicare during a calendar year (beneficiary's unique identifier, state and county codes, zip code, date of birth, date of death, sex, race, age, monthly entitlement indicators [A/B/both], reasons for entitlement, state buy-in indicators, and monthly managed care indicators). In addition, we have three segments under the beneficiary summary file: Chronic Conditions segment, Other Chronic or Potentially Disabling Conditions segment, and Cost and Utilization segment.

Medicare Provider Analysis and Review (MedPAR) File. This file contained information on inpatient hospital and SNF final action stay records. Each MedPAR record may represent one claim or multiple claims, depending on the length of a beneficiary's stay and the amount of inpatient services used throughout the stay.

Outpatient Standard Analytical File (OUTSAF). This file contained institutional outpatient providers such as hospital outpatient departments, rural health clinics, renal dialysis facilities, outpatient rehabilitation facilities, and community mental health centers. The claims include diagnosis (ICD-9, ICD-10), Healthcare Common Procedure Coding System (HCPCS) codes, dates of service, reimbursement amount, outpatient provider number, revenue center codes, and beneficiary demographic information.

Carrier File (Physician/Supplier Part B File). This file contained final fee-for-service (FFS) claims. Most of the claims are from physicians, physician assistants, clinical social workers, or nurse practitioners. Claims for other providers, such as free-standing facilities, are also found in the Carrier file. The claims include diagnosis and procedure (ICD-9, CMS HCPCS codes), dates of service, reimbursement amounts, provider numbers (e.g., UPIN, PIN, NPI), and beneficiary demographic information.

CHAPTER 4

Aim 1 Results

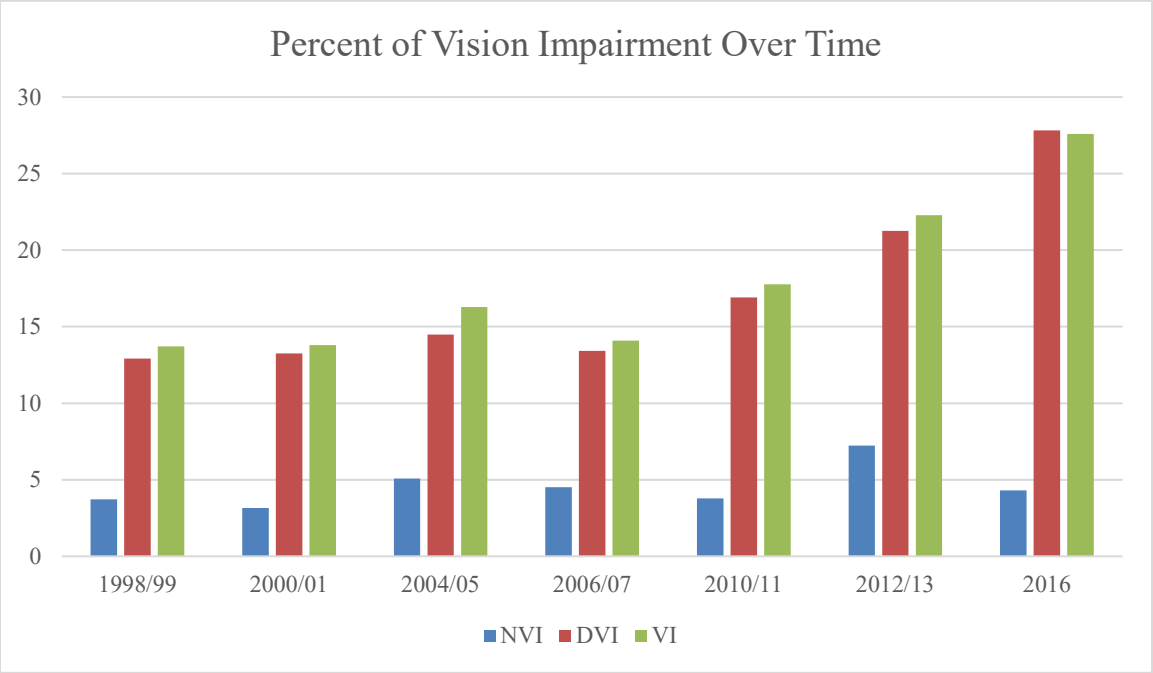
Aim 1: To examine the predictor factors of VI in older Mexican Americans over time.

This chapter describes the results of Aim one. The purpose of this aim was to identify if age, sex, education, nativity status, comorbidities, and depressive symptoms were predictors of VI among older Mexican Americans over time. We hypothesized that participants with VI will be older, female sex, foreign-born, indicate low education, report high depressive symptoms, and have two or more comorbidities when compared to participants without VI.

PERCENT OF VISION IMPAIRMENT OVER TIME

Figure 4.1 displays the prevalence of NVI, DVI, and VI of participants from Wave 3 to Wave 9 of the H-EPESE. NVI ranged from 3.14% in 2000/2001 (Wave 4) to 7.24% in 2012/2013 (Wave 8). DVI ranged from 12.92% at baseline 1998/1999 (Wave 3) to 27.83% in 2016 (Wave 9). VI ranged from 13.72% at baseline 1998/1999 (Wave 3) to 27.59% in 2016 (Wave 9).

Figure 4.1 Percent of vision impairment over time.



Abbreviations: NVI=near vision impairment only, DVI=distant vision impairment only, VI=vision impairment (near and/or distant)

ANALYSES FOR OVERALL SAMPLE

At baseline (1998/1999), the mean age of the overall sample was 77.17 (SD ± 5.48) years, 59.83% were female, 51.30% were married, and the mean years of education was 4.95 (SD ± 3.88) (Table 4.1). A higher percentage of the overall sample reported financial strain (53.56%), were born in the United States (57.10%), conducted interview in Spanish (71.95%), and indicated living with family (74.55%) (Table 4.1). The most reported comorbidity was arthritis (50.83%), followed by hypertension (48.37%), diabetes (28.85%), cancer (6.26%), heart attack (5.66%), stroke (3.20%), and hip fracture (1.73%) (Table 4.1). The mean BMI was 28.45 kg/m2 (SD ± 5.50) and the mean MMSE score was 22.77 (SD ± 5.27) (Table 4.1). Fifteen percent reported depressive symptoms, 9.46 % were current smokers, and 22.35% reported a hearing impairment (Table 4.1).

Table 4.1 Descriptive baseline characteristics for sample among older Mexican Americans included for final analysis (N=1501).

Characteristics	Total N (%)
Total	1501 (100%)
Age, Mean ± SD	77.17 ± 5.48
Sex (female)	898 (59.83)
Married	770 (51.30)
Education (years), Mean ± SD	4.95 ± 3.88
Financial Strain	804 (53.56)
Nativity (US born)	857 (57.10)
Spanish Interview	1080 (71.95)
Lives with Family	1119 (74.55)
Hypertension	726 (48.37)
Arthritis	763 (50.83)
Cancer	94 (6.26)
Diabetes	433 (28.85)
Heart Attack	85 (5.66)
Hip Fracture	26 (1.73)
Stroke	48 (3.20)
BMI, Mean ± SD	28.45 ± 5.50
BMI Categories	
Underweight	23 (1.53)
Normal	287 (25.78)
Overweight	563 (37.51)
Obese Category 1	352 (23.45)
Obese Category 2	176 (11.73)

MMSE (total), Mean ± SD	22.77 ± 5.27
Depressive symptoms (CES-D ≥ 16)	231 (15.39)
Current Smoking	142 (9.46)
Hearing Impairment	334 (22.25)

Abbreviations: SD=standard deviation, US=United States, BMI=body mass index, MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

ANALYSES FOR NEAR VISION IMPAIRMENT

Descriptive baseline characteristics of the sample by near vision impairment (NVI) are presented in Table 4.2. Four percent of older Mexican Americans had NVI. Participants with NVI compared to those without NVI were significantly more likely to report co-morbid condition of stroke (10.71% vs. 2.91%), lower MMSE score (20.96 SD ± 5.50 vs. 22.57 SD ± 5.25), and hearing impairment (33.93% vs. 22.80%). No significant differences were found by age, sex, marital status, education, financial strain, nativity status, language of interview, living status (with family vs. alone), comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, and hip fracture), BMI, depressive symptoms, and smoking status.

Table 4.2 Descriptive baseline characteristics by near vision impairment among older Mexican Americans (N=1501).

Characteristics	**NVI N (%)**	**No NVI N (%)**	**p-value**
Total	56 (3.73)	1445 (96.27)	
Age, Mean ± SD	78.13 ± 5.15	77.13 ± 5.49	0.1824
Sex (female)	32 (57.14)	866 (59.93)	0.6763
Married	26 (46.43)	744 (51.49)	0.4574
Education (years), Mean ± SD	4.68 ± 3.43	4.96 ± 3.90	0.5927

Financial Strain	35 (62.50)	769 (53.22)	0.1718
Nativity (US born)	28 (50.00)	829 (57.37)	0.2742
Spanish Interview	42 (75.00)	1038 (71.83)	0.6048
Lives with Family	42 (75.00)	1077 (74.53)	0.9372
Hypertension	32 (57.14)	694 (48.03)	0.1805
Arthritis	29 (51.79)	734 (50.80)	0.8844
Cancer	3 (5.36)	91 (6.30)	0.2243
Diabetes	19 (33.93)	414 (28.65)	0.3923
Heart Attack	4 (7.14)	81 (5.61)	0.1858
Hip Fracture	3 (5.36)	23 (1.59)	0.0556
Stroke	6 (10.71)	42 (2.91)	0.0011
BMI, Mean ± SD	28.46 ± 5.38	28.45 ± 5.51	0.9856
BMI Categories			0.9290
Underweight	0 (0.00)	23 (1.59)	
Normal	16 (28.57)	371 (25.67)	
Overweight	22 (39.29)	541 (37.44)	
Obese Category 1	11 (19.64)	341 (23.60)	
Obese Category 2	7 (12.50)	169 (11.70)	
MMSE (total), Mean ± SD	20.96 ± 5.50	22.57 ± 5.25	0.0090
Depressive symptoms (CES-D ≥ 16)	7 (12.50)	224 (15.50)	0.5413
Current Smoking	4 (7.14)	138 (9.55)	0.1689
Hearing Impairment	19 (33.93)	315 (22.80)	0.0323

Abbreviations: NVI=near vision impairment, SD=standard deviation, US=United States, BMI=body mass index, MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

ANALYSES FOR DISTANT VISION IMPAIRMENT

Descriptive baseline characteristics of the sample by distant vision impairment (DVI) are presented in Table 4.3. Thirteen percent of older Mexican Americans had DVI. Participants with DVI compared to those without DVI were significantly more likely to be older (79.25 SD ± 6.25 vs. 76.86 SD ± 5.29) and have higher financial strain (61.34% vs. 52.41%). Additionally, participants with DVI compared to those without DVI were significantly more likely to report co-morbid conditions such as hypertension (56.70% vs. 47.13%), arthritis (58.76% vs. 49.66%), cancer (10.31% vs. 5.66%), and stroke (7.73% vs. 2.52%). Lastly, participants with DVI compared to those without DVI were significantly more likely to report lower MMSE score (20.12 SD ± 5.16 vs. 23.16 SD ± 5.17), high depressive symptoms (22.68% vs. 14.31%), and hearing impairment (29.38% vs. 21.19%). No significant differences were found by sex, marital status, education, nativity status, language of interview, living status (with family vs. alone), comorbidities (diabetes, heart attack, and hip fracture), BMI, and smoking status.

Table 4.3 Descriptive baseline characteristics by distant vision impairment among older Mexican Americans (N=1501).

Characteristics	DVI N (%)	No DVI N (%)	p-value
Total	194 (12.92)	1307 (87.08)	
Age, Mean ± SD	79.25 ± 6.25	76.86 ± 5.29	<0.0001
Sex (female)	118 (60.82)	780 (59.68)	0.7612
Married	94 (48.45)	676 (51.72)	0.3955
Education (years), Mean ± SD	4.53 ± 3.70	5.01 ± 3.76	0.1020
Financial Strain	119 (61.34)	685 (52.41)	0.0200
Nativity (US born)	112 (57.73)	745 (57.00)	0.8477
Spanish Interview	148 (76.29)	932 (71.31)	0.1496

Lives with Family	142 (73.20)	977 (74.75)	0.6426
Hypertension	110 (56.70)	616 (47.13)	0.0128
Arthritis	114 (58.76)	649 (49.66)	0.0179
Cancer	20 (10.31)	74 (5.66)	0.0127
Diabetes	66 (34.02)	367 (28.08)	0.0883
Heart Attack	16 (8.25)	69 (5.28)	0.0951
Hip Fracture	5 (2.58)	21 (1.61)	0.3336
Stroke	15 (7.73)	33 (2.52)	0.0001
BMI, Mean ± SD	28.13 ± 5.53	28.49 ± 5.50	0.3862
BMI Categories			0.7971
Underweight	4 (2.06)	19 (1.45)	
Normal	54 (27.84)	333 (25.48)	
Overweight	74 (38.14)	489 (37.41)	
Obese Category 1	42 (21.65)	310 (23.72)	
Obese Category 2	20 (10.31)	156 (11.94)	
MMSE (total), Mean ± SD	20.12 ± 5.16	23.16 ± 5.17	<0.0001
Depressive symptoms (CES-D ≥ 16)	44 (22.68)	187 (14.31)	0.0026
Current Smoking	24 (12.37)	118 (9.03)	0.1377
Hearing Impairment	57 (29.38)	277 (21.19)	0.0105

Abbreviations: SD=standard deviation, US=United States, BMI=body mass index, MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

ANALYSES FOR VISION IMPAIRMENT (NEAR OR DISTANT)

Descriptive baseline characteristics of the sample by vision impairment (VI) (near or distant) are presented in Table 4.4. Fourteen percent of older Mexican Americans had VI (near or distant). Participants with VI compared to those without VI were significantly more likely to be older (79.14 SD ± 6.17 vs. 76.85 SD ± 5.29) and have higher financial strain (60.68% vs. 52.43%). Additionally, participants with VI compared to those without VI were significantly more likely to report co-morbid conditions such as hypertension (55.34% vs. 47.26%), arthritis (58.25% vs. 49.65%), cancer (9.71% vs. 5.71%), and stroke (7.28% vs. 2.55%). Lastly, participants with VI compared to those without VI were significantly more likely to report lower MMSE score (20.14 SD ± 5.30 vs. 23.19 SD ± 5.15), high depressive symptoms (21.84% vs. 14.36%), and hearing impairment (30.10% vs. 21.00%). No significant differences were found by sex, marital status, education, nativity status, language of interview, living status (with family vs. alone), comorbidities (diabetes, heart attack, and hip fracture), BMI, and smoking status.

Table 4.4 Descriptive baseline characteristics by vision impairment (near or distant) among older Mexican Americans (N=1501).

Characteristics	**VI** **N (%)**	**No VI** **N (%)**	**p-value**
Total	206 (13.72)	1295 (86.28)	
Age, Mean ± SD	79.14 ± 6.17	76.85 ± 5.29	<0.0001
Sex (female)	126 (61.17)	772 (59.61)	0.6732
Married	96 (46.60)	674 (52.05)	0.1466
Education (years), Mean ± SD	4.49 ± 3.64	5.02 ± 3.91	0.0638
Financial Strain	125 (60.68)	679 (52.43)	0.0275
Nativity (US born)	119 (57.77)	738 (56.99)	0.8339
Spanish Interview	158 (76.70)	922 (71.20)	0.1025
Lives with Family	149 (72.33)	970 (74.90)	0.4309
Hypertension	114 (55.34)	612 (47.26)	0.0311

Arthritis	120 (58.25)	643 (49.65)	0.0218
Cancer	20 (9.71)	74 (5.71)	0.0280
Diabetes	70 (33.98)	363 (28.03)	0.0800
Heart Attack	16 (7.77)	69 (5.33)	0.1595
Hip Fracture	5 (2.43)	21 (1.62)	0.4104
Stroke	15 (7.28)	33 (2.55)	0.0003
BMI, Mean ± SD	28.18 ± 5.49	28.49 ± 5.51	0.4598
BMI Categories			0.8866
Underweight	4 (1.94)	19 (1.47)	
Normal	56 (27.18)	331 (25.56)	
Overweight	79 (38.35)	484 (37.37)	
Obese Category 1	45 (21.84)	307 (23.71)	
Obese Category 2	22 (10.68)	154 (11.89)	
MMSE (total), Mean ± SD	20.14 ± 5.30	23.19 ± 5.15	<0.0001
Depressive symptoms (CES-D ≥ 16)	45 (21.84)	186 (14.36)	0.0057
Current Smoking	25 (12.14)	117 (9.03)	0.1578
Hearing Impairment	62 (30.10)	272 (21.00)	0.0036

Abbreviations: SD=standard deviation, US=United States, BMI=body mass index, MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

LONGITUDINAL ANALYSES FOR NEAR VISION IMPAIRMENT

Table 4.5 shows the GEE models for NVI over 18 years of follow-up as a function of sociodemographic characteristics, smoking status, comorbidities, cognitive impairment, depressive symptoms, and hearing impairment. Two models were performed to determine the predictor factors of NVI. Model 1 included time (years), age (years), sex, marital status, education

(years), financial strain, nativity status, language of interview, living status (alone vs. with family), and comorbidities greater than two (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, or stroke). Model 2 included smoking status, BMI, cognitive impairment, depressive symptoms, and hearing impairment along with the variables included in Model 1 to test whether the addition of these variables modified the relationship between socio-demographics and comorbidities with NVI.

In Model 1, the OR of NVI over time was 1.09 (95% CI 1.04-1.14). Spanish interview (OR=2.45, 95% CI 1.16-5.21) and two or more comorbidities (OR=1.64, 95% CI 1.05-2.58) were predictors of NVI over time (Model 1). After controlling for all covariates (Model 2), time (OR=1.11, 95% CI 1.05-1.18), Spanish interview (OR=2.73, 95% CI 1.13-6.57), cognitive impairment (OR=2.01, 95% CI 1.18-3.45), depressive symptoms (OR=1.89, 95% CI 1.12-3.18), and hearing impairment (OR=2.26, 95% CI 1.34-3.83) were predictors of NVI. Additional analyses with specific comorbidities indicated that heart attack was a predictor of NVI over time (OR=2.06, 95% CI 1.04-4.10).

Table 4.5 Generalized estimating equation models for Near VI among older Mexican Americans over 18 years of follow-up (N=1295).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.09 (1.04-1.14)	1.11 (1.05-1.18)
Age	1.02 (0.98-1.07)	1.00 (0.95-1.06)
Sex (female)	0.88 (0.54-1.42)	0.90 (0.51-1.60)
Married	0.92 (0.52-1.64)	0.90 (0.45-1.79)
Education (years)	1.01 (0.95-1.08)	1.05 (0.97-1.14)
Financial Strain	1.26 (0.84-1.91)	1.14 (0.70-1.85)
Nativity (Foreign born)	0.90 (0.58-1.38)	0.79 (0.48-1.32)
Spanish Interview	2.45 (1.16-5.21)	2.73 (1.13-6.57)
Lives with Family	0.89 (0.51-1.56)	0.82 (0.42-1.57)

Comorbidities ≥ 2	1.64 (1.05-2.58)	1.59 (0.96-2.65)
Current Smoking		1.72 (0.69-4.29)
BMI Categories		
Underweight		0.95 (0.23-3.93)
Normal		reference
Overweight		0.65 (0.37-1.16)
Obese Category 1		0.94 (0.50-1.76)
Obese Category 2		0.57 (0.22-1.47)
Cognitive Impairment (MMSE < 21)		2.01 (1.18-3.45)
Depressive symptoms (CES-D ≥ 16)		1.89 (1.12-3.18)
Hearing Impairment		2.26 (1.34-3.83)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

LONGITUDINAL ANALYSES FOR DISTANT VISION IMPAIRMENT

Table 4.6 shows the GEE models for DVI over 18 years of follow-up as a function of sociodemographic characteristics, smoking status, comorbidities, cognitive impairment, depressive symptoms, and hearing impairment. Two models were performed to determine the predictor factors of DVI. Model 1 included time (years), age (years), sex, marital status, education (years), financial strain, nativity status, language of interview, living status (alone or with family), and comorbidities greater than two (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, or stroke). Model 2 included smoking status, BMI, cognitive impairment, depressive symptoms, and hearing impairment along with the variables included in Model 1 to test whether the addition of these variables modified the relationship between socio-demographics and comorbidities with DVI.

In Model 1, the OR of DVI over time was 1.09 (95% CI 1.07-1.12). Age (OR=1.06, 95% CI 1.03-1.09), education (OR=0.94, 95% CI 0.91-0.98), financial strain (OR=1.48, 95% CI 1.17-1.86) and two or more comorbidities (OR=1.39, 95% CI 1.09-1.78) were predictors of DVI over time (Model 1). After controlling for all covariates (Model 2), time (OR=1.09, 95% CI 1.06-1.13), age (OR=1.09, 95% CI 1.00-1.07), financial strain (OR=1.49, 95% CI 1.12-1.98), two or more comorbidities (OR=1.38, 95% CI 1.05-1.83), cognitive impairment (OR=1.88, 95% CI 1.43-2.49), depressive symptoms (OR=1.89, 95% CI 1.39-2.57), and hearing impairment (OR=1.80, 95% CI 1.35-2.38) were predictors of DVI. Additional analyses with specific comorbidities indicated that arthritis was a predictor of DVI over time (OR=1.49, 95% CI 1.10-2.01).

Table 4.6 Generalized estimating equation models for Distant VI among older Mexican Americans over 18 years of follow-up (N=1295).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.09 (1.07-1.12)	1.09 (1.06-1.13)
Age	1.06 (1.03-1.09)	1.04 (1.00-1.07)
Sex (female)	1.23 (0.90-1.67)	1.30 (0.90-1.87)
Married	0.85 (0.61-1.18)	0.95 (0.64-1.40)
Education (years)	0.94 (0.91-0.98)	0.98 (0.93-1.02)
Financial Strain	1.48 (1.17-1.86)	1.49 (1.12-1.98)
Nativity (Foreign born)	0.83 (0.64-1.08)	0.77 (0.57-1.03)
Spanish Interview	0.92 (0.68-1.25)	1.19 (0.80-1.77)
Lives with Family	1.33 (0.99-1.79)	1.22 (0.87-1.72)
Comorbidities ≥ 2	1.39 (1.09-1.78)	1.38 (1.05-1.83)
Current Smoking		1.25 (0.69-2.27)
BMI Categories		
Underweight		1.60 (0.78-3.27)
Normal		reference

Overweight		0.86 (0.63-1.18)
Obese Category 1		0.93 (0.64-1.33)
Obese Category 2		0.89 (0.52-1.53)
Cognitive Impairment (MMSE < 21)		1.88 (1.43-2.49)
Depressive symptoms (CES-D ≥ 16)		1.89 (1.39-2.57)
Hearing Impairment		1.80 (1.35-2.38)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

LONGITUDINAL ANALYSES FOR VISION IMPAIRMENT (NEAR OR DISTANT)

Table 4.7 shows the general estimating equation models for VI (near or distant) over 18 years of follow-up as a function of sociodemographic characteristics, smoking status, comorbidities, cognitive impairment, depressive symptoms, and hearing impairment. Two models were performed to determine the predictor factors of VI (near or distant). Model 1 included time (years), age (years), sex, marital status, education (years), financial strain, nativity status, language of interview, living status (alone vs. with family), and comorbidities greater than two (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, or stroke). Model 2 included smoking status, BMI, cognitive impairment, depressive symptoms, and hearing impairment along with the variables included in Model 1 to test whether the addition of these variables modified the relationship between socio-demographics and comorbidities with VI.

In Model 1, the OR of VI (near or distant) over time was 1.09 (95% CI 1.07-1.12). Age (OR=1.05, 95% CI 1.02-1.08), financial strain (OR=1.42, 95% CI 1.13-1.77) and two or more comorbidities (OR=1.38, 95% CI 1.08-1.76) were predictors of VI (near or distant) over time (Model 1). After controlling for all covariates (Model 2), time (OR=1.10, 95% CI 1.07-1.13), age (OR=1.03, 95% CI 1.00-1.06), financial strain (OR=1.47, 95% CI 1.11-1.93), two or more comorbidities (OR=1.39, 95% CI 1.06-1.83), cognitive impairment (OR=1.80, 95% CI 1.38-2.35),

depressive symptoms (OR=1.79, 95% CI 1.33-2.42), and hearing impairment (OR=1.79, 95% CI 1.35-2.37) were predictors of VI (near or distant). Additional analyses with specific comorbidities indicated that arthritis was a predictor of VI (near or distant) over time (OR=1.57, 95% CI 1.16-2.12).

Table 4.7 Generalized estimating equation models for VI (Near or Distant) among older Mexican Americans over 18 years of follow-up (N=1295).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.09 (1.07-1.12)	1.10 (1.07-1.13)
Age	1.05 (1.02-1.08)	1.03 (1.00-1.06)
Sex (female)	1.22 (0.91-1.64)	1.31 (0.92-1.85)
Married	0.88 (0.63-1.22)	1.02 (0.70-1.48)
Education (years)	0.94 (0.91-0.98)	0.97 (0.93-1.02)
Financial Strain	1.42 (1.13-1.77)	1.47 (1.11-1.93)
Nativity (Foreign born)	0.86 (0.67-1.11)	0.80 (0.60-1.07)
Spanish Interview	0.98 (0.73-1.33)	1.24 (0.84-1.83)
Lives with Family	1.27 (0.95-1.70)	1.13 (0.81-1.58)
Comorbidities ≥ 2	1.38 (1.08-1.76)	1.39 (1.06-1.83)
Current Smoking		1.27 (0.73-2.21)
BMI Categories		
Underweight		1.55 (0.76-3.18)
Normal		reference
Overweight		0.88 (0.65-1.19)
Obese Category 1		0.98 (0.68-1.39)
Obese Category 2		0.86 (0.51-1.46)
Cognitive Impairment (MMSE < 21)		1.80 (1.38-2.35)

Depressive symptoms (CES-D ≥ 16)		1.79 (1.33-2.42)
Hearing Impairment		1.79 (1.35-2.37)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

ANALYSIS OF MODERATOR EFFECTS

We performed several interaction terms between variables included in Model 1 and Model 2. We found significant interaction terms between diabetes and depressive symptoms, and diabetes and cognitive impairment for NVI, DVI, and VI (p-value < 0.0001). Stratified analysis by diabetes (Table 4.8) shows that those with diabetes and depressive symptoms had increased odds of NVI (OR= 5.33, 95% CI 2.39-11.80), DVI (OR=3.43, 95% CI 2.16-5.44), and VI (OR=3.48, 95% CI 2.25-5.38) than those with without diabetes and with depressive symptoms. Those with diabetes and cognitive impairment had increased odds of NVI (OR=5.75, 95% CI 2.23-14.80), DVI (OR=2.34, 95% CI 1.45-3.78), and VI (OR=2.32, 95% CI 1.45-3.71) than those without diabetes and with cognitive impairment.

Table 4.8 Generalized estimating equation models for Near and Distant VI by diabetes among older Mexican Americans over 18 years of follow-up (N=1295).

	Diabetes	**Non-Diabetes**
	OR (95% CI)	**OR (95% CI)**
Near VI		
Depressive symptoms	5.33 (2.39-11.80)	0.75 (0.32-1.73)
Cognitive Impairment	5.75 (2.23-14.80)	1.36 (0.70-2.63)
Distant VI		
Depressive symptoms	3.43 (2.16-5.44)	1.34 (0.89-2.01)

Cognitive Impairment	2.34 (1.45-3.78)	1.83 (1.30-2.57)
Near or Distant VI		
Depression	3.48 (2.25-5.38)	1.21 (0.81-1.82)
Cognitive Impairment	2.32 (1.45-3.71)	1.73 (1.25-2.39)

Abbreviations: OR=odds ratio; CI=confidence interval; VI=vision impairment. Analysis controlled for all covariates.

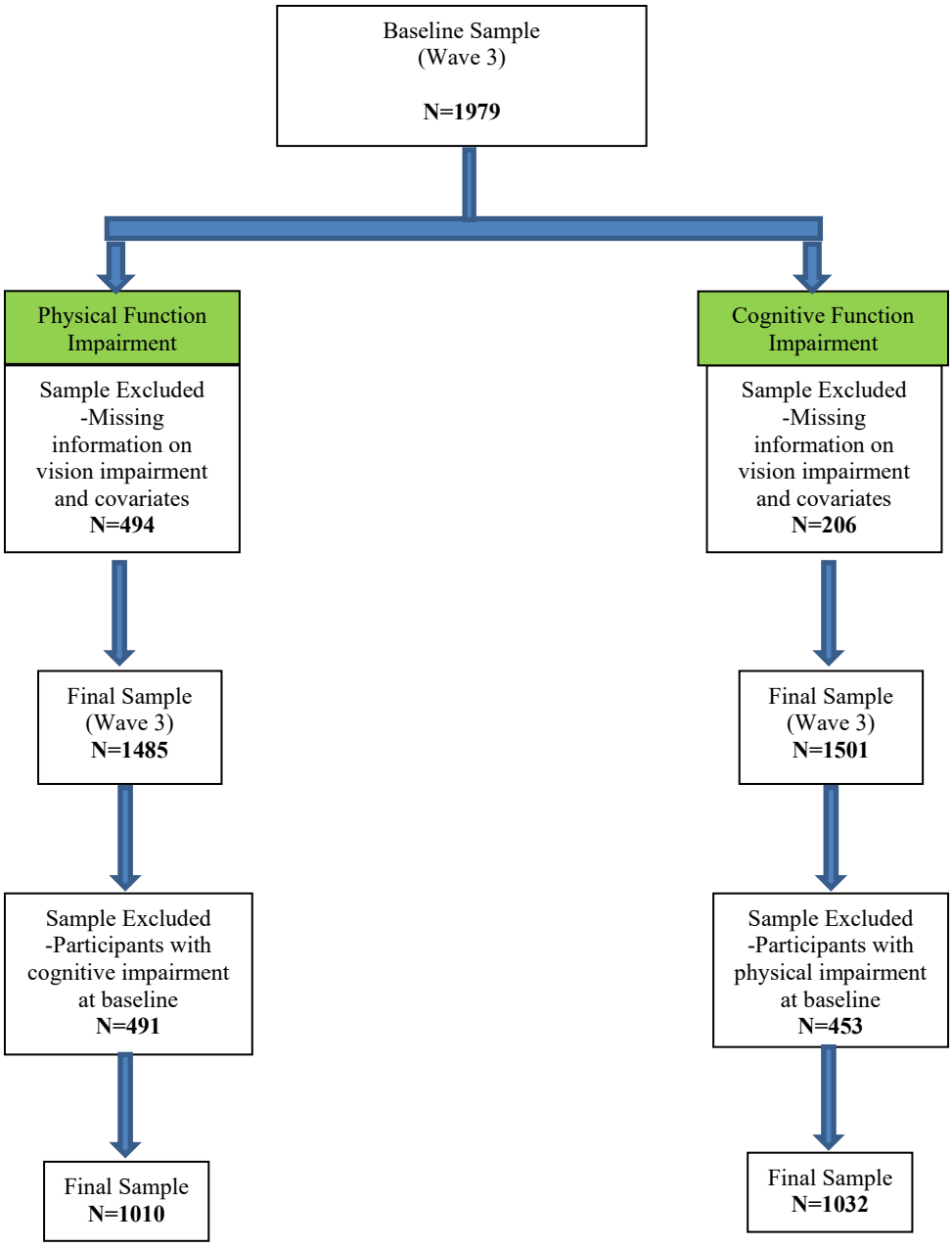
CHAPTER 5

Aim 2 Results

Aim 2: To examine the effect of VI on physical and cognitive function, frailty, disability, and falls among older Mexican Americans over time.

This chapter describes the results of Aim two. The purpose of this aim was to examine the effect of VI on health outcomes. The outcomes examined were physical function impairment (SPPB ≤ 7), cognitive impairment (MMSE < 21), frailty (modified frailty phenotype), activities of daily living disability (modified Katz-7 ADL index), instrumental activities of daily living (modified LIADL Index) and falls (≥ 1 during the past 12 months) among older Mexican Americans over time. First, we hypothesized that participants with VI will be more likely to experience greater decline in physical and cognitive function over time when compared to those without VI. Second, we hypothesized that participants with VI will be more likely to develop frailty, disability, and to have falls over time when compared to those without VI. Third, we hypothesized that participants with VI and high social isolation will be at increased risk of frailty, disability, and falls than those with VI and low social isolation over time. Fourth, we hypothesized that high depressive symptoms would mediate the relationship between VI and physical and cognitive function, frailty, disability, and falls over time.

Figure 5.1 Flowchart of sample selection for Aim 2a.



PHYSICAL FUNCTION IMPAIRMENT

Descriptive Analysis

At baseline (1998/1999), the mean age of the overall sample was 77.16 (SD ± 5.45) years, 59.80% were female, 51.25% were married, and the mean years of education was 4.98 (SD ± 3.88) (Table 5.1). A higher percentage of the overall sample reported financial strain (53.20%), were born in the United States (57.04%), conducted interview in Spanish (71.99%), and indicated living with family (74.68%) (Table 5.1). The most reported comorbidity was arthritis (50.77%), followed by hypertension (48.22%), diabetes (28.89%), cancer (6.33%), heart attack (5.72%), stroke (3.23%) and hip fracture (1.75%) (Table 5.1). The mean BMI was 28.47 kg/m2 (SD ± 5.50) and the mean MMSE score was 22.82 (SD ± 5.22) (Table 5.1). Fifteen percent reported depressive symptoms, 9.36 % were current smokers, 22.29% reported a hearing impairment, 3.70% were near vision impaired, 12.79% distant vision impaired, and 13.60% were vision impaired (near or distant) (Table 5.1).

Descriptive baseline characteristics of the sample by physical function impairment are also presented in Table 5.1. Thirty one percent of older Mexican Americans had physical function impairment (SPPB < 7). Participants with SPPB < 7 compared to those with SPPB ≥ 7 were significantly more likely to be older (78.97 SD ± 6.05 vs. 76.36 SD ± 4.97), female sex (66.23% vs. 56.98%), not married (55.65% vs. 45.64%), report lower mean years of education (4.49 SD ± 3.64 vs. 5.20 SD ± 3.96), and have higher financial strain (62.03% vs. 49.32%). Additionally, participants with SPPB < 7 compared to those with SPPB ≥ 7 were significantly more likely to report co-morbid conditions such as hypertension (53.64% vs. 45.83%), arthritis (57.40% vs. 47.87%), diabetes (38.19% vs. 24.81%), heart attack (9.93% vs. 3.88%), hip fracture (3.53% vs. 0.97%), and stroke (4.86% vs. 2.52%). Lastly, participants with SPPB < 7 compared to those with SPPB ≥ 7 were significantly more likely to report lower MMSE score (21.16 SD ± 5.76 vs. 23.55 SD ± 4.80), high depressive symptoms (25.83% vs. 10.66%), hearing impairment (28.48% vs. 19.57%), DVI (17.66% vs. 10.66%), and VI (near or distant) (18.32% vs. 11.53%). No significant

differences were found by nativity status, language of interview, living status (with family vs. alone), comorbidity (cancer), smoking status, and NVI.

Table 5.1 Baseline descriptive characteristics of the sample by physical function impairment among older Mexican Americans (N=1485).

Characteristics	Total N (%)	SPPB < 7 N (%)	SPPB ≥ 7 N (%)	p-value
Total	1495 (100)	453 (30.97)	1032 (69.03)	
Age, Mean ± SD	77.16 ± 5.45	78.97 ± 6.05	76.36 ± 4.97	<0.0001
Sex (female)	888 (59.80)	300 (66.23)	588 (56.98)	0.0008
Married	761 (51.25)	200 (44.15)	561 (54.36)	0.0003
Education (years), Mean ± SD	4.98 ± 3.88	4.49 ± 3.64	5.20 ± 3.96	0.0008
Financial Strain	790 (53.20)	281 (62.03)	509 (49.32)	<0.0001
Nativity (US born)	847 (57.04)	249 (54.97)	598 (57.95)	0.2857
Spanish Interview	1069 (71.99)	323 (71.30)	746 (72.29)	0.6973
Lives with Family	1109 (74.68)	332 (73.29)	777 (75.29)	0.4141
Hypertension	716 (48.22)	243 (53.64)	473 (45.83)	0.0056
Arthritis	754 (50.77)	260 (57.40)	494 (47.87)	0.0007
Cancer	94 (6.33)	37 (8.17)	57 (5.52)	0.0593
Diabetes	429 (28.89)	173 (38.19)	256 (24.81)	<0.0001
Heart Attack	85 (5.72)	45 (9.93)	40 (3.88)	<0.0001
Hip Fracture	26 (1.75)	16 (3.53)	10 (0.97)	0.0005
Stroke	48 (3.23)	22 (4.86)	26 (2.52)	0.0190
BMI, Mean ± SD	28.47 ± 5.50	28.86 ± 6.36	28.30 ± 5.07	0.0973
BMI Categories				0.0002
Underweight	22 (1.48)	7 (1.55)	15 (1.45)	
Normal	380 (25.59)	123 (27.15)	257 (24.90)	
Overweight	562 (37.85)	155 (34.22)	407 (39.44)	
Obese Category 1	346 (23.30)	90 (19.87)	256 (24.81)	
Obese Category 2	175 (11.78)	78 (17.22)	97 (9.40)	
MMSE (total), Mean ± SD	22.82 ± 5.22	21.16 ± 5.76	23.55 ± 4.80	<0.0001
Depressive symptoms (CES-D ≥ 16)	227 (15.29)	117 (25.83)	110 (10.66)	<0.0001
Current Smoking	139 (9.36)	34 (7.51)	105 (10.17)	0.1040
Hearing Impairment	331 (22.29)	129 (28.48)	202 (19.57)	0.0001
Near VI	55 (3.70)	23 (5.08)	32 (3.10)	0.0633
Distant VI	190 (12.79)	80 (17.66)	110 (10.66)	0.0002
VI (Near or Distant)	202 (13.60)	83 (18.32)	119 (11.53)	0.0004

Abbreviations: SPPB=Short Physical Performance Battery; SD=standard deviation; US=United States; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale; VI=vision impairment

Longitudinal Analysis

Table 5.2 presents the GEE models for physical function impairment (SPPB < 7) over an 18-year period as a function of NVI. Two models were performed to study the association between NVI and physical function impairment. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family versus alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship between socio-demographics and health characteristics with NVI.

No significant association was found between NVI (OR=1.25, 95% CI 0.79-1.97) and physical function impairment over time after controlling for all variables in Model 1 and 2 compared to those without NVI. Time (OR=1.05, 95% CI 1.03-1.09), age (OR=1.07, 95% CI 1.04-1.09), female sex (OR=1.66, 95% CI 1.31-2.10), financial strain (OR=1.30, 95% CI 1.07-1.58), obese category 2 (OR=1.48, 95% 1.02-2.13), arthritis (OR=1.43, 95% CI 1.19-1.72), hip fracture (OR=3.95, 95% CI 1.94-8.02), lower MMSE score (OR=1.56, 95% CI 1.26-1.93), depressive symptoms (OR=1.69, 95% CI 1.32-2.16), and hearing impairment (OR=1.26, 95% CI 1.00-1.57) were factors associated with physical function impairment (Model 2).

Table 5.2 Generalized estimating equation models for physical function impairment (SPPB < 7) among older Mexican Americans as a function of near vision impairment over 18 years of follow-up (N=1032).

	Model 1	Model 2
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.09 (1.06-1.12)	1.05 (1.03-1.09)
Near VI	1.25 (0.79-1.97)	0.92 (0.53-1.60)
Age	1.08 (1.05-1.11)	1.07 (1.04-1.09)
Sex (female)	1.63 (1.30-2.03)	1.66 (1.31-2.10)
Married	0.87 (0.69-1.09)	0.99 (0.78-1.26)
Education (years)	0.95 (0.92-0.98)	0.97 (0.95-1.00)
Financial Strain	1.43 (1.19-1.71)	1.30 (1.07-1.58)
Nativity (Foreign born)	1.11 (0.89-1.37)	1.11 (0.83-1.45)
Spanish Interview	0.92 (0.72-1.19)	1.10 (0.89-1.39)
Lives with Family	1.25 (0.99-1.56)	1.15 (0.90-1.46)
Current Smoking		0.86 (0.57-1.30)
BMI Categories		
Underweight		1.03 (0.56-1.88)
Normal		Reference
Overweight		0.86 (0.68-1.08)
Obese Category 1		1.02 (0.77-1.35)
Obese Category 2		1.48 (1.02-2.13)
Hypertension		0.84 (0.68-1.04)
Arthritis		1.43 (1.19-1.72)
Cancer		1.31 (0.92-1.87)
Diabetes		1.16 (0.93-1.45)
Heart Attack		1.20 (0.82-1.74)

Hip Fracture		3.95 (1.94-8.02)
Stroke		1.32 (0.82-2.13)
Cognitive Impairment (MMSE < 21)		1.56 (1.26-1.93)
Depressive symptoms (CES-D ≥ 16)		1.69 (1.32-2.16)
Hearing Impairment		1.26 (1.00-1.57)

Note: VI=vision impairment; OR=odds ratio; CI=confidence interval; SPPB=Short Physical Performance Battery; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those who scored ≥ 7 in the SPPB at baseline.

Table 5.3 presents the GEE models for physical function impairment (SPPB < 7) over an 18-year period as a function of DVI. Two models were performed to study the association between distant vision impairment. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship between socio-demographics and health characteristics with DVI.

In Model 1, a significant association was found between DVI (OR=1.09, 95% CI 1.06-1.12) and physical function over time compared to those without DVI. However, in Model 2 when we controlled for all covariates (Model 2) the association between DVI and physical function impairment is no longer significant (OR=1.29, 95% CI 0.98-1.70). Time (OR=1.06, 95% CI 1.03-1.09), age (OR=1.07, 95% CI 1.04-1.09), female sex (OR=1.65, 95% CI 1.31-2.09), financial strain (OR=1.29, 95% CI 1.06-1.57), obese category 2 (OR=1.49, 95% 1.04-2.15), arthritis (OR=1.42, 95% CI 1.18-1.71), hip fracture (OR=3.89, 95% CI 1.91-7.94), lower MMSE score (OR=1.53, 95% CI 1.23-1.90), and depressive symptoms (OR=1.66, 95% CI 1.30-2.12) were factors associated with physical function impairment (Model 2).

Table 5.3 Generalized estimating equation models for physical function impairment (SPPB < 7) among older Mexican Americans as a function of distant vision impairment over 18 years of follow-up (N=1032).

	Model 1	Model 2
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.09 (1.06-1.12)	1.06 (1.03-1.09)
Distant VI	1.67 (1.32-2.11)	1.29 (0.98-1.70)
Age	1.08 (1.05-1.10)	1.07 (1.04-1.09)
Sex (female)	1.62 (1.30-2.02)	1.65 (1.31-2.09)
Married	0.87 (0.70-1.10)	0.99 (0.78-1.26)
Education (years)	0.95 (0.93-0.98)	0.97 (0.95-1.00)
Financial Strain	1.41 (1.18-1.69)	1.29 (1.06-1.57)
Nativity (Foreign born)	1.11 (0.89-1.37)	1.11 (0.89-1.38)
Spanish Interview	0.96 (0.75-1.24)	1.12 (0.85-1.48)
Lives with Family	1.24 (0.99-1.55)	1.15 (0.90-1.46)
Current Smoking		0.86 (0.57-1.30)
BMI Categories		
Underweight		1.00 (0.54-1.84)
Normal		Reference
Overweight		0.87 (0.69-1.09)
Obese Category 1		1.03 (0.78-1.35)
Obese Category 2		1.49 (1.04-2.15)
Hypertension		0.85 (0.69-1.05)
Arthritis		1.42 (1.18-1.71)
Cancer		1.32 (0.92-1.88)
Diabetes		1.16 (0.93-1.45)
Heart Attack		1.18 (0.81-1.71)

Hip Fracture		3.89 (1.91-7.94)
Stroke		1.32 (0.82-2.13)
Cognitive Impairment (MMSE < 21)		1.53 (1.23-1.90)
Depressive symptoms (CES-D ≥ 16)		1.66 (1.30-2.12)
Hearing Impairment		1.23 (0.98-1.55)

Note: VI=vision impairment; OR=odds ratio; CI=confidence interval; SPPB=Short Physical Performance Battery; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those who scored ≥ 7 in the SPPB at baseline.

Table 5.4 presents the GGE models for physical function impairment (SPPB < 7) over an 18-year period as a function of VI (near or distant). Two models were performed to study the association between vision impairment (near or distant) and physical function impairment. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship between socio-demographics and health characteristics with VI (near or distant).

In Model 1, a significant association was found between VI (OR=1.60, 95% CI 1.27-2.01) and physical function over time compared to those without VI. However, in Model 2 when we controlled for all covariates (Model 2) the association between VI and physical function impairment is no longer significant (OR=1.23, 95% CI 0.94-1.61). Time (OR=1.06, 95% CI 1.03-1.09), age (OR=1.07, 95% CI 1.04-1.09), female sex (OR=1.65, 95% CI 1.31-2.09), financial strain (OR=1.29, 95% CI 1.06-1.57), obese category 2 (OR=1.49, 95% 1.03-2.15), arthritis (OR=1.42, 95% CI 1.18-1.71), hip fracture (OR=3.87, 95% CI 1.91-7.89), lower MMSE score (OR=1.54, 95% CI 1.24-1.91), and depressive symptoms (OR=1.66, 95% CI 1.30-2.12) were factors associated with physical function impairment (Model 2).

Table 5.4 Generalized estimating equation models for physical function impairment (SPPB < 7) among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1032).

	Model 1	Model 2
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.09 (1.06-1.12)	1.06 (1.03-1.09)
VI (near or distant)	1.60 (1.27-2.01)	1.23 (0.94-1.61)
Age	1.08 (1.05-1.10)	1.07 (1.04-1.09)
Sex (female)	1.62 (1.30-2.02)	1.65 (1.31-2.09)
Married	0.87 (0.70-1.10)	0.99 (0.78-1.26)
Education (years)	0.95 (0.93-0.98)	0.97 (0.95-1.00)
Financial Strain	1.41 (1.18-1.69)	1.29 (1.06-1.57)
Nativity (Foreign born)	1.11 (0.90-1.37)	1.11 (0.89-1.39)
Spanish Interview	0.96 (0.74-1.23)	1.11 (0.84-1.47)
Lives with Family	1.24 (0.99-1.55)	1.15 (0.90-1.46)
Current Smoking		0.86 (0.57-1.29)
BMI Categories		
Underweight		1.00 (0.55-1.85)
Normal		Reference
Overweight		0.86 (0.69-1.08)
Obese Category 1		1.02 (0.77-1.35)
Obese Category 2		1.49 (1.03-2.15)
Hypertension		0.85 (0.69-1.05)
Arthritis		1.42 (1.18-1.71)
Cancer		1.31 (0.92-1.87)
Diabetes		1.16 (0.93-1.45)
Heart Attack		1.18 (0.81-1.71)

Hip Fracture		3.87 (1.91-7.89)
Stroke		1.32 (0.81-2.13)
Cognitive Impairment (MMSE < 21)		1.54 (1.24-1.91)
Depressive symptoms (CES-D ≥ 16)		1.66 (1.30-2.12)
Hearing Impairment		1.24 (0.99-1.56)

Note: VI=vision impairment; OR=odds ratio; CI=confidence interval; SPPB=Short Physical Performance Battery; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those who scored ≥ 7 in the SPPB at baseline.

COGNITIVE IMPAIRMENT

Descriptive Analysis

At baseline (1998/1999), the mean age of the overall sample was 77.17 (SD ± 5.48) years, 59.83% were female, 51.30% were married, the mean years of education was 4.95 (SD ± 3.88) (Table 5.5). A higher percentage of the overall sample reported financial strain (53.36%), were born in the United States (57.10%), conducted interview in Spanish (71.95%), and indicated living with family (74.55%) (Table 5.5). The most reported comorbidity was arthritis (50.83%), followed by hypertension (48.37%), diabetes (28.85%), cancer (6.26%), heart attack (5.66%), stroke (3.20%) and hip fracture (1.73%) (Table 5.5). The mean BMI was 28.45 kg/m2 (SD ± 5.50) (Table 5.5). Fifteen percent reported depressive symptoms, 9.46 % were current smokers, 22.25% reported a hearing impairment, 3.73% were near vision impaired, 12.92% distant vision impaired, and 13.72% were vision impaired (near or distant) (Table 5.5).

Descriptive baseline characteristics of the sample by cognitive impairment are also presented in Table 5.5. Thirty three percent of older Mexican Americans had cognitive impairment (MMSE < 21). Participants with MMSE < 21 compared to those with MMSE ≥ 21 were significantly more likely to be older (79.04 SD ± 6.26 vs. 76.25 SD ± 4.80), not married (56.42% vs. 44.95%), report lower mean years of education (3.27 SD ± 3.17 vs. 5.77 SD ± 3.93), have

higher financial strain (61.10% vs. 49.90%), foreign-born (49.69% vs. 39.60%), and conducted the interview in Spanish (78.62% vs. 68.71%). Lastly, participants with MMSE < 21 compared to those with MMSE ≥ 21 were significantly more likely to report high depressive symptoms (21.38% vs. 12.48%), DVI (20.98% vs. 9.01%), and VI (near or distant) (22.20% vs 9.60%). No significant differences were found by sex, living status (with family vs. alone), comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), BMI, smoking status, hearing impairment, and NVI.

Table 5.5 Baseline descriptive characteristics of the sample by cognitive impairment among older Mexican Americans (N=1501).

Characteristics	Total N (%)	MMSE < 21 N (%)	MMSE ≥ 21 N (%)	p-value
Total	1501 (100)	491 (32.71)	1010 (67.29)	
Age, Mean ± SD	77.17 ± 5.48	79.04 ± 6.26	76.25 ± 4.80	<0.0001
Sex (female)	898 (59.83)	305 (62.12)	593 (58.71)	0.2068
Married	770 (51.30)	214 (43.58)	556 (55.05)	<0.0001
Education (years), Mean ± SD	4.95 ± 3.88	3.27 ± 3.17	5.77 ± 3.93	<0.0001
Financial Strain	804 (53.56)	300 (61.10)	504 (49.90)	<0.0001
Nativity (US born)	857 (57.10)	247 (50.31)	610 (60.40)	0.0002
Spanish Interview	1080 (71.95)	386 (78.62)	694 (68.71)	<0.0001
Lives with Family	1119 (74.55)	356 (72.51)	763 (75.54)	0.2047
Hypertension	726 (48.37)	231 (47.05)	495 (49.01)	0.4752
Arthritis	763 (50.83)	258 (52.55)	505 (50.00)	0.3546
Cancer	94 (6.26)	31 (6.31)	63 (6.24)	0.9545
Diabetes	433 (28.85)	150 (30.55)	283 (28.02)	0.3101
Heart Attack	85 (5.66)	33 (6.72)	52 (5.15)	0.2162
Hip Fracture	26 (1.73)	11 (2.24)	15 (1.49)	0.2928
Stroke	48 (3.20)	20 (4.07)	28 (2.77)	0.1789
BMI, Mean ± SD	28.45 ± 5.50	28.16 ± 5.99	28.59 ± 5.25	0.1568
BMI Categories				0.1610
Underweight	23 (1.53)	11 (2.24)	12 (1.19)	
Normal	387 (25.78)	137 (27.90)	250 (24.75)	
Overweight	563 (37.51)	176 (35.85)	387 (38.32)	
Obese Category 1	352 (23.45)	104 (21.18)	248 (24.55)	
Obese Category 2	176 (11.73)	63 (12.83)	113 (11.19)	

Depressive symptoms (CES-D ≥ 16)	231 (15.39)	105 (21.38)	126 (12.48)	<0.0001
Current Smoking	142 (9.46)	40 (8.15)	102 (10.10)	0.2253
Hearing Impairment	334 (22.25)	115 (23.42)	219 (21.68)	0.4474
Near VI	56 (3.73)	25 (5.09)	31 (3.07)	0.0524
Distant VI	194 (12.92)	103 (20.98)	91 (9.01)	<0.0001
VI (Near or Distant)	206 (13.72)	109 (22.20)	97 (9.60)	<0.0001

Abbreviations: SD=standard deviation; US=United States; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale; VI=vision impairment.

Longitudinal Analysis

Table 5.6 presents the GEE models for cognitive impairment (MMSE < 21) over an 18-year period as a function of NVI. Two models were performed to study the association between NVI and cognitive impairment. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship between socio-demographics and health characteristics with NVI.

No significant association was found between NVI (OR=1.45, 95% CI 0.83-2.53) and cognitive impairment over time after controlling for all variables in Model 1 and 2 compared to those without NVI. Time (OR=1.13, 95% CI 1.10-1.16), age (OR=1.05, 95% CI 1.01-1.08), financial strain (OR=1.35, 95% CI 1.08-1.69), lives with family (OR=1.48, 95% CI 1.09-2.01), underweight (OR=2.10, 95% 1.07-4.10), and depressive symptoms (OR=1.77, 95% CI 1.37-2.29) were factors associated with cognitive impairment (Model 2). High level of education was associated with lower odds of cognitive impairment (OR=0.88, 95% CI 0.85-0.92),

Table 5.6 Generalized estimating equation models for cognitive impairment (MMSE < 21) among older Mexican Americans as a function of near vision impairment over 18 years of follow-up (N=1010).

	Model 1	Model 2
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.13 (1.10-1.16)	1.13 (1.10-1.16)
Near VI	1.48 (0.93-2.36)	1.45 (0.83-2.53)
Age	1.06 (1.04-1.09)	1.05 (1.01-1.08)
Sex (female)	0.78 (0.60-1.02)	0.77 (0.58-1.03)
Married	0.78 (0.60-1.02)	0.84 (0.63-1.13)
Education (years)	0.90 (0.87-0.93)	0.88 (0.85-0.92)
Financial Strain	1.38 (1.14-1.68)	1.35 (1.08-1.69)
Nativity (Foreign born)	1.01 (0.79-1.30)	0.94 (0.72-1.22)
Spanish Interview	0.88 (0.65-1.19)	1.00 (0.71-1.42)
Lives with Family	1.40 (1.06-1.83)	1.48 (1.09-2.01)
Current Smoking		1.23 (0.80-1.88)
BMI Categories		
Underweight		2.10 (1.07-4.10)
Normal		Reference
Overweight		0.94 (0.72-1.23)
Obese Category 1		0.78 (0.56-1.09)
Obese Category 2		0.66 (0.39-1.14)
Hypertension		0.80 (0.62-1.03)
Arthritis		1.06 (0.84-1.33)
Cancer		0.82 (0.56-1.20)
Diabetes		1.24 (0.95-1.62)
Heart Attack		0.83 (0.53-1.30)

Hip Fracture		1.23 (0.64-2.38)
Stroke		1.11 (0.64-1.94)
Depressive symptoms (CES-D ≥ 16)		1.77 (1.37-2.29)
Hearing Impairment		1.27 (0.97-1.65)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those who scored ≥ 21 in the MMSE at baseline.

Table 5.7 presents the GEE models for cognitive impairment (MMSE < 21) over an 18-year period as a function of DVI. Two models were performed to study the association between DVI and cognitive impairment. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship between socio-demographics and health characteristics with DVI.

A significant association was found between DVI (OR=1.94, 95% CI 1.48-2.53) and cognitive impairment over time compared to those without DVI (Model 1). When we controlled for all covariates (Model 2) the association between DVI and cognitive impairment remained significant (OR=1.83, 95% CI 1.35-2.48). Time (OR=1.13, 95% CI 1.10-1.16), age (OR=1.05, 95% CI 1.02-1.08), financial strain (OR=1.35, 95% CI 1.07-1.69), lives with family (OR=1.47, 95% CI 1.08-2.00), and depressive symptoms (OR=1.68, 95% CI 1.30-2.18) were factors associated with cognitive impairment (Model 2). High level of education was associated with lower odds of cognitive impairment (OR=0.89, 95% CI 0.85-0.92).

Table 5.7 Generalized estimating equation models for cognitive impairment (MMSE < 21) among older Mexican Americans as a function of distant vision impairment over 18 years of follow-up (N=1010).

	Model 1	Model 2
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.13 (1.10-1.16)	1.13 (1.10-1.16)
Distant VI	1.94 (1.48-2.53)	1.83 (1.35-2.48)
Age	1.06 (1.03-1.08)	1.05 (1.02-1.08)
Sex (female)	0.77 (0.59-1.00)	0.76 (0.57-1.01)
Married	0.79 (0.60-1.03)	0.84 (0.63-1.13)
Education (years)	0.90 (0.87-0.93)	0.89 (0.85-0.92)
Financial Strain	1.37 (1.13-1.67)	1.35 (1.07-1.69)
Nativity (Foreign born)	1.02 (0.79-1.31)	0.94 (0.72-1.23)
Spanish Interview	0.91 (0.67-1.23)	1.01 (0.71-1.44)
Lives with Family	1.38 (1.06-1.81)	1.47 (1.08-2.00)
Current Smoking		1.21 (0.79-1.86)
BMI Categories		
Underweight		1.95 (0.98-3.87)
Normal		Reference
Overweight		0.95 (0.72-1.24)
Obese Category 1		0.77 (0.56-1.08)
Obese Category 2		0.67 (0.39-1.15)
Hypertension		0.81 (0.63-1.04)
Arthritis		1.04 (0.83-1.31)
Cancer		0.81 (0.55-1.18)
Diabetes		1.24 (0.95-1.61)
Heart Attack		0.81 (0.51-1.29)

Hip Fracture		1.25 (0.65-2.38)
Stroke		1.15 (0.67-1.98)
Depressive symptoms (CES-D ≥ 16)		1.68 (1.30-2.18)
Hearing Impairment		1.22 (0.94-1.58)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those who scored ≥ 21 in the MMSE at baseline.

Table 5.8 presents the GEE models for cognitive impairment (MMSE < 21) over an 18-year period as a function of vision impairment (near or distant). Two models were performed to study the association between vision impairment (near or distant) and cognitive impairment. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship between socio-demographics and health characteristics with VI (near or distant).

A significant association was found between VI (OR=1.84, 95% CI 1.43-2.38) and cognitive impairment over time compared to those without VI (Model 1). When we controlled for all covariates (Model 2) the association between VI and cognitive impairment remained significant (OR=1.75, 95% CI 1.31-2.34). Time (OR=1.13, 95% CI 1.10-1.16), age (OR=1.05, 95% CI 1.02-1.08), financial strain (OR=1.35, 95% CI 1.07-1.69), lives with family (OR=1.48, 95% CI 1.09-2.01), and depressive symptoms (OR=1.69, 95% CI 1.31-2.18) were factors associated with cognitive impairment (Model 2). High level of education was associated with lower odds of cognitive impairment (OR=0.89, 95% CI 0.85-0.92).

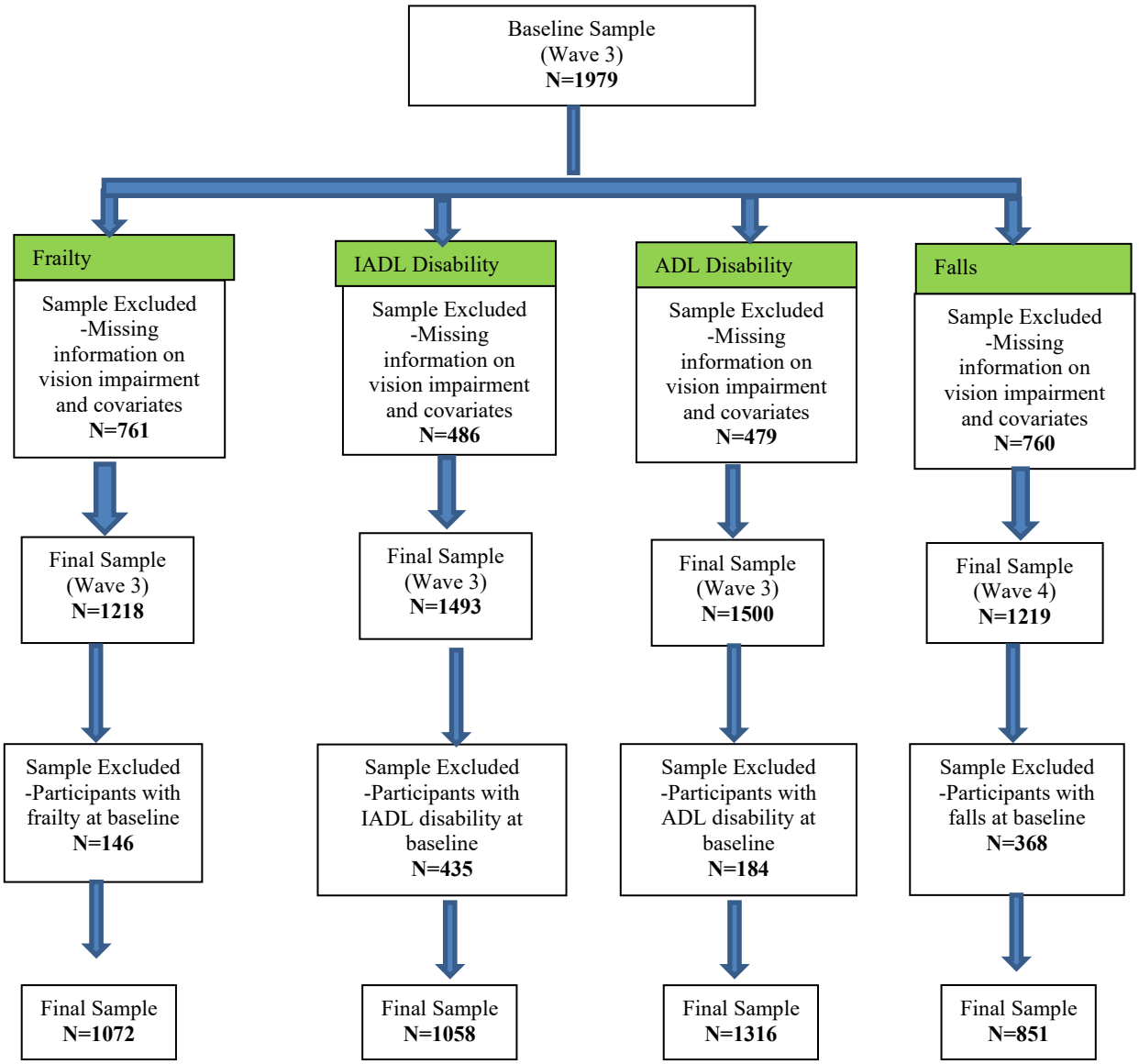
Table 5.8 Generalized estimating equation models for cognitive impairment (MMSE < 21) among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1010).

	Model 1	Model 2
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.13 (1.10-1.16)	1.13 (1.10-1.16)
VI (Near or distant)	1.84 (1.43-2.38)	1.75 (1.31-2.34)
Age	1.06 (1.03-1.09)	1.05 (1.02-1.08)
Sex (female)	0.76 (0.59-0.99)	0.76 (0.57-1.01)
Married	0.79 (0.60-1.03)	0.84 (0.63-1.13)
Education (years)	0.90 (0.87-0.93)	0.89 (0.85-0.92)
Financial Strain	1.38 (1.13-1.67)	1.35 (1.07-1.69)
Nativity (Foreign born)	1.01 (0.79-1.30)	0.94 (0.72-1.22)
Spanish Interview	0.90 (0.66-1.22)	1.01 (0.71-1.43)
Lives with Family	1.39 (1.06-1.82)	1.48 (1.09-2.01)
Current Smoking		1.20 (0.78-1.85)
BMI Categories		
Underweight		1.97 (0.99-3.91)
Normal		Reference
Overweight		0.94 (0.72-1.24)
Obese Category 1		0.77 (0.55-1.07)
Obese Category 2		0.67 (0.39-1.15)
Hypertension		0.81 (0.63-1.04)
Arthritis		1.04 (0.82-1.31)
Cancer		0.80 (0.55-1.17)
Diabetes		1.24 (0.95-1.62)
Heart Attack		0.81 (0.51-1.28)

Hip Fracture		1.24 (0.65-2.38)
Stroke		1.13 (0.66-1.96)
Depressive symptoms (CES-D ≥ 16)		1.69 (1.31-2.18)
Hearing Impairment		1.22 (0.94-1.59)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those who scored ≥ 21 in the MMSE at baseline.

Figure 3.1 Flowchart of sample selection for Aim 2b.



FRAILTY

Descriptive Analysis

At baseline (1998/1999), the mean age of the overall sample was 77.09 (SD ± 5.42) years, 58.70% were female, 53.53% were married, the mean years of education was 4.98 (SD ± 3.89) (Table 5.9). A higher percentage of the overall sample reported financial strain (52.38%), were born in the United States (57.88%), conducted interview in Spanish (71.51%), and indicated living with family (75.21%) (Table 5.9). The most reported comorbidity was arthritis (50.41%), followed by hypertension (47.37%), diabetes (28.08%), cancer (5.50%), heart attack (4.84%), stroke (2.87%) and hip fracture (1.15%) (Table 5.9). The mean BMI was 28.42 kg/m2 (SD ± 5.28) and the mean MMSE score was 22.98 (SD ± 5.12) (Table 5.9). Thirteen percent reported depressive symptoms, 9.85 % were current smokers, 20.61% reported a hearing impairment, 3.53% were near vision impaired, 12.64% distant vision impaired, and 13.55% were vision impaired (near or distant) (Table 5.9).

Descriptive baseline characteristics of the sample by frailty are also presented in Table 5.9. Fifty eight percent of older Mexican Americans were frail. Participants with frailty compared to those without frailty were significantly more likely to be older (77.88 SD ± 5.84 vs. 76.00 SD ± 4.56), female sex (62.98% vs. 52.83%), not married (50.35% vs. 41.43%), and report lower mean years of education (4.69 SD ± 3.68 vs. 5.38 SD ± 3.90). Additionally, participants with frailty compared to those without frailty were significantly more likely to report co-morbid conditions such as hypertension (51.21% vs. 42.11%), arthritis (53.90% vs. 45.61%), diabetes (33.62% vs. 20.47%), heart attack (6.81% vs. 2.14%), and stroke (4.11% vs. 1.17%). Lastly, participants with frailty compared to those without frailty were significantly more likely to report lower MMSE score (22.32 SD ± 5.33 vs. 23.89 SD ± 4.67), high depressive symptoms (20.28% vs. 2.92%), hearing impairment (28.11% vs. 15.79%), DVI (15.32% vs. 8.97%), and VI (near or distant) (16.74% vs. 9.16%). No significant differences were found by financial strain, nativity status,

language of interview, living status (with family vs. alone), comorbidities (cancer and hip fracture), smoking status, and NVI.

Table 5.9 Baseline descriptive characteristics of the sample by frailty among older Mexican Americans (N=1218).

Characteristics	Total N (%)	Frail N (%)	Non-Frail N (%)	p-value
Total	1218 (100)	705 (57.88)	513 (42.12)	
Age, Mean ± SD	77.09 ± 5.42	77.88 ± 5.84	76.00 ± 4.56	<0.0001
Sex (female)	715 (58.70)	444 (62.98)	271 (52.83)	0.0004
Married	652 (53.53)	350 (49.65)	302 (58.57)	0.0014
Education (years), Mean ± SD	4.98 ± 3.89	4.69 ± 3.68	5.38 ± 3.90	0.0028
Financial Strain	638 (52.38)	385 (31.61)	253 (49.32)	0.0679
Nativity (US born)	705 (57.88)	396 (56.17)	309 (60.23)	0.1561
Spanish Interview	871 (71.51)	515 (73.05)	356 (69.40)	0.1630
Lives with Family	916 (75.21)	522 (74.04)	394 (76.80)	0.2706
Hypertension	577 (47.37)	361 (51.21)	216 (42.11)	0.0017
Arthritis	614 (50.41)	380 (53.90)	234 (45.61)	0.0043
Cancer	67 (5.50)	45 (6.38)	22 (4.29)	0.1134
Diabetes	342 (28.08)	237 (33.62)	105 (20.47)	<0.0001
Heart Attack	59 (4.84)	48 (6.81)	11 (2.14)	0.0002
Hip Fracture	14 (1.15)	11 (1.56)	3 (0.58)	0.1724
Stroke	35 (2.87)	29 (4.11)	6 (1.17)	0.0024
BMI, Mean ± SD	28.42 ± 5.28	28.17 ± 6.32	28.46 ± 5.13	0.6062
BMI Categories				0.0048
Underweight	18 (1.48)	15 (2.13)	3 (0.58)	
Normal	304 (24.96)	181 (25.67)	123 (23.98)	
Overweight	475 (39.00)	266 (37.73)	209 (40.74)	
Obese Category 1	286 (23.48)	151 (21.42)	135 (26.32)	
Obese Category 2	135 (11.08)	92 (13.05)	43 (8.38)	
MMSE (total), Mean ± SD	22.98 ± 5.12	22.32 ± 5.33	23.89 ± 4.67	<0.0001
Depressive symptoms (CES-D ≥ 16)	158 (12.97)	143 (20.28)	15 (2.92)	<0.0001
Current Smoking	120 (9.85)	66 (9.36)	54 (10.53)	0.5007
Hearing Impairment	251 (20.61)	170 (24.11)	81 (15.79)	0.0004
Near VI	43 (3.53)	29 (4.11)	14 (2.73)	0.1961
Distant VI	154 (12.64)	108 (15.32)	46 (8.97)	0.0010
VI (Near or Distant)	165 (13.55)	118 (16.74)	47 (9.16)	0.0001

Abbreviations: SD=standard deviation; US=United States; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale; VI=vision impairment

Longitudinal Analysis

Table 5.10 presents the GEE models for frailty over an 18-year period as a function of NVI. Two models were performed to study the association between NVI and frailty. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family versus alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with NVI.

In Model 1, a significant association was found between NVI (OR=2.28, 95% CI 1.29-4.04) and frailty over time compared to those without NVI. However, in Model 2 when we controlled for all covariates (Model 2) the association between NVI and frailty is no longer significant (OR=1.67, 95% CI 0.87-3.21). Time (OR=1.22, 95% CI 1.18-1.26), age (OR=1.07, 95% CI 1.04-1.10), financial strain (OR=1.52, 95% CI 1.14-2.03), overweight (OR=0.65, 95% CI 0.48-0.90), arthritis (OR=1.42, 95% CI 1.06-1.90), cancer (OR=1.88, 95% CI 1.16-3.05), lower MMSE score (OR=1.51, 95% CI 1.11-2.06), and depressive symptoms (OR=4.69, 95% CI 3.45-6.38) were factors associated with frailty (Model 2). Those with hypertension had lower odds of frailty (OR=0.69, 95% CI 0.52-0.92).

Table 5.10 Generalized estimating equation models for frailty among older Mexican Americans as a function of near vision impairment over 18 years of follow-up (N=1072).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.21 (1.17-1.25)	1.22 (1.18-1.26)
Near VI	2.28 (1.29-4.04)	1.67 (0.87-3.21)
Age	1.07 (1.04-1.10)	1.07 (1.04-1.10)
Sex (female)	1.21 (0.88-1.65)	1.06 (0.75-1.48)

Married	0.83 (0.60-1.15)	0.93 (0.66-1.32)
Education (years)	0.99 (0.95-1.02)	1.00 (0.96-1.04)
Financial Strain	1.78 (1.35-2.35)	1.52 (1.14-2.03)
Nativity (Foreign born)	1.09 (0.81-1.46)	0.98 (0.72-1.34)
Spanish Interview	0.88 (0.61-1.28)	0.94 (0.64-1.38)
Lives with Family	1.18 (0.85-1.65)	1.23 (0.87-1.75)
Current Smoking		1.40 (0.81-2.40)
BMI Categories		
Underweight		2.15 (0.96-4.84)
Normal		Reference
Overweight		0.65 (0.48-0.90)
Obese Category 1		0.86 (0.57-1.31)
Obese Category 2		1.27 (0.75-2.16)
Hypertension		0.69 (0.52-0.92)
Arthritis		1.42 (1.06-1.90)
Cancer		1.88 (1.16-3.05)
Diabetes		1.10 (0.80-1.52)
Heart Attack		1.08 (0.61-1.94)
Hip Fracture		2.08 (0.82-5.25)
Stroke		1.35 (0.72-2.55)
Cognitive Impairment (MMSE < 21)		1.51 (1.11-2.06)
Depressive symptoms (CES-D ≥ 16)		4.69 (3.45-6.38)
Hearing Impairment		0.97 (0.69-1.36)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

Table 5.11 presents the GEE models for frailty over an 18-year period as a function of DVI. Two models were performed to study the association between DVI and frailty. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with DVI.

A significant association was found between DVI (OR=2.66, 95% CI 1.91-3.71) and frailty over time compared to those without DVI (Model 1). When we controlled for all covariates (Model 2) the association between DVI and frailty remained significant (OR=1.95, 95% CI 1.34-2.86). Time (OR=1.22, 95% CI 1.18-1.26), age (OR=1.07, 95% CI 1.03-1.10), financial strain (OR=1.49, 95% CI 1.11-1.99), arthritis (OR=1.40, 95% CI 1.05-1.88), cancer (OR=1.81, 95% CI 1.12-2.94), lower MMSE score (OR=1.42, 95% CI 1.03-1.95), and depressive symptoms (OR=4.48, 95% CI 3.29-6.11) were factors associated with frailty (Model 2). Those with hypertension had lower odds of frailty (OR=0.70, 95% CI 0.53-0.93).

Table 5.11 Generalized estimating equation models for frailty among older Mexican Americans as a function of distant vision impairment over 18 years of follow-up (N=1072).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.22 (1.18-1.26)	1.22 (1.18-1.26)
Distant VI	2.66 (1.91-3.71)	1.95 (1.34-2.86)
Age	1.06 (1.03-1.10)	1.07 (1.03-1.10)
Sex (female)	1.19 (0.87-1.64)	1.05 (0.75-1.47)
Married	0.85 (0.61-1.19)	0.94 (0.66-1.34)
Education (years)	0.99 (0.95-1.03)	1.00 (0.96-1.04)

Financial Strain	1.72 (1.29-2.27)	1.49 (1.11-1.99)
Nativity (Foreign born)	1.09 (0.81-1.46)	0.99 (0.73-1.36)
Spanish Interview	0.90 (0.62-1.31)	0.94 (0.64-1.39)
Lives with Family	1.15 (0.82-1.61)	1.22 (0.86-1.72)
Current Smoking		1.33 (0.77-2.31)
BMI Categories		
Underweight		2.10 (0.92-4.85)
Normal		Reference
Overweight		0.65 (0.47-0.90)
Obese Category 1		0.86 (0.56-1.30)
Obese Category 2		1.28 (0.76-2.18)
Hypertension		0.70 (0.53-0.93)
Arthritis		1.40 (1.05-1.88)
Cancer		1.81 (1.12-2.94)
Diabetes		1.12 (0.81-1.54)
Heart Attack		1.01 (0.56-1.81)
Hip Fracture		1.93 (0.76-4.89)
Stroke		1.36 (0.73-2.53)
Cognitive Impairment (MMSE < 21)		1.42 (1.03-1.95)
Depressive symptoms (CES-D ≥ 16)		4.48 (3.29-6.11)
Hearing Impairment		0.96 (0.69-1.35)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

Table 5.12 presents the GEE models for frailty over an 18-year period as a function of VI (near or distant). Two models were performed to study the association between vision impairment (near or distant) and frailty. Model 1 included time (years), sex, marital status, education (years),

financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with VI (near or distant).

A significant association was found between VI (OR=2.53, 95% CI 1.82-3.50) and frailty over time compared to those without VI (Model 1). When we controlled for all covariates (Model 2) the association between VI and frailty remained significant (OR=1.89, 95% CI 1.30-2.73). Time (OR=1.22, 95% CI 1.18-1.26), age (OR=1.07, 95% CI 1.04-1.10), financial strain (OR=1.49, 95% CI 1.12-2.00), overweight (OR=0.65, 95% CI 0.47-0.90), arthritis (OR=1.41, 95% CI 1.05-1.88), cancer (OR=1.83, 95% CI 1.13-2.97), lower MMSE score (OR=1.42, 95% CI 1.03-1.95), and depressive symptoms (OR=4.51, 95% CI 3.31-6.15) were factors associated with frailty (Model 2).

Table 5.12 Generalized estimating equation models for frailty among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1072).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.22 (1.18-1.25)	1.22 (1.18-1.26)
VI (Near or distant)	2.53 (1.82-3.50)	1.89 (1.30-2.73)
Age	1.07 (1.03-1.10)	1.07 (1.04-1.10)
Sex (female)	1.20 (0.87-1.64)	1.05 (0.75-1.47)
Married	0.84 (0.60-1.17)	0.93 (0.66-1.32)
Education (years)	0.99 (0.96-1.03)	1.00 (0.96-1.04)
Financial Strain	1.73 (1.30-2.29)	1.49 (1.12-2.00)
Nativity (Foreign born)	1.08 (0.81-1.46)	0.99 (0.72-1.34)
Spanish Interview	0.90 (0.62-1.31)	0.94 (0.64-1.39)

Lives with Family	1.16 (0.83-1.61)	1.23 (0.87-1.73)
Current Smoking		1.34 (0.78-2.33)
BMI Categories		
Underweight		2.13 (0.92-4.89)
Normal		Reference
Overweight		0.65 (0.47-0.90)
Obese Category 1		0.86 (0.57-1.30)
Obese Category 2		1.28 (0.76-2.17)
Hypertension		0.70 (0.53-0.94)
Arthritis		1.41 (1.05-1.88)
Cancer		1.83 (1.13-2.97)
Diabetes		1.12 (0.81-1.54)
Heart Attack		1.02 (0.57-1.83)
Hip Fracture		1.95 (0.77-4.93)
Stroke		1.36 (0.73-2.53)
Cognitive Impairment (MMSE < 21)		1.42 (1.03-1.95)
Depressive symptoms (CES-D ≥ 16)		4.51 (3.31-6.15)
Hearing Impairment		0.95 (0.68-1.32)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

IADL DISABILITY

Descriptive Analysis

At baseline (1998/1999), the mean age of the overall sample was 77.18 (SD ± 5.48) years, 59.68% were female, 51.37% were married, the mean years of education was 4.96 (SD ± 3.88)

(Table 5.13). A higher percentage of the overall sample reported financial strain (53.45%), were born in the United States (57.20%), conducted interview in Spanish (71.94%), and indicated living with family (74.61%) (Table 5.13). The most reported comorbidity was arthritis (50.90%), followed by hypertension (48.36%), diabetes (28.87%), cancer (6.30%), heart attack (5.63%), stroke (3.22%) and hip fracture (1.67%) (Table 5.13). The mean BMI was 28.43 kg/m2 (SD ± 5.49) and the mean MMSE score was 22.77 (SD ± 5.27) (Table 5.13). Fifteen percent reported depressive symptoms, 9.51 % were current smokers, 22.17% reported a hearing impairment, 3.75% were near vision impaired, 12.99% distant vision impaired, and 13.80% were vision impaired (near or distant) (Table 5.13).

Descriptive baseline characteristics of the sample by IADL disability are also presented in Table 5.13. Twenty nine percent of older Mexican Americans indicated IADL limitations in one or more of the activities of the modified Lawton Instrumental Activities of Daily Living Index (LIADL). Participants with IADL disability compared to those without IADL disability were significantly more likely to be older (79.49 SD ± 6.36 vs. 76.23 SD ± 4.77), female sex (71.49% vs. 54.82%), not married (60.23% vs. 43.86%), report lower mean years of education (3.82 SD ± 3.21 vs. 5.42 SD ± 4.04), foreign-born (47.13% vs. 41.02%), conducted the interview in Spanish (78.39% vs. 69.28%). Additionally, participants with IADL disability compared to those without IADL disability were significantly more likely to report co-morbid conditions such as hypertension (55.17% vs. 45.56%), arthritis (59.31% vs. 47.45%), diabetes (36.55% vs. 25.71%), heart attack (10.11% vs. 3.78%), and stroke (5.98% vs. 2.08%). Lastly, participants with IADL disability compared to those with no IADL disability were significantly more likely to report lower MMSE score (20.32 SD ± 5.89 vs. 23.78 SD ± 4.63), high depressive symptoms (28.05% vs. 10.02%), %), hearing impairment (32.41% vs. 17.96%), currently not smoking (94.02% vs. 89.04%), NVI (6.44% vs. 2.65%), DVI (24.14% vs. 8.41%), and VI (near or distant) (25.06% vs. 9.17%). No significant differences were found by financial strain, living status (with family vs. alone), and comorbidities (cancer and hip fracture).

Table 5.13 Baseline descriptive characteristics of the sample by IADL disability among older Mexican Americans (N=1493).

Characteristics	Total N (%)	IADL Disability N (%)	No IADL Disability N (%)	p-value
Total	1493 (100)	435 (29.14)	1058 (70.86)	
Age, Mean ± SD	77.18 ± 5.48	79.49 ± 6.36	76.23 ± 4.77	<0.0001
Sex (female)	891 (59.68)	311 (71.49)	580 (54.82)	<0.0001
Married	767 (51.37)	173 (39.77)	594 (56.14)	<0.0001
Education (years), Mean ± SD	4.96 ± 3.88	3.82 ± 3.21	5.42 ± 4.04	<0.0001
Financial Strain	798 (53.45)	249 (57.24)	549 (51.89)	0.0596
Nativity (US born)	854 (57.20)	230 (52.87)	624 (58.98	0.0303
Spanish Interview	1074 (71.94)	341 (78.39)	733 (69.28)	0.0004
Lives with Family	1114 (74.61)	312 (71.12)	802 (75.80)	0.0998
Hypertension	722 (48.36)	240 (55.17)	482 (45.56)	0.0007
Arthritis	760 (50.90)	258 (59.31)	502 (47.45)	<0.0001
Cancer	94 (6.30)	35 (8.05)	59 (5.58)	0.0743
Diabetes	431 (28.87)	159 (36.55)	272 (25.71)	<0.0001
Heart Attack	84 (5.63)	44 (10.11)	40 (3.78)	<0.0001
Hip Fracture	25 (1.67)	11 (2.53)	14 (1.32)	0.0991
Stroke	48 (3.22)	26 (5.98)	22 (2.08)	0.0001
BMI, Mean ± SD	28.43 ± 5.49	28.61 ± 5.81	28.36 ± 5.36	0.4344
BMI Categories				0.0177
Underweight	23 (1.54)	8 (0.54)	15 (1.42)	
Normal	385 (25.79)	119 (27.36)	266 (25.14)	
Overweight	561 (37.58)	144 (33.10)	417 (37.41)	
Obese Category 1	350 (23.44)	97 (22.30)	253 (23.91)	
Obese Category 2	174 (11.65)	67 (15.40)	107 (10.11)	
MMSE (total), Mean ± SD	22.77 ± 5.27	20.32 ± 5.89	23.78 ± 4.63	<0.0001
Depressive symptoms (CES-D ≥ 16)	228 (15.27)	122 (28.05)	106 (10.02)	<0.0001
Current Smoking	142 (9.51)	26 (5.98)	116 (10.96)	0.0028
Hearing Impairment	331 (22.17)	141 (32.41)	190 (17.96)	<0.0001
Near VI	56 (3.75)	28 (6.44)	28 (2.65)	0.0005
Distant VI	194 (12.99)	105 (24.14)	89 (8.41)	<0.0001
VI (Near or Distant)	206 (13.80)	109 (25.06)	97 (9.17)	<0.0001

Abbreviations: IADL=Instrumental Activities of Daily Living; SD=standard deviation; US=United States; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale; VI=vision impairment

Longitudinal Analysis

Table 5.14 presents the GEE models for IADL disability over an 18-year period as a function of NVI. Two models were performed to study the association between NVI and IADL disability. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with NVI.

A significant association was found between NVI (OR=3.21, 95% CI 2.10-4.90) and IADL disability over time compared to those without NVI (Model 1). When we controlled for all covariates (Model 2) the association between NVI and IADL disability remained significant (OR=2.71, 95% CI 1.65-4.45). Time (OR=1.28, 95% CI 1.24-1.32), age (OR=1.08, 95% CI 1.05-1.11), female sex (OR=2.29, 95% CI 1.75-3.00), years of education (OR=0.91, 95% CI 0.88-0.94), financial strain (OR=1.28, 95% CI 1.05-1.58), lives with family (OR=1.88, 95% CI 1.42-2.49), arthritis (OR=1.48, 95% CI 1.21-1.81), diabetes (OR=1.66, 95% CI 1.31-2.11), hip fracture (OR=2.58, 95% CI 1.38-4.80), stroke (OR=2.09, 95% CI 1.24-3.53), lower MMSE score (OR=2.00, 95% CI 1.58-2.54), depressive symptoms (OR=1.71, 95% CI 1.32-2.22), and hearing impairment (OR=1.29, 95% CI 1.01-1.66) were factors associated with IADL disability (Model 2).

Table 5.14 Generalized estimating equation models for IADL disability among older Mexican Americans as a function of near vision impairment over 18 years of follow-up (N=1058).

	Model 1	Model 2
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.29 (1.25-1.32)	1.28 (1.24-1.32)
Near VI	3.21 (2.10-4.90)	2.71 (1.65-4.45)
Age	1.09 (1.07-1.11)	1.08 (1.05-1.11)
Sex (female)	2.16 (1.67-2.79)	2.29 (1.75-3.00)
Married	0.73 (0.56-0.94)	0.78 (0.59-1.03)
Education (years)	0.90 (0.87-0.93)	0.91 (0.88-0.94)
Financial Strain	1.37 (1.14-1.65)	1.28 (1.05-1.58)
Nativity (Foreign born)	1.12 (0.89-1.41)	1.12 (0.88-1.43)
Spanish Interview	1.13 (0.85-1.48)	1.20 (0.88-1.63)
Lives with Family	1.87 (1.44-2.43)	1.88 (1.42-2.49)
Current Smoking		1.25 (0.83-1.88)
BMI Categories		
Underweight		1.58 (0.78-3.22)
Normal		Reference
Overweight		0.88 (0.69-1.14)
Obese Category 1		0.90 (0.65-1.23)
Obese Category 2		0.99 (0.68-1.46)
Hypertension		0.97 (0.79-1.21)
Arthritis		1.48 (1.21-1.81)
Cancer		1.12 (0.75-1.69)
Diabetes		1.66 (1.31-2.11)
Heart Attack		1.45 (0.91-2.30)

Hip Fracture		2.58 (1.38-4.80)
Stroke		2.09 (1.24-3.53)
Cognitive Impairment (MMSE < 21)		2.00 (1.58-2.54)
Depressive symptoms (CES-D ≥ 16)		1.71 (1.32-2.22)
Hearing Impairment		1.29 (1.01-1.66)

Abbreviations: IADL=instrumental activities of daily living; VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those non-IADL disabled at baseline.

Table 5.15 presents the GEE models for IADL disability over an 18-year period as a function of DVI. Two models were performed to study the association between DVI and IADL disability. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with DVI.

A significant association was found between DVI (OR=2.41, 95% CI 1.87-3.11) and IADL disability over time compared to those without DVI (Model 1). When we controlled for all covariates (Model 2) the association between DVI and IADL disability remained significant (OR=1.89, 95% CI 1.41-2.53). Time (OR=1.28, 95% CI 1.24-1.32), age (OR=1.08, 95% CI 1.06-1.11), female sex (OR=2.27, 95% CI 1.73-2.98), years of education (OR=0.91, 95% CI 0.88-0.94), financial strain (OR=1.26, 95% CI 1.03-1.55), lives with family (OR=1.86, 95% CI 1.40-2.46), arthritis (OR=1.47, 95% CI 1.20-1.80), diabetes (OR=1.66, 95% CI 1.31-2.11), hip fracture (OR=2.61, 95% CI 1.39-4.91), stroke (OR=2.20, 95% CI 1.30-3.72), lower MMSE score

(OR=1.93, 95% CI 1.52-2.45), and depressive symptoms (OR=1.67, 95% CI 1.29-2.16) were factors associated with IADL disability (Model 2).

Table 5.15 Generalized estimating equation models for IADL disability among older Mexican Americans as a function of distant vision impairment over 18 years of follow-up (N=1058).

	Model 1	Model 2
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.29 (1.25-1.32)	1.28 (1.24-1.32)
Distant VI	2.41 (1.87-3.11)	1.89 (1.41-2.53)
Age	1.09 (1.06-1.11)	1.08 (1.06-1.11)
Sex (female)	2.13 (1.65-2.75)	2.27 (1.73-2.98)
Married	0.74 (0.56-0.96)	0.79 (0.60-1.04)
Education (years)	0.90 (0.87-0.93	0.91 (0.88-0.94)
Financial Strain	1.35 (1.12-1.63)	1.26 (1.03-1.55)
Nativity (Foreign born)	1.13 (0.89-1.42)	1.14 (0.89-1.45)
Spanish Interview	1.15 (0.87-1.53)	1.21 (0.89-1.64)
Lives with Family	1.85 (1.43-2.41)	1.86 (1.40-2.46)
Current Smoking		1.25 (0.82-1.87)
BMI Categories		
Underweight		1.57 (0.76-3.24)
Normal		Reference
Overweight		0.89 (0.69-1.14)
Obese Category 1		0.89 (0.65-1.22)
Obese Category 2		1.01 (0.69-1.48)
Hypertension		0.98 (0.79-1.22)
Arthritis		1.47 (1.20-1.80)

Cancer		1.09 (0.73-1.63)
Diabetes		1.66 (1.31-2.11)
Heart Attack		1.38 (0.86-2.20)
Hip Fracture		2.61 (1.39-4.91)
Stroke		2.20 (1.30-3.72)
Cognitive Impairment (MMSE < 21)		1.93 (1.52-2.45)
Depressive symptoms (CES-D ≥ 16)		1.67 (1.29-2.16)
Hearing Impairment		1.28 (0.99-1.64)

Abbreviations: IADL=instrumental activities of daily living; VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those non-IADL disabled at baseline.

Table 5.16 presents the GEE models for IADL disability over an 18-year period as a function of VI (near or distant). Two models were performed to study the association between VI (near or distant) and IADL disability. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with VI (near or distant).

A significant association was found between VI (OR=2.55, 95% CI 2.00-3.26) and IADL disability over time compared to those without VI (Model 1). When we controlled for all covariates (Model 2) the association between VI and IADL disability remained significant (OR=2.03, 95% CI 1.53-2.70). Time (OR=1.28, 95% CI 1.24-1.32), age (OR=1.08, 95% CI 1.05-1.11), female sex (OR=2.28, 95% CI 1.74-2.99), years of education (OR=0.91, 95% CI 0.88-0.94), financial strain (OR=1.26, 95% CI 1.02-1.54), lives with family (OR=1.87, 95% CI 1.41-2.47), arthritis (OR=1.46,

95% CI 1.19-1.79), diabetes (OR=1.66, 95% CI 1.31-2.11), hip fracture (OR=2.63, 95% CI 1.40-4.97), stroke (OR=2.18, 95% CI 1.28-3.69), lower MMSE score (OR=1.92, 95% CI 1.51-2.44), and depressive symptoms (OR=1.67, 95% CI 1.29-2.17) were factors associated with IADL disability (Model 2).

Table 5.16 Generalized estimating equation models for IADL disability among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1058).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.29 (1.25-1.32)	1.28 (1.24-1.32)
VI (Near or distant)	2.55 (2.00-3.26)	2.03 (1.53-2.70)
Age	1.09 (1.06-1.11)	1.08 (1.05-1.11)
Sex (female)	2.14 (1.66-2.76)	2.28 (1.74-2.99)
Married	0.73 (0.56-0.96)	0.79 (0.60-1.04)
Education (years)	0.90 (0.87-0.93)	0.91 (0.88-0.94)
Financial Strain	1.34 (1.12-1.62)	1.26 (1.02-1.54)
Nativity (Foreign born)	1.13 (0.90-1.42)	1.14 (0.89-1.45)
Spanish Interview	1.15 (0.87-1.52)	1.20 (0.88-1.64)
Lives with Family	1.85 (1.43-2.41)	1.87 (1.41-2.47)
Current Smoking		1.23 (0.82-1.86)
BMI Categories		
Underweight		1.58 (0.77-3.28)
Normal		Reference
Overweight		0.88 (0.68-1.14)
Obese Category 1		0.88 (0.64-1.21)
Obese Category 2		1.00 (0.68-1.47)
Hypertension		0.98 (0.79-1.22)

Arthritis		1.46 (1.19-1.79)
Cancer		1.08 (0.73-1.61)
Diabetes		1.66 (1.31-2.11)
Heart Attack		1.37 (0.86-2.19)
Hip Fracture		2.63 (1.40-4.97)
Stroke		2.18 (1.28-3.69)
Cognitive Impairment (MMSE < 21)		1.92 (1.51-2.44)
Depressive symptoms (CES-D ≥ 16)		1.67 (1.29-2.17)
Hearing Impairment		1.26 (0.98-1.62)

Abbreviations: IADL=instrumental activities of daily living; VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those non-IADL disabled at baseline.

ADL DISABILITY

Descriptive analysis

At baseline (1998/1999), the mean age of the overall sample was 77.17 (SD ± 5.48) years, 59.87% were female, 51.27% were married, the mean years of education was 4.95 (SD ± 3.88) (Table 5.17). A higher percentage of the overall sample reported financial strain (53.53%), were born in the United States (57.13%), conducted interview in Spanish (71.93%), and indicated living with family (74.53%) (Table 5.18). The most reported comorbidity was arthritis (50.80%), followed by hypertension (48.40%), diabetes (28.87%), cancer (6.27%), heart attack (5.67%), stroke (3.20%) and hip fracture (1.73%) (Table 5.18). The mean BMI was 28.45 kg/m2 (SD ± 5.50) and the mean MMSE score was 22.77 (SD ± 5.27) (Table 5.18). Fifteen percent reported depressive symptoms, 9.47 % were current smokers, 22.20% reported a hearing impairment, 3.73% were near vision impaired, 12.93% distant vision impaired, and 13.73% were vision impaired (near or distant) (Table 5.17).

Descriptive baseline characteristics of the sample by ADL disability are also presented in Table 5.17. Twelve percent of older Mexican Americans indicated ADL limitations in one or more of the activities of the modified Katz-7 Activities of Daily Living (ADL) Index. Participants with ADL disability compared to those with no ADL disability were significantly more likely to be older (79.79 SD ± 6.52 vs. 76.80 SD ± 5.22), female sex (70.65% vs. 58.36%), not married (66.30% vs. 46.28%), report lower mean years of education (4.32 SD ± 4.84 vs. 5.04 SD ± 3.91) and indicated living alone versus with family (32.07% vs. 24.54%). Additionally, participants with ADL disability compared to those without ADL disability were significantly more likely to report co-morbid conditions such as hypertension (58.70% vs. 46.96%), arthritis (68.48% vs. 48.33%), cancer (9.78% vs. 5.78%), diabetes (45.11% vs. 26.60%), heart attack (15.76% vs. 4.26%), hip fracture (4.89% vs. 1.29%), and stroke (8.70% vs. 2.43%). Lastly, participants with ADL disability compared to those without ADL disability were significantly more likely to report lower MMSE score (20.62 SD ± 6.02 vs. 23.07 SD ± 5.09), high depressive symptoms (30.98% vs. 13.22%), NVI (6.52% vs. 3.34%), DVI (26.09% vs. 11.09%), and VI (near or distant) (26.63% vs. 11.93%). No significant differences were found by financial strain, nativity status, language of interview, BMI, smoking status, and hearing impairment.

Table 5.17 Baseline descriptive characteristics of the sample by ADL disability among older Mexican Americans (N=1500).

Characteristic	Total N (%)	ADL Disability N (%)	No ADL Disability N (%)	p-value
Total	1500 (100)	184 (12.27)	1316 (87.73)	
Age, Mean ± SD	77.17 ± 5.48	79.79 ± 6.52	76.80 ± 5.22	<0.0001
Sex (female)	698 (59.87)	130 (70.65)	768 (58.36)	0.0014
Married	769 (51.27)	62 (33.70)	707 (53.72)	<0.0001
Education (years), Mean ± SD	4.95 ± 3.88	4.32 ± 4.84	5.04 ± 3.91	0.0180
Financial Strain	803 (53.53)	103 (55.98)	700 (53.19)	0.4778
Nativity (US born)	857 (57.13)	98 (53.26)	759 (57.67)	0.2571
Spanish Interview	1079 (71.93)	131 (71.20)	948 (72.04)	0.8121
Lives with Family	1118 (74.53)	125 (67.93)	993 (75.46)	0.0283
Hypertension	726 (48.40)	108 (58.70)	618 (46.96)	0.0028
Arthritis	762 (50.80)	126 (68.48)	636 (48.33)	<0.0001
Cancer	94 (6.27)	18 (9.78)	76 (5.78)	0.0357

Diabetes	433 (28.87)	83 (45.11)	350 (26.60)	<0.0001
Heart Attack	85 (5.67)	29 (15.76)	56 (4.26)	<0.0001
Hip Fracture	26 (1.73)	9 (4.89)	17 (1.29)	0.0005
Stroke	48 (3.20)	16 (8.70)	32 (2.43)	<0.0001
BMI, Mean ± SD	28.45 ± 5.50	28.86 ± 5.97	28.39 ± 5.44	0.2758
BMI Categories				0.0759
Underweight	23 (1.53)	4 (2.17)	19 (1.44)	
Normal	387 (25.80)	45 (24.46)	342 (25.99)	
Overweight	562 (37.47)	62 (33.70)	500 (37.99)	
Obese Category 1	352 (37.47)	40 (21.74)	312 (23.71)	
Obese Category 2	176 (11.73)	33 (17.93)	143 (10.87)	
MMSE (total), Mean ± SD	22.77 ± 5.27	20.62 ± 6.02	23.07 ± 5.09	<0.0001
Depressive symptoms (CES-D ≥ 16)	231 (15.40)	57 (30.98)	174 (13.22)	<0.0001
Current Smoking	142 (9.47)	11 (5.98)	131 (9.95)	0.0844
Hearing Impairment	333 (22.20)	50 (3.33)	283 (21.50)	0.0831
Near VI	56 (3.73)	12 (6.52)	44 (3.34)	0.0332
Distant VI	194 (12.93)	48 (26.09)	146 (11.09)	<0.0001
VI (Near or Distant)	206 (13.73)	49 (26.63)	157 (11.93)	<0.0001

Abbreviations: ADL=Activities of Daily Living; SD=standard deviation; US=United States; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale; VI=vision impairment

Longitudinal Analyses

Table 5.18 presents the GEE models for ADL disability over an 18-year period as a function of NVI. Two models were performed to study the association between NVI and ADL disability. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variable included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with NVI.

In Model 1, a significant association was found between NVI (OR=1.45, 95% CI 1.00-2.11) and ADL disability over time compared to those without NVI. However, in Model 2 when we controlled for all covariates (Model 2) the association between NVI and ADL disability is no longer significant (OR=1.15, 95% CI 0.73-1.83). Time (OR=1.21, 95% CI 1.18-1.24), age

(OR=1.06, 95% CI 1.04-1.09), female sex (OR=1.64, 95% CI 1.28-2.11), financial strain (OR=1.61, 95% CI 1.30-1.99), Spanish interview (OR=1.37, 95% CI 1.01-1.85), obese category 1 (OR=1.37, 95% CI 1.02-1.83), obese category 2 (OR=1.96, 95% 1.39-2.76), arthritis (OR=1.76, 95% CI 1.42-2.19), diabetes (OR=1.38, 95% CI 1.11-1.71), hip fracture (OR=3.00, 95% CI 1.57-5.72), stroke (OR=1.88, 95% CI 1.22-2.88), lower MMSE score (OR=2.27, 95% CI 1.81-2.85), and depressive symptoms (OR=1.90, 95% CI 1.47-2.47) were factors associated with ADL disability (Model 2). Those with hearing impairment had lower odds of ADL disability (OR=0.74, 95% CI 0.57-0.97).

Table 5.18 Generalized estimating equation models for ADL disability among older Mexican Americans as a function of near vision impairment over 18 years of follow-up (N=1316).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.22 (1.20-1.25)	1.21 (1.18-1.24)
Near VI	1.45 (1.00-2.11)	1.15 (0.73-1.83)
Age	1.07 (1.05-1.09)	1.06 (1.04-1.09)
Sex (female)	1.80 (1.43-2.26)	1.64 (1.28-2.11)
Married	0.91 (0.72-1.14)	0.98 (0.76-1.26)
Education (years)	0.96 (0.93-0.98)	0.99 (0.96-1.02)
Financial Strain	1.71 (1.43-2.04)	1.61 (1.30-1.99)
Nativity (Foreign born)	0.96 (0.78-1.19)	0.98 (0.78-1.22)
Spanish Interview	1.14 (0.89-1.46)	1.37 (1.01-1.85)
Lives with Family	1.35 (1.08-1.68)	1.25 (0.96-1.63)
Current Smoking		0.89 (0.54-1.48)
BMI Categories		
Underweight		1.95 (0.99-3.83)

Normal		Reference
Overweight		1.02 (0.80-1.30)
Obese Category 1		1.37 (1.02-1.83)
Obese Category 2		1.96 (1.39-2.76)
Hypertension		1.05 (0.84-1.31)
Arthritis		1.76 (1.42-2.19)
Cancer		1.06 (0.72-1.56)
Diabetes		1.38 (1.11-1.71)
Heart Attack		1.22 (0.82-1.82)
Hip Fracture		3.00 (1.57-5.72)
Stroke		1.88 (1.22-2.88)
Cognitive Impairment (MMSE < 21)		2.27 (1.81-2.85)
Depressive symptoms (CES-D ≥ 16)		1.90 (1.47-2.47)
Hearing Impairment		0.74 (0.57-0.97)

Abbreviations: ADL=activities of daily living; VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those non-ADL disabled at baseline.

Table 5.19 presents the GEE models for ADL disability over an 18-year period as a function of DVI. Two models were performed to study the association between DVI and ADL disability. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with DVI.

In Model 1, a significant association was found between DVI (OR=1.72, 95% CI 1.38-2.15) and ADL disability over time compared to those without DVI. However, in Model 2 when we controlled for all covariates (Model 2) the association between DVI and ADL disability is no longer significant (OR=1.30, 95% CI 0.98-1.71). Time (OR=1.21, 95% CI 1.18-1.24), age (OR=1.06, 95% CI 1.04-1.09), female sex (OR=1.64, 95% CI 1.28-2.11), financial strain (OR=1.59, 95% CI 1.29-1.97), Spanish interview (OR=1.38, 95% CI 1.02-1.86), obese category 1 (OR=1.36, 95% CI 1.01-1.81), obese category 2 (OR=1.97, 95% 1.39-2.77), arthritis (OR=1.78, 95% CI 1.41-2.17), diabetes (OR=1.38, 95% CI 1.11-1.71), hip fracture (OR=2.99, 95% CI 1.56-5.74), stroke (OR=1.87, 95% CI 1.22-2.88), lower MMSE score (OR=2.23, 95% CI 1.78-2.80), and depressive symptoms (OR=1.87, 95% CI 1.44-2.42) were factors associated with ADL disability (Model 2). Those with hearing impairment had lower odds of ADL disability (OR=0.74, 95% CI 0.56-0.96).

Table 5.19 Generalized estimating equation models for ADL disability among older Mexican Americans as a function of distant vision impairment over 18 years of follow-up (N=1316).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.23 (1.20-1.26)	1.21 (1.18-1.24)
Distant VI	1.72 (1.38-2.15)	1.30 (0.98-1.71)
Age	1.07 (1.05-1.09)	1.06 (1.04-1.09)
Sex (female)	1.79 (1.42-2.24)	1.64 (1.28-2.11)
Married	0.91 (0.73-1.15)	0.98 (0.76-1.27)
Education (years)	0.96 (0.93-0.99)	0.99 (0.96-1.02)
Financial Strain	1.70 (1.42-2.02)	1.59 (1.29-1.97)
Nativity (Foreign born)	0.97 (0.79-1.20)	0.98 (0.79-1.23)
Spanish Interview	1.17 (0.92-1.50)	1.38 (1.02-1.86)
Lives with Family	1.33 (1.07-1.67)	1.25 (0.96-1.63)

Current Smoking		0.88 (0.53-1.47)
BMI Categories		
Underweight		1.92 (0.97-3.79)
Normal		Reference
Overweight		1.02 (0.80-1.30)
Obese Category 1		1.36 (1.01-1.81)
Obese Category 2		1.97 (1.39-2.77)
Hypertension		1.06 (0.85-1.32)
Arthritis		1.75 (1.41-2.17)
Cancer		1.05 (0.72-1.55)
Diabetes		1.38 (1.11-1.71)
Heart Attack		1.20 (0.81-1.79)
Hip Fracture		2.99 (1.56-5.74)
Stroke		1.87 (1.22-2.88)
Cognitive Impairment (MMSE < 21)		2.23 (1.78-2.80)
Depressive symptoms (CES-D ≥ 16)		1.87 (1.44-2.42)
Hearing Impairment		0.74 (0.56-0.96)

Abbreviations: ADL=activities of daily living; VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those non-ADL disabled at baseline.

Table 5.20 presents the GEE models for ADL disability over an 18-year period as a function of VI (near or distant). Two models were performed to study the association between VI (near or distant) and ADL disability. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing

impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with VI (near or distant).

A significant association was found between VI (OR=1.71, 95% CI 1.38-2.12) and ADL disability over time compared to those without VI (Model 1). When we controlled for all covariates (Model 2) the association between VI and ADL disability remained significant (OR=1.32, 95% CI 1.01-1.72). Time (OR=1.21, 95% CI 1.18-1.24), age (OR=1.06, 95% CI 1.04-1.09), female sex (OR=1.64, 95% CI 1.28-2.11), financial strain (OR=1.60, 95% CI 1.29-1.97), Spanish interview (OR=1.37, 95% CI 1.01-1.86), obese category 1 (OR=1.36, 95% CI 1.02-1.82), obese category 2 (OR=1.97, 95% 1.40-2.77), arthritis (OR=1.75, 95% CI 1.41-2.18), diabetes (OR=1.38, 95% CI 1.11-1.71), hip fracture (OR=2.99, 95% CI 1.56-5.73), stroke (OR=1.87, 95% CI 1.22-2.87), lower MMSE score (OR=2.22, 95% CI 1.77-2.79), and depressive symptoms (OR=1.87, 95% CI 1.45-2.43) were factors associated with ADL disability (Model 2). Those with hearing impairment had lower odds of ADL disability (OR=0.73, 95% CI 0.56-0.95).

Table 5.20 Generalized estimating equation models for ADL disability among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1316).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.23 (1.20-1.25)	1.21 (1.18-1.24)
VI (Near or distant)	1.71 (1.38-2.12)	1.32 (1.01-1.72)
Age	1.07 (1.05 -1.09)	1.06 (1.04-1.09)
Sex (female)	1.79 (1.43-2.25)	1.64 (1.28-2.11)
Married	0.91 (0.72-1.14)	0.98 (0.76-1.26)
Education (years)	0.96 (0.93-0.99)	0.99 (0.96-1.02)
Financial Strain	1.70 (1.42-2.03)	1.60 (1.29-1.97)
Nativity (Foreign born)	0.97 (0.79-1.20)	0.98 (0.79-1.23)
Spanish Interview	1.17 (0.92-1.49)	1.37 (1.01-1.86)

Lives with Family	1.33 (1.07-1.67)	1.25 (0.96-1.63)
Current Smoking		0.88 (0.53-1.46)
BMI Categories		
Underweight		1.93 (0.97-3.82)
Normal		Reference
Overweight		1.03 (0.81-1.31)
Obese Category 1		1.36 (1.02-1.82)
Obese Category 2		1.97 (1.40-2.77)
Hypertension		1.06 (0.85-1.32)
Arthritis		1.75 (1.41-2.18)
Cancer		1.05 (0.72-1.54)
Diabetes		1.38 (1.11-1.71)
Heart Attack		1.20 (0.81-1.79)
Hip Fracture		2.99 (1.56-5.73)
Stroke		1.87 (1.22-2.87)
Cognitive Impairment (MMSE < 21)		2.22 (1.77-2.79)
Depressive symptoms (CES-D ≥ 16)		1.87 (1.45-2.43)
Hearing Impairment		0.73 (0.56-0.95)

Abbreviations: ADL=activities of daily living; VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. The analyses were conducted among those non-ADL disabled at baseline.

FALLS

Descriptive Analysis

At baseline (2000/2001), the mean age of the overall sample was 78.67 (SD ± 4.96) years, 60.21% were female, 50.21% were married, the mean years of education was 4.97 (SD ± 3.89) (Table 5.21). A higher percentage of the overall sample reported financial strain (58.98%), were born in the United States (57.51%), conducted interview in Spanish (86.55%), and indicated living with family (73.09%) (Table 5.24). The most reported comorbidity was arthritis (54.14%), followed by hypertension (49.88%), diabetes (31.01%), cancer (5.17%), heart attack (4.27%), stroke (3.12%) and hip fracture (2.46%) (Table 5.24). The mean BMI was 28.02 kg/m2 (SD ± 5.42) and the mean MMSE score was 22.51 (SD ± 5.26) (Table 5.24). Ten percent reported depressive symptoms, 7.79 % were current smokers, 20.75% reported a hearing impairment, 3.20% were near vision impaired, 12.80% distant vision impaired, and 13.45% were vision impaired (near or distant) (Table 5.21).

Descriptive baseline characteristics of the sample by falls are also presented in Table 5.24. Thirty percent of older Mexican Americans reported one or more falls during the past 12 months (falls ≥ 1). Participants with falls ≥ 1 compared to those with no falls were significantly more likely to be older (79.14 SD ± 5.34 vs. 78.46 SD ± 4.77), female sex (68.48% vs. 56.64%), not married (56.52% vs. 46.89%), and indicated living alone versus with family (79.57% vs. 24.56%). Additionally, participants with falls ≥ 1 compared to those with no falls were significantly more likely to report co-morbid conditions such as hypertension (54.62% vs. 47.83%), arthritis (62.50% vs. 50.53%), cancer (7.07% vs. 4.35%), diabetes (36.14% vs. 28.79%), hip fracture (1.56% vs. 1.29%), and stroke (4.89% vs. 2.35%). Lastly, participants with falls ≥ 1 compared to those with no falls were significantly more likely to report lower MMSE score (21.88 SD ± 5.50 vs. 22.79 SD ± 5.13), high depressive symptoms (15.22% vs. 8.23%), DVI (19.57% vs. 9.87%), and VI (near or distant) (20.92% vs. 10.22%). No significant differences were found by education, financial

strain, nativity status, language of interview, comorbidity (heart attack), BMI, smoking status, hearing impairment, and NVI.

Table 5.21 Baseline descriptive characteristics of the sample by falls among older Mexican Americans (N=1219).

Characteristic	Total N (%)	Falls ≥ 1 N (%)	No Falls N (%)	p-value
Total	1219 (100)	368 (30.19)	851 (69.81)	
Age, Mean ± SD	78.67 ± 4.96	79.14 ± 5.34	78.46 ± 4.77	0.0364
Sex (female)	734 (60.21)	252 (68.48)	482 (56.64)	0.0001
Married	612 (50.21)	160 (43.48)	452 (53.11)	0.0020
Education (years), Mean ± SD	4.97 ± 3.89	4.81 ± 3.78	5.03 ± 3.93	0.3612
Financial Strain	719 (58.98)	230 (62.50)	489 (57.46)	0.1006
Nativity (US born)	701 (57.51)	209 (56.79)	492 (57.81)	0.7406
Spanish Interview	1055 (86.55)	314 (85.33)	741 (87.07)	0.4116
Lives with Family	891 (73.09)	249 (20.43)	642 (75.44)	0.0049
Hypertension	608 (49.88)	201 (54.62)	407 (47.83)	0.0294
Arthritis	660 (54.14)	230 (62.50)	430 (50.53)	0.0001
Cancer	63 (5.17)	26 (7.07)	37 (4.35)	0.0491
Diabetes	378 (31.01)	133 (36.14)	245 (28.79)	0.0108
Heart Attack	52 (4.27)	16 (4.35)	36 (4.23)	0.9257
Hip Fracture	30 (2.46)	19 (1.56)	11 (1.29)	<0.0001
Stroke	38 (3.12)	18 (4.89)	20 (2.35)	0.0191
BMI, Mean ± SD	28.02 ± 5.42	28.22 ± 5.59	28.93 ±5.35	0.4008
BMI Categories				0.6955
Underweight	25 (2.05)	8 (2.17)	17 (2.00)	
Normal	344 (28.22)	102 (27.72)	242 (28.44)	
Overweight	455 (37.33)	129 (35.05)	326 (37.31)	
Obese Category 1	273 (22.40)	87 (23.64)	186 (21.86)	
Obese Category 2	122 (10.01)	42 (11.41)	80 (9.40)	
MMSE (total), Mean ± SD	22.51 ± 5.26	21.88 ± 5.50	22.79 ± 5.13	0.0054
Depressive symptoms (CES-D ≥ 16)	126 (10.34)	56 (15.22)	70 (8.23)	0.0002
Current Smoking	95 (7.79)	31 (8.42)	64 (7.52)	0.5891
Hearing Impairment	253 (20.75)	66 (17.93)	187 (21.97)	0.1104
Near VI	39 (3.20)	17 (4.62)	22 (2.59)	0.0639
Distant VI	156 (12.80)	72 (19.57)	84 (9.87)	<0.0001
VI (Near or Distant)	164 (13.45)	77 (20.92)	87 (10.22)	<0.0001

Abbreviations: SPPB=Short Physical Performance Battery; SD=standard deviation; US=United States; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale; VI=vision impairment. Dataset for falls outcome starts from Wave 4.

Longitudinal Analysis

Table 5.22 presents the GEE models for falls over an 18-year period as a function of NVI. Two models were performed to study the association between NVI and falls. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family versus alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with NVI.

A significant association was found between NVI (OR=2.06, 95% CI 1.31-3.22) and falls over time compared to those without NVI (Model 1). When we controlled for all covariates (Model 2) the association between NVI and falls remained significant (OR=2.08, 95% CI 1.22-3.55). Time (OR=1.21, 95% CI 1.16-1.25), diabetes (OR=1.50, 95% CI 1.15-1.97), heart attack (OR=1.61, 95% CI 1.02-2.55), stroke (OR=2.08, 95% CI 1.24-3.48), and depressive symptoms (OR=1.53, 95% CI 1.09-2.15) were factors associated with falls (Model 2).

Table 5.22 Generalized estimating equation models for falls among older Mexican Americans as a function of near vision impairment over 14 years of follow-up (N=851).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.18 (1.15-1.22)	1.21 (1.16-1.25)
Near VI	2.06 (1.31-3.22)	2.08 (1.22-3.55)
Age	1.01 (0.98-1.04)	1.00 (0.97-1.04)
Sex (female)	1.17 (0.92-1.50)	1.19 (0.89-1.60)
Married	0.77 (0.58-1.02)	0.88 (0.63-1.22)
Education (years)	1.00 (0.97-1.03)	1.02 (0.98-1.06)
Financial Strain	1.18 (0.96-1.46)	1.15 (0.90-1.47)

Nativity (Foreign born)	1.00 (0.79-1.27)	1.03 (0.78-1.35)
Spanish Interview	0.86 (0.61-1.20)	0.83 (0.56-1.21)
Lives with Family	0.93 (0.71-1.24)	0.85 (0.60-1.20)
Current Smoking		0.65 (0.35-1.20)
BMI Categories		
Underweight		1.21 (0.49-2.97)
Normal		Reference
Overweight		0.80 (0.60-1.07)
Obese Category 1		0.71 (0.48-1.04)
Obese Category 2		0.77 (0.47-1.26)
Hypertension		1.16 (0.87-1.54)
Arthritis		1.29 (0.99-1.68)
Cancer		1.17 (0.74-1.88)
Diabetes		1.50 (1.15-1.97)
Heart Attack		1.61 (1.02-2.55)
Hip Fracture		1.31 (0.56-3.09)
Stroke		2.08 (1.24-3.48)
Cognitive Impairment (MMSE < 21)		0.95 (0.71-1.27)
Depressive symptoms (CES-D ≥ 16)		1.53 (1.09-2.15)
Hearing Impairment		0.97 (0.69-1.36)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. Dataset for falls outcome starts from Wave 4. The analyses were conducted among those without falls at baseline.

Table 5.23 presents the GEE models for falls over an 18-year period as a function of DVI. Two models were performed to study the association between distant vision impairment and falls.. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity

status, language of interview, and living status (with family vs. alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with DVI.

In Model 1, a significant association was found between DVI (OR=1.36, 95% CI 1.00-1.83) and falls over time compared to those without DVI. However, in Model 2 when we controlled for all covariates (Model 2) the association between DVI and is no longer significant (OR=1.30, 95% CI 0.89-1.92). Time (OR=1.21, 95% CI 1.16-1.25), diabetes (OR=1.50, 95% CI 1.15-1.97), heart attack (OR=1.60, 95% CI 1.01-2.53), stroke (OR=2.11, 95% CI 1.25-3.55), and depressive symptoms (OR=1.50, 95% CI 1.07-2.10) were factors associated with falls (Model 2).

Table 5.23 Generalized estimating equation models for falls among older Mexican Americans as a function of distant vision impairment over 14 years of follow-up (N=851).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.18 (1.15-1.22)	1.21 (1.16-1.25)
Distant VI	1.36 (1.00-1.83)	1.30 (0.89-1.92)
Age	1.00 (0.98-1.03)	1.00 (0.97-1.04)
Sex (female)	1.16 (0.91-1.48)	1.18 (0.88-1.59)
Married	0.78 (0.59-1.04)	0.88 (0.64-1.23)
Education (years)	1.00 (0.97-1.03)	1.02 (0.98-1.06)
Financial Strain	1.18 (0.95-1.45)	1.14 (0.89-1.46)
Nativity (Foreign born)	1.01 (0.80-1.27)	1.04 (0.79-1.37)
Spanish Interview	0.87 (0.62-1.23)	0.84 (0.57-1.23)
Lives with Family	0.92 (0.69-1.22)	0.84 (0.60-1.19)
Current Smoking		0.67 (0.37-1.24)

BMI Categories		
Underweight		1.13 (0.45-2.84)
Normal		Reference
Overweight		0.79 (0.59-1.06)
Obese Category 1		0.71 (0.48-1.04)
Obese Category 2		0.74 (0.46-1.22)
Hypertension		1.19 (0.89-1.58)
Arthritis		1.27 (0.98-1.66)
Cancer		1.19 (0.75-1.89)
Diabetes		1.50 (1.15-1.97)
Heart Attack		1.60 (1.01-2.53)
Hip Fracture		1.30 (0.54-3.15)
Stroke		2.11 (1.25-3.55)
Cognitive Impairment (MMSE < 21)		0.95 (0.71-1.27)
Depressive symptoms (CES-D ≥ 16)		1.50 (1.07-2.10)
Hearing Impairment		0.99 (0.70-1.39)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. Dataset for falls outcome starts from Wave 4. The analyses were conducted among those without falls at baseline.

Table 5.24 presents the GEE models for falls over an 18-year period as a function of VI (near or distant). Two models were performed to study the association between VI (near or distant) and falls. Model 1 included time (years), sex, marital status, education (years), financial strain, nativity status, language of interview, and living status (with family versus alone). Model 2 included smoking status, BMI, comorbidities (hypertension, arthritis, cancer, diabetes, heart attack, hip fracture, and stroke), MMSE score, depressive symptoms, hearing impairment, and

variables included in Model 1 to test whether the addition of these variables modified the relationship socio-demographics and health characteristics with VI (near or distant).

A significant association was found between VI (OR=1.46, 95% CI 1.09-1.96) and falls over time compared to those without VI (Model 1). When we controlled for all covariates (Model 2) the association between VI and falls remained significant (OR=1.45, 95% CI 1.00-2.10). Time (OR=1.21, 95% CI 1.16-1.25), diabetes (OR=1.51, 95% CI 1.15-1.97), heart attack (OR=1.60, 95% CI 1.01-2.53), stroke (OR=2.10, 95% CI 1.25-3.51), and depressive symptoms (OR=1.49, 95% CI 1.07-2.09) were factors associated with falls (Model 2).

Table 5.24 Generalized estimating equation models for falls among older Mexican Americans as a function of vision impairment (near or distant) over 14 years of follow-up (N=851).

	Model 1	**Model 2**
Predictor variables	**OR (95% CI)**	**OR (95% CI)**
Time	1.18 (1.15-1.22)	1.21 (1.16-1.25)
VI (Near or distant)	1.46 (1.09-1.96)	1.45 (1.00-2.10)
Age	1.01 (0.98-1.03)	1.00 (0.97-1.04)
Sex (female)	1.16 (0.91-1.48)	1.18 (0.88-1.58)
Married	0.78 (0.59-1.03)	0.88 (0.63-1.22)
Education (years)	1.00 (0.97-1.03)	1.02 (0.98-1.06)
Financial Strain	1.17 (0.95-1.44)	1.14 (0.89-1.46)
Nativity (Foreign born)	1.01 (0.80-1.28)	1.04 (0.79-1.37)
Spanish Interview	0.87 (0.62-1.23)	0.83 (0.57-1.22)
Lives with Family	0.92 (0.70-1.22)	0.85 (0.60-1.19)
Current Smoking		0.67 (0.36-1.23)
BMI Categories		
Underweight		1.13 (0.60-1.07)
Normal		Reference

Overweight		0.80 (0.60-1.06)
Obese Category 1		0.71 (0.48-1.04)
Obese Category 2		0.75 (0.46-1.22)
Hypertension		1.19 (0.90-1.58)
Arthritis		1.27 (0.97-1.66)
Cancer		1.18 (0.75-1.88)
Diabetes		1.51 (1.15-1.97)
Heart Attack		1.60 (1.01-2.53)
Hip Fracture		1.30 (0.54-3.13)
Stroke		2.10 (1.25-3.51)
Cognitive Impairment (MMSE < 21)		0.93 (0.69-1.25)
Depressive symptoms (CES-D ≥ 16)		1.49 (1.07-2.09)
Hearing Impairment		0.97 (0.69-1.36)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale. Dataset for falls outcome starts from Wave 4. The analyses were conducted among those without falls at baseline.

ANALYSIS FOR MODERATOR EFFECTS

We performed the interaction term between social isolation and NVI, DVI, and VI for each outcome in Aim 2 to test hypothesis 2c. and non-significant interaction terms were found. Then several interaction terms between variables included in Model 1 and Model 2 were performed. We found significant interaction terms between DVI and nativity status, and VI (near or distant) and nativity status for ADL disability (p-value < 0.0001). Stratified analysis by nativity status (Table 5.25) shows that those with DVI and being foreign born had increased odds of ADL disability (OR= 1.76, 95% CI 1.20-2.57) than those with DVI and being US born (OR=0.95, 95% CI 0.64-1.41). Stratified analysis by nativity status (Table 5.25) shows that those with VI and being foreign

born had increased odds of ADL disability (OR=1.78, 95% CI 1.24-2.59) than those with VI and being US born (OR=0.94, 95% CI 0.64-1.39).

Table 5.25 Generalized estimating equation models significant interaction models for ADL disability among older Mexican Americans over 18 years of follow-up.

	ADL disability	
	Foreign Born	**US Born**
	OR (95% CI)	**OR (95% CI)**
DVI	1.76 (1.20-2.57)	0.95 (0.64-1.41)
VI	1.78 (1.24-2.59)	0.94 (0.64-1.39)

ANALYSIS FOR MEDIATOR EFFECTS

To test hypothesis 2d, mediation analyses were performed for each outcome in Aim 2. We only found a mediator effect of depressive symptoms on the relationship between NVI and ADL disability. Table 5.26 presents the GEE to determine whether depressive symptoms is a mediator on the relationship between NVI and ADL disability (Baron & Kenny, 1986). In Model 1, NVI was a significant predictor of ADL disability controlling for time and socio-demographic variables (OR 1.45, 95% CI 1.00-2.11). In Model 2, NVI is a significant predictor of depressive symptoms (mediator) controlling for time and socio-demographic variables (OR 1.78 95% CI 1.14-1.48). In Model 3, depressive symptoms (mediator) is a significant predictor of ADL disability controlling for time and socio-demographic variables (OR=2.32, 95% CI 1.88-2.87). In Model 4, NVI is no longer a significant predictor of ADL disability with depressive symptoms (mediator) in the model controlling for time and socio-demographic variables (OR=1.24, 95% CI

0.84-1.86) and after controlling for all variables (OR=1.15, 95% CI 0.73-1.83) in Model 5. Thus, depressive symptoms is a mediator in the relationship between NVI and ADL disability.

Table 5.26 Generalized estimating equation models for depressive symptoms (mediator variable) and ADL disability among older Mexican Americans over 18 years of follow-up.

Variables	Model 1 ADL Disability OR (95% CI)	Model 2 High depressive symptoms OR (95% CI)	Model 3 ADL Disability OR (95% CI)	Model 4 ADL Disability OR (95% CI)	Model 5 ADL Disability OR (95% CI)
NVI	1.45 (1.00-2.11)	1.78 (1.26-2.53)		1.24 (0.84-1.86)	1.15 (0.73-1.83)
High depressive symptoms			2.32 (1.88-2.87)	2.33 (1.88-2.88)	1.90 (1.47-2.47)

Model 1 includes NVI, time, and demographic variables
Model 2 includes time, NVI, and demographic variables
Model 3 includes time, high depressive symptoms, and demographic variables
Model 4 includes time, NVI, high depressive symptoms, and demographic variables
Model 5 includes time, NVI, high depressive symptoms, and all covariates

Abbreviations: OR=odds ratio; CI=confidence interval

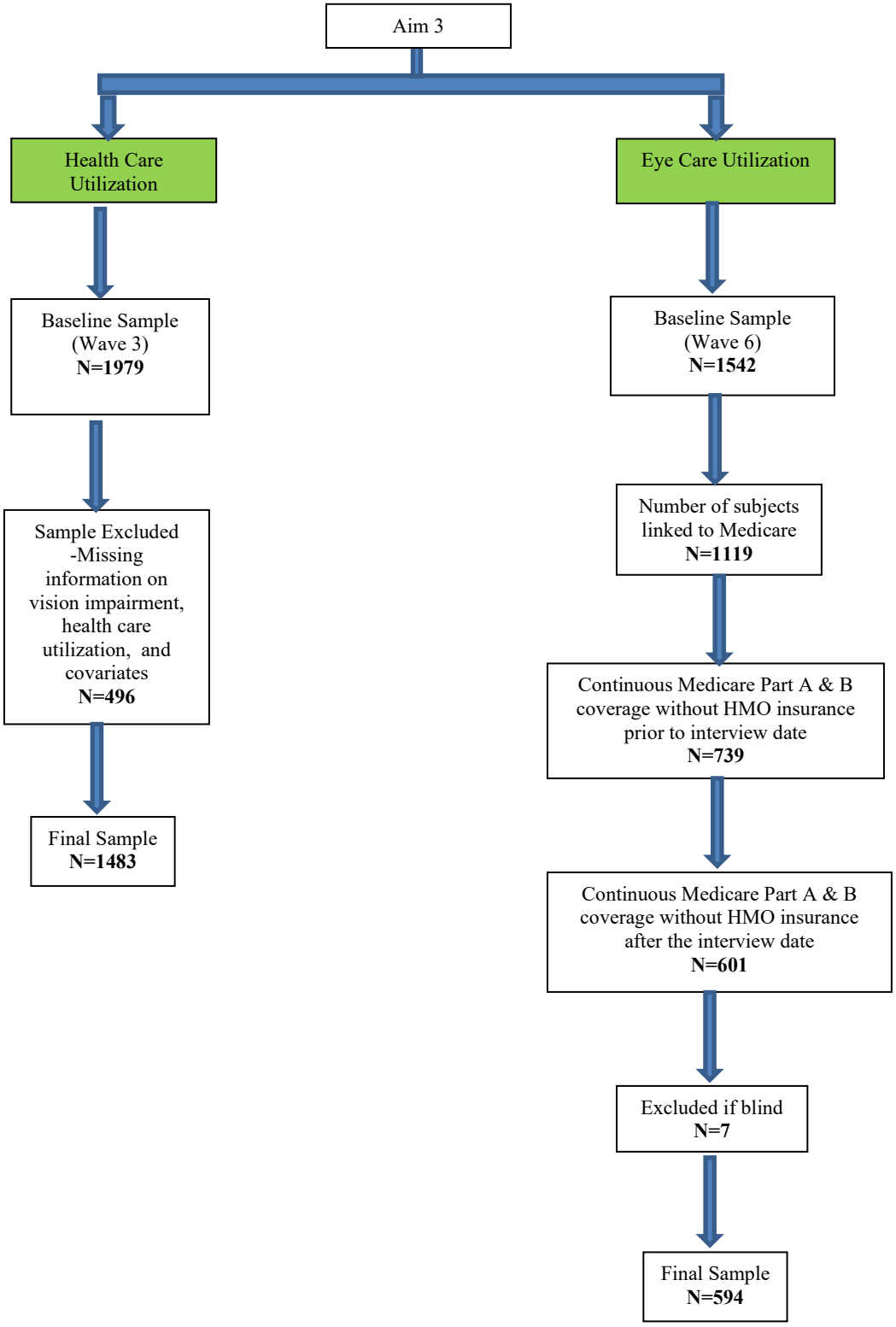
CHAPTER 6

Aim 3 Results

Aim 3: To determine the effect of VI on health care utilization and the factors associated with eye care utilization among older Mexican Americans over time.

This chapter describes the results of Aim three. The purpose of this aim was to determine the effect of VI on health care utilization and the factors associated with eye care utilization. The outcomes examined for health care utilization were medical doctor visits ≤ 1 and hospital stay ≥ 1 day among older Mexican Americans over time. Socio-demographic characteristics, dual enrollment, and comorbidities were examined as factors associates with eye care utilization defined as visiting an optometrist or ophthalmologist and utilizing diagnostic or therapeutic vision services. First, we hypothesized that participants with VI will have greater medical doctor visits and hospitalizations compared to those without VI. Second, we hypothesized that low education, foreign-born, and Spanish language of interview will be associated with lower eye care utilization over time. Third, we hypothesized that participants with dual enrollment (Medicare and Medicaid) will have more access to eye care utilization compared to those without dual enrollment (Medicare and Medicaid).

Figure 6.1 Flowchart of sample selection for Aim 3.



HEALTH CARE UTILIZATION

Descriptive Analysis

At baseline (1998/1999), the mean age of the overall sample was 77.16 (SD ± 5.48) years, 59.68% were female, 51.31% were married, the mean years of education was 4.94 (SD ± 3.86) (Table 6.1). A higher percentage of the overall sample reported financial strain (53.67%), were born in the United States (57.38%), conducted interview in Spanish (71.15%), and indicated living with family (74.58%) (Table 6.1). The most reported comorbidity was arthritis (50.71%), followed by hypertension (48.35%), diabetes (28.86%), cancer (6.27%), heart attack (5.80%), stroke (3.24%) and hip fracture (1.69%) (Table 6.1). The mean BMI was 28.40 kg/m2 (SD ± 5.45) and the mean MMSE score was 22.81 (SD ± 3.86) (Table 6.1). Fifteen percent reported depressive symptoms, 9.51 % were current smokers, 22.39% reported a hearing impairment, and 13.82% were vision impaired (near or distant) (Table 6.1).

Descriptive baseline characteristics of the sample by MD visits are also presented in Table 6.1. Eighty nine percent of older Mexican Americans had MD visits ≥ 1. Participants with MD visits ≥ 1 compared to those with no visits were significantly more likely to be female sex (60.92% vs. 51.88%), to report no currently smoking (91.08% vs. 85.62%), to report co-morbid conditions such as hypertension (51.93% vs. 18.75%), arthritis (53.29% vs. 29.38%), cancer (6.95% vs. 0.63%), diabetes (38.99% vs. 11.25%), heart attack (6.35% vs. 1.25%), to report VI (near or distant) (14.74% vs. 6.25%), and to have higher BMI (28.54 SD ± 5.39 vs. 27.31 SD ± 5.80). No significant differences were found by age, marital status, education, nativity status, language of interview, living status (with family vs. alone), comorbidities (hip fracture and stroke), MMSE score, and depressive symptoms.

Descriptive baseline characteristics of the sample by hospital stay are also presented in Table 6.1. Twenty percent of older Mexican Americans had hospital stay ≥ 1. Participants with hospital stay ≥ 1 compared to those without a hospital stay were significantly more likely to be female sex (64.75% vs. 58.42%), not married (55.59% vs. 46.97%), report co-morbid

conditions such as hypertension (54.58% vs. 46.80%), arthritis (58.98% vs. 47.87%), cancer (9.49% vs. 5.47%), diabetes (34.24% vs. 27.53%), heart attack (13.90% vs. 3.79%), hip fracture (3.39% vs. 1.26%), and stroke (8.14% vs. 1.62%), report high depressive symptoms (19.66% vs. 14.14%), report VI (near or distant) (17.29% vs. 12.96%), and have lower MMSE score (22.18 SD ± 5.28 vs. 22.96 SD ± 5.26). No significant differences were found by age, education, financial strain, nativity status, language of interview, living status (with family vs. alone), BMI, smoking status, and hearing impairment.

Table 6.1 H-EPESE baseline descriptive characteristics of the sample by medical doctor visits and hospital stay among older Mexican Americans (N=1483).

Variables	Total N (%)	Medical Doctor Visits		p-value	Hospital Stay		p-value
		One or more visits N (%)	No Visits N (%)		One or more stays	No stays	
Total	1483 (100)	1323 (89.21)	160 (10.79)		295 (19.89)	1188 (80.11)	
Age, Mean ± SD	77.16 ± 5.48	77.16 ± 5.47	77.19 ± 5.63	0.9392	77.27 ± 5.68	77.14 ± 5.44	0.7039
Sex (female)	885 (59.68)	802 (60.92)	83 (51.88)	0.0332	191 (64.75)	694 (58.42)	0.0474
Married	761 (51.31)	670 (50.64)	91 (56.88)	0.1363	131 (44.41)	630 (53.03)	0.0080
Education (years), Mean ± SD	4.94 ± 3.86	4.97 ± 3.88	4.72 ± 3.71	0.4378	4.79 ± 3.83	4.98 ± 3.87	0.4479
Financial Strain	796 (53.67)	704 (53.21)	92 (57.50)	0.3043	156 (52.88)	640 (53.87)	0.7600
Nativity (US born)	851 (57.38)	763 (57.67)	88 (55.00)	0.5186	163 (55.25)	688 (57.91)	0.4086
Spanish Interview	1064 (71.15)	943 (71.28)	121 (75.63)	0.2486	208 (70.51)	856 (72.05)	0.5977
Lives with Family	1106 (74.58)	980 (74.07)	126 (78.75)	0.1995	215 (72.88)	891 (75.00)	0.4545
Hypertension	717 (48.35)	687 (51.93)	30 (18.75)	<0.0001	161 (54.58)	556 (46.80)	0.0168
Arthritis	752 (50.71)	705 (53.29)	47 (29.38)	<0.0001	174 (58.98)	578 (48.65)	0.0015
Cancer	93 (6.27)	92 (6.95)	1 (0.63)	0.0004	28 (9.49)	65 (5.47)	0.0108
Diabetes	428 (28.86)	410 (30.99)	18 (11.25)	<0.0001	101 (34.24)	327 (27.53)	0.0228
Heart Attack	86 (5.80)	84 (6.35)	2 (1.25)	0.0062	41 (13.90)	45 (3.79)	0.0001
Hip Fracture	25 (1.69)	22 (1.66)	3 (1.88)	0.7460	10 (3.39)	15 (1.26)	0.0196
Stroke	48 (3.24)	46 (3.48)	2 (1.25)	0.1590	24 (8.14)	24 (1.62)	0.0001
BMI, Mean ± SD	28.40 ± 5.45	28.54 ± 5.39	27.31 ± 5.80	0.0074	28.11 ± 5.06	28.48 ± 5.54	0.3010
BMI Categories				0.0243			0.5875

Underweight	24 (1.62)	18 (1.36)	6 (3.75)		6 (2.03)	18 (1.52)	
Normal	381 (25.69)	335 (25.32)	46 (28.75)		74 (25.08)	307 (25.84)	
Overweight	559 (37.69)	492 (37.19)	67 (41.88)		121 (41.02)	438 (35.87)	
Obese Category 1	349 (23.53)	320 (24.19)	29 (18.13)		61 (20.68)	288 (24.24)	
Obese Category 2	170 (11.46)	158 (11.94)	12 (7.50)		33 (11.19)	137 (11.53)	
MMSE (total), Mean ± SD	22.81 ± 3.86	22.84 ± 5.28	22.53 ± 5.19	0.4826	22.18 ± 5.28	22.96 ± 5.26	0.0229
Depressive symptoms (CES-D ≥ 16)	226 (15.24)	209 (15.80)	17 (10.63)	0.0855	58 (19.66)	168 (14.14)	0.0182
Current Smoking	141 (9.51)	118 (8.92)	23 (14.38)	0.0263	32 (10.85)	109 (9.18)	0.3808
Hearing Impairment	332 (22.39)	286 (21.62)	46 (28.75)	0.0409	72 (24.41)	260 (21.89)	0.3525
VI (Near or Distant)	205 (13.82)	195 (14.74)	10 (6.25)	0.0033	51 (17.29)	154 (12.96)	0.0541

Abbreviations: SD=standard deviation; US=United States; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale; VI=vision impairment

Longitudinal Analysis

Table 6.2 presents the GEE models for MD visits over an 18-year period as a function of VI (near or distant). A significant association was found between VI (OR=1.59, 95% CI 1.11-2.30) and MD visits over time compared to those without VI when we controlled for all covariates. Years of education (OR=1.03, 95% CI 1.00-1.07), hypertension (OR=2.96, 95% CI 2.33-3.77), arthritis (OR=1.72, 95% CI 1.37-2.15), cancer (OR=2.27, 95% CI 1.23-4.20), diabetes (OR=1.89, 95% CI 1.41-2.55), and hearing impairment (OR=0.73, 95% CI 0.56-0.94) were also factors associated with MD visits.

Table 6.2 presents the GEE models for hospital stay over an 18-year period as a function of VI (near or distant). A significant association was found between VI (OR=1.37, 95% CI 1.11-1.70) and hospital stay over time compared to those without VI when we controlled for all covariates. Arthritis (OR=1.24, 95% CI 1.05-1.46), cancer (OR=1.70, 95% CI 1.30-2.22), diabetes (OR=1.30, 95% CI 1.41-2.55), heart attack (OR=1.60, 95% CI 1.01-2.53), stroke (OR=2.10, 95% CI 1.10-1.54), heart attack (OR=3.17, 95% CI 2.40-4.19), hip fracture (OR=2.13, 95% CI 1.36-

3.35), stroke (OR=2.81, 95% CI 2.03-3.90), and depressive symptoms (OR=1.23, 95% CI 1.00-1.51) were also factors associated with hospital stay.

Table 6.2 H-EPESE generalized estimating equation models for health care utilization among older Mexican Americans as a function of vision impairment (near or distant) over 18 years of follow-up (N=1483).

Predictor variables	Medical Doctor Visits OR (95% CI)	Hospital Stay OR (95% CI)
Time	1.00 (0.97-1.03)	1.00 (0.98-1.03)
VI (Near or distant)	1.59 (1.11-2.30)	1.37 (1.11-1.70)
Age	1.00 (0.98-1.03)	1.00 (0.98-1.01)
Sex (female)	1.01 (0.78-1.31)	1.12 (0.92-1.35)
Married	0.86 (0.64-1.15)	0.84 (0.69-1.03)
Education (years)	1.03 (1.00-1.07)	0.99 (0.96-1.01)
Financial Strain	0.67 (0.54-0.85)	1.10 (0.93-1.29)
Nativity (Foreign born)	1.14 (0.89-1.46)	1.10 (0.93-1.31)
Spanish Interview	0.84 (0.63-1.13)	0.98 (0.80-1.20)
Lives with Family	1.07 (0.79-1.45)	1.07 (0.89-1.30)
Current Smoking	0.91 (0.63-1.33)	0.99 (0.73-1.33)
BMI Categories		
Underweight	0.76 (0.37-1.55)	1.19 (0.65-2.16)
Normal	Reference	Reference
Overweight	0.91 (0.71-1.17)	0.99 (0.82-1.20)
Obese Category 1	1.02 (0.74-1.41)	0.82 (0.66-1.03)
Obese Category 2	0.99 (0.64-1.52)	0.83 (0.61-1.13)
Hypertension	2.96 (2.33-3.77)	0.98 (0.83-1.17)
Arthritis	1.72 (1.37-2.15)	1.24 (1.05-1.46)

Cancer	2.27 (1.23-4.20)	1.70 (1.30-2.22)
Diabetes	1.89 (1.41-2.55)	1.30 (1.10-1.54)
Heart Attack	1.39 (0.77-2.52)	3.17 (2.40-4.19)
Hip Fracture	1.40 (0.60-3.31)	2.13 (1.36-3.35)
Stroke	1.18 (0.62-2.25)	2.81 (2.03-3.90)
Cognitive Impairment (MMSE < 21)	1.21 (0.93-1.57)	0.97 (0.82-1.15)
Depressive symptoms (CES-D ≥ 16)	1.19 (0.84-1.67)	1.23 (1.00-1.51)
Hearing Impairment	0.73 (0.56-0.94)	0.94 (0.76-1.15)

Abbreviations: VI=vision impairment; OR=odds ratio; CI=confidence interval; BMI=body mass index; MMSE=Mini Mental State Exam; CES-D=Center for Epidemiologic Studies Depression Scale

Analysis for moderator effects

We performed several interaction terms between variables. We found significant interaction terms between VI (near or distant) and low depressive symptoms for hospital stay (p-value < 0.0303). Stratified analysis by depressive symptoms (Table 6.3) shows that those with VI and low depressive symptoms had increased odds of hospital stay (OR=1.56, 95% CI 1.21-1.99) than those with VI and high depressive symptoms (OR=0.99, 95% CI 0.66-1.48).

Table 6.3 H-EPESE moderator analysis – depressive symptoms moderating the relationship between vision impairment (near or distant) and hospital stay.

	High Depressive Symptoms OR (95% CI)	**Low Depressive Symptoms OR (95% CI)**
VI	0.99 (0.66-1.48)	1.56 (1.21-1.99)

Abbreviations: OR=odds ratio; CI=confidence interval; VI=vision impairment

EYE CARE UTILIZATION

The prevalence of eye diseases diagnosis at wave 5 interview date (2004/2005) and one year later are presented in Table 6.4. At interview 49.3% indicated having an eye disease and increased to 63.5% one year later. At wave 5 interview date, the most reported eye disease diagnosis was cataract (31.0%), followed by glaucoma (18.4%), other eye disease (including unspecified retinal disorder, unspecified disorder of choroid, unspecified disorder of iris and ciliary body, unspecified visual disturbance, and unspecified visual loss) (14.8%), age related macular degeneration (AMD) (10.8%), and retinopathy (7.7%) (Table 6.4). One year after wave 5 interview date, the most reported eye disease diagnosis was cataract (45.1%), followed by other eye disease (25.9%), glaucoma (24.2%), AMD (15.3%), and retinopathy (12.0%) (Table 6.4).

Table 6.4 Prevalence of eye diseases at interview date (wave 5) and one year later.

Eye disease	**Prevalence N (%)**	
	At interview (Wave 5)	**Year after interview at wave 5**
Any	293 (49.3)	377 (63.5)
AMD	64 (10.8)	91 (15.3)
Cataract	184 (31.0)	268 (45.1)
Glaucoma	109 (18.4)	144 (24.2)
Retinopathy	46 (7.7)	71 (12.0)
Other	88 (14.8)	154 (25.9)

Abbreviations: AMD=age-related macular degeneration.
Other category = included (but not limited to) unspecified retinal disorder, unspecified disorder of choroid, unspecified disorder of iris and ciliary body, unspecified visual disturbance, and unspecified visual loss.

One year following wave 5 interview date, the unadjusted rate of outpatient visits to optometrist or ophthalmologist are presented in Table 6.5. The highest percentage of the overall sample by age category was 39.6% for 81-85 years, followed by 32.0% for those aged 75-80 years, and 28.5% for those aged 86 years or older. A majority of the sample were female (63.8%), had less than 6 years of education (72.7%), were US born (59.4%), conducted interview in Spanish (84.0%), and indicated having Medicaid (76.3%). A higher percentage of the overall sample reported having no mobility impairment (64.3%) and had an Elixhauser Weighted Comorbidity Score ≥ 5 (52.7%). Fifteen percent of the overall sample self-reported a vision problem and 67.2% indicate being told by doctor had eye problems.

Descriptive characteristics of the sample for outpatient visits are presented in Table 6.5. For any outpatient visit, the highest percentage of the overall sample by age was 56.2% for those aged 81-85 years, followed by 55.3% for those aged 75-80 years, and 44.4% for those aged 86 years or older. A majority of the sample were female (56.5%), had 7 or more years of education (56.2%), were non-US born (52.7%), conducted interview in Spanish (54.5%), and indicated having Medicaid (53.9%). A higher percentage of the overall sample reported having no mobility impairment (58.9%) and had an Elixhauser Weighted Comorbidity Score ≥ 5 (55.9%). Forty-eight percent self-reported a vision problem and 61.2% indicate being told by doctor had eye problems.

Descriptive characteristics of the sample for optometrist visits are presented in Table 6.5. The highest percentage of the overall sample by age 24.7% for those aged 75-80 years, followed by 23.4% for those aged 81-85 years, and 17.2% for those aged 86 years or older. A majority of the sample were female (23.2%), had less than 6 years of education (23.6%), were US born (22.4%), conducted interview in Spanish (24.0%), and indicated having Medicaid (24.7%). A higher percentage of the overall sample reported having no mobility impairment (25.9%) and had an Elixhauser Weighted Comorbidity Score ≥ 5 (22.7%). Twenty one percent self-reported a vision problem and 24.8% indicate being told by doctor had eye problems.

Descriptive characteristics of the sample for ophthalmologist visits are presented in Table 6.5. For ophthalmologist visits, the highest percentage of the overall sample by age was 40.4% for those aged 81-85 years, followed by 34.3% for those aged 75-80 years, and 34.3% for those aged 86 years or older. A majority of the sample were female (40.4%), had 7 or more years of education (43.2%), were non-US born (38.2%), conducted interview in Spanish (37.9%), and indicated having Medicaid (38.0%). A higher percentage reported having no mobility impairment (40.1%) and had an Elixhauser Weighted Comorbidity Score ≥ 5 (41.5%). Thirty four percent self-reported a vision problem and 45.4% indicate being told by doctor has eye problems.

Table 6.5 Unadjusted rate of outpatient visits to optometrist or ophthalmologist the year following the interview date (wave 5).

		Outpatients Visits		
Characteristics	**Sample N (%)**	**Any N (%)**	**Optometrist N (%)**	**Ophthalmologist N (%)**
Age (years)				
75-80	190 (32.0)	105 (55.3)	47 (24.7)	70 (36.8)
81-85	235 (39.6)	132 (56.2)	55 (23.4)	95 (40.4)
85+	169 (28.5)	75 (44.4)	29 (17.2)	58 (34.3)
Sex				
Male	215 (36.2)	98 (45.6)	43 (20.0)	70 (32.6)
Female	379 (63.8)	214 (56.5)	88 (23.2)	153 (40.4)
Education years				
0-6	432 (72.7)	221 (51.2)	102 (23.6)	153 (35.4)
7+	162 (27.3)	91 (56.2)	29 (17.9)	70 (43.2)
Nativity				
Non-US Born	241 (40.6)	127 (52.7)	52 (21.6)	92 (38.2)
US Born	353 (59.4)	185 (52.4)	79 (22.4)	131 (37.1)
Interview Language				
English	95 (16.0)	40 (42.1)	11 (11.6)	34 (35.8)
Spanish	499 (84.0)	272 (54.5)	120 (24.0)	189 (37.9)
Medicaid				
No	141 (23.7)	68 (48.2)	19 (13.5)	51 (36.2)
Yes	453 (76.3)	244 (53.9)	112 (24.7)	172 (38.0)
Mobility impairment				
None	382 (64.3)	225 (58.9)	99 (25.9)	153 (40.1)

Stand with support	157 (26.4)	68 (43.3)	24 (15.3)	55 (35.0)
Unable to stand	55 (9.3)	19 (34.5)	8 (14.5)	15 (27.3)
Self-reported vision problems				
No	505 (85.0)	269 (53.3)	112 (22.2)	193 (38.2)
Yes	89 (15.0)	43 (48.3)	19 (21.3)	30 (33.7)
Told by doctor has eye problems				
No	195 (32.8)	68 (34.9)	32 (16.4)	42 (21.5)
Yes	399 (67.2)	244 (61.2)	99 (24.8)	181 (45.4)
Elixhauser Weighted Comorbidity Score				
< 5	281 (47.3)	137 (48.8)	60 (21.4)	93 (33.1)
5+	313 (52.7)	175 (55.9)	71 (22.7)	130 (41.5)

Table 6.6 presents the adjusted odds ratios of visiting an optometrist or ophthalmologist in outpatient settings the year following the wave 5 interview date. Greater odds of visiting an optometrist or ophthalmologist were found for Spanish interview (OR=1.82, 95% CI 1.09-3.03), told by doctor had eye problems (OR=3.13, 95% CI 2.13-4.60), and scored ≥ 5 on the Elixhauser Weighted Comorbidity index (OR=1.58, 95% CI 1.10-2.27) compared to those with no visit to an optometrist or ophthalmologist after controlling for all covariates. Lower odds of visiting an optometrist or ophthalmologist were found for male sex (OR=0.63, 95% CI 0.43-0.91) and participants who reported mobility impairment, stand with support (OR=0.43, 95% CI 0.28-0.66) and unable to stand (OR=0.30, 95% CI 0.16-0.59). Age, years of education, Medicaid, and self-reported vision problems were not significantly associated with visiting an optometrist or ophthalmologist the year following wave 5 interview date.

Table 6.6 Adjusted odds ratios of visiting an optometrist or ophthalmologist in outpatient settings the year following the interview date (wave 5).

Characteristics	**Odds Ratio (95% CI)**	**P-value**
Age		
75-80	Reference	

81-85	1.03 (0.68 - 1.55)	0.9002
85+	0.69 (0.44 - 1.09)	0.1135
Sex		
Female	Reference	
Male	0.63 (0.43 - 0.91)	0.0145
Education years		
0-6	Reference	
7+	1.17 (0.76 - 1.82)	0.4769
Nativity		
Non-US Born	Reference	
US Born	1.27 (0.86 - 1.88)	0.2265
Interview Language		
English	Reference	
Spanish	1.82 (1.09 - 3.03)	0.0227
Medicaid		
No	Reference	
Yes	1.48 (0.93 - 2.36)	0.0974
Mobility impairment		
None	Reference	
Stand with support	0.43 (0.28 - 0.66)	0.0001
Unable to stand	0.30 (0.16 - 0.59)	0.0004
Self-reported vision problems		
No	Reference	
Yes	0.78 (0.47 - 1.29)	0.3361
Told by doctor has eye problems		
No	Reference	

Yes	3.13 (2.13 - 4.60)	<.0001
Elixhauser Weighted Comorbidity Score		
<5	Reference	
≥5	1.58 (1.10-2.27)	0.0129

One year following wave 5 interview date, the unadjusted rate of diagnostic and therapeutic vision services utilization is presented in Table 6.7. For any vision service, the highest percentage of the sample by age was 35.7% for those aged 81-85 years, followed by 34.2% for those aged 75-80, and 25.4% for those 86 years or older. A majority of the sample were female (36.9%), had 7 or more years of education (40.1%), were US born (36.0%), conducted interview in English (34.7%), and indicated having Medicaid (33.1%). A higher percentage of the overall sample reported having no mobility impairment (38.0%) and had an Elixhauser Weighted Comorbidity Score ≥ 5 (32.6%). Thirty seven percent self-reported a vision problem and 37.3% indicated being told by doctor had eye problems (Table 6.7).

Descriptive characteristics of the sample for AMD are presented in Table 6.7. For AMD, the highest percentage of the sample by age was 5.3% for those aged 75-80 years, followed by 3.4% for those aged 81-85 years, and 1.2% for those aged 86 years or older. A majority of the sample were female (3.7%), had 7 or more years of education (4.3%), were non-US born (3.7%), conducted interview in English (5.3%), and indicated having Medicaid (3.5%). A higher percentage of the AMD sample reported having no mobility impairment (3.7%) and had an Elixhauser Weighted Comorbidity Score < 5 (3.6%). Five percent self-reported a vision problem and 4.5% indicate being told by doctor had eye problems.

Descriptive characteristics of the sample for cataract are presented in Table 6.7. For cataract, the highest percentage of the sample by age was 5.1% for those aged 81-85 years, followed by 4.2% for those aged 75-80 years, and 1.8% for those aged 86 years or older. A majority of the sample were female (4.4%), had 7 or more years of education (4.9%), were non-US born

(38.2%), conducted interview in Spanish (37.9%), and indicated having Medicaid (4.2%). A higher percentage reported having no mobility impairment (5.5%) and had an Elixhauser Weighted Comorbidity Score ≥ 5 (4.2%). Five percent self-reported a vision problem and 4.5% indicated being told by doctor had eye problems.

Descriptive characteristics of the sample for glaucoma are presented in Table 6.7. For glaucoma, the highest percentage of the sample by age was 32.2% for those aged 81-85 years, followed by 32.1% for those aged 75-80 years, and 24.3% for those aged 86 years or older. A majority of the sample were female (34.6%), had 7 or more years of education (39.5%), were US born (33.7%), conducted interview in English (30.5%), and indicated having Medicaid (30.9%). A higher percentage reported having no mobility impairment (35.3%) and had an Elixhauser Weighted Comorbidity Score ≥ 5 (31.0%). Thirty five percent self-reported a vision problem and 34.8% indicated being told by doctor had eye problems.

Descriptive characteristics of the sample for retinopathy are presented in Table 6.7. For retinopathy, the highest percentage of the sample by age was 5.8% for those aged 75-80 years, followed by 2.6% for those aged 81-85 years, and 0.6% for those aged 86 years or older. A majority of the sample were female (3.2%), had 7 or more years of education (3.7%), were non-US born (3.7%), conducted interview in English (4.2%), and indicated having Medicaid (3.8%). A higher percentage reported having no mobility impairment (3.9%) and had an Elixhauser Weighted Comorbidity Score < 5 (3.2%). Six percent self-reported a vision problem and 4.3% indicated being told by doctor had eye problems.

Table 6.7 Unadjusted rate of diagnostic and therapeutic vision services utilization the year following the interview date (wave 5).

	Vision Services					
Characteristics	Sample N (%)	Any N (%)	AMD N (%)	Cataract N (%)	Glaucoma N (%)	Retinopathy N (%)
Age						
75-80	190 (32.0)	65 (34.2)	10 (5.3)	8 (4.2)	61 (32.1)	11 (5.8)

81-85	235 (39.6)	84 (35.7)	8 (3.4)	12 (5.1)	78 (33.2)	6 (2.6)
85+	169 (28.5)	43 (25.4)	2 (1.2)	3 (1.8)	41 (24.3)	1 (0.6)
Sex						
Male	215 (36.2)	52 (24.2)	6 (2.8)	8 (3.7)	49 (22.8)	6 (2.8)
Female	379 (63.8)	140 (36.9)	14 (3.7)	15 (4.0)	131 (34.6)	12 (3.2)
Education years						
0-6	432 (72.7)	127 (29.4)	13 (3.0)	15 (3.5)	116 (26.9)	12 (2.8)
7+	162 (27.3)	65 (40.1)	7 (4.3)	8 (4.9)	64 (39.5)	6 (3.7)
Nativity						
Non-US Born	241 (40.6)	65 (27.0)	9 (3.7)	8 (3.3)	61 (25.3)	9 (3.7)
US Born	353 (59.4)	127 (36.0)	11 (3.1)	15 (4.2)	119 (33.7)	9 (2.5)
Interview Language						
English	95 (16.0)	33 (34.7)	5 (5.3)	6 (6.3)	29 (30.5)	4 (4.2)
Spanish	499 (84.0)	159 (31.9)	15 (3.0)	17 (3.4)	151 (30.3)	14 (2.8)
Medicaid						
No	141 (23.7)	42 (29.8)	4 (2.8)	5 (3.5)	40 (28.4)	1 (0.7)
Yes	453 (76.3)	150 (33.1)	16 (3.5)	18 (4.0)	140 (30.9)	17 (3.8)
Mobility impairment						
None	382 (64.3)	145 (38.0)	14 (3.7)	21 (5.5)	135 (35.3)	15 (3.9)
Stand with support	157 (26.4)	41 (26.1)	5 (3.2)	1 (0.6)	40 (25.5)	3 (1.9)
Unable to stand	55 (9.3)	6 (10.9)	1 (1.8)	1 (1.8)	5 (9.1)	0 (0.0)
Self-reported vision problems						
No	505 (85.0)	159 (31.5)	16 (3.2)	19 (3.8)	149 (29.5)	13 (2.6)
Yes	89 (15.0)	33 (37.1)	4 (4.5)	4 (4.5)	31 (34.8)	5 (5.6)
Told by doctor has eye problems						
No	195 (32.8)	43 (22.1)	2 (1.0)	5 (2.6)	41 (21.0)	1 (0.5)
Yes	399 (67.2)	149 (37.3)	18 (4.5)	18 (4.5)	139 (34.8)	17 (4.3)
Elixhauser Weighted Comorbidity Score						
<5	281 (47.3)	90 (32.0)	10 (3.6)	10 (3.6)	83 (29.5)	9 (3.2)
≥5	313 (52.7)	102 (32.6)	10 (3.2)	13 (4.2)	97 (31.0)	9 (2.9)

Abbreviations: AMD=age-related macular degeneration

Table 6.8 presents the adjusted odds ratios of utilizing a diagnostic or therapeutic vision service the year following the wave 5 interview date. Greater odds of utilizing a diagnostic or therapeutic vision service were found for US born (OR=1.72, 95% CI 1.13-2.61), told by doctor has eye problems (OR=2.04, 95% CI 1.34-3.10), and Medicaid (OR=1.70, 95% CI 1.04-2.78) compared to those with no utilization of a diagnostic or therapeutic vision service after controlling for all covariates. Lower odds of utilizing a diagnostic or therapeutic vision service were found for male sex (OR=0.56, 95% CI 0.38-0.84) and participants who reported mobility impairment, stand with support (OR=0.48, 95% CI 0.31-0.76) and unable to stand (OR=0.14, 95% CI 0.06-0.37). Age, years of education, language of interview, the Elixhauser Weighted Comorbidity Score, and self-reported vision problems were not significantly associated with utilizing a diagnostic or therapeutic vision service the year following wave 5 interview date.

Table 6.8 Adjusted odds ratios of utilizing a diagnostic or therapeutic vision service the year following the interview date (wave 5).

Characteristic	Odds Ratio (95% CI)	P-value
Age		
75-80	Reference	
81-85	1.13 (0.74 - 1.72)	0.5844
85+	0.76 (0.46 - 1.24)	0.2675
Sex		
Female	Reference	
Male	0.56 (0.38 - 0.84)	0.0050
Education years		
0-6	Reference	
7+	1.42 (0.91 - 2.22)	0.1229
Nativity		

Non-US Born	Reference	
US Born	1.72 (1.13 - 2.61)	0.0109
Interview Language		
English	Reference	
Spanish	1.08 (0.64 - 1.83)	0.7652
Medicaid		
No	Reference	
Yes	1.70 (1.04 - 2.78)	0.0352
Mobility impairment		
None	Reference	
Stand with support	0.48 (0.31 - 0.76)	0.0017
Unable to stand	0.14 (0.06 - 0.37)	0.0001
Self-reported vision problems		
No	Reference	
Yes	1.55 (0.91 - 2.62)	0.1059
Told by doctor has eye problems		
No	Reference	
Yes	2.04 (1.34 - 3.10)	0.0009
Elixhauser Weighted Comorbidity Score		
<5	Reference	
≥5	1.24 (0.85-1.80)	0.2652

CHAPTER 7

DISCUSSION

In our research study we examined the (1) predictor factors of VI, (2) effect of VI on physical and cognitive function, frailty, IADL disability, ADL disability, and (3) VI as predictor factor of health care utilization and predictor factors of eye care utilization among older Mexican Americans. Descriptive analyses were performed to examine the baseline sample characteristics by VI and outcomes. GEE modeling was performed to obtain the OR and 95% CI of VI, health outcomes, and health care utilization. We found that predictor factors of VI were age, financial strain, multimorbidity, lower MMSE scores, high depressive symptoms, and hearing impairment. VI had a significant effect on cognitive function, frailty, IADL disability, ADL disability, falls, MD visits, and hospital stays. However, we did not find a significant effect of VI on physical function impairment. The most prevalent eye disease were cataract and glaucoma.

AIM 1: To examine the predictor factors of VI in older Mexican Americans over time.

The purpose of aim one this study was to determine if older age, female sex, low education, foreign-born, social isolation, high depressive symptoms, and multimorbidity are predictors of VI among older Mexican Americans over time.

Results of this study indicated that at baseline only four percent of older Mexican Americans reported NVI, however, reports of DVI were higher at fourteen percent. Predictors of NVI and DVI were time, lower MMSE score, depressive symptoms, and hearing impairment. Spanish interview was a predictor of NVI only. Other predictors of DVI were age, financial strain, and multimorbidity. Older age and multimorbidity were not significant predictors for NVI. Female sex, foreign-born, social isolation, and low education were not significant predictors for both NVI

and DVI. Additional analysis with specific comorbidities indicated that heart attack was a predictor of NVI and arthritis a predictor of DVI over time.

Female sex was not associated with VI over time and are not congruent with previous longitudinal research findings where female sex has been found to be associated with VI in older adults using the Beaver Dam Eye Study over a 20-year follow-up period (Klein et al., 2013). Findings from Evans, Klein, and Varma showed that older age was associated with VI and are similar to our findings (Evans et al., 2002; Klein et al., 2013; Varma et al., 2016). Findings from Livingston, Ulldemolins, Tielsch, and Ryskulova showed that lower education was associated with VI while we did not find this association (Livingston et al., 1997; Ulldemolins et al., 2012; Tielsch et al., 1991; Ryskulova et al., 2008). Liang et al. using the Stockholm County Council Public Health Surveys (SCCPHS) in Sweden (Liang et al., 2018) and Wilson et al. using the 2003-2008 NHANES (Wilson et al., 2014) found that being foreign-born was associated with VI. Being foreign-born was not associated with VI in our study. To our knowledge, no previous research has been conducted to analyze the relationship between language of interview and VI. In our study, Spanish interview was associated with NVI only and not with DVI when performing longitudinal analysis over 18 years. Contrary to our findings where we did not find an association between social isolation and VI, findings from Tetteh, Coyle, and Resnick found an association between social isolation and VI (Tetteh et al., 2020; Coyle et al., 2017; Resnick et al., 1997).

Findings from Court, Garin, and Buttery demonstrated that multimorbidity was associated with VI (Court et al., 2014; Garin et al., 2014; Buttery et al., 2015). Garin et al., using the COURAGE in Europe from Garin et al. demonstrated that both NVI and DVI was associated with multimorbidity when performing cross-sectional analysis, however, in our study multimorbidity was associated with DVI only and not with NVI over time (Garin et al., 2014). Furthermore, Garin and colleagues found that when performing analysis of specific comorbidities, arthritis was a predictor of DVI (Garin et al., 2014) and are similar to our findings on DVI. Garin et al. found that DVI was associated with diabetes and stroke, while NVI was associated with stroke only (Garin

et al., 2014). Stroke was not a significant predictor for VI in our study. Our sample of the H-EPESE had a low occurrence of stroke and could be a reason this association was not found. Diabetes was not a significant predictor of VI in our study and this could be due to participants in the H-EPESE sample are visiting their physician more frequently for diabetes thus preventing VI before it occurs.

Depressive symptoms have been also found to be associated with VI in older adults among participants from the Korean National Health Insurance database (Choi et al., 2018) and among participants in the RCT international multicenter longitudinal prospective cohort study in the Netherlands (Heesterbeek et al., 2017) over twelve and two years of follow-up, respectively. Several studies have found VI associated with cognitive impairment (Swenor et al., 2018; Hale et al., 2020a; Hale et al., 2020b; Dias-Venegas et al., 2016; Gupta, 2021) similar to our findings over 18-years of follow-up. Hearing impairment has been found to be associated with VI in older adults from the Smith Kettlewell Institute (SKI) longitudinal study of vision and function in the elderly (Schneck et al., 2012) and the Blue Mountains Eye Study (Chia et al., 2006) which are similar to results in our study for both NVI and DVI.

In summary, the findings from Aim 1 provide further confirmation that lower cognition, depressive symptoms, and hearing impairment are predictors of VI over time. The study findings are unique because both NVI and DVI were analyzed separately to further understand the individual predictors that may be similar or different for NVI only, DVI only, or both near and distant VI. This research adds knowledge related to health disparity and access research with finding that Spanish interview was related to NVI indicating that there may be a barrier with near vision eye examination access due to language barriers for older Mexican Americans that have limited English proficiency. This is an important issue that can be addressed by including language barrier as a risk factor during the eye screening process for healthcare providers. It is also recommended health care policy makers develop further regulations to address vision health disparities due to language.

AIM 2: To examine the effect of VI on physical and cognitive function, frailty, disability, and falls among older Mexican Americans over time.

The purpose of this aim was to determine whether VI predicts physical and cognitive function, frailty, disability, and falls and whether these relationships are moderated by social isolation or mediated by high depressive symptoms among older Mexican Americans over time.

Results indicated that NVI, DVI, and VI (near or distant) was not associated with physical function impairment and are not consistent with some published longitudinal studies regarding physical function impairment. For example, VI was found to be associated with physical function impairment (walking and gardening) using longitudinal analysis from the German Study on Ageing, Cognition and Dementia in Primary Care Patients (Hajek et al., 2016). The inconsistency of results could be due to the difference in measurement of physical function impairment. In our study we used the SPPB test to determine physical function impairment.

DVI and VI (near or distant) was associated with cognitive function impairment and are consistent with published longitudinal studies regarding cognitive function impairment. For example, cognitive function impairment has been found to be associated with VI using longitudinal analysis of the German Study on Ageing, Cognition and Dementia in Primary Care Patients (Hajek et al., 2016), the Study of Osteoporotic Fractures (SOF) (Lin et al., 2004), the Aging, Demographics, and Memory Study (ADAMS) (Ehrlich et al., 2021), and the Health Aging, and Body Composition (ABC) study (Swenor et al., 2018) which are similar with the results found in our study for VI over an 18-year period.

No significant association was found between NVI and cognitive impairment over 18 years of follow-up which is not consistent with previous research performed by Reyes-Ortiz using the H-EPESE (Reyes-Ortiz et al., 2005). Reyes-Ortiz et al. found that NVI predicted cognitive decline

over 7 years of follow-up and DVI did not predict cognitive decline (Reyes-Ortiz et al., 2005). Possible reasons for the inconsistency could be the following: (1) measure used (Reyes-Ortiz separated NVI and DVI using objective vision measures whereas our research study separated NVI and DVI using self-reported measures), (2) attrition effect, (3) longer follow-up of 18 years versus 7 years, and (4) excluding participants may have underestimated the relationship since excluded are more likely to have lower MMSE scores (Reyes-Ortiz et al., 2005).

The findings of this study are consistent with previous studies regarding frailty. For example, frailty has been found to be associated with VI using the longitudinal study of the Women's Health and Aging Studies (WHAS) (OR=3.5) (Swenor et al., 2020), the English Longitudinal Study of Ageing (ELSA) (Liljas et al., 2017) (OR=3.25), and the Toledo Study for Healthy Aging (TSHA) (OR=2.5) which are similar with the results found in our study for VI over an 18-year period. Our study is unique because it applies to older Mexican Americans and is the longest follow-up research study conducted to examine the association between VI and frailty.

In our study we found that participants with DVI were almost two times more likely to report IADL disability after controlling for all covariates. These results are similar to those found in the longitudinal study in France for distance visual acuity using the Three City Alienor population-based study (Nael et al., 2017) where participants with VI had greater odds of IADL disability than those without VI. It is also similar to those found in the Salisbury Eye Evaluation study (Lam et al., 2013) and in the eight-years of follow-up of the French Three-City Cohort study (Peres et al., 2017).

We found that participants with VI (near or distant) had greater odds of ADL disability over time after controlling for all covariates. The findings are somewhat consistent with previous studies related to VI and ADL disability. For example, longitudinal findings from Lam et al. and Cao et al. showed that VI was associated with ADL disability (Lam et al., 2013; Cao et al., 2021). Findings using the Salisbury Eye Evaluation study indicated that over three years of follow-up, VI predicted increased difficulty in performing ADLs among older Americans (Lam et al., 2013). Findings from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) over twelve years of

follow-up showed that progressive decline in vision was significantly associated with increased risk of ADL disability (Cao et al., 2021). No significant association was found with ADL disability when we analyzed NVI and DVI separately. These results are not consistent with previous findings from the French Three-City Cohort study when specific ADL tasks were analyzed separately over eight years of follow-up where they found that NVI was associated with difficulty in ADL tasks of bathing and dressing only (Peres et al., 2017).

We found VI as predictor of falls over time and these findings are similar to those published by Moller et al. using the Swedish National Study on Aging and Care (SNAC) where the authors found that those with VI have greater odds of falls over 3 and 6 years of follow-up (Moller et al., 2012) and by Klein et al. using the Beaver Dam Eye Study where the authors found that those with VI have greater odds of falls over 5 years of follow-up (Klein et al., 2003a).

AIM 3: To determine the factors of health and eye care utilization among older Mexican Americans with and without VI over time.

The purpose of this aim was to determine the effect VI on health care utilization (MD visits and hospitalizations) and the factors associated with eye care utilization among older Mexican Americans over time.

Results indicated that at baseline participants with health care utilization (MD visits and hospitalizations) were significantly more likely to report VI. We found that participants with VI had greater odds of MD visits ≥ 1 over time after controlling for all covariates. Participants with VI had greater odds of hospital stay over time after controlling for all covariates. Cataract and glaucoma were the most reported vision impairment diagnosis at wave 5 interview date (2004/2005). A higher percentage of participants reported visit to ophthalmologist compared to optometrist. The highest percentage of diagnostic and therapeutic vision services utilization was for those with glaucoma and cataract. Factors associated with optometrist or ophthalmologist visit

were female sex, Spanish interview, told by doctor had eye problems, and scored ≥ 5 on the Elixhauser Weighted Comorbidity Index. Factors associated with utilizing a diagnostic or therapeutic vision service were female sex, US born, told by doctor has eye problems, and Medicaid coverage.

We found VI as predictor of health care utilization over time and these findings are similar to those published by Bal et al. using the Medicare data set where they found that time to first hospitalization was significantly higher for Medicare recipients with VI over 3 years of follow-up (Bal et al., 2017).

Previous longitudinal studies have consistently indicated that female sex is associated with VI when compared to male sex (Aljied et al., 2018; Varma et al., 2004; Klein et al., 2013). In our research study we found that being male had lower odds of eye care utilization and these findings are similar to those published by McClure et al. using the ancillary study of the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) where the authors found that male sex have less odds of having an eye examination over 2 years of follow-up (McClure et al., 2016).

Eye care access for foreign-born participants and language of interview has been shown to be an important topic for Mexican Americans. In our research study we found that being US born was associated with eye care utilization for a diagnostic or therapeutic vision service when compared to participants who were non-US born. These findings are similar to those published by Liang et al. and Wilson et al. where they found that being foreign-born increased the prevalence of having a VI (Liang et al., 2018; Wilson et al., 2014). In our research study we found that Spanish interview was associated with optometrist and ophthalmologist visit. This was opposite of what we were expecting to find based on previous research articles that indicated an important determinant of health care access is whether a language barrier exists (Zheng et al., 2012; Al Shamsi et al., 2020). For example, Hamm and colleagues indicated that eye care treatment with a health care provider could be affected by communication barriers (Hamm et al., 2021). While Nesher et al. recommended using a recorded explanation of vision testing in the patient's native language (Nesher et al., 2001). Additional research needs to be conducted in this area.

Sloan and colleagues linked the National Long-Term Care Survey (NLTCS) with the Medicare data set and found that regular eye examinations are protective for vision decline and decline with ADL/IADL disability (Sloan et al., 2005). Being told by doctor has eye problems was associated with eye care utilization for both visiting an eye provider and receiving diagnostic and therapeutic vision services in our study. This is important because Mexican Americans in this study are reporting that their vision impairment is being addressed if their physician mentioned they had problems. Thus, follow-up care is being received for VI in this population.

Original Medicare will pay for the cost of diagnosing and treating most eye diseases and conditions however for the most part they will not pay for routine vision services such as vision exams or corrective lenses (Backman, 2021). Medicaid is administered by each state for qualified low-income individuals and may cover vision services such as eye exams and vision treatment if it is related to medical care for diseases that can impair vision (cataracts, glaucoma, etc.) (Silvia, 2021). Current health policy for coverage of vision services in the US is reflective in our study because we found that having Medicaid coverage was associated with utilizing a diagnostic or therapeutic vision service, however, it was not associated with visiting an optometrist or ophthalmologist.

CONCLUSION

This research study found that VI among older Mexican Americans is common. The highest percentage of VI by type was DVI (12.9 to 27.8%), followed by VI (near or distant) (13.7% to 27.6%), and NVI (3.7% to 4.3%). The most prevalent vision impairment diagnoses were cataract (45.1%) and glaucoma (24.2%).

Summary for:

AIM 1:

Predictors of VI longitudinal analysis over 18 years of follow-up:

- Predictors of NVI, DVI, and VI were time, lower Mini Mental State Exam score, depressive symptoms, and hearing impairment.
- Spanish interview was a predictor of NVI only.
- Other predictors of DVI and VI were age, financial strain, and 2 or more comorbidities reported.

AIM 2:

Predictors of health outcomes longitudinal analysis over 18 years of follow-up:

- Participants with NVI had greater OR of IADL disability and falls than those without VI after controlling for all covariates.
- Participants with DVI had greater OR of cognitive impairment, frailty, and IADL disability than those without DVI after controlling for all covariates.
- Participants with VI had greater OR of cognitive impairment, frailty, IADL disability, ADL disability, and falls than those without VI after controlling for all covariates.

AIM 3:

VI as predictor care utilization longitudinal analysis over 18 years of follow-up:

- Those with VI had greater OR of having medical doctor visits and been hospitalized than those without VI after controlling for all covariates.

Factors associates with eye care utilization one year following wave 5 interview date (2004/2005):

- Factors associated with visiting an optometrist or ophthalmologist were female sex, Spanish interview, told by doctor has eye problems, and scored ≥ 5 on the Elixhauser Weighted Comorbidity index.

- Factors associated with utilizing a diagnostic or therapeutic vision service were female sex, US born, told by doctor has eye problems, and Medicaid coverage.

These findings suggest that current vision health disparities exist among older Mexican Americans and are important to address among health care providers and policy makers.

LIMITATIONS OF THE STUDY

The present study has some limitations. First, VI was a self-reported measure and was not objectively measured using vision assessments such as the commonly used Snellen visual acuity chart. However, self-experienced VI has previously demonstrated a significant association with objectively measured VI (Zimdars et al., 2012). Second, the use of the MMSE for cognitive impairment underestimates mild cognitive impairment (Folstein et al., 1975) which may have underestimated the relationship between VI and cognitive impairment. Third, generalizability of the study is limited to Mexican Americans living in the geographic region of the Southwestern US (Texas, New Mexico, Colorado, Arizona, and California). Fourth, due to longitudinal follow-up over 18 years of time, attrition from loss to follow-up or death occurred. However, the most appropriate statistical method of GEE modeling was used to account for this attrition limitation. Lastly, our sample included Mexican Americans only and did not allow for analysis between different race/ethnic groups for comparison racial/ethnic disparities between groups.

STRENGTHS OF THE STUDY

There are many strengths of this study. First, our study is unique in that it included long follow-up over 18 years of time analyzing VI among older Mexican Americans. Second, this study was able to capture results for both self-reported NVI and DVI separately among several health outcomes and makes this study unique when compared to other longitudinal survey VI research studies. Third, for physical function impairment we used the objective measure of SPPB instead

of subjective measures commonly used in research studies. Fourth, we performed analysis of the association of VI and several health outcomes (physical and cognitive impairment, frailty, disability, and falls) which allowed for comparison of what the most important outcome was among this population as it relates to VI. Fifth, linkage to the Medicare data set allowed us to obtain prevalence estimates for the most common eye diagnosis (cataract, AMD, glaucoma, and retinopathy) for this Mexican American population. Finally, this is the first known study linking the H-EPESE data set to the Medicare data to determine eye care utilization.

FUTURE RESEARCH IMPLICATIONS

Future research is recommended to determine whether health care and eye care access exists for individuals with a language barrier. Additional research is suggested to determine if patients are compliant with using recommended services by vision providers (e.g., glasses/medication/vision therapy) that will decrease functional impairment related to VI. In our study we found that higher comorbidities were a predictor for visiting an optometrist or ophthalmologist, but higher comorbidities were not a predictor for utilizing a diagnostic or therapeutic vision service. These results are somewhat consistent with previous studies finding that multimorbidity was associated with VI. More research in this area is needed. It is also recommended to perform longer years of follow-up with analysis using the H-EPESE and linking to Medicare data to confirm results of our study used for 1 year of follow-up related to eye care utilization.

VI is an important issue to be addressed because it relates to major cause of disability among older adults. Furthermore, addressing vision impairment among older Mexican Americans is essential due to the Hispanic men population expected to be the largest population with low vision in the next few decades. Ensuring high quality vision care among older Mexican Americans is essential and research should continue to address the needs of this population. Ensuring vision health policy that adequately addresses the needs of older Mexican Americans is also essential.

Research is needed to continue to address possible vision health reimbursement/coverage that is limited because VI is a significant predictor for declines in health outcomes (cognition, activities of daily living, frailty, and falls) as found in our study. Finally, additional research is recommended to continue to address VI clinical care and determine evidence-based techniques that adequately address VI from prevalent eye diseases.

APPENDIX

Medicare Dataset Codes

INTERNATIONAL CLASSIFICATION OF DISEASES (ICD)-9 VISION DIAGNOSIS CODES

Table A.1 ICD-9 Vision Diagnosis Codes in Medicare Provider and Analysis Review (MedPAR) Files, Carrier Claims, and Outpatient Standard Analytic Files (OutSAFs).

AMD	36250	Macular degeneration (senile), unspecified
	36251	Nonexudative senile macular degeneration
	36252	Exudative senile macular degeneration
	36253	Cystoid macular degeneration
	36257	Drusen (degenerative)
Cataract	36600	Nonsenile cataract, unspecified
	36601	Anterior subcapsular polar cataract
	36602	Posterior subcapsular polar cataract
	36603	Cortical, lamellar, or zonular cataract
	36604	Nuclear cataract
	36609	Other and combined forms of nonsenile cataract
	36610	Senile cataract, unspecified
	36611	Pseudoexfoliation of lens capsule
	36612	Incipient senile cataract
	36613	Anterior subcapsular polar senile cataract
	36614	Posterior subcapsular polar senile cataract
	36615	Cortical senile cataract
	36616	Senile nuclear sclerosis
	36617	Total or mature cataract
	36618	Hypermature cataract
	36619	Other and combined forms of senile cataract
	36620	Traumatic cataract, unspecified
	36621	Localized traumatic opacities
	36622	Total traumatic cataract
	36623	Partially resolved traumatic cataract

	36630	Cataracta complicata, unspecified
	36631	Glaucomatous flecks (subcapsular)
	36632	Cataract in inflammatory ocular disorders
	36633	Cataract with neovascularization
	36634	Cataract in degenerative ocular disorders
	36641	Diabetic cataract
	36642	Tetanic cataract
	36643	Myotonic cataract
	36644	Cataract associated with other syndromes
	36645	Toxic cataract
	36646	Cataract associated with radiation and other physical influences
	36650	After-cataract, unspecified
	36651	Soemmering's ring
	36652	Other after-cataract, not obscuring vision
	36653	After-cataract, obscuring vision
	3668	Other cataract
	3669	Unspecified cataract
	37931	Aphakia
	74331	Congenital capsular and subcapsular cataract
	74332	Congenital cortical and zonular cataract
	74333	Congenital nuclear cataract
	74334	Total and subtotal cataract, congenital
	74339	Other congenital cataract and lens anomalies
	V431	Lens replaced by other means
Glaucoma	36473	Goniosynechiae
	36500	Preglaucoma, unspecified
	36501	Open angle with borderline findings, low risk
	36502	Anatomical narrow angle borderline glaucoma
	36503	Steroid responders borderline glaucoma
	36504	Ocular hypertension
	36510	Open-angle glaucoma, unspecified
	36511	Primary open angle glaucoma
	36512	Low tension open-angle glaucoma
	36513	Pigmentary open-angle glaucoma

	36514	Glaucoma of childhood
	36515	Residual stage of open angle glaucoma
	36520	Primary angle-closure glaucoma, unspecified
	36521	Intermittent angle-closure glaucoma
	36522	Acute angle-closure glaucoma
	36523	Chronic angle-closure glaucoma
	36524	Residual stage of angle-closure glaucoma
	36531	Corticosteroid-induced glaucoma, glaucomatous stage
	36532	Corticosteroid-induced glaucoma, residual stage
	36541	Glaucoma associated with chamber angle anomalies
	36542	Glaucoma associated with anomalies of iris
	36543	Glaucoma associated with other anterior segment anomalies
	36544	Glaucoma associated with systemic syndromes
	36551	Phacolytic glaucoma
	36552	Pseudoexfoliation glaucoma
	36559	Glaucoma associated with other lens disorders
	36560	Glaucoma associated with unspecified ocular disorder
	36561	Glaucoma associated with pupillary block
	36562	Glaucoma associated with ocular inflammations
	36563	Glaucoma associated with vascular disorders
	36564	Glaucoma associated with tumors or cysts
	36565	Glaucoma associated with ocular trauma
	36581	Hypersecretion glaucoma
	36582	Glaucoma with increased episcleral venous pressure
	36583	Aqueous misdirection
	36589	Other specified glaucoma
	3659	Unspecified glaucoma
Retinopathy	25050	Diabetes with ophthalmic manifestations, type II or unspecified type, not stated as uncontrolled
	36201	Background diabetic retinopathy
	36202	Proliferative diabetic retinopathy
	36203	Nonproliferative diabetic retinopathy NOS
	36204	Mild nonproliferative diabetic retinopathy
	36205	Moderate nonproliferative diabetic retinopathy

	36206	Severe nonproliferative diabetic retinopathy
	36207	Diabetic macular edema
Other	36000	Purulent endophthalmitis, unspecified
	36001	Acute endophthalmitis
	36002	Panophthalmitis
	36003	Chronic endophthalmitis
	36004	Vitreous abscess
	36011	Sympathetic uveitis
	36012	Panuveitis
	36013	Parasitic endophthalmitis NOS
	36014	Ophthalmia nodosa
	36019	Other endophthalmitis
	36020	Degenerative disorder of globe, unspecified
	36021	Progressive high (degenerative) myopia
	36023	Siderosis of globe
	36024	Other metallosis of globe
	36029	Other degenerative disorders of globe
	36030	Hypotony of eye, unspecified
	36031	Primary hypotony of eye
	36032	Ocular fistula causing hypotony
	36033	Hypotony associated with other ocular disorders
	36034	Flat anterior chamber of eye
	36040	Degenerated globe or eye, unspecified
	36041	Blind hypotensive eye
	36042	Blind hypertensive eye
	36043	Hemophthalmos, except current injury
	36044	Leucocoria
	36050	Foreign body, magnetic, intraocular, unspecified
	36051	Foreign body, magnetic, in anterior chamber of eye
	36052	Foreign body, magnetic, in iris or ciliary body
	36053	Foreign body, magnetic, in lens
	36054	Foreign body, magnetic, in vitreous
	36055	Foreign body, magnetic, in posterior wall
	36059	Intraocular foreign body, magnetic, in other or multiple sites

	36060	Foreign body, intraocular, unspecified
	36061	Foreign body in anterior chamber
	36062	Foreign body in iris or ciliary body
	36063	Foreign body in lens
	36064	Foreign body in vitreous
	36065	Foreign body in posterior wall of eye
	36069	Intraocular foreign body in other or multiple sites
	36081	Luxation of globe
	36089	Other disorders of globe
	3609	Unspecified disorder of globe
	36100	Retinal detachment with retinal defect, unspecified
	36101	Recent retinal detachment, partial, with single defect
	36102	Recent retinal detachment, partial, with multiple defects
	36103	Recent retinal detachment, partial, with giant tear
	36104	Recent retinal detachment, partial, with retinal dialysis
	36105	Recent retinal detachment, total or subtotal
	36106	Old retinal detachment, partial
	36107	Old retinal detachment, total or subtotal
	36110	Retinoschisis, unspecified
	36111	Flat retinoschisis
	36112	Bullous retinoschisis
	36113	Primary retinal cysts
	36114	Secondary retinal cysts
	36119	Other retinoschisis and retinal cysts
	3612	Serous retinal detachment
	36130	Retinal defect, unspecified
	36131	Round hole of retina without detachment
	36132	Horseshoe tear of retina without detachment
	36133	Multiple defects of retina without detachment
	36181	Traction detachment of retina
	36189	Other forms of retinal detachment
	3619	Unspecified retinal detachment
	36210	Background retinopathy, unspecified
	36211	Hypertensive retinopathy

	36212	Exudative retinopathy
	36213	Changes in vascular appearance of retina
	36214	Retinal microaneurysms NOS
	36215	Retinal telangiectasia
	36216	Retinal neovascularization NOS
	36217	Other intraretinal microvascular abnormalities
	36218	Retinal vasculitis
	36220	Retinopathy of prematurity, unspecified
	36221	Retrolental fibroplasia
	36222	Retinopathy of prematurity, stage 0
	36223	Retinopathy of prematurity, stage 1
	36224	Retinopathy of prematurity, stage 2
	36225	Retinopathy of prematurity, stage 3
	36226	Retinopathy of prematurity, stage 4
	36227	Retinopathy of prematurity, stage 5
	36229	Other nondiabetic proliferative retinopathy
	36230	Retinal vascular occlusion, unspecified
	36231	Central retinal artery occlusion
	36232	Retinal arterial branch occlusion
	36233	Partial retinal arterial occlusion
	36234	Transient retinal arterial occlusion
	36235	Central retinal vein occlusion
	36236	Venous tributary (branch) occlusion
	36237	Venous engorgement
	36240	Retinal layer separation, unspecified
	36241	Central serous retinopathy
	36242	Serous detachment of retinal pigment epithelium
	36243	Hemorrhagic detachment of retinal pigment epithelium
	36254	Macular cyst, hole, or pseudohole
	36255	Toxic maculopathy
	36256	Macular puckering
	36260	Peripheral retinal degeneration, unspecified
	36261	Paving stone degeneration
	36262	Microcystoid degeneration

	36263	Lattice degeneration
	36264	Senile reticular degeneration
	36265	Secondary pigmentary degeneration
	36266	Secondary vitreoretinal degenerations
	36270	Hereditary retinal dystrophy, unspecified
	36271	Retinal dystrophy in systemic or cerebroretinal lipidoses
	36272	Retinal dystrophy in other systemic disorders and syndromes
	36273	Vitreoretinal dystrophies
	36274	Pigmentary retinal dystrophy
	36275	Other dystrophies primarily involving the sensory retina
	36276	Dystrophies primarily involving the retinal pigment epithelium
	36277	Dystrophies primarily involving Bruch's membrane
	36281	Retinal hemorrhage
	36282	Retinal exudates and deposits
	36283	Retinal edema
	36284	Retinal ischemia
	36285	Retinal nerve fiber bundle defects
	36289	Other retinal disorders
	3629	Unspecified retinal disorder
	36300	Focal chorioretinitis, unspecified
	36301	Focal choroiditis and chorioretinitis, juxtapapillary
	36303	Focal choroiditis and chorioretinitis of other posterior pole
	36304	Focal choroiditis and chorioretinitis, peripheral
	36305	Focal retinitis and retinochoroiditis, juxtapapillary
	36306	Focal retinitis and retinochoroiditis, macular or paramacular
	36307	Focal retinitis and retinochoroiditis of other posterior pole
	36308	Focal retinitis and retinochoroiditis, peripheral
	36310	Disseminated chorioretinitis, unspecified

	36311	Disseminated choroiditis and chorioretinitis, posterior pole
	36312	Disseminated choroiditis and chorioretinitis, peripheral
	36313	Disseminated choroiditis and chorioretinitis, generalized
	36314	Disseminated retinitis and retinochoroiditis, metastatic
	36315	Disseminated retinitis and retinochoroiditis, pigment epitheliopathy
	36320	Chorioretinitis, unspecified
	36321	Pars planitis
	36322	Harada's disease
	36330	Chorioretinal scar, unspecified
	36331	Solar retinopathy
	36332	Other macular scars
	36333	Other scars of posterior pole
	36334	Peripheral scars
	36335	Disseminated scars
	36340	Choroidal degeneration, unspecified
	36341	Senile atrophy of choroid
	36342	Diffuse secondary atrophy of choroid
	36343	Angioid streaks of choroid
	36350	Hereditary choroidal dystrophy or atrophy, unspecified
	36351	Circumpapillary dystrophy of choroid, partial
	36352	Circumpapillary dystrophy of choroid, total
	36353	Central dystrophy of choroid, partial
	36354	Central choroidal atrophy, total
	36355	Choroideremia
	36356	Other diffuse or generalized dystrophy of choroid, partial
	36357	Other diffuse or generalized dystrophy of choroid, total
	36361	Choroidal hemorrhage, unspecified
	36362	Expulsive choroidal hemorrhage
	36363	Choroidal rupture
	36370	Choroidal detachment, unspecified
	36371	Serous choroidal detachment

	36372	Hemorrhagic choroidal detachment
	3638	Other disorders of choroid
	3639	Unspecified disorder of choroid
	36400	Acute and subacute iridocyclitis, unspecified
	36401	Primary iridocyclitis
	36402	Recurrent iridocyclitis
	36403	Secondary iridocyclitis, infectious
	36404	Secondary iridocyclitis, noninfectious
	36405	Hypopyon
	36410	Chronic iridocyclitis, unspecified
	36411	Chronic iridocyclitis in diseases classified elsewhere
	36421	Fuchs' heterochromic cyclitis
	36422	Glaucomatocyclitic crises
	36423	Lens-induced iridocyclitis
	36424	Vogt-koyanagi syndrome
	3643	Unspecified iridocyclitis
	36441	Hyphema of iris and ciliary body
	36442	Rubeosis iridis
	36451	Essential or progressive iris atrophy
	36452	Iridoschisis
	36453	Pigmentary iris degeneration
	36454	Degeneration of pupillary margin
	36455	Miotic cysts of pupillary margin
	36456	Degenerative changes of chamber angle
	36457	Degenerative changes of ciliary body
	36459	Other iris atrophy
	36460	Idiopathic cysts of iris, ciliary body, and anterior chamber
	36461	Implantation cysts of iris, ciliary body, and anterior chamber
	36462	Exudative cysts of iris or anterior chamber
	36463	Primary cyst of pars plana
	36464	Exudative cyst of pars plana
	36470	Adhesions of iris, unspecified
	36471	Posterior synechiae of iris

	36472	Anterior synechiae of iris
	36474	Adhesions and disruptions of pupillary membranes
	36475	Pupillary abnormalities
	36476	Iridodialysis
	36477	Recession of chamber angle of eye
	36481	Floppy iris syndrome
	36482	Plateau iris syndrome
	36489	Other disorders of iris and ciliary body
	3649	Unspecified disorder of iris and ciliary body
	36505	Open angle with borderline findings, high risk
	36506	Primary angle closure without glaucoma damage
	36570	Glaucoma stage, unspecified
	36571	Mild stage glaucoma
	36572	Moderate stage glaucoma
	36573	Severe stage glaucoma
	36574	Indeterminate stage glaucoma
	3670	Hypermetropia
	3671	Myopia
	36720	Astigmatism, unspecified
	36721	Regular astigmatism
	36722	Irregular astigmatism
	36731	Anisometropia
	36732	Aniseikonia
	3674	Presbyopia
	36751	Paresis of accommodation
	36752	Total or complete internal ophthalmoplegia
	36753	Spasm of accommodation
	36781	Transient refractive change
	36789	Other disorders of refraction and accommodation
	3679	Unspecified disorder of refraction and accommodation
	36800	Amblyopia, unspecified
	36801	Strabismic amblyopia
	36802	Deprivation amblyopia
	36803	Refractive amblyopia

	36810	Subjective visual disturbance, unspecified
	36811	Sudden visual loss
	36812	Transient visual loss
	36813	Visual discomfort
	36814	Visual distortions of shape and size
	36815	Other visual distortions and entoptic phenomena
	36816	Psychophysical visual disturbances
	3682	Diplopia
	36830	Binocular vision disorder, unspecified
	36831	Suppression of binocular vision
	36832	Simultaneous visual perception without fusion
	36833	Fusion with defective stereopsis
	36834	Abnormal retinal correspondence
	36840	Visual field defect, unspecified
	36841	Scotoma involving central area
	36842	Scotoma of blind spot area
	36843	Sector or arcuate visual field defects
	36844	Other localized visual field defect
	36845	Generalized visual field contraction or constriction
	36846	Homonymous bilateral field defects
	36847	Heteronymous bilateral field defects
	36851	Protan defect
	36852	Deutan defect
	36853	Tritan defect
	36854	Achromatopsia
	36855	Acquired color vision deficiencies
	36859	Other color vision deficiencies
	36860	Night blindness, unspecified
	36861	Congenital night blindness
	36862	Acquired night blindness
	36863	Abnormal dark adaptation curve
	36869	Other night blindness
	3688	Other specified visual disturbances
	3689	Unspecified visual disturbance

	36900	Profound impairment, both eyes, impairment level not further specified
	36901	Better eye: total vision impairment; lesser eye: total vision impairment
	36902	Better eye: near-total vision impairment; lesser eye: not further specified
	36903	Better eye: near-total vision impairment; lesser eye: total vision impairment
	36904	Better eye: near-total vision impairment; lesser eye: near-total vision impairment
	36905	Better eye: profound vision impairment; lesser eye: not further specified
	36906	Better eye: profound vision impairment; lesser eye: total vision impairment
	36907	Better eye: profound vision impairment; lesser eye: near-total vision impairment
	36908	Better eye: profound vision impairment; lesser eye: profound vision impairment
	36910	Moderate or severe impairment, better eye, impairment level not further specified
	36911	Better eye: severe vision impairment; lesser eye: blind, not further specified
	36912	Better eye: severe vision impairment; lesser eye: total vision impairment
	36913	Better eye: severe vision impairment; lesser eye: near-total vision impairment
	36914	Better eye: severe vision impairment; lesser eye: profound vision impairment
	36915	Better eye: moderate vision impairment; lesser eye: blind, not further specified
	36916	Better eye: moderate vision impairment; lesser eye: total vision impairment
	36917	Better eye: moderate vision impairment; lesser eye: near-total vision impairment
	36918	Better eye: moderate vision impairment; lesser eye: profound vision impairment
	36920	Moderate or severe impairment, both eyes, impairment level not further specified

	36921	Better eye: severe vision impairment; lesser eye; impairment not further specified
	36922	Better eye: severe vision impairment; lesser eye: severe vision impairment
	36923	Better eye: moderate vision impairment; lesser eye: impairment not further specified
	36924	Better eye: moderate vision impairment; lesser eye: severe vision impairment
	36925	Better eye: moderate vision impairment; lesser eye: moderate vision impairment
	3693	Unqualified visual loss, both eyes
	3694	Legal blindness, as defined in U.S.A.
	36960	Profound impairment, one eye, impairment level not further specified
	36961	One eye: total vision impairment; other eye: not specified
	36962	One eye: total vision impairment; other eye: near-normal vision
	36963	One eye: total vision impairment; other eye: normal vision
	36964	One eye: near-total vision impairment; other eye: vision not specified
	36965	One eye: near-total vision impairment; other eye: near-normal vision
	36966	One eye: near-total vision impairment; other eye: normal vision
	36967	One eye: profound vision impairment; other eye: vision not specified
	36968	One eye: profound vision impairment; other eye: near-normal vision
	36969	One eye: profound vision impairment; other eye: normal vision
	36970	Moderate or severe impairment, one eye, impairment level not further specified
	36971	One eye: severe vision impairment; other eye: vision not specified
	36972	One eye: severe vision impairment; other eye: near-normal vision

	36973	One eye: severe vision impairment; other eye: normal vision
	36974	One eye: moderate vision impairment; other eye: vision not specified
	36975	One eye: moderate vision impairment; other eye: near-normal vision
	36976	One eye: moderate vision impairment; other eye: normal vision
	3698	Unqualified visual loss, one eye
	3699	Unspecified visual loss

PROVIDER VISIT

Table A.2 Healthcare Common Procedure Coding System (HCPCS) Codes in Medicare Carrier Line file for outpatient/office visit to provider with specialty "18" for "Ophthalmology" and “41” for "Optometrist".

Visit Type	HCPCS
Office or other outpatient visit for the evaluation and management of an established patient	92002-92014
Medical examination and evaluation with initiation or continuation of a diagnostic and treatment program	99212-99215

DIAGNOSTIC/THERAPEUTIC PROCEDURE

Table A.3 Healthcare Common Procedure Coding System (HCPCS) Codes in Medicare Carrier Line and Outpatient Revenue Center files.

Diagnostic/therapeutic Procedure	HCPCS
AMD	92235 92240 92283 92284 92287 67208 67210 67218 67220
Cataract	66830 66840 66850 66852 66920 66930 66940 66982 66983 66984 66985 66986 66987 76516 76519
Glaucoma	92015 92018 92019 92020 92060 92065 92070 92071 92072 92081 92082 92083 92100 92120 92130 92133 92135 92136 92140 92225 92226 92230 92235 92238 92240 92250 92254 92260 92270 92275 92284 92285 92286 92287 92310 92311 92312 92313 92314 92315 92316 92317 92325 92326 92340 92341 92342 92352 92353 92354 92355 92358 92370 92371 92499 G0117 G0118
Low Vision Rehabilitation Services	92065
Retinopathy	46512 76511 76512 76513 92134 92235 92240 92250 92260 92287 67028 67036 67038 67039 67040 67108 67109 67112 67208 67210 67220 67227 67228 67288 67515
Vision Services	V2020-V2799

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VITA

Mandi Sonnenfeld was born on March 5, 1976, to Thomas and Carol Holt, in Ord Nebraska. Mandi completed her schooling up to high school at North Loup-Scotia High School in Scotia, Nebraska. She completed her Bachelor of Science degree in Psychology at Texas State University in San Marcos, Texas, in the year 1998. Mandi completed her Master of Occupational Therapy degree at Texas Woman's University in Houston, Texas, in the year 2001. Upon graduation, she worked as an occupational therapist in the states of Nebraska and Texas primarily in the inpatient rehabilitation facility (IRF) and skilled nursing facility settings (SNF). Mandi also worked as a Rehabilitation Director at two skilled nursing facilities in Texas. After several years working as an occupational therapy clinician, in 2016, Mandi decided to pursue her PhD in Rehabilitation Sciences at the University of Texas Medical Branch in Galveston, Texas to enhance her skills as a disability and rehabilitation researcher among older adults. Mandi is graduating from her PhD in Rehabilitation Science in summer, 2022.

Permanent Address: 3020 Bernadino Drive
La Marque, Texas 77568