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Arthritis Impact on the Physical Function, Disability, and Health-Related Quality of Life among Older Mexican-Americans

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ARTHRITIS IMPACT ON THE PHYSICAL FUNCTION, DISABILITY, AND HEALTH-RELATED QUALITY OF LIFE AMONG OLDER MEXICAN-AMERICANS

by

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Dissertation

Presented to the Faculty of the Graduate School of
The University of Texas Medical Branch
in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

The University of Texas Medical Branch

May, 2009

Dedication

This dissertation is dedicated with loving appreciation to my parents, my brothers and sisters, my wife, and my children.

Acknowledgements

I would like to sincerely thank the following influential and motivating individuals who believed in me and helped me along this course of this endeavor. First, many grateful thanks go to the devoted members of my dissertation committee, Drs. Elizabeth Protas, Ken Ottenbacher, Soham Al Snih, Yong-fang Kuo, Dennis Hart, and Anita Mercado for their dedication to me and this endeavor.

I was personally impressed with the professional way Dr. Protas guided me over the past few years, even in the face of several obstacles. I, also, want to express my deep gratitude for Dr. Ottenbacher and Dr. Al Snih, mentorships and times. Your advices helped me to open my mind to the vast amount of possible opportunities that the field of rehabilitation could offer. Additionally, I would also like to express my gratitude to Dr. Kuo, Dr. Hart, and Dr. Mercado for their participation on my dissertation committee through their insightful comments and advice. I am honored to have all these great professors as members of my dissertation committee.

Many thanks also go to every faculty member, postdoctoral fellow, staff, and graduate student of the Preventive Medicine and Community Health program. I cannot thank them enough for being effective teachers, invaluable mentors, and good friends. Without your help, I would not focus my thoughts toward a career in aging and musculoskeletal research.

Support for this dissertation was provided from a scholarship from the Saudi Ministry of Higher Education. Additional support was granted from Peyton and Lydia Schapper Endowed Scholarship and from the International Society for Neurochemistry assistantship.

Last but not least, I thank my parents, Mubarak and Mounira, and my brothers and sisters for their prayers, love, and support. Finally, I would like to express my sincerest thanks to my beloved wife Khalood, and our children: Moaied and Raween; for their sacrifices and patience in being away, for a long time, from our families and close friends.

ARTHRITIS IMPACT ON THE PHYSICAL FUNCTION, DISABILITY, AND HEALTH-RELATED QUALITY OF LIFE AMONG OLDER MEXICAN-AMERICANS

Publication No._____

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The University of Texas Medical Branch, 2009

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Background and Purpose: Arthritis is a major cause of disability with a sizable impact on health-related quality of life (HRQoL) in older adults, especially among older non-Hispanic white subjects. The purpose of this study is to examine the relation between arthritis and its effects on the physical function, disability, and health-related quality of life, over time, among older Mexican-Americans, the fastest growing subset of the older population. **Design**: A six-year prospective cohort study (2000 to 2006). **Setting**: Five Southwestern states: Texas, New Mexico, Colorado, Arizona, and California. **Participants**: A population-based sample of 621 non-institutionalized Mexican-Americans aged 65 or older from wave four of the Hispanic Established Population for Epidemiologic Studies of the Elderly (Hispanic EPESE). **Measurements**: Included sociodemographic variables, self-reported of: arthritis, pain on weight-bearing, activities of daily living (ADL), instrumental activities of daily living (IADL), physical and mental HRQoL, medical conditions, cognitive function and depressive symptoms. Lower and upper extremity muscles strength, lower body function test and body mass index (BMI) were also obtained. General linear mixed models and generalized estimating equations (GEE) were used to examine the time effect on: 1) each stage of the disablement process and 2) physical and mental HRQoL over three points of time (2000-2001, 2001-2002, and 2006). This study conforms to STROBE (STrengthening the Reporting of

OBservational studies in Epidemiology) guidelines for cohort studies. **Results**: The results indicate 1) a significant association between arthritis and greater impairment (pain and poor muscle strength), functional limitation, disability (ADL and IADL), and physical HRQoL across time; and 2) a significant association between impairment, functional limitation, and IADL limitation with physical and mental HRQoL across time. **Conclusions**: In older Mexican-Americans, arthritis is a highly prevalent medical condition which significantly impacts physical function, daily activities, and physical HRQoL over time. In this cohort, impairment, functional limitation, and disability were associated with poorer physical and mental HRQoL. These findings could guide efforts in reaching the goals of the National Arthritis Action Plan, as well as the Healthy People 2010 initiative goals of increasing quality of life and eliminating health disparities in this segment of the older U.S. population.

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LIST OF ABBREVIATIONS

AAWL	Arthritis-Attributable Work Limitations
ADL	Activity Of Daily Living
AHEAD	Asset And Health Dynamic Survey Among The Oldest Old
ANOVA	Analysis Of Variance
AS	Subjects With Arthritis
BMI	Body Mass Index
CDC	The Centers For Disease Control And Prevention
CES-D	Center For Epidemiological Studies Depression Scale
DHHS	The Department Of Health And Human Services
DPM	Disablement Process Model
EDM	Enabling-Disabling Model
EPESE	Established Population For The Epidemiological Study Of The Elderly
EQ-5D	The European Quality Of Life Measure
FM	Fibromyalgia
FPS	The Face Pain Scale
GEE	Generalized Estimating Equations
HR	Hazard Ratio
HRQoL	Health-Related Quality Of Life
IADL	Instrumental Activity Of Daily Living
ICCs	Intraclass Correlation Coefficients
IOM	The Institute Of Medicine
Kg	Kilogram
LEMS	Lower Extremity Muscle Strength
LSR	Least-Squares Regression
m	Meter
MCS	Mental Component Summary, Sf-36
MGPQ	McGill Pain Questionnaire
MI	Multiple Imputation
MVA	Missing Value Analysis
NAAP	The National Arthritis Action Plan
NAMCS	The National Ambulatory Medical Care Survey
NAS	Subjects Without Arthritis (Non-Arthritic Subjects)
NDI	The National Death Index
NHAMCS	The National Hospital Ambulatory Medical Care Survey
NHIS	The National Health Interview Survey
NHANES	The National Health And Nutrition Examination Survey

NMMT	The Nicholas Manual Muscle Tester
OA	Osteoarthritis
OARS	The Older American Resources And Services
OR	Odds Ratio
OT	Occupational Therapy
PCS	Physical Component Summary, Sf-36
QWB-SA	Quality Of Well-Being Scale-Self-Administered
RA	Rheumatoid Arthritis
SAS	Statistical Analysis System
SD	Standard Deviation
SEM	Structural Equation Modeling
SES	Socio-Economic Status
SF-36	The Medical Outcomes Study 36-Item Short-Form Health Survey
SLE	Systemic Lupus Erythematous
SPPB	Short Physical Performance Battery
SPSS	The Social Sciences Software
STROBE	The Strengthening The Reporting Of Observational Studies In Epidemiology
TBMS	Total Body Muscle Strength
UEMS	Upper Extremity Muscle Strength
US	The United State
VAS	The Visual Analogical Scale
WHO	World Health Organization

1.0 INTRODUCTION

The purpose of this study was to examine the relation between arthritis and its effects on the physical function, disability, and health-related quality of life in a sample of older Mexican-Americans. This chapter is composed of the following sections: rationale, purpose, significance, specific aims and operational definitions for key study terms.

1.1 RATIONALE

It has been estimated that about 67 million adults will have self-reported doctor-diagnosed arthritis by the year 2030, 50% of them older adults [1]. Arthritis is a general medical condition meaning inflammation of a joint [2]. Arthritis comprises over 100 different diseases and conditions [3].

This general medical condition is a major and growing public health problem, prevalent among older adults, with a sizeable impact on both physical and mental health-related quality of life of those affected [4-6]. Arthritis is also the most common cause of disability in the United States (US) [7, 8]. Thus, the medical and economic effects of arthritis on public health are of great concern to policy makers, researchers and clinicians [9]. Nevertheless, for many older adults and their families, the function limitation, disability, and quality of life may be of greater importance than the symptoms of arthritis itself.

The seven most common chronic health problems among the older population are arthritis, hypertension, heart disease, diabetes, respiratory diseases, stroke, and cancer

[10]. In the US, arthritis is one of the most commonly reported chronic conditions, affecting about 47% of older adults, followed by hypertension at 41%, and heart disease at 31% [11]. Moreover, the prevalence of arthritis is projected to increase by 40% over the next 25 years [12].

Economically, arthritis was responsible for $81 billion in direct medical costs in 2003, up from $51.1 billion in 1997 [13]. Moreover, each year, arthritis is responsible for about 750,000 hospitalizations [14] and 36 million outpatient visits [15]. Finally, the estimated total cost attributed to arthritis was $128 billion, equal to 1.2% of the 2003 US gross domestic product [13].

Arthritis affects older Hispanics more than any other racial or ethnic group [16]. The adjusted prevalence of arthritis is 52% in older Hispanics, 47% in older non-Hispanic blacks, and 32% in older non-Hispanic whites, according to data from the Asset and Health Dynamic Survey Among the Oldest Old (AHEAD) [16]. Interestingly, Fontaine et al. (2007) [17] indicates that Hispanic origin is one important arthritis risk factor.

1.2 PURPOSE

The objective of this investigation was to examine the association between arthritis and its effects on the physical function, disability, and health-related quality of life in a sample of older Mexican-Americans over three points in time (i.e., 2000-2001, 2001-2002, and 2006).

Physical function was determined by using impairment and functional limitation. Impairment was assessed using two major variables: the presence of pain on weight-bearing and lower and upper extremity muscle strength (weakness). Functional limitation was determined using lower body limitation.

Disability was assessed using two self-assessments measures, the activities of daily living (ADLs) and instrumental activities of daily living (IADLs) scales. Lastly, health-related quality of life (HRQoL) was measured using the 36-item Short Form (SF-36).

1.3 SIGNIFICANCE OF THE STUDY

Given that the risk of developing arthritis increases with age, it is expected to impose a greater burden on the American individual, society and health care system as the average population grows older. Therefore, there is an urgent need for a planned and coordinated strategy for establishing evidence-based multidisciplinary programs that expand the number of arthritis specialists (e.g., medicine, nursing, surgery, physical rehabilitation, and mental health) and increase availability of public health interventions to improve health-related quality of life through lifestyle changes and disease self-management [9].

Globally, the World Health Organization (WHO) and the World Bank designated the years 2000 to 2010 as the Bone and Joint Decade to enhance awareness, understanding and research of musculoskeletal disorders, including arthritis. The purpose of the decade is to improve health-related quality of life for people with bone and joint diseases and injuries worldwide [18-21].

In the US, the Healthy People 2010 initiative, for the first time included arthritis as a key focus area [22]. The Department of Health and Human Services (DHHS) started the Healthy People 2010 initiative in 2000 to achieve two major goals [22]: to increase years and quality of healthy life and to eliminate disparities in health between racial and ethnic groups [22]. Arthritis, as a key focus area in this initiative, has been addressed by

eight specific objectives [23]. These objectives are 1) Reduce the mean level of joint pain, 2) Reduce activity limitations, 3) Reduce personal care limitations, 4) Increase health care provider counseling for weight and physical activity, 5) Reduce the effect on employment, 6) Eliminate racial disparities in total knee replacements, 7) Increase the proportion of those seeing a health care provider for joint symptoms, and 8) Increase the proportion of those receiving arthritis education [23].

Likewise, the National Arthritis Action Plan: A Public Health Strategy (NAAP) was developed in 1999 to reduce the burden of arthritis [24-26]. The three organizations which led development of this plan were the Arthritis Foundation, the Centers for Disease Control and Prevention (CDC), and the Association of State and Territorial Health Officials [24-27].

Not surprisingly, studies using the Medical Outcome Survey Short Form-36 (SF-36) [4, 28] or the CDC measure show significantly poorer HRQoL in older adults with arthritis than in older adults without arthritis [5, 6, 29-31].

Unfortunately, little is known about the effect of arthritis on physical function, disability, and health-related quality of life in older Mexican-Americans, a rapidly increasing population that suffers high rates of arthritis. Findings from the current study will provide valuable information for the Healthy People 2010 initiative, the National Arthritis Action Plan, policy makers, researchers, and clinicians regarding the impact of arthritis on physical function, disability, and HRQoL.

1.4 SPECIFIC AIMS

The specific aims and related hypotheses of this investigation were:

1.4.1 Aim 1

The first aim was to examine the association between arthritis and stages of the disablement process (impairment, functional limitation, and disability) over three points of time (2000-2001, 2001-2002, and 2006) among older Mexican-Americans.

1.4.1.1 Hypothesis 1.a

Arthritis would be associated with greater impairment.

1.4.1.2 Hypothesis 1.b

Arthritis would be associated with greater functional limitation.

1.4.1.3 Hypothesis 1.c

Arthritis would be associated with greater disability.

1.4.2 Aim 2

The second aim was to examine the association between arthritis and stages of the disablement process (impairment, functional limitation, and disability) on the **physical** HRQoL over three points of time (2000-2001, 2001-2002, and 2006) among older Mexican-Americans.

1.4.2.1 Hypothesis 2.a

Arthritis would be associated with poorer physical HRQoL.

1.4.2.2 Hypothesis 2.b

Greater impairment would be associated with poorer physical HRQoL.

1.4.2.3 Hypothesis 2.c

Greater functional limitation would be associated with poorer physical HRQoL.

1.4.2.4 Hypothesis 2.d

Greater disability would be associated with poorer physical HRQoL.

1.4.3 Aim 3

The third aim was to examine the association between arthritis and stages of the disablement process (impairment, functional limitation, and disability) on **mental**

HRQoL over three points of time (2000-2001, 2001-2002, and 2006) among older Mexican-Americans.

1.4.3.1 Hypothesis 3.a

Arthritis would be associated with poorer mental HRQoL.

1.4.3.2 Hypothesis 3.b

Greater impairment would be associated with poorer mental HRQoL.

1.4.3.3 Hypothesis 3.c

Greater functional limitation would be associated with poorer mental HRQoL.

1.4.3.4 Hypothesis 3.d

Greater disability would be associated with poorer mental HRQoL.

1.5 DEFINITIONS OF THE KEY TERMS

I) Arthritis: A doctor-diagnosed arthritis.

II) Disability: Experiencing difficulty doing activities in any domain of life due to a health or physical problem.

III) Functional limitation: Restrictions in performing fundamental physical actions used in daily life by one's age-sex group.

IV) Impairment: Lower and/or upper extremity muscle strength, and feeling a pain during standing and walking.

V) Health related quality of life (HRQoL): A person’s or group's perceived physical and mental health.

2.0 REVIEW OF RELATED LITERATURE

This chapter reviews salient literature and is composed of four sections: older population and health status, arthritis, disability, and health-related quality of life. It begins with an overview of the epidemiology of aging in the US with a focus on Hispanic-related issues. The second section presents an overview of arthritis, focusing on the two most important types that affect older adults: rheumatoid arthritis (RA) and osteoarthritis (OA). Finally, disability and health-related quality of life (as impacted by arthritis) are discussed.

2.1 OLDER POPULATION AND HEALTH STATUS IN THE UNITED STATES

This section briefly discusses the aging issue in the US and its diversity. Then, it examines health status for older Hispanics from four angles: life expectancy, mortality, chronic diseases and disability.

2.1.1 Older Population

Generally, the US is relatively young compared with other developed countries [32]. The US has a lower proportion of adults aged 65 or older than that of most countries in Western Europe [32]. However, the proportion of the US population aged 65 or older is growing rapidly [33]. The 2000 US Census counted about 35 million people aged 65 years or older, which represents roughly one in eight Americans [34]. By 2030, it has been estimated that the number of Americans aged 65 or older will double to about 71 million, equating to roughly one in five Americans [33, 35].

The older population in the United States has become more racially and ethnically diverse in recent years, and this trend is expected to continue [36]. In 2003, 83% of older adults in the United States were non-Hispanic white, 8% were non-Hispanic black, 6% were Hispanic, and 3% were Asian [32]. However, by 2030, the face of older adults in the United States will be changed significantly: only 72% of this population will be non-Hispanic white, 11% will be Hispanic, 10% will be black, and 5% will be Asian [32].

The Hispanic population increased 58% from 1990-2000 as compared to 3% for non-Hispanic whites [35]. The older Hispanic population (65 years or older) is also increasing at a rate double that of the non-Hispanic white population, and is projected to reach 15 million by 2050 [37]. Approximately two thirds of the Hispanic population is Mexican-American, roughly 67% [38, 39].

2.1.2 Health Status

In general, older Americans are healthier than in the past, with lower rates of disability. Yet, a significant proportion suffers from health problems and chronic disease, and causes of death have not changed dramatically; this is especially true in racial and ethnic minorities [32, 33, 40].

Data from the 2004 National Health Interview Survey (NHIS) showed that 39% of non-Hispanic white adults aged 65 years or older reported very good or excellent health, as compared with 24% of non-Hispanic blacks and 29% of Hispanics [33, 41]. However, the health status among Hispanics and older Hispanics seems paradoxical, given the population's relatively low socioeconomic status [39, 42]. In the following sections, health status is briefly discussed from four angles: life expectancy, mortality, chronic diseases and disability.

2.1.2.1 Life Expectancy

Life expectancy is defined as the average number of years of life remaining at a given age. Life expectancy at birth and age 65 are the two measures used widely in epidemiological studies. Overall, life expectancy at birth has continued to improve over time [43]. For instance, it increased from 47.3 years in 1900 to 68.2 years in 1950 and to 76.9 years in 2000 [40].

By gender, it increased from 46 to 75 years for men and from 48 to 80 years for women, over the period 1900 to 2004, which is nearly 30 years' gain over the century. Women tend to live longer than men, but the gap has decreased recently [40, 41]. Likewise, life expectancy at age 65 also increased during this period. Among men, life expectancy at age 65 rose from 12 to 17 years and among women, from 12 to 20 years.

However, data shows that life expectancy at birth is disparate between races (particularly white and black persons); it has, however, narrowed since 1990. For the Hispanic population, life expectancy also improved for men by 4.2% and for women by 1.8% , in recent years [40].

2.1.2.2 Mortality

Improved medical and prevention services have significantly increased the life expectancy in the US during the past century. However, they also have produced a major shift in the leading causes of death for all age groups, including older adults, from infectious diseases and acute illnesses to chronic diseases and degenerative illnesses. According to the 2002-2004 National Center for Health Statistics report, age-adjusted death rates per 100,000 were the lowest among Hispanics (613.9), followed by whites (820.3) and blacks (1,059.7) [40]. Mortality rates among Hispanics based on census and vital statistics data are questionable because these rates might be underestimated [39].

The top three causes of death for US adults aged 65 or older were heart disease (32% of all deaths), cancer (22%), and stroke (8%). These accounted for 61% of all deaths in this age group. Moreover, smoking, poor diet, and physical inactivity were found to be the root causes of approximately 35% of US deaths. These behaviors often underlie the development of the nation's leading chronic disease killers among older adults, including heart disease, cancer, stroke, and diabetes.

2.1.2.3 Chronic Conditions

The seven most common chronic health problems in the older population are arthritis, hypertension, heart disease, diabetes, respiratory diseases, stroke and cancer [10]. Currently, about 80% of older Americans are living with at least one chronic condition and 50% have at least two [33].

There are differences in the literature in reporting chronic diseases prevalence among Hispanics in particular. However, findings from Hispanic Established Population for Epidemiologic Studies of the Elderly (EPESE) provide the most accurate rates for this segment of population [39, 42].

According to the National Vital Statistics System, the Hispanic population aged 65 or over has the highest prevalence rate of heart disease (32.4%) as compared to blacks (32.0%) or whites (31.8%) [33]. Similarly, arthritis prevalence is higher among older Hispanic compared to other ethnic groups, as discussed previously [16].

2.1.2.4 Disability

Several instruments have been developed for use in assessing disability among older adults. The most common measures are activities of daily living (ADLs) and instrumental activities of daily living (IADL). For example, the National Health Interview Survey (NHIS) has measured ADL and IADL limitations since 1982 [44].

In addition, the 2000 census counted 49.7 million people with disability. For those aged 65 or older, disability rates among people who reported only one race were 40% for non-Hispanic Whites, 53% for Blacks, and 58% for American Indians or Alaska Natives [45]. However, the rate for Hispanics was 49%, and for individuals who reported two or more races, it was 52% [45]. Approximately half of severe disabilities in older adults occur chronically and progressively while the other half occur catastrophically [11, 46]. Fried et al. (1994) [47] reported that 90% of disability results from chronic disease such as arthritis and other musculoskeletal conditions. Generally, advances in medical care as well as changes in socioeconomic factors in the last 25 years have decreased the disability prevalence rates significantly among older Americans [48].

2.2 ARTHRITIS

Arthritis conditions are major causes of disability and among the most common chronic disease problems in the US, with 21.6% (46.4 million) of US adults affected [1, 49]. There is evidence that arthritis and other rheumatic conditions are of a growing health concern, primarily because the 65 and older segment of the US population is growing relatively faster than the rest [3, 12, 49, 50].

It has been estimated that about 67 million adults will have self-reported doctor-diagnosed arthritis by the year 2030, 50% of them older adults [1]. Arthritis is a general medical condition meaning inflammation of a joint [2]. Arthritis comprises over 100 different diseases and conditions [3]. All forms of arthritis share certain symptoms such as sore, stiff, inflamed, and painful joints [51]. However, the various forms of arthritis are quite different from each other in terms of etiology, manifestation, diagnosis, prognosis,

and treatment. The most common forms of arthritis in the elderly are rheumatoid arthritis and osteoarthritis [52].

2.2.1 Most Common Types of Arthritis in Elderly

2.2.1.1 Rheumatoid arthritis (RA)

Rheumatoid arthritis is a chronic, multisystem inflammatory autoimmune disease of unknown etiology [51]. There were about 1.3 million US adults suffering from RA in 2005, down from an estimated 2.1 million in 1995 [49]. It is proposed that this disease progresses in three stages [51, 53, 54].

The first stage is swelling of the synovial lining, causing pain, warmth, stiffness, redness and swelling around the joint. The second stage is the rapid division and growth of cells, or pannus, which causes the synovium to thicken. In the third stage, the inflamed cells release enzymes that may digest bone and cartilage, often causing the involved joint to lose its shape and alignment, promoting more pain and loss of movement [51, 53, 54].

Initially RA affects the hands, wrists and feet; it may later involve any synovial joint such as the knee, ankle, hip, elbow, and shoulder [55]. The most common joints affected by RA are shown in Figure 2.1.

This disease clearly shortens one's survival by 5-10 years [56] and produces a significant disability [55, 56]. It can lead to long-term joint damage, which results in chronic pain, then functional limitation and disability [54].

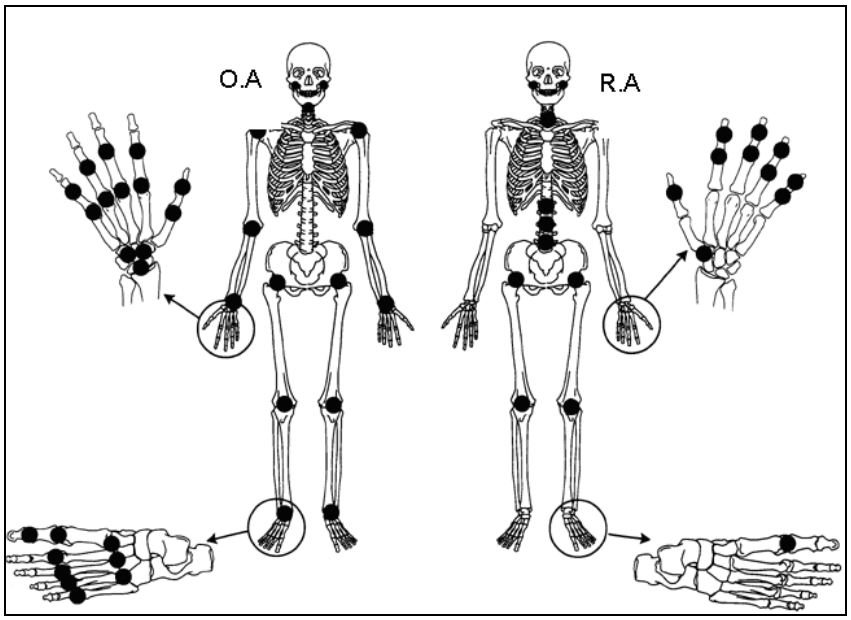

Figure 2.1 Joint distribution in RA (right) and OA (left). Adapted from Koopman and Moreland (2005)

2.2.1.2 Osteoarthritis (OA)

Osteoarthritis (OA) is one of the oldest recognized and most common forms of arthritis [12, 49]. The current comprehensive definition of OA is "morphologic, biochemical, molecular, and biomechanical changes of both cells and matrix which lead to softening, fibrillation, ulceration, and loss of articular cartilage, sclerosis, eburnation of subchondral bone, osteophytes, and subchondral cysts" [57]. Globally, OA is known by several names, such as degenerative joint disease, ostoarthrosis, hypertrophic arthritis, and degenerative arthritis [58]. In terms of prevalence, OA affected nearly 27 million Americans aged 25-74 years in 2005, up from an estimated 21 million in 1995 [59].

Osteoarthritis is classified as primary, idiopathic, or secondary. Idiopathic means that the OA occurs without clear underlying predisposing factors. When OA occurs following a systemic pathogenic factor, it is called secondary OA [60]. Generally, the

point of onset of OA is undetectable; however, pathology (radiological changes) and symptoms are used as markers of the disease [60].

Osteoarthritis is simply characterized by a deterioration of articular cartilage and formation of new bone at the joint surfaces. The most common OA joint involvement is shown in Figure 2.1. The main symptom of OA is pain, often leading to mobility limitation and stiffness [60, 61]. This pain is commonly described as a sharp ache or a burning sensation in the associated muscles and tendons. In some cases, OA can cause crepitus which occurs when the affected joint is moved or touched, and in some cases is associated with tendon-related muscle spasms and contractions [60]. OA is occasionally associated with acute or subacute inflammation, most commonly in erosive (inflammatory) OA of the hands, but it may occur in other peripheral joints [60].

2.2.2 Measurements (Arthritis Case Definition)

In most public health surveys such as the National Health and Nutrition Examination Survey (NHANES), arthritis is measured as a self reported condition [49, 62-64]. For example, the NHANES survey asked subjects directly about their condition, "Have you ever had, or has a doctor ever told you that you have, arthritis or rheumatism?" and "Have you EVER been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?" [59]. Similarly, in some population-based epidemiologic studies such as the ongoing Hispanic Established Population for the Epidemiological Study of the Elderly (H-EPESE) survey, assessed self-reported arthritis was studied by asking if subjects "had ever been told by a doctor that they had arthritis or rheumatism" [65]. In another prospective longitudinal study, The Health and Retirement Study (HRS), arthritis was measured

according to self-report by "Have you ever had, or has a doctor ever told you that you have, arthritis or rheumatism?" [66]. Additionally, the Health, Well-Being, and Aging in Latin America and the Caribbean Study (SABE) studies assessed self-reported arthritis by asking if subjects “had ever been told by a doctor or nurse that they have arthritis, rheumatism, or osteoarthritis” [67].

However, self-reported measures of arthritis may or may not correspond to the diagnostic criteria for rheumatological conditions such as the criteria of the American College of Rheumatology for RA or OA [49]. Despite that, “self-reported doctor-diagnosed arthritis” provides the most credible estimate of overall arthritis prevalence, with acceptable sensitivity and specificity for surveillance purposes [49].

2.2.3 Risk Factors

Several factors have been associated with developing arthritis. Some, called ‘nonmodifiable risk factors’, cannot be changed. Others, called ‘modifiable risk factors’, can be modified. Nonmodifiable risk factors are older age, female gender, and genetic predisposition [68]. Previous joint injuries, infections, depressive symptoms, increased body weight, and certain occupations are known as modifiable risk factors.

2.2.3.1 A- Nonmodifiable Risk Factors

A.1. Age:

The incidence and prevalence of arthritis increases with age [66]. Since longitudinal studies are needed to determine incidence rates, incidence has been studied less often than prevalence. Because relatively few new cases occur even in large populations, estimates of incidence are often imprecise [66]. Findings from the Alameda County Study, a longitudinal population based study, indicated that increasing age is a significant risk factor for incident self-reported arthritis [69]. The odds ratio (OR) was

2.00 (95% CI= 1.40–2.85) for subjects aged 45–49 and increased to 3.13 (95% CI= 2.32–4.22) for subjects 50 years or over [69].

Recently, the 2003–2005 National Health Interview Survey (NHIS) reported arthritis prevalence for those aged 18-44 years at 8%, 45–64 years at 29%, and 65 years or older at 50% [12, 49], as shown in Figure 2.2. This supports the notion that arthritis is associated with age, as the data show a 50% greater likelihood of arthritis for those aged 65 years or older [49]. This is supported by other studies as well, showing that arthritis is a highly prevalent chronic condition in older adults, especially in persons aged 65 years or older [70-72].

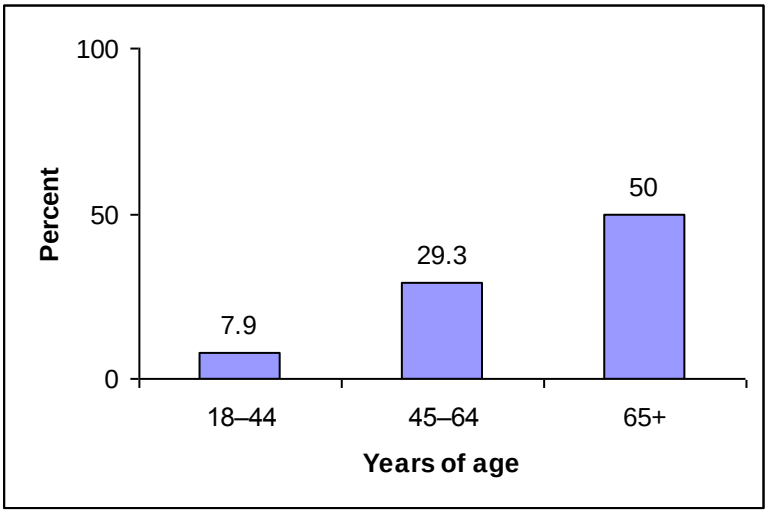

Figure 2.2 Percent of those with doctor-diagnosed arthritis, by age group, National Health Interview Survey, United States, 2003–2005

A.2. Gender:

According to most epidemiological studies, arthritis is more common in women. For example, in the current NHIS data, the age-adjusted arthritis prevalence was higher for women than for men (24% versus 18%) (Figure 2.3) [12, 16, 49]. In a longitudinal study of 7,447 older participants aged 70 years or older, the Asset and Health Dynamic Survey Among the Oldest Old (AHEAD), the prevalence of self-reported arthritis was greater in women (31%) than in men (23%) [16].

In a separate study of 2,873 Mexican-Americans aged 65 or older, prevalence of arthritis was 50% in women compared to 29% in men [65]. In explaining the difference, some studies have suggested that the female sex hormone estrogen can influence both the incidence and progression of certain types of arthritis [73]. However, oral contraceptive use has been shown to reduce the risk of RA [74, 75].

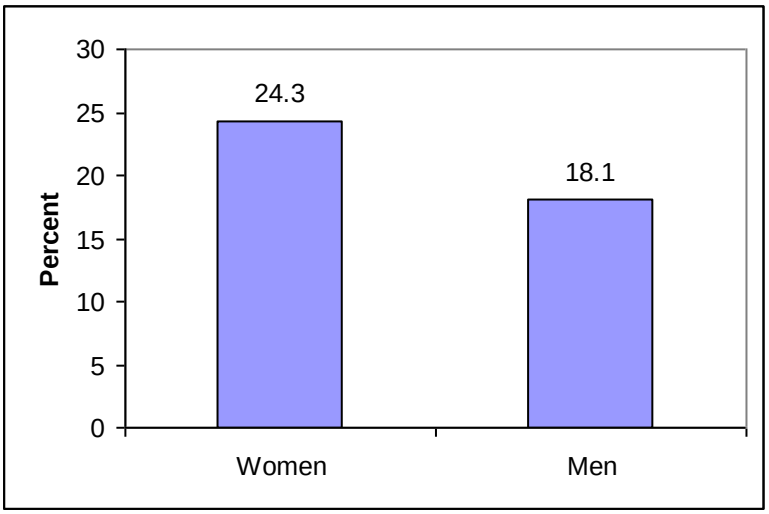

Figure 2.3 Percent of doctor-diagnosed arthritis, by gender, National Health Interview Survey, United States, 2003–2005

A.3. Race and Ethnicity:

Racial/ethnic differences have been documented in the prevalence of arthritis [8]. To examine racial/ethnic differences in arthritis prevalence, CDC analyzed data from the 2003–2005 National Health Interview Survey (NHIS) [1, 49]. The study showed that age-adjusted arthritis prevalence was similar for non-Hispanic whites and African Americans, 22%, and was lower in Hispanics, 16.5% (Figure 2.4) [1, 49].

However, data from AHEAD showed that arthritis affects minority groups more than whites. The prevalence of arthritis was 25% in non-Hispanic whites, 40% in non-Hispanic blacks, and 44% in Hispanics [16]. Despite the existence of ethnic and racial disparities [76], it is not yet clear if race and ethnicity is highly affected by arthritis in the current literature. Therefore, prospective longitudinal studies with larger samples are needed to understand this issue and to assess potential causal roles [76].

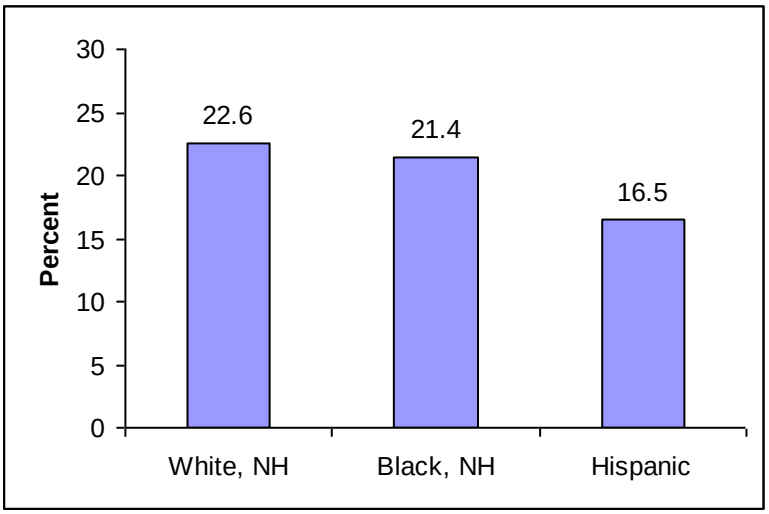

Figure 2.4 Percent of doctor-diagnosed arthritis, by race/ethnicity, National Health Interview Survey, United States, 2003–2005

A.4. Genetics:

Genetics characteristics are considered another nonmodifiable risk factor for arthritis. Particular genes are associated with a higher risk of some types of arthritis, such as RA, ankylosing spondylitis, systemic lupus erythematous (SLE), and osteoarthritis [68, 77]. For example, in a meta-analysis of 10 studies, Han et al. (2005) [78] found that the CTLA-4 gene exon-1 +49A/G polymorphism is a risk factor for RA in Asians, but not Europeans.

Furthermore, in a family-based analyses of 844 simplex families from four ethnic groups (Caucasian, Asian, Hispanic and African American), a haplotype containing the PD1.3A allele was significantly associated with SLE among Caucasian families (P= 0.01). For Hispanic families, two novel single-nucleotide polymorphisms (SNPs) were significantly associated with SLE risk [79]. In terms of osteoarthritis, a twin study revealed that genetic factors account for about 50% of cases of OA in the hands and hips but less in the knees [80].

A.5. Socioeconomic Status (SES):

Socioeconomic disparities are associated with arthritis [81, 82]. In the general population, the rate of arthritis is higher among persons with low education and with low income [83]. For example, data from the recent NHIS indicated that subjects with arthritis were more likely to have less than a high school education (age-adjusted) (23.2% versus 21.2%), Figure 2.5 [12].

Additionally, analyses from the Canadian Community Health Survey (>15 years, N = 127,513) found that low income and low education were positively associated with reporting arthritis [83]. Recently, in Australia, the risk of arthritis was found to be

associated with lower income, according to data from the Victorian Population Health Survey (*N* = 7,500) [84]. A Danish case-control study of 515 patients with RA found that low level of education was significantly associated with risk of RA [85]. In older adults, Dunlop et al. [16] found high prevalence of arthritis strongly associated with lower income, less education and less wealth.

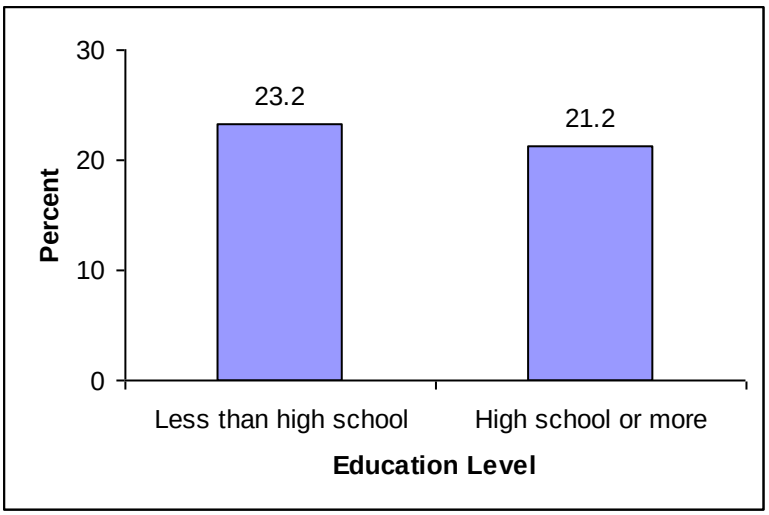

Figure 2.5 Percent of doctor-diagnosed arthritis, by education level, National Health Interview Survey, United States, 2003–2005

2.2.3.2 B- Modifiable Risk Factors

B.1. Overweight and Obesity:

Many studies have found increased body weight associated with increased risk of arthritis, up to twice that in normal weight adults [86-88]. Data from NHIS 2003-2005 indicated that persons who are overweight or obese report more doctor-diagnosed arthritis than thinner people [12]. Age-adjusted prevalence was 16.3% in under/normal

weight subjects, 21.7% in overweight subjects, and 30.6% in obese subjects (Figure 2.6) [12].

Data from the Victorian Population Health Survey (N = 7,500), found that a higher body mass index (BMI) was independently associated with arthritis [84]. Analyses of a longitudinal study of 1985 subjects found obesity significantly associated with 23-year incidence of osteoarthritis of the hands among subjects disease free at baseline [89]. Also, it has been reported that there is a weak relationship between increased body weight and hip OA, as compared to the knee OA. Being overweight was found to be a factor significantly associated with bilateral OA in hip joint, but not significantly associated with unilateral affected joint [90].

Furthermore, weight loss may decrease the risk of arthritis and improve symptoms [91]. For example, Felson et al. (1992) [92] examined women who participated in the Framingham knee osteoarthritis study (from 1983 to 1985) and revealed that a weight loss of 11.2 pounds over a 10-year period decreased the likelihood of developing knee OA by more than 50% (OR= 0.46; 95% Cl = 0.24 to 0.86).

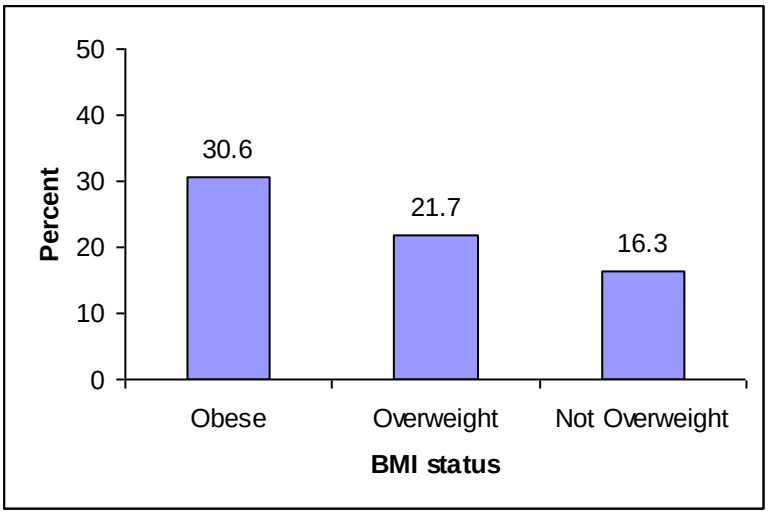

Figure 2.6 Percent of doctor-diagnosed arthritis, by BMI status, National Health Interview Survey, United States, 2003–2005

B.2. Occupational Factors:

Occupational factors are associated with arthritis. Occupations that require repetitious tasks increase the risk for osteoarthritis because these movements overwork specific joints and fatigue joint-protecting muscles [90]. Data from the Framingham study suggest that such job activities are associated with 15–30% of cases of OA in men [93].

Other occupational activities that include standing, climbing stairs, walking on uneven ground and sitting have been conflictingly linked to osteoarthritis risk [94]. However, in a recent systematic review by Jensen (2008) [95] of 19 studies, the author found limited evidence for a relation between hip OA and construction workers and no evidence linking stair or ladder climbing to hip OA[95].

B.3. Previous Joints Trauma:

Several epidemiological studies examine the relationship between joint injuries in young adults and risk for later arthritis, especially OA. In a longitudinal study by Gelber

et al. (2000) [96], 1321 former medical students were surveyed and their injury status recorded at baseline. The researchers found that 36 years' prior joint injury increased significantly the risk of OA at that site of injury (OR = 5.17; 95% CI= 3.07-8.71).

Similarly, higher rates of OA have been found in athletes in a variety of sports [97, 98]. For instance, in a recent case-control study, Thelin et al. (2006) [99] studied 825 cases of x-ray-verified knee OA for athletes who were matched with 825 controls from the general population. They found that playing soccer and ice hockey were significantly associated with knee OA (OR= 1.52; 95% CI= 1.04–2.20) and (OR= 2.06; 95% CI= 1.21–3.50), respectively [99].

B.4. Diet and Nutrition:

While dietary factors have been found to be an important RA risk factor [100], research suggests that changes in diet and nutrition can decrease the instance of RA [101, 102]. In a prospective cohort of 57,053 subjects, Pedersen et al. (2005) [100] found no association between intake of foods or dietary supplements (such as long chain fatty acids, olive oil, vitamins A, E, C, and D, zinc, selenium, iron, and meat) on RA development [100], while the extreme (undernutrition) was found to be a risk factor for disability in RA patients [103]. Vitamin intake has been found to significantly affect OA progression; in the longitudinal Framingham knee OA cohort study [104], a 3-fold reduction in risk of OA progression was observed for persons in the middle and highest tertile of vitamin C intake, compared to those whose intake was in the lowest tertile [104].

As discussed earlier, the Healthy People 2010 initiative has eight objectives under the arthritis focus area (focus area 2) [23]. Additionally, Healthy People 2010 has targets

subjects with arthritis by two additional objectives; however, these two objective are under the nutrition focus area (focus area 19) [105].

B.5. Depression:

Most studies have shown that arthritis is strongly associated with depression [106]. In a study of 188 older women with RA (N = 87) and OA (N = 101), Zautra and Smith [107] found that depression was associated with pain in both groups, but strongly in RA [107]. Findings from the Health and Retirement Survey (HRS) indicated that arthritis is strongly associated with major depression (attributable risk = 18.1%) in older adults [108]. Finally, a longitudinal study (with a 20 year follow-up) has shown that, as observed in a group of 1149 women and 964 men, depressive symptoms increase the risk of self-reported arthritis (OR= 1.53; 95% CI= 1.12–2.10) [69].

However, this relationship of arthritis and depression is poorly understood, because, in general, depressive symptoms are associated with pain and disability, the two main symptoms of arthritis [109].

2.2.4 Consequences of Arthritis

In older adults, arthritis is usually associated with ancillary medical conditions, high health-care cost, substantial activity limitation, work disability, and reduced quality of life. Arthritis is also a risk factor for other comorbid conditions [110-113]. Not only are there direct costs of this disease (i.e., hospital and pharmaceutical costs), but also there are substantial indirect costs [114-116]. In the following two sub-sections, specific risk factors and medical condition attributed to arthritis are discussed.

2.2.4.1 Arthritis as a Risk Factor

Several studies have found that arthritis is associated with developing other medical conditions [112, 117-120]. For example, patients with arthritis are at high risk of

developing hypertension, diabetes mellitus, hypercholesterolemia, pulmonary, cardiological, or digestive diseases [112, 117-120]. A cross-sectional study was conducted by Wolfe et al. [121] to determine whether the risk for cardiovascular and/or cerebrovascular disease (CCVD) is higher in patients with RA or OA. From a sample of 11,572 arthritic patients (9,093 with RA; 2,479 with OA), risk of multiple cardiovascular events (i.e., myocardial infarction (MI), congestive heart failure (CHF), and stroke) was significantly increased only in patients with RA [121].

2.2.4.2 Arthritis and Economic

In 2003, direct costs attributable to arthritis and other rheumatic conditions (AORC) were around $80.8 billion, as measured by: inpatient and outpatient care, prescription drugs, and residual (i.e., home health care, vision aids, dental visits, and medical devices) [114]. The average per-person direct costs were $1,752, with the highest cost services for ambulatory care ($914), followed by emergency department and inpatient services ($352), prescriptions ($338), and other costs ($146) [114].

Total indirect costs attributable to AORC were about $47.0 billion; average per-person lost earnings were $1,590, as measured among 29.5 million working-age adults [114]. National overall costs (direct and indirect) totaled $128 billion, equal to 1.2% of US GDP in 2003 [114]. Among states/areas, total costs attributable to AORC ranged from $225.5 million (District of Columbia) to $12.1 billion in California. New York and Texas had the next highest total costs at $8.7 billion [114].

An estimated 36.5 million medical visits were due to AORC in 1997, as realized in physician office visits (89%), acute care hospital outpatient services (7%), and emergency departments (4%) as reported by the National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Ambulatory Medical Care Survey

(NHAMCS) [15]. In addition, the 1997 National Hospital Discharge Survey reported 744,000 hospitalizations due to AORC [14].

2.3 DISABILITY

The first Disability sub-section compares and contrasts two important disability models: the Disablement Process Model (DPM) and the Enabling-Disabling Model (EDM). Subsequently, the association between arthritis and disability is reviewed in the second sub-section.

2.3.1 Two Important Disability Models

Several conceptual schemes have informed discussion regarding disability research, most prominently the Disablement Process Model (DPM) and the Enabling-Disabling Model (EDM) [122, 123]. Both models were developed in the US during the 1990s. The DPM [124] is a sociomedical model developed by two researchers, Dr. Lois Verbrugge, a demographer at the University of Michigan, and Dr. Alan Jette, a physical therapist from Boston University.

The DPM was disseminated and published in 1994 by the journal Social Science and Medicine. In 1997, the Institute of Medicine (IOM) introduced the enabling-disabling model (EDM) [125] in the book *Enabling America, Assessing the Role of Rehabilitation Science and Engineering*. The EDM is a modified version of a previous model published by IOM in 1991 [126].

DPM is similar to EDM in that it treats disability as a continuum of components, rather than an absolute case; this stems from both models' adaptation of Dr. Saad Nagi's disability model [127]. In 1965, Nagi identified four basic components of the disability process: 1) pathology, 2) impairment, 3) functional limitation, and 4) disability. Since

then, most contributions have identified the same components. Consequently, DPM and EDM are alike in expanding and elaborating these components and are used in both research and clinical practice [127]. Each model has a different perspective from which to describe disability and its pathway.

The main pathway of DPM starts with pathology (Figure 2.7) and its consequences — impairment, functional limitation, and disability — incorporating three fundamental characteristics: 1) Epidemiological risk factors such as behavior, demographic, lifestyle, and biological attributes; 2) Intra-individual factors such as lifestyle and behavior changes, psychosocial attributes and coping, and activity accommodations that might affect functional limitation; and, 3) Extra-individual factors such as medical care and rehabilitation, medication and other therapeutic regimens, external support, physical, and social environment [124, 127].

Conversely, the IOM model (Figure 2.8) starts with a state of "no disabling condition", followed by pathology, impairment, and functional limitation [125, 127]. Most importantly, it includes bidirectional arrows to depict the concept of disabling factors (moving from left to right) or enabling factors (moving from right to left). Lastly, it illustrates how quality of life and transitional factors (biological, life style and behavior, and three dimensions of environment) interact. Ultimately, the IOM model does not include disability, as in the previous model [125, 127]. Instead, the IOM committee treated disability as a product of the individual's interaction with his/her environment; as such, it is not inherent to the individual [125, 127].

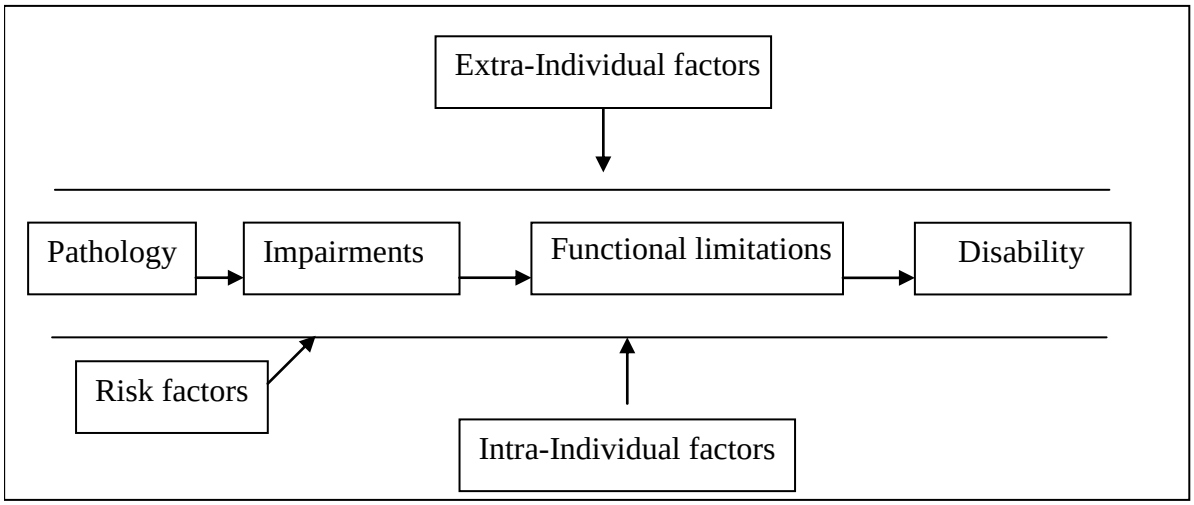

Figure 2.7 Verbrugge and Jette Model (DPM) (1994)

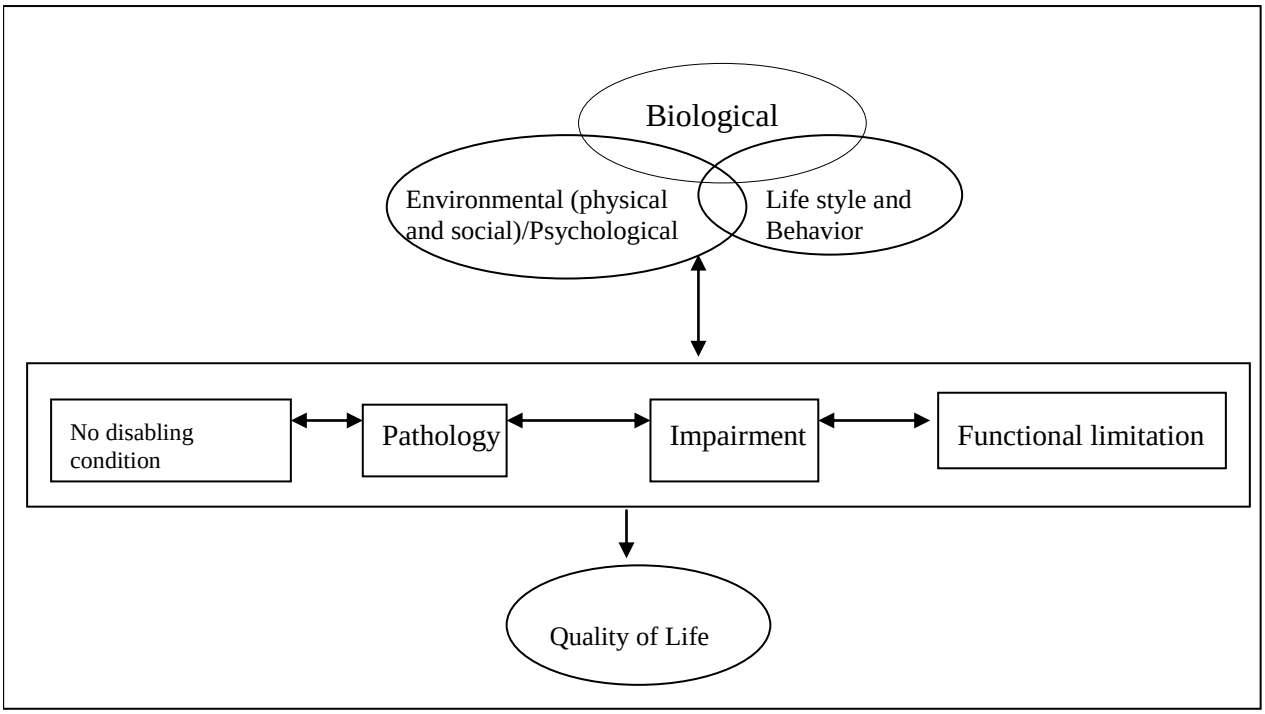

Figure 2.8 Institutes of Medicine Model (EDM) (1997)

As a result of the difference in general structure, each model has different definitions for each component. First, as indicated in Table 1.2, the terms of pathology, according to the Verbrugge and Jette model of disability (DPM), refers very specifically to biochemical and physiological abnormalities detected and medically labeled as a disease, injury, congenital, or developmental condition. In their perspective, medical diagnoses are required to satisfy clinical significance [124]; undiagnosed pathologies would not be included in this version of the concept [124]. Unlike DPM, the EDM model views pathology as interruption or interference of normal bodily processes or structures that need to be addressed early-on if they are to prevent disability [125].

'Impairments' (the second component in the disability pathway), is defined by DPM as "dysfunctions and significant structural abnormalities in specific body systems". The term 'significant' is used to indicate the consequential effects of the abnormality, specifically, that it can affect one's social, mental, or physical functioning [124]. The authors also specify that impairment can occur in primary and secondary locales, immediately or delayed. Impairments are identified via medical procedures, including exams, laboratory tests, imaging, medical histories and symptom reports. The data collection method in DPM, however, via self-report, is questionable [124].

EDM describes impairment as "loss and/or abnormality of mental, emotional, physiological, or anatomical structure or function: includes all losses or abnormalities, not just those attributable to active pathology; also includes pain" [125]. Moreover, the severity of impairment is affected by many factors such as the condition, tissues and organs affected, and extent of damage [125].

Each model also defines ‘functional limitation’ differently, where DPM regards it as “restrictions in performing fundamental physical and mental actions used in daily life by one's age-sex group” [124]; Verbrugge and Jette emphasized this point, stating that these are "generic actions (required) in many specific circumstances". The authors exemplify the physical and mental actions required for an individual to interact with the social and physical environment, including overall mobility; discrete motions and strengths; trouble seeing, hearing, or communicating; and other general examples [124]. Data collection can be done through self-reports or proxy reports [124]. In contrast ‘functional limitation’ is briefly addressed in the IOM model, stating that the term describes “restriction or lack of ability to perform an action or activity in the manner or within the range considered normal that results from impairment” [125].

Finally, DPM defined ‘disability’ as “experiencing difficulty doing activities in any domain of life due to a health or physical problem” [124]. Likewise, EDM defined it as “inability or limitation in performing socially defined activities and roles expected of individuals within a social and physical environment” [125].

Table 2.1 Names and Definitions of Components of the Two Disability Models

	First Component	Second Component	Third Component	Fourth Component
DPM(1994)	Pathology	Impairment	Functional limitation	Disability
	Biochemical & physiological abnormalities that are detected *and* medically labeled as disease, injury, or congenital or developmental conditions	Dysfunctions and significant structural abnormalities in specific body systems	Restrictions in performing fundamental physical and mental actions used in daily life by one's age-sex group	Experiencing difficulty doing activities in any domain of life due to a health or physical problem
EDM(1997)	Pathology	Impairment	Functional limitation	Disability
	Interruption or interference of normal bodily processes or structures	Loss and/or abnormality of mental, emotional, physiological, or anatomical structure or function: includes all losses or abnormalities, not just those attributable to active pathology; also includes pain	Restriction or lack of ability to perform an action or activity in the manner or within the range considered normal that results from impairment	Inability or limitation in performing socially defined activities and roles expected of individuals within a social and physical environment

2.3.2 Arthritis and Disability

Data from the National Health Interview Survey (NHIS) for 2003 – 2005 showed that 41% (19 million) of the 46 million adults with arthritis reported limitations in their normal activities because arthritis [12]. In 2002, 21% of US adults had doctor-diagnosed arthritis, where more than one third of them had activity limitations attributable to arthritis. Of those working-age (aged 18-64) adults with arthritis, one third also had arthritis-attributable work limitations (AAWL) [128].

Similarly, Theis et al. (2007) [129] used the 2002 NHIS data to estimate the prevalence of AAWL, finding that, of those aged 18-64 with arthritis, AAWL was noted in 30% of cases [129]. The prevalence of AAWL was highest among people ages 45-64 years (10.2%), women (6.3%), non-Hispanic blacks (7.7%), those with less than a high school education (8.6%), and those with an annual household income <$20,000 (12.6%) [129]. Notably, AAWL significantly increased among people with arthritis-attributable activity limitations (OR= 9.1; 95%CI= 7.1-11.6) [129]. Data from the 2003 Behavioral Risk Factor Surveillance System (BRFSS) showed that, among working-age (aged 18-64) persons in all US states, AAWL was high, ranging from 3.4 - 15% of adults with arthritis [128].

2.4 HEALTH-RELATED QUALITY OF LIFE

This section reviews the definitions of the two parts of 'health-related quality of life': quality of life and health. While there are many definitions for quality of life (QoL), this study refers to a person's assessment of 'satisfaction with life' [130, 131]. For example, Post et al. (1999) [132] in a systematic review found that 'quality of life' has been used synonymously with: health status, physical functioning, perceived health

status, subjective health, health perceptions, symptoms, need satisfaction, individual cognition, functional disability, psychiatric disturbance, and well-being. Vetter [133] suggested that health and quality of life are inherently interrelated, thus giving rise to the concept of health-related quality of life (HRQoL). Therefore, quality of life is the umbrella for health.

According to the World Health Organization (WHO), quality of life is an "individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" [134]. Health is generally defined as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" [135]. Lastly, the CDC (2000) [136] defined HRQoL as "an individual's or group's perceived physical and mental health over time". In 1993, CDC developed a 4-item Healthy Days Core Module as a tool for public health surveillance of HRQoL [136].

2.4.1 Arthritis and HRQoL

Findings from several studies indicate that subjects with arthritis have poorer HRQoL than those without arthritis [5, 30]. Mili et al. (20003) [5] compared subjects from the general population in 15 states and Puerto Rico with and without arthritis using the CDC HRQOL model. They found that subjects with arthritis were three times more likely to report their general health as 'fair' to 'poor' and averaged more physical, mental, and overall unhealthy days than participants without arthritis [5].

In a separate study, Dominick et al. (2004) [30] examined the CDC HRQoL modules using the Medicare data on 41,467 older adults from Pennsylvania with and without arthritis [30]. This study found that subjects with OA and RA had poorer HRQoL

than those without arthritis [30]. Also, the CDC's HRQoL modules could distinguish those with and without arthritis as well as between different types of arthritis (OA and RA) in older adults [30].

Likewise, using the SF-36 measure, the general populations of eight countries, including the US, were assessed to study the impact of common chronic conditions on HRQoL [28]. This large study found that arthritis impacted HRQoL the most, for the entire population of the countries studied [28].

3.0 METHODS

This chapter is organized into four main sections. The first describes the conceptual model used to guide each analysis. The second discusses the research design and sample of the current study, including characteristics of the studied population and data collection methods. The third describes research variables and measurements. Finally, the last address data management and analysis.

3.1 THE STUDY CONCEPTUAL MODEL

In the present study, the disablement process model was modified by adding physical and mental components of the health-related quality of life to arrive at an overall outcome (Figure 3.1). As discussed in the previous chapter, the concept of quality of life has been used as a core element of the Institute of Medicine (IOM) disability model (Figure 2.8) [125]. Thus, HRQoL was incorporated into this study's conceptual model. Health-related quality of life is assessed using the Medical Outcomes Study (MOS) 36-Item Short-Form Health Survey (SF-36) [137]. SF-36 is the most widely used generic measure of HRQoL for chronic diseases [138], orthopedic conditions [139], and most importantly, for arthritis [140].

As shown in Figure 3.1, the first element, pathology, was operationally defined here as self-reported physician diagnosis of arthritis. The second element, impairment, was represented by self-reported pain on weight-bearing along with reduced lower and upper body muscle strength (performance-based measures). The third element, functional limitation, was addressed through lower body limitation, chosen because it is a more

significant factor in predicting future disability than upper body limitation [141-146]. This component of the model was assessed using the short physical performance battery (SPPB) which includes three tasks: standing balance, walking speed, and repeated chair stands [147]. Finally, the fourth component, disability, assessed having difficulty in doing any activity of daily living (ADL) (e.g., bathing, grooming, dressing, eating) [148] or instrumental ADL (IADL) (e.g., driving, shopping, preparing meals, handling money) [149].

Potential risk factors for arthritis were organized into one box, external to the main disablement pathway. This approach, unlike the original model, facilitates an understanding of the impact of arthritis. The three independent boxes as described in the DPM are: predisposing risk factors, intra-individual factors, and extra-individual factors [122, 124]. In the current investigation, arthritis risks factors were classified as non-modifiable and modifiable factors. The non-modifiable risk factors included age, sex, level of education, and nativity. The modifiable risk factors were represented by language of interview, body mass index (BMI), depressive symptoms, low cognitive status, and medical conditions (heart attack, stroke, hypertension, diabetes, osteoporosis and cancer). These factors are thought to mediate or moderate the relations among pathology, impairment, functional limitation, and disability [122, 124] as well as the physical and mental components of the HRQoL [144].

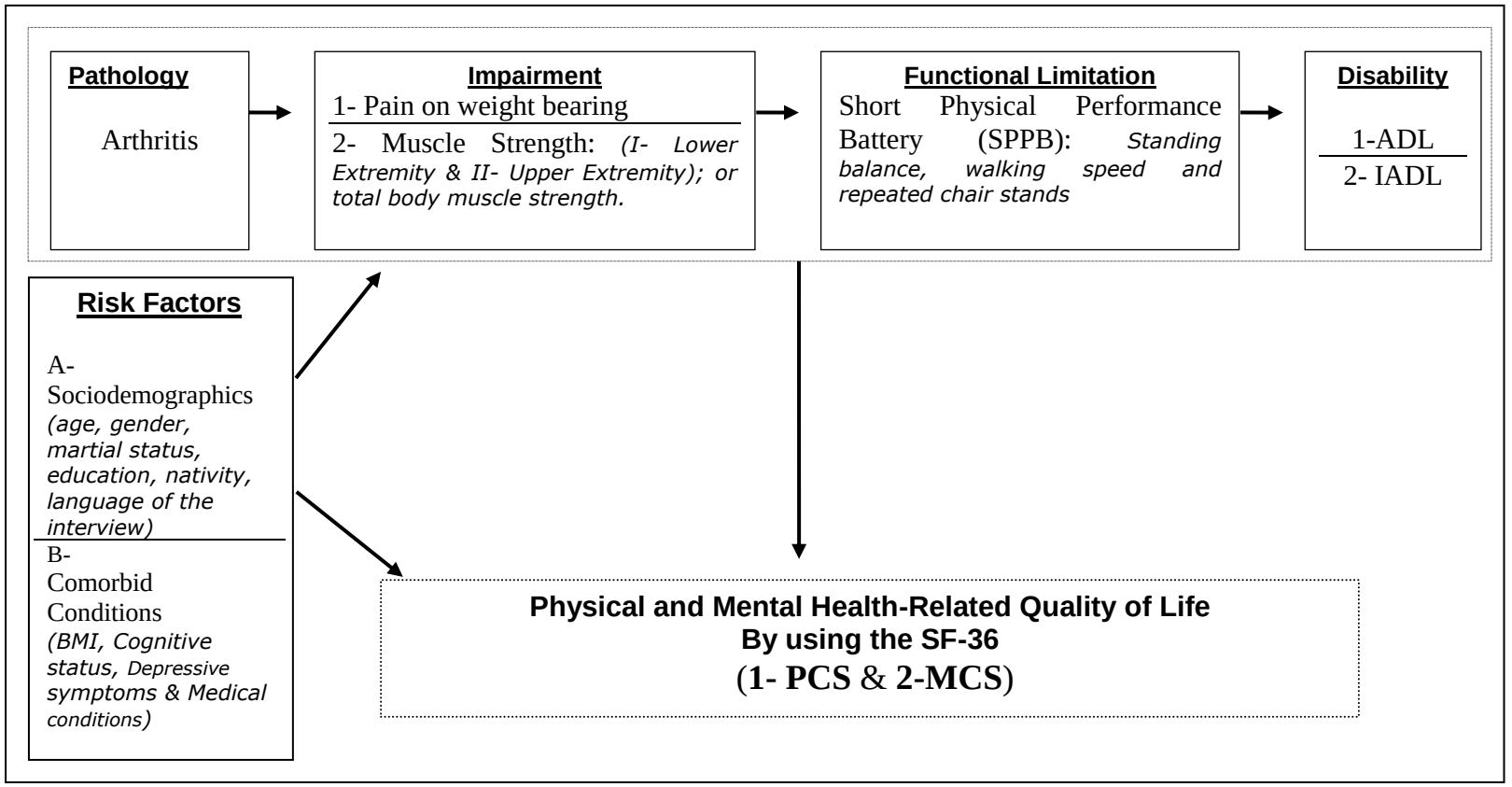

Figure 3.1 The Conceptual Model for the Current Investigation; adapted from Verbrugge and Jette (1994) and IOM (1997)

3.2 RESEARCH DESIGN AND SAMPLE

Data from the Hispanic Established Population for the Epidemiological Study of the Elderly (EPESE) were analyzed longitudinally to evaluate the association between arthritis and physical function, disability, and health related quality of life among older Mexican-Americans.

3.2.1 Description of the Hispanic EPESE Study

The Hispanic EPESE is an ongoing population-based study of 3050 non-institualized Mexican-Americans aged 65 or over at baseline (1993-1994) in five southwestern states (Arizona, California, Colorado, New Mexico, and Texas). Six waves of data have been collected (1993-1994, 1995-1996, 1998-1999, 2000-2001, 2004-2005, and 2006-2007) to accomplish this task.

To generalize findings to approximately 500,000 Mexican-Americans aged 65 or older, subjects were selected according to a multistage area probability cluster sample that involved 1) selection of counties, 2) census tracts (a small census based geographical area), and 3) households. In the first stage, counties were selected if at least 6.6% of the county population was of Mexican-American ethnicity. In the second stage, census tracts were selected with a probability proportional to the size of their older Mexican-American population, using counts from the 1990 US census; there were 206 census tracts in the analyzed sample. In the third stage, census blocks (very small area units within census tracts) were selected at random to obtain at least 400 households within each census tract. These households were screened to identify subjects in the target population of older Mexican-Americans. The sample and its characteristics have been described thoroughly elsewhere [150-152]. Generally, the Hispanic EPESE research design was closely modeled

after the design of prior EPESE studies (New Haven, East Boston, North Carolina, and rural Iowa) [153] and includes many of the EPESE instruments used repeatedly as standard measures in studies of older adults.

Bilingual interviewers (Spanish and English) who conducted all interviews were trained by the project staff and employed by Harris Interactive, Inc. (formerly Louis Harris and Associates). Interviews were conducted in the home of the respondent or their proxy. The baseline and first follow-up interview lasted approximately 90 minutes, with the second, third, and fourth interviews each lasting approximately 60 minutes.

3.2.2 The disablement Process Study (A Sub-Sample)

After Wave 3 data collection, a list of respondents covered by Medicare (N= 1598) was created. This represented approximately 81% of the sample at Wave 3. Respondents who had Medicare coverage were chosen for the disablement process study in order to link the sub-study data with Medicare claims data. A random sample of 800 subjects was selected with the goal of conducting at least 500 interviews. This was exceeded, as 621 subjected were interviewed in Wave one (2000-2001) (see Figure 3.2). In the second wave (2001-2002), 551 interviews were completed. Finally, 359 subjects were re-interviewed in 2006.

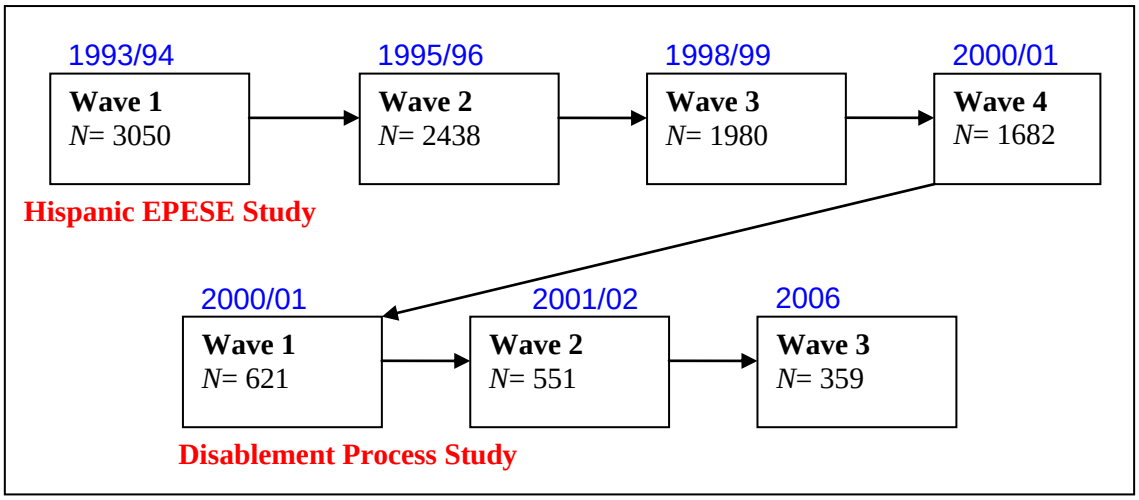

Figure 3.2 The Roots of the disablement Process Study

3.2.3 Study Population

Data employed was from the baseline of the disablement process study, Wave 2, and Wave 3 (Figure 3.2). At baseline (2000-2001) 621 subjects had completed in-home face to face interviews in either Spanish or English at the subject's preference. Proxy interviews were not included due to the physical nature of some of the measurements. In Wave 2 (2001-2002), 549 subjects were re-interviewed in person and 2 by proxy; 48 refused to be interviewed or were lost in the follow-up, and 22 were confirmed dead through either the National Death Index (NDI) or reports from relatives. In Wave 3 (2006), 359 subjects were re-interviewed in person, and 39 by proxy; 47 refused to be interviewed or were lost in the follow-up and 121 were confirmed dead (Figure 3.3).

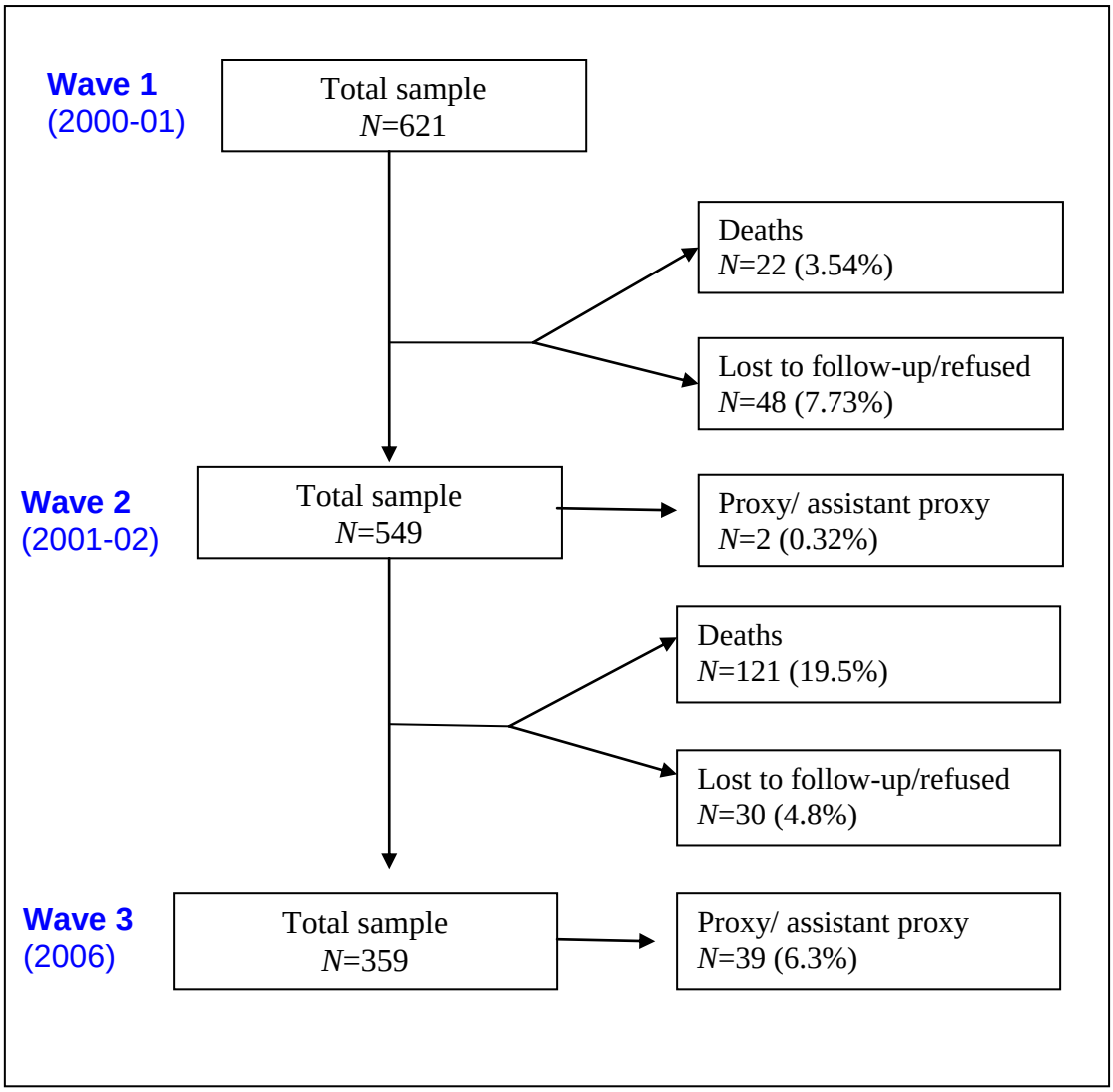

Figure 3.3 Status of the sample at baseline and follow-up.

3.3 RESEARCH VARIABLES AND MEASUREMENTS

3.3.1 The Four Elements of the Disablement Process Model

3.3.1.1 Pathology

A prior physician diagnosis of arthritis was assessed with the question: "Has a doctor ever told you that you have arthritis or rheumatism?" Similar questions have been used in other national surveys [154, 155]. Moreover, such a question is thought to

provide the most credible estimate of overall arthritis prevalence, with acceptable sensitivity and specificity, mainly for longitudinal epidemiological studies [49].

3.3.1.2 Impairment

There are two main variables under the impairment element. The first variable is ‘pain on weight-bearing’; the second is ‘muscle strength’. The latter was measured by two different instruments, depending upon the joint and movement to be measured.

A. Pain on weight-bearing was assessed with the question; “In the past month, did you notice any pain or discomfort when you stood or walked?”
B. For large muscle groups, muscle strength was measured using the Nicholas Manual Muscle Tester (NMMT). NMMT is used mainly for large muscle groups of the lower and upper extremities. The peak force (in kilograms) required to break an isometric contraction (break test) is measured as the examiner applies pressure against the subject with the NMMT. A load cell in the device provides digital output ranging from 0.0 to 199.9 kg (equivalent to approximately 440 lb), with higher scores indicating greater muscle strength. A previous study has shown that NMMT is a reliable and valid measure in older subjects [156]. The five positions tested using the NMMT are:

    1- Knee extension.
    2- Hip flexion.
    3- Hip abduction.
    4- Shoulder abduction1 at 0 degree.
    5- Shoulder abduction 2 at 90 degree.

C. For handgrip strength, the Jamar Hydraulic Dynamometer was used. In a sitting position with his elbow resting on the table and palm facing up, a subject was instructed to squeeze the handgrip as hard as he/she could while receiving verbal encouragement. This test of dynamometrical grip strength test is reliable, valid, and easy to administer for older subjects [157-160].

For the current study, two 'muscles strength' variables were generated to be used in the analyses related to Aim 1: lower extremity muscle strength (knee extension, and two hip readings) and upper extremity muscle strength (two shoulder readings and grip strength). Furthermore, for Aims 2 and 3, all five muscle strength readings were combined into one variable called 'total body muscle strength' in order to avoid a collinearity issue between lower and upper extremity muscle strength.

3.3.1.3 Functional Limitation

Because it can be problematical to separate functional limitations from disability, Verbrugge and Jette [124] suggested that investigators need to clarify their conceptual intent clearly. Therefore, in this study functional limitation was addressed through three lower body tests by using the Short Physical Performance Battery (SPPB) [147, 161]. The SPPB tests three functions:

A. Standing balance consists of side-by-side, semi-tandem, tandem and full-tandem standing. Subjects progress to the next standing condition after holding the previous stand for 10 seconds. Standing balance score ranges from 0 to 4, with 0 reflecting no standing balance completed and 4 indicating full-tandem standing for the full 10 seconds.

B. Walking speed entailed walking across a small room (8-foot walk), timed to the nearest second. Scores were divided into quartiles ranging from 0 to 4, with 0 reflecting an incomplete walk and 1– 4 indicating quartiles dependent on completion times (higher score indicating faster completion).

C. The time for repeated chair-stands (5 in total) was estimated to the nearest tenth of a second. This was done after the subject stood once from a sitting position with arms folded across the chest. These scores were also divided into quartiles, where 0 reflected no chair stands completed and 1-4 reflecting quartiles related to completion time (higher score indicating faster completion).

The total score was created by combining these measures with a range of 0-12, where higher scores indicate better functioning. The SPPB has shown excellent reliability and sensitivity [143, 162]. This measure was used as a continuous variable after normality of the distribution was examined.

3.3.1.4 Disability

Disability was assessed by means of two self-report activities of daily living instruments:

A. Activity of daily living (ADL): subjects were asked whether they needed assistance in performing seven ADL tasks. These questions were from the modified version of the Katz activities of daily living scale [148]. Tasks included walking across a small room, bathing, grooming, dressing, eating, and transferring from bed to chair and toileting. For the analysis, ADL limitation was dichotomized into ‘no help needed’ and ‘needed help’, including those unable to perform one or more of the seven tasks.

B. Instrumental activity of daily living (IADL): subjects were asked if they were able to do 10 tasks. These questions were based on the Older American Resources and Services (OARS) Instrumental Activities of Daily Living scale [163] and the Rosow-Breslau scale [164]. The 10 tasks include using a telephone, driving, shopping, preparing meals, performing light housework, taking medications, handling money, doing heavy housework, walking up and down stairs, and walking half a mile. For the analysis, IADL limitation was dichotomized as 'no help needed' versus 'needed help' to perform one or more of the ten IADL tasks.

The correlation between the ADL and IADL measures was high ($r = 0.61$) in this population [165-167]. Therefore, both ADL and IADL variables were tested independently to avoid collinearity issue.

3.3.2 Health-Related Quality of Life

The Short-Form 36-item Health Survey (SF-36) is a gold standard and widely used measure of self-reported health-related quality of life [133, 140, 168, 169]. The SF-36 consists of 36 items and 8 domains about subjects' physical and mental status. The Physical Composite Scale (PCS) is calculated as a summary scale that includes physical functioning (PF), role limitation due to physical function (RP), bodily pain (BP), and general health (GH) scales. The Mental Composite Scale (MCS) summary includes general mental health (MH), role limitations due to emotional problems (RE), social functioning (SF), and vitality (VT) ratings.

The PCS and MCS scores range from 0 to 100, where higher values reflect a better health-related quality of life [170, 171]. These global scores (PCS and MCS) provide information on the respondent's HRQoL, summarized in just two values, thereby offering an easier interpretation of the data and reducing the number of statistical analyses needed. Furthermore, both the PCS and MCS have demonstrated to have good discriminate validity for identifying differences between clinically meaningful groups [172].

The minimum clinically important difference (MCID) for various arthritic conditions range between 5 to 10 points for each SF-36 domain score [171], and range between 2.5 to 5 points for PCS and MCS scores [171]. The SF-36 has been translated into many languages including Spanish. The Spanish version of the SF-36 is a valid measure of self-reported health status for Mexican-Americans as well as for other Hispanic groups [169, 173]. For this study, the Cronbach's alpha for the SF-36 ranged from 0.76 to 0.96 [169].

3.3.3 Covariate Variables (Risk Factors)

3.3.3.1 Sociodemographic Factors

I) Age: as a continuous variable.

II) Gender: (Male=1 vs. Female=0).

III) Marital status: married, separated, divorced, widowed, and never married (Married=1 vs. Otherwise=0).

IV) Years of formal education: as a continuous variable.

V) Nativity: (foreign born=1 vs. US born=0).

VI) Interviewed in English: (Yes=1 vs. No (Spanish) =0).

3.3.3.2 Comorbid Conditions

I) Body Mass Index (BMI): calculated by dividing a subject's weight in kilograms by his/her height in meters squared. Anthropometric measurements were collected in the home using the methods and instructions employed in other EPESE studies [158]. Height was measured using a tape placed against the wall; weight was measured using a Metro 9800 measuring scale. BMI was used as a continuous variable.

II) Cognitive status: measured by the 30-item Mini-Mental State Examination (MMSE) [174]. The MMSE scale is reliable and valid to be used with the Hispanic population and both of its versions (English and Spanish) were adopted from the Diagnostic Interview Scale [175]. Scores on this scale have a potential range of 0–30, with lower scores indicating poorer cognitive ability. MMSE score was used as a dichotomized variable (<21 vs. ≥21), using a cut-point frequently employed for population with low average education [176]. Subjects scoring <21 were classified as having low cognitive status.

III) Depressive symptoms: assessed with the Center for Epidemiological Studies Depression (CES-D) scale [177]. The CED-D scale is a reliable and valid instrument to be used with the Hispanic population [178]. The scale consists of 20 items that ask how often specific symptoms were experienced during the past week; responses were scored on a 4-point scale (scored 0–3) where potential total scores ranged from 0 to 60. Subjects who scored ≥16 were classified as having high levels of depressive symptoms [177].

IV) Medical conditions: assessed by the sum of positive responses to self-reported physician diagnoses of: heart attack, stroke, hypertension, diabetes, osteoporosis

and cancer (range 0-6). Such self-reported medical conditions have been shown to be reliable with medical records [179].

3.4 DATA MANAGEMENT AND ANALYSES

3.4.1 Data Management

All data from the Hispanic EPESE study and the Disablement Process sub-sample were centrally stored at the Hispanic EPESE coordinating office, located at the University of Texas Medical Branch at Galveston (Department of Preventive Medicine and Community Health). Data for each wave were obtained from the Hispanic EPESE local network drive and subsequently merged and evaluated using the Statistical Analysis System software (SAS version 9.1.2) [180] for sample characteristics and all specific aims.

To avoid exclusion bias, all subjects from the Disablement Process sub-sample at baseline who remained in the sample through the 2nd and 3rd follow-up interviews were included in the analyses. Therefore, the total records for the current study were one thousand, five hundred and twenty nine (1,529) records for 621 subjects.

However, before performing any adjusted analyses, independent-samples t-tests and chi-square tests were computed to determine whether there were any significant differences between the retained and dropout subjects in sociodemographic characteristics and other variables. Table 3.1 presents baseline description of subjects who were retained and the dropouts. Dropout subjects were older, significantly more likely to have low cognitive status and high depressive symptoms, have poorer lower and upper extremity muscle strength, have lower SPPB score, report any ADL and IADL limitations; and have lower PCS and MCS scores than retained subjects.

Table 3.1 Descriptive characteristics of retained and dropout subjects at baseline (N=621)

Characteristic		Total		Retained		Dropouts		p-value
		N=621		N=342	55%	N=279	45%	
Age (years)	mean (sd)	78.1	5.1	77.3	4.4	79	5.8	<.0001
Sex	Women	372	59.9	211	61.7	161	57.7	0.31
Married	Yes	317	51.1	176	51.5	141	50.5	0.82
Nativity (US born)	Yes	378	60.9	199	58.2	179	64.1	0.13
Education (years)	mean (sd)	5.1	3.8	5.4	3.8	4.9	3.7	0.10
English Interview	Yes	108	17.4	50	17.9	58	17	0.75
BMI (kg/m^2)	mean (sd)	28.1	5.3	28.3	4.8	27.9	5.8	0.43
Low Cognitive Status (MMSE < 21)	Yes	217	35	101	29.5	116	41.5	<.001
Depressive Symptoms (CES-D ≥ 16)	Yes	73	11.7	30	8.77	43	15.41	0.01
Medical Condition	mean (sd)	1.1	0.9	1.1	0.9	1.1	0.9	0.75
Arthritis	Yes	350	56.4	186	54.4	164	58.8	0.27
Pain	Yes	295	47.5	161	47.1	134	48	0.81
LLMS (kg)	mean (sd)	29	10.7	30.1	11.2	27.4	9.8	0.002
UEMS (kg)	mean (sd)	38.5	12.2	40	12.6	36.7	11.6	<.001
SPPB	mean (sd)	7	3.4	7.6	3.1	6.3	3.6	<.0001
Any ADL limitation	Yes	116	18.7	42	12.3	74	26.5	<.0001
Any IADL limitation	Yes	284	45.7	132	38.6	152	54.4	<.0001
PCS	mean (sd)	41.4	12.5	43	12	39.3	13	<.001
MCS	mean (sd)	55.1	8.5	56.2	7.9	53.7	8.9	<.001

MMSE= Mini-Mental State Examination; CES-D= Center for Epidemiological Studies–Depression; BMI= Body Mass Index; LEMS = Lower Extremity Muscle Strength; UEMS = Upper Extremity Muscle Strength; SPPB= Short Physical Performance Battery; ADL= Activities of Daily Living; IADL= Instrumental Activities of Daily Living; HRQoL= Health-Related Quality of Life; PCS= Physical Component Summary; MCS= Mental Component Summary.

3.4.2 Data Screening Procedures

Because the choice of statistical tests should consider the distributional characteristics of the data, it is vital to thoroughly consider the quality of the input before performing primary analyses related to the study's specific Aims. The results, presented in Tables 1-.3 in Appendix A, show the univariate descriptive statistics at each wave for all continuous and binary (categorical) variables. For all variables, measures of central tendency (mean, and median), measures of variability (standard deviation, coefficient of variation, minimum and maximum values), and measures of shape (skewness and kurtosis) were computed [181].

'Measures of central tendency' were used to represent the "center" of the distribution [181]. Measures of variability provide information about the degree to which individual scores are clustered about or deviate from the average value in a distribution [181]. Since most hypotheses need to be tested using a liner mixed model (which assumes multivariate normality), univariate distributions and bivariate scatter-plots were reviewed to evaluate skewness (degree of symmetry about the mean), kurtosis (degree of flatness or peakness of a distribution), and, for bivariate distributions, linearity. Near-zero skewness and kurtosis values indicate symmetrical and mesokurtic distributions (normal distribution).

All observed bivariate scatter plots appeared to satisfy the liner mixed model assumption of linearity. Furthermore, bivariate correlations among study variables were computed to determine degree of collinearity among them at each Wave (Appendix A, Tables 4 to 6).

Finally, since the PCS and MCS were the two outcome measures for Specific Aims 2 and 3, respectively, item bias or differential item functioning (DIF) analyses need to be conducted. As discussed previously, the SF-36 was found to be a reliable and valid measure for HRQoL in this sample of older Mexican-Americans using three classical tests: 1) comparing SF-36 scores with scores from a national representative sample, 2) examining the SF-36 dimension reliability, and 3) evaluating its construct validity through a confirmatory factor analysis using structural equation modeling (SEM) [169].

According to the literature from educational and psychological fields, DIF is present when respondents from different groups have differing probabilities of success on an item, after controlling for overall ability [182]. In epidemiological and clinical research, several studies have examined the presence of potential measure bias for general functional status measures (such as SF-36) [183-185] or specific functional status measures (e.g., shoulder, lumbar spine, and knee joints) [186-188], with respect to age, sex, language, and many other factors.

The three most commonly used methods to assess the DIF are: Mantel-Haenszel, logistic regression, and item response theory (IRT) [182]. Therefore, for the current study, a powerful method called DIFwithpar, developed by Crane and Gibbons (2006) [189, 190], was used to perform DIF analyses. DIFwithpar employs item response theory and ordinal logistic regression models for each item of a measure using STATA and PARSCALE software [189]. This DIF analysis program is available for free download from the Statistical Components Archive at Boston College [190]. For 621 older Mexican-Americans, STATA 10 [191] was used to examine DIF related to the language

of test administration (English vs. Spanish) in addition to age (younger than 85 vs. 85 or older) and sex for each item in both PCS and MCS.

Tables 7 and 8 in Appendix A summarized the DIF findings for PCS and MCS, respectively. For PCS, 5 items were identified with nonuniform DIF in respect to language, age, and sex. For MCS, 7 items were identified with either uniform or nonuniform DIF in respect to the same covariate factors. However, Perkins et al. (2006) [183] found more than 15 items exhibiting DIF related to age, race, and education, by using two large national datasets, DIF Medical Outcomes Study (MOS) and National Survey of Functional Health Status.

In the current study, after removing those items identified as DIF, the 8 scales and the two summary composite scores (PCS and MCS) were recalculated. Subsequently, all longitudinal models were reanalyzed by using the new PCS and MCS as outcome variables. The final findings were not significantly changed in terms of the associations' direction and magnitude. Therefore, the effect of DIF rarely transferred to the scale or summary levels. In summary, classical and modern tests demonstrated that both PCS and MCS of the SF-36 are reasonably valid measures for physical and mental HRQoL in this sample of older Mexican-Americans.

3.4.3 Treating Missing Data

It is common in longitudinal epidemiological studies to have some missing data [192, 193]. That was the case in the current study (see Tables 1 to 3 in Appendix A). Therefore, the Missing Value Analysis (MVA) function included in the Statistical Package for the Social Sciences software (SPSS, version 16.0) [194] was used to

determine that the missing data was not completely at random (MCAR). This result was confirmed by Little's chi-square test ($X^2 = 159$, DF = 30, $P < .0001$).

For the study's three Specific Aims, two separate longitudinal methods were used to analyze the data depending on the outcome variable level of measurement. For a continuous outcome variable, such as lower extremity muscle strength, the liner mixed model was used [195-198]. For binary outcomes, such as pain and disability, the generalized estimating equations (GEE) approach was used [195, 196, 199, 200]. Both are kinds of generalized linear models and can handle missing data better than other statistical models such as repeated measure analysis of variance (ANOVA) or least-squares regression (LSR) models [201].

However, the missing value assumption using the GEE is more restrictive than the liner mixed model. The GEE approach assumes MCAR, while the liner mixed model is more flexible [201]. Therefore, handling missing data inappropriately (such as using the last observation carried forward (LOCF) method), or ignoring them (by using complete case analysis) may bias study results, reducing power and efficiency [202, 203]. Thus, a powerful missing data estimation technique such as the multiple imputation (MI) method is highly recommended [204].

This method was proposed by Rubin in 1977 [205, 206] and is one of the most attractive methods for handling missing data in multivariate analyses [207]. It is used mainly in longitudinal studies with continuous and dichotomous outcome variables [192]. Moreover, the MI method is a sophisticated and valid method that has emerged as a flexible alternative to other imputation methods such as regression and likelihood

methods [193, 204, 208-210]. This method of imputation has been used recently in many longitudinal epidemiological studies [211, 212].

For the current study, the MI method was performed to impute missing data in conjunction with the GEE and linear mixed model methods [205, 206, 209]. Thus, SAS software was used (using proc MI and proc MIANALYZE) [213, 214]. The imputation model, which included the sociodemographic variables, comorbid conditions, the disablement process component variables, and physical and mental composite scores, was essentially the same as the analysis model. Any missing data for any outcome variable, as well as associated covariates, were imputed. In total, five imputed datasets were used in the analysis [180].

3.4.4 Statistical Analyses

After conducting univariate analysis for each variable (e.g., mean, median, range) and examining the correlation coefficients among study variables at each Wave (see Tables 4-6 in Appendix A), a series of analyses were performed to address the study's Aims.

Bivariate analysis was conducted using t-test and chi square tests to test differences at baseline by arthritis status. Moreover, Mantel-Haenszel Chi-Square test for overall trend was computed for dichotomous outcome variables (e.g., pain, ADL). For continuous outcome variables (e.g., PCS, MCS), ANOVA and Tukey post-hoc test were used to find any significant difference between three group means. Longitudinal analyses were also conducted to assess the change over time of an outcome measured repeatedly for every subject in the study [196, 215, 216]. As stated earlier, the general linear mixed model (mixed model) was applied to all continuous outcome variables [196, 198] and, for

dichotomous outcome variables, generalized estimating equations (GEE) were performed [201].

All analyses were performed using the SAS System, version 9.1.2 [180]. The SAS System's MIXED and GENMOD procedures were used to conduct the mixed model and GEE, respectively, to examine the time effect on outcomes by non-time-varying (i.e., time-independent, between subjects) and time-varying (i.e., time-dependent, within subjects) covariates over three points of time [196, 198, 217-219]. A significance level of $p < 0.05$ was used in this study. The following sub-section describes statistical strategies for each aim.

3.4.4.1 AIM 1:

The first aim was to examine the association between arthritis and stages of the disablement process (impairment, functional limitation, and disability) over three points of time (2000-2001, 2001-2002, and 2006) among older Mexican-Americans.

Hypothesis 1.a:

Arthritis would be associated with greater impairment.

The statistical analyses used to test this hypothesis were divided into three parts:

I- Arthritis would be associated with presence of pain on weight-bearing.

The GEE model was used to assess the time effect of pain by employing non-time-varying (e.g., gender, education) and time-varying (e.g., arthritis, BMI) covariates. Generally, the GEE model uses generalized linear methods to model longitudinal data.

However, this method is different from the likelihood method of estimation that most generalized linear models use. The GEE model utilizes a quasi-likelihood method of estimation [192, 200]. Generally, the GEE model is a known function of the dependent variable's marginal expectation and provides a linear function of one or more explanatory

variables, each of which estimates population average regression coefficients, not subject-specific regression coefficients [201, 217].

Two models were implemented to assess the relationship between arthritis and pain. In Model 1, time, sociodemographic variables described in Figure 3.1 (i.e., age, gender, marital status, education, nativity, language of interview) and arthritis were included. In model 2, comorbid conditions (i.e., BMI, cognitive status, depressive symptoms, and medical conditions) were added to the variables in Model l. An interaction between arthritis and time was also entered into the model to examine whether the odds of having pain on weight-bearing over time were greater for subjects with arthritis.

II- Arthritis would be associated with poorer performance in lower extremis muscle strength (LEMS).

III- Arthritis would be associated with poorer performance in upper extremis muscle strength (UEMS).

Mixed models were used to assess the time effect on lower and upper extremities muscle strength over three time points by non-time-varying (e.g., gender, education) and time-varying (e.g., medical conditions, BMI) covariates. The MIXED procedure fits a variety of mixed linear models of data and enables the use of these fitted models to make statistical inferences about the data [198, 201]. The mixed linear model also provides the flexibility of modeling by examining not only the variable means, but also their variances and covariances [198, 201]. Finally, because the mixed model uses a method called a likelihood-based ignorable analysis, all available data is included in the analysis. This

method differs from complete case analysis in which any observation with a missing value is dropped from the analysis [195-198, 201].

Two models were implemented to independently assess the relationship between arthritis and both LEMS and UEMS. In Model 1, time, sociodemographic variables (i.e., age, gender, marital status, education, nativity, and language of interview), and arthritis were included. Model 2 included comorbid conditions (BMI, cognitive status, depressive symptoms, and medical conditions) along with all variables in Model l. Moreover, an interaction between arthritis and time was also entered into the models to examine whether changes in LEMS or UEMS over time were lower for subjects with arthritis.

Alternative Analyses:

Since both of LEMS and UEMS are continuous outcome variables, each variable was divided by its median, creating the categories "LEMS Higher vs. Lower score" and "UEMS Higher vs. Lower score." Dichotomizing the outcomes would be easier for clinicians to interpret than using continuous outcome variables, which ranged from 6.24 kg to 96.3 kg (LEMS) and from 5.84 kg to 103.5 kg (UEMS), respectively [220]. Using the median rather than the mean to create global categories more appropriately represents the majority of cases, especially in skewed distribution [221, 222]. For LEMS, the median was 28.71 kg and for UEMS it was 37.11 kg.

Consequently, two independent GEE models were used to assess the time effect of LEMS and UEMS. 'Higher vs. Lower score' over time by employing non-time-varying (e.g., gender, education) and time-varying (e.g., arthritis, BMI) covariates. Associations in both analyses were reported using odds ratios (OR) and 95% confidence intervals (CI).

Hypothesis 1.b:

Arthritis would be associated with more functional limitation.

Mixed models were used to assess the effect on lower body function as measured by SPPB over time by non-time-varying (e.g., gender, education) and time-varying (e.g., arthritis, BMI) covariate.

Three models were constructed to assess the relationship between arthritis and functional limitation. In Model 1, time, sociodemographic variables, and arthritis were included. In Model 2, comorbid conditions (BMI, cognitive status, depressive symptoms, and medical conditions) were included along with the variables from Model l. In Model 3, impairment variables (pain, LEMS and UEMS) (Figure 3.1) were added to the variables in Model 2. Moreover, an interaction between arthritis and time was entered into the model to examine whether changes in SPPB score over time were lower for subjects with arthritis.

Alternative Analysis:

SPPB scores were categorized according to cut points validated by Guralnik et al. [147] in which scores greater than 9 were considered consistent with mild to no mobility limitation. Dichotomizing the outcomes would be easier for clinicians to interpret than using continuous outcome variable [220].

Consequently, the GEE model was used to assess the time effect of SPPB (mild or no limitation vs. otherwise) over time by employing non-time-varying (e.g., gender, education) and time-varying (e.g., arthritis, BMI) covariates. This association was reported using OR and its 95% CI.

Hypothesis 1.c:

Arthritis would be associated with ADL and IADL limitation.

The statistical analyses for this hypothesis were divided into two parts:

I. Arthritis would be associated with ADL limitation.

II. Arthritis would be associated with IADL limitation.

In both cases, the GEE models were used to assesses the effect of arthritis on disability over time by employing non-time-varying and time-varying covariates independently. Thus, four models were used to assess the relationship between arthritis and the two types of disability. In Model 1, time, sociodemographic variables, and arthritis were included. In Model 2, comorbid conditions (BMI, cognitive status, depressive symptoms, and medical conditions) were included with the variables from Model l. In Model 3, the impairment variables (pain, LEMS and UEMS) (Figure 3.1) were included along with the variables from Model 2. Lastly, Model 4 included functional limitation variable (SPPB score) with the variables from Model 3. An interaction between arthritis and time was also entered into the model to examine whether the odds of having any ADL or IADL limitation over time were greater for subjects with arthritis.

3.4.4.2 AIMS 2 AND 3:

AIM 2 was to examine the association between arthritis and stage of disablement process (impairment, functional limitation, and disability) on **physical** HRQoL, as measured by SF-36 Physical Component Summary (PCS) over three points of time (2000-2001, 2001-2002, and 2006) among older Mexican-Americans.

AIM 3 was to examine the association between arthritis and stages of disablement process (impairment, functional limitation, and disability) on **mental** HRQoL as

measured by SF-36 Mental Component Summary (MCS) over three points of time (2000-2001, 2001-2002, and 2006) among older Mexican-Americans.

Since both outcome variables PCS and MCS are continuous, the linear mixed model was used to test each hypothesis.

Hypothesis.a:

*Arthritis would be associated with poorer **physical** and **mental** HRQoL.*

Mixed models were used to assess the time effect on physical and mental HRQoL, as measured by PCS and MCS over time by non-time-varying (e.g., gender, education) and time-varying (e.g., medical conditions, BMI) covariates.

The same two models were used to assess the relationship between arthritis and PCS and MCS (Model 1 and Model 2). An interaction between arthritis and time was entered into the model to examine whether changes in PCS or MCS score over time were lower for subjects with arthritis.

Hypothesis b:

*Greater impairment (pain and total body muscle strength) would be associated with poorer **physical** and **mental** HRQoL.*

Three models were constructed to assess the relationship between impairment and PCS and MCS. Model 1 included time, sociodemographic variables, and both impairment variables (pain and total body muscle strength). In Model 2, comorbid conditions (BMI, cognitive status, depressive symptoms, and medical conditions) were included along with the variables from Model l. In Model 3, arthritis was included along with the variables from Model 2. An interaction between pain and time was also entered into the model to examine whether changes in PCS or MCS score over time were lower for subjects with

pain. Another interaction between total body muscle strength quartile and time was also added into the model to examine whether changes in PCS or MCS score over time differed for subjects in each quartile of TBMS.

Hypothesis c:

Greater functional limitation (as measured by SPPB) would be associated with poorer ***physical*** *and* ***mental*** *HRQoL.*

Four models were constructed to assess the relationship between functional limitation and PCS and MCS, independently. Model 1 included time, sociodemographic variables, and functional limitation variable (SPPB). In Model 2, comorbid conditions were included with the variables from Model l. In Models 3 and 4, arthritis and the impairment variables were included with the variables in Model 2, respectively. An interaction between SPPB quartiles and time was also entered into the model to examine whether changes in PCS or MCS score over time were different for subjects in each quartile of SPPB.

Hypothesis 2.d:

Greater disability (as measured by ADL/IADL limitation) would be associated with poorer physical and mental HRQoL.

Five models were conducted to assess the relationship between disability and PCS and MCS, independently. Model 1 included time, sociodemographic variables, and ADL or IADL variable. In Model 2, comorbid conditions were included with the variables from Model l. In Model 3, 4, and 5, arthritis, impairment, and functional limitation variables were included with the variables in Model 2, respectively. An interaction between ADL or IADL limitation, independently, and time was also entered into the

model to examine whether changes in PCS or MCS score over time were lower for subjects with ADL or IADL limitation.

Alternative Analyses:

Since both of PCS and MCS are continuous outcome variables, each was divided by its median by creating the categories: "PCS Higher vs. Lower score" and "MCS Higher vs. Lower score." As discussed earlier, dichotomized outcomes would be easier for clinicians to interpret than continuous outcome variables [220]. Using the median to create global rather than mean categories is more appropriately to represent the majority of the cases, especially in skewed distribution cases [221, 222]. For PCS, the median was 42.4 and for MCS it was 57.7.

Consequently, two independent GEE models were used to assess the time effect of PCS and MCS 'Higher vs. Lower score' over time by employing non-time-varying (e.g., gender, education) and time-varying (e.g., arthritis, BMI) covariates. Associations in both analyses were reported using OR and the 95% confidence intervals (CI).

Sensitivity Analyses for all Hypotheses in Aim 1 and 2:

In addition to the above analyses of all available observations, sensitivity analyses were conducted with estimates obtained using complete cases (N=342). The purpose of these analyses was to help ensure that reasonable conclusions were drawn from available case analyses. All of the relative direction and magnitude of any estimate are summarized in Tables in Appendix B. Finally, the residuals were inspected to ensure that any final model was consistent with its statistical assumptions. Thus, all model assumptions were tested and were not severely violated.

4.0 THE IMPACT OF ARTHRITIS ON IMPAIRMENT, FUNCTIONAL LIMITATION AND DISABILITY

The purpose of this study was to examine the impact of arthritis on physical function, disability, and health-related quality of life over three points of time (2000-2001, 2001-2002, and 2006) among older Mexican-Americans. This chapter is composed of three sections: (4.1) Subject characteristics; (4.2) Results of Aim 1, comprised of a) Relationship between arthritis and impairment, b) Relationship between arthritis and functional limitation, c) Relationship between arthritis and disability; and (4.3) Summary of the Results.

4.1 BASELINE SUBJECT CHARACTERISTICS

Baseline sociodemographic characteristics for the study sample by arthritis condition are illustrated in Table 4.1. Of the 621 subjects at baseline, 271 (44%) were without arthritis while 350 (56%) were arthritic. The average age for subjects without arthritis was 77.7 years (±5.2) and for those with arthritis was 78.3 years (±5.1). For those who reported arthritis, more were female (62%, $p < 0.001$). Moreover, subjects with arthritis were more likely to have less education and a higher BMI. Finally, subjects with arthritis were significantly more likely to report a larger number of medical conditions than their non-arthritic counterparts.

Table 4.1 Descriptive characteristics of subjects with and without arthritis at baseline (N=621)

Characteristic		Without Arthritis		With Arthritis		*p*-value
		N=271	44%	N=350	56%	
Age (years)	**mean (sd)**	77.79	5.2	78.3	5.1	0.22
Sex	**Women**	139	37.4	233	62.6	<.001
	Men	132	53.0	117	47.0	
Married	**Yes**	142	44.8	175	55.2	0.55
	No	129	42.4	175	57.6	
Nativity (US born)	**Yes**	167	44.2	211	55.8	0.73
	No	104	42.8	139	57.2	
Education (years)	**mean (sd)**	5.5	3.79	4.88	3.76	0.04
English Interview	**Yes**	50	46.3	58	53.7	0.54
	No	221	43.1	292	56.9	
BMI (kg/m^2)	**mean (sd)**	27.4	5.5	28.71	5.3	<.01
Low Cognitive Status (*MMSE < 21)	**Yes**	86	39.6	131	60.4	0.14
	No	185	45.8	219	54.2	
Depressive Symptoms (*CES-D ≥ 16)	**Yes**	25	34.3	48	65.8	0.08
	No	246	44.9	302	55.1	
Medical Condition	**0**	98	53.0	87	47.0	0.004
	1	104	42.1	143	57.9	
	2 or more	69	36.5	120	63.5	

* MMSE= Mini-Mental State Examination; CES-D= Center for Epidemiological Studies–Depression

Table 4.2 shows the descriptive statistics for the disablement process components and health-related quality of life by arthritis condition at three time points. Subjects with arthritis were more likely to be impaired (as measured by pain on weight-bearing and muscle strength) and functionally limited (as measured by the Short Physical Performance Battery) than subjects without arthritis at each time point. Subjects with arthritis were also more likely to be disabled, as measured by ADL and IADL limitations.

Finally, they had significantly lower PCS scores (physical HRQoL) at every time point. However, no statistical differences in MCS score existed between the two groups (except at Time 1, when subjects with arthritis reported lower mental HRQoL scores).

Nevertheless, within subject analyses revealed that, at Time 0, subjects without arthritis had significantly more IADL limitation (34.5%) compared to Time 1 or Time 2. At Time 1 only, subjects without arthritis had significantly more functional limitations (SPPB mean= 7.9, SD=3.4) and better physical (PCS mean= 46.1, SD=10.8) and mental (MCS mean= 57.6, SD=6.8) HRQoL, compared to Time 0 or Time 2. At Time 2, subjects without arthritis had significantly more ADL limitation (26.4%) than at any other point in time. However, subjects with arthritis at Time 1 had significantly more pain on weight-bearing (82.6%), functional limitation (SPPB mean= 6, SD=3.7), any ADL limitation (79.3%) and any IADL limitation (75.5%) than at Time 0 or Time 2. Also, subjects with arthritis had significantly better physical HRQoL (PCS mean= 38, SD= 12.4) compared to other points in time.

Table 4.2 Descriptive statistics: the disablement process components and health-related quality of life by arthritis condition and over three points of time (2000-2001; 2001-2002; and 2006)

			Time 0 (N=621)				**Time 1** (N=549)				**Time 2** (N=359)			
			NAS (N=271)		AS (N=350)		NAS (N=202)		AS (N=347)		NAS (N=136)		AS (N=223)	
Impairment	Pain on weight-bearing	Pain, n %	84$	28.5	211	71.5	46$	17.4	218	82.6	58$	27.4	154	72.6
	Muscle Strength	LEMS (kg), mean ±sd	30.8*	11.3	27.4	10.8	29.2	10.2	27.9	11.7	32.3	15.2	29.8	13.4
		UEMS (kg), mean ±sd	41.3*	13.2	36.3	12.4	39.4**	13.2	36.4	13.4	39.7*	15.3	34.4	12
		TBMS (kg), mean ±sd	72.3*	22.6	64	21.7	68.8	21.2	65.4	23	72.1**	29.2	64.4	22.4
	Functional Limitation †	SPPB, mean ±sd	7.4*†	3.3	6.7	3.5	7.9*	3.4	6	3.7	6.4**	3.6	5.3	3.7
Disability	ADL ^	Any ADL limitation, n %	29$	25	87	75	24$	20.7	92	79.3	33$	26.4	92	73.6
	IADL ^	Any IADL limitation, n %	98$	34.5	186	65.5	69$	24.5	213	75.5	83$	31.6	180	68.4
HRQoL	Physical †	PCS, mean ±sd	45.7*	11.5	38	12.4	46.1*	10.8	37.4	12.9	41.4*	11.9	34.8	12
	Mental ‡	MCS, mean ±sd	54.9	8.1	55.2	8.8	57.6*	6.8	55.8	8.5	55.4	10.1	54.2	10.8

NAS= Non –Arthritic subjects; AS= Arthritic subjects. TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

* ttest p<.001 (between subjects (subjects with arthritis vs. no arthritis)); ** ttest p<.05 (between subjects); † Anova p<.001 (within subject (Time0 vs. Time1 vs. Time2 for each group)); ‡ Anova p<.05 (within subject) $ X^2 P<.001 (between subjects); ^ Mantel-Haenszel X^2 P<.001 (within subject); ^^ Mantel-Haenszel X^2 P<.05 (within subject)

4.2 SPECIFIC AIM 1

The first specific aim was to examine the association between arthritis and stages of disablement (impairment, functional limitation, and disability), over three points of time (2000-2001, 2001-2002, and 2006) among older Mexican-Americans.

4.2.1 Hypothesis 1.a:

Hypothesis 1.a: Arthritis would be associated with greater impairment.

4.2.1.1 Part I

I- Arthritis would be associated with presence of pain on weight-bearing.

Table 4.3 presents the results of the GEE models for pain on weight-bearing as a function of arthritis over time. Two models assessed the relationship between arthritis and pain on weight-bearing. Model 1 included time, age (in years), gender (male vs. female), marital status (married vs. otherwise), amount of formal education (in years), nativity (foreign born vs. US born), language in which the interview was conducted (English vs. Spanish) and arthritis (Yes vs. No). In Model 2, BMI (kg/m2), low cognitive status (Yes vs. No), high depressive symptoms (Yes vs. No), and medical conditions (total number) were assessed in addition to the variables from Model 1.

In Model 1, the odds ratio (OR) of having pain on weight-bearing across time and as a function of arthritis was 3.18 (95 % CI= 2.54-3.98). In Model 2, the odds of having pain on weight-bearing joints across time was 2.96 (95 % CI= 2.36-3.72). Sensitivity analyses using estimates obtained from complete cases showed nearly the same findings for relative direction and magnitude of the estimated relationship between arthritis and pain (see Appendix B – Table B.1.1.1).

Other factors, such as high BMI, high depressive symptoms, and medical conditions, were significantly associated with pain on weight-bearing. An interaction effect between time and arthritis on pain on weight-bearing was not significant (F=2.42, df=2, p=0.08) (see Appendix C). Sensitivity analysis confirmed these findings.

Table 4.3 General Estimation Equations (GEE) models for impairment (pain on weight-bearing) as a function of arthritis over three points of time

Explanatory variables	**Model 1**			**Model 2**		
	OR	**95 % CI**		**OR**	**95 % CI**	
Time 1 vs. Time 0	0.94	0.76	1.17	0.94	0.75	1.17
Time 2 vs. Time 0	1.54	1.16	2.04	1.36	1.01	1.82
Age	1.01	0.99	1.03	1.02	0.99	1.05
Male vs. Female	0.73	0.56	0.95	0.81	0.62	1.05
Married (Yes vs. No)	1.18	0.92	1.51	1.17	0.91	1.50
Education	0.96	0.93	0.99	0.97	0.93	1.00
Nativity (foreign born vs. US born)	0.98	0.76	1.27	0.96	0.74	1.25
Interviewed in English (Yes vs. No)	1.20	0.86	1.66	1.19	0.85	1.68
Arthritis (Yes vs. No)	3.18	2.54	3.98	2.96	2.36	3.72
BMI (Kg/m2)				1.05	1.03	1.08
Low cognitive status (Yes vs. No)				1.08	0.85	1.39
Depressive symptoms (Yes vs. No)				1.76	1.24	2.50
Medical conditions (Total number)				1.29	1.13	1.47

BMI= Body Mass Index.

4.2.1.2 Part II

II: Arthritis would be associated with poorer lower extremity muscle strength (LEMS).

Table 4.4 presents the results of the linear mixed models, each of which assessed the relationship between arthritis and lower extremity muscle strength over three points of time. Two models were used, as done when examining arthritis and pain (Table 4.3).

A significant negative relationship between arthritis and LEMS (Estimate= -1.28, SE= 0.61, p= 0.04) existed when using Model 1. This relationship decreased in Model 2 by 0.08 kg; in fact, after controlling for all covariates, the relationship was shown to be not statistically significant. Model 2 showed a significant negative relationship between arthritis and LEMS. Sensitivity analyses using estimates obtained from complete cases showed that the significant negative relationship between arthritis and LEMS continued in Model 2 (Estimate= -1.79, SE= 0.83, p= 0.03) (Appendix B- Table 1.1.2). Other factors such as age, low cognitive status, and medical conditions were also negatively associated with LEMS, while the attributes male gender, interviewed in English, and BMI were positively associated with LEMS. There was no interaction-effect between time and arthritis using LEMS (F= 1.44, df= 2, p= 0.23). Sensitivity analysis confirmed these findings.

Furthermore, all analyses were reevaluated (with an unadjusted GEE) with the LEMS variable dichotomized (Higher vs. Lower score). Greater lower extremity muscle strength was negatively associated with arthritis (OR = 0.79; 95% CI = 0.63 – 0.98) (data not shown). Higher and lower scores were divided by the median of LEMS, 28.53 kg. Surprisingly, this association did not remain significant after controlling for all covariates (OR = 0.98; 95% CI = 0.76 – 1.26).

Table 4.4 General linear mixed models estimates for impairment (lower extremity muscle strength (Kg)) as a function of arthritis over three points of time

Explanatory variables	**Model 1**			**Model 2**		
	β	(SE)	P-value	β	(SE)	P-value
Intercept	54.4	4.99	<.001	45.5	5.75	<.001
Time 1 vs. Time 0	-0.13	0.68	0.85	-0.48	0.70	0.49
Time 2 vs. Time 0	3.86	0.81	<.001	3.61	0.84	<.001
Age	-0.37	0.06	<.001	-0.28	0.07	<.001
Male vs. Female	8.51	0.66	<.001	8.49	0.68	<.001
Married (Yes vs. No)	0.88	0.65	0.18	0.70	0.67	0.30
Education	-0.04	0.08	0.63	-0.08	0.09	0.34
Nativity (foreign born vs. US born)	-0.76	0.63	0.23	-0.76	0.64	0.24
Interviewed in English (Yes vs. No)	2.73	0.86	<.001	2.95	0.88	<.001
Arthritis (Yes vs. No)	-1.28	0.61	0.04	-1.20	0.63	0.05
BMI (Kg/m2)				0.15	0.06	0.01
Low cognitive status (Yes vs. No)				-2.90	0.71	<.001
Depressive symptoms (Yes vs. No)				-0.09	1.02	0.93
Medical conditions (Total number)				-0.75	0.33	0.02

BMI= Body Mass Index.

4.2.1.3 Part III

III: Arthritis would be associated with poorer upper extremity muscle strength (UEMS).

Table 4.5 presents the results of the linear mixed models assessing the relationship between arthritis and UEMS over three points of time. As with previous methods, the aforementioned models were used.

There was a significant negative relationship between arthritis and UEMS (Estimate= -1.52, SE= 0.55, p= 0.01) in Model 1. This relationship increased in Model 2 by 0.07 kg and remained statistically significant after controlling for all covariates. Sensitivity analyses using estimates obtained from complete cases revealed that the

relative direction and magnitude between arthritis and UEMS was similar (see Appendix B – Table B.1.1.3).

Other factors, such as Time 1, age, and medical conditions were negatively associated with UEMS, while attributes like male gender and BMI were positively associated. There was no interaction effect between time and arthritis relative to UEMS (F= 0.52, df= 2, p= 0.60). Sensitivity analysis confirmed these findings.

Moreover, all analyses were reevaluated (with unadjusted GEE) with the UEMS variable dichotomized (Higher vs. Lower score). Greater upper extremity muscle strength was negatively associated with arthritis (OR = 0.92; 95% CI = 0.56 – 0.85) (data not shown). Higher and lower scores were divided by the median UEMS: 37.02 kg. After controlling for all covariates, this association remained significant (OR = 0.69; 95% CI = 0.53 – 0.90).

Table 4.5 General linear mixed models estimates for impairment (upper extremity muscle strength) as a function of having arthritis over three points of time

Explanatory variables	**Model 1**			**Model 2**		
	β	(SE)	P-value	β	(SE)	P-value
Intercept	81.8	5.78	<.001	73.8	6.41	<.001
Time 1 vs. Time 0	-0.94	0.45	0.03	-0.91	0.45	0.04
Time 2 vs. Time 0	0.33	0.70	0.64	1.08	0.73	0.14
Age	-0.63	0.07	<.001	-0.57	0.07	<.001
Male vs. Female	16.31	0.77	<.001	16.25	0.77	<.001
Married (Yes vs. No)	-0.49	0.72	0.49	-0.74	0.71	0.30
Education	-0.03	0.10	0.78	-0.03	0.10	0.77
Nativity (foreign born vs. US born)	-0.03	0.74	0.96	0.07	0.73	0.92
Interviewed in English (Yes vs. No)	1.22	0.83	0.14	1.59	0.85	0.06
Arthritis (Yes vs. No)	-1.52	0.55	0.01	-1.59	0.56	<.01
BMI (Kg/m2)				0.20	0.06	<.01
Low cognitive status (Yes vs. No)				-1.13	0.65	0.08
Depressive symptoms (Yes vs. No)				-1.24	0.89	0.17
Medical conditions (Total number)				-0.89	0.32	0.01

BMI= Body Mass Index.

4.2.2 Hypothesis 1.b:

Hypothesis 1.b: Arthritis would be associated with greater functional limitation.

Table 4.6 presents the results of the linear mixed models assessing the relationship between arthritis and functional limitation among older Mexican-Americans as measured by the Short Physical Performance Battery (SPPB) over three points of time (2000-2001, 2001-2002, and 2006). Three models assessed the relationship between arthritis and SPPB. In Model 3, the impairment variables (pain and TBMS) were used in conjunction with other covariates from Models 1 and 2.

In Model 1, after adjusting for time, age, gender, marital status, education, nativity, language of the interview, and arthritis, there existed a significant negative relationship between arthritis and SPPB (Estimate= -0.57, SE= 0.17, p <.01). After adding more covariates in Models 2 and 3, the association with SPPB decreased by 0.3 and 0.17 points, respectively. However these associations remained statistically significant in both models. Sensitivity analyses using estimates obtained from complete cases showed approximately the same findings for the relative direction and magnitude of the relationship between arthritis and SPPB (see Appendix B – Table B.1.2).

Other factors associated negatively with SPPB were older age, higher BMI, low cognitive status, presence of depressive symptoms, medical conditions, and pain on weight-bearing joints. However, high total body muscles strength (TBMS) was significantly associated with increased SPPB score. There was a significant interaction effect between time and arthritis on SPPB (F= 4.03, df= 2, p= 0.02). Figure 4.1 shows the adjusted mean distribution of SPPB over the three points of time by arthritis condition. In Time 0 (2000-2001) subjects both with and without arthritis) had virtually the same SPPB score.

For arthritic subjects, post hoc t-tests performed using the Tukey multiple comparisons test showed a significant decrease in SPPB scores between Time 0 and Time 2, equal to 0.6 points (t-test= 2.21, p =0.03). Between subjects analysis in Time 1 revealed that the SPPB score for non-arthritic subjects was roughly 0.8 points higher than for their non-arthritic counterparts (t-test= 3.13, p <.001). However, sensitivity analysis did not confirm this effect (F= 2.37, df=2, p= 0.09).

All analyses were reevaluated (with unadjusted GEE) with the SPPB variable dichotomized into ‘mild’ or ‘no limitation' (score of 9 or greater). A negative association between the two variables and arthritis was discovered (OR = 0.66; 95% CI = 0.52 – 0.84) (data not shown). Surprisingly, after controlling for all covariates, this association did not remain significant (OR = 0.89; 95% CI = 0.68 – 1.17).

Table 4.6 General linear mixed models estimate for functional limitation (Short Physical Performance Battery) as a function of arthritis over three points of time

Explanatory variables	**Model 1**			**Model 2**			**Model 3**		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	19.5	1.95	<.001	20.6	1.93	<.001	17.4	1.95	<.001
Time 1	-0.17	0.14	0.23	-0.17	0.14	0.24	0.11	0.15	0.48
Time 2	-0.97	0.20	<.001	-0.42	0.20	0.03	-0.26	0.21	0.20
Age	-0.16	0.02	<.001	-0.14	0.02	<.001	-0.12	0.02	<.001
Male	0.64	0.27	0.02	0.47	0.24	0.05	-0.29	0.25	0.25
Married	0.05	0.23	0.83	0.13	0.21	0.55	0.25	0.21	0.24
Education	0.02	0.03	0.60	0.01	0.03	0.80	<.01	0.03	0.90
Nativity	0.16	0.26	0.53	0.25	0.23	0.27	0.31	0.22	0.15
Interviewed in English	-0.24	0.26	0.37	-0.11	0.25	0.65	-0.13	0.26	0.60
Arthritis	-0.57	0.17	<.01	-0.54	0.17	<.01	-0.40	0.18	0.02
BMI (Kg/m2)				-0.04	0.02	0.02	-0.05	0.02	0.01
Low cognitive status				-0.98	0.19	<.001	-0.81	0.20	<.001
Depressive symptoms				-1.17	0.25	<.001	-0.72	0.27	0.01
Medical conditions				-0.46	0.10	<.001	-0.29	0.10	<.01
Pain							-0.73	0.17	<.001
TBMS (Kg)							0.03	<.01	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength.

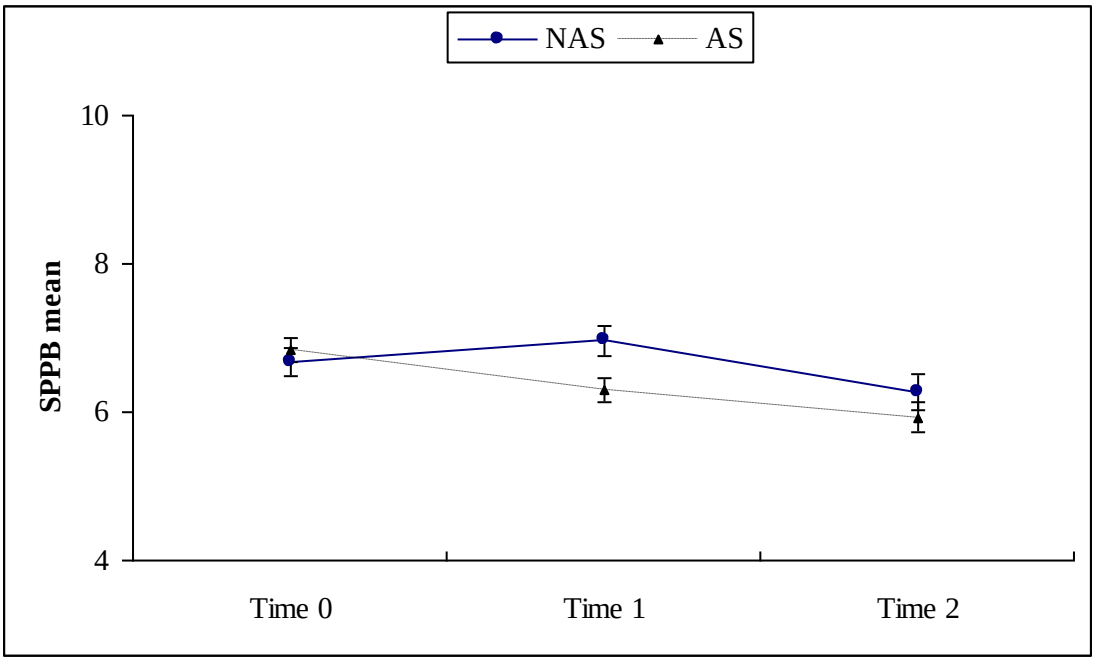

Figure 4.1 Adjusted SPPB mean and standard errors over time for Arthritic Subjects (AS) and Non- Arthritic Subjects (NAS).

4.2.3 Hypothesis 1.c:

Hypothesis 1.c: Arthritis would be associated with greater disability.

4.2.3.1 Part I

I- Arthritis would be associated with greater ADL limitation.

Table 4.7 shows the resulting GEE models for ADL limitation as a function of arthritis over time. Four models assessed the relationship between arthritis and ADL limitation. In Model 4, the functional limitation (SPPB score) variable was added to those used in Models 1 through 3.

In Model 1, the odds ratio (OR) of having ADL limitation across time as a function of arthritis was 1.86 (95 % CI= 1.43- 2.42). In Model 2, the odds of having ADL limitation across time was 1.67 (95 % CI= 1.26- 2.21). Additionally, the odds of ADL

limitation across time was 1.51 (95 % CI= 1.05- 2.18) in Model 4. This significant association was not confirmed by sensitivity analysis (Appendix B- Table B.1.3.1).

Other factors such as age, low cognitive status, high depressive symptoms, presence of medical conditions, and pain on weight-bearing joints were significantly positively associated across time with having ADL limitation. However, 'interviewed in English' (vs. Spanish), 'high TMBS', and 'high SPPB' were negatively associated across time with having ADL limitation. An interaction effect between time and arthritis on ADL limitation was not significant (F=1.98, df= 2, p=0.13) (see Appendix C). Sensitivity analysis confirmed these findings.

4.2.3.2 Part II

II- Arthritis would be associated with greater IADL disability.

Table 4.8 shows the results of GEE models for IADL limitation as a function of arthritis over time. Four models assessed the relationship between arthritis and IADL limitation. In Model 4, the functional limitation (SPPB score) was added to covariates analyzed in Models 1 through 3.

In Model 1, the odds ratio (OR) of having IADL limitation across time as a function of arthritis was 1.84 (95 % CI= 1.47- 2.31). In Model 2, the odds of having IADL limitation across time was 1.74 (95 % CI= 1.37- 2.20). Additionally, the odds of having IADL limitation across time was 1.47 (95 % CI= 1.11- 1.93) in Model 4, where impairment and functional limitation variables were added. Sensitivity analyses using estimates obtained from complete cases showed roughly the same findings for the relative direction and magnitude of the estimated relationship between arthritis and IADL (see Appendix B – Table B.1.3.2).

Other factors such as age, being interviewed in English (vs. Spanish), high BMI, low cognitive status, high depressive symptoms, presence of medical conditions, and pain on weight-bearing were significantly associated across time with having IADL limitation. In contrast, high TMBS and SPPB scores were negatively associated across time with IADL limitation. An interaction effect between time and arthritis on IADL limitation was not significant (F= 0.11, df= 2, p=0.89) (see Appendix C). Sensitivity analysis confirmed these findings.

Table 4.7 General Estimation Equations (GEE) models for Disability (activities of daily living (ADL)) as a function of arthritis over three points of time

Explanatory variables	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	OR	**95 % CI**		**OR**	**95 % CI**		**OR**	**95 % CI**		**OR**	**95 % CI**	
Time 1	1.06	0.84	1.34	1.09	0.85	1.40	1.09	0.83	1.42	0.83	0.56	1.23
Time 2	1.94	1.46	2.56	1.59	1.16	2.18	1.66	1.19	2.31	1.45	0.95	2.21
Age	1.09	1.05	1.12	1.10	1.06	1.13	1.08	1.04	1.12	1.03	1.00	1.07
Male	0.72	0.50	1.04	0.84	0.58	1.21	1.39	0.92	2.09	1.19	0.76	1.88
Married	0.96	0.69	1.34	0.99	0.69	1.41	0.97	0.68	1.39	0.95	0.63	1.42
Education	0.97	0.93	1.02	1.00	0.95	1.04	1.01	0.96	1.06	0.98	0.93	1.03
Nativity	0.83	0.59	1.17	0.86	0.61	1.21	0.84	0.59	1.19	0.81	0.54	1.21
Interviewed in English	0.78	0.53	1.15	0.68	0.45	1.02	0.67	0.43	1.04	0.57	0.34	0.97
Arthritis	1.86	1.43	2.42	1.67	1.26	2.21	1.46	1.09	1.96	1.51	1.05	2.18
BMI (Kg/m2)				1.03	1.00	1.06	1.03	1.00	1.06	1.02	0.98	1.06
Low cognitive status				1.81	1.34	2.46	1.84	1.35	2.50	1.52	1.04	2.21
Depressive symptoms				2.66	1.91	3.72	2.55	1.82	3.58	1.86	1.20	2.89
Medical conditions				1.58	1.36	1.84	1.54	1.31	1.80	1.37	1.13	1.66
Pain							2.05	1.55	2.70	1.90	1.37	2.63
TBMS (Kg)							0.98	0.97	0.98	0.98	0.97	0.99
SPPB										0.62	0.58	0.66

OR= Odds Ratio; BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

Table 4.8 General Estimation Equations (GEE) models for Disability (instrumental activities of daily living (IADL)) as a function of arthritis over three points of time

Explanatory variables	Model 1			Model 2			Model 3			Model 4		
	OR	95 % CI		OR	95 % CI		OR	95 % CI		OR	95 % CI	
Time 1	1.18	0.99	1.40	1.26	1.04	1.53	1.28	1.04	1.57	1.26	0.99	1.61
Time 2	2.84	2.14	3.77	2.63	1.94	3.57	2.91	2.10	4.02	3.05	2.13	4.36
Age	1.08	1.05	1.12	1.09	1.06	1.12	1.07	1.04	1.11	1.04	1.01	1.08
Male	0.49	0.36	0.67	0.53	0.39	0.73	0.79	0.56	1.13	0.73	0.50	1.05
Married	1.02	0.77	1.35	1.05	0.79	1.40	1.03	0.77	1.39	1.07	0.78	1.47
Education	0.95	0.92	0.99	0.97	0.93	1.01	0.97	0.94	1.01	0.96	0.92	1.00
Nativity	0.76	0.56	1.02	0.73	0.54	0.99	0.71	0.52	0.97	0.67	0.49	0.93
Interviewed in English	1.30	0.93	1.81	1.22	0.87	1.71	1.29	0.91	1.84	1.49	1.01	2.19
Arthritis	1.84	1.47	2.31	1.74	1.37	2.20	1.46	1.14	1.87	1.47	1.11	1.93
BMI (Kg/m2)				1.03	1.01	1.06	1.04	1.01	1.07	1.03	1.00	1.06
Low cognitive status				1.79	1.37	2.33	1.75	1.33	2.29	1.48	1.09	2.01
Depressive symptoms				2.55	1.87	3.48	2.48	1.78	3.46	2.06	1.38	3.07
Medical conditions				1.40	1.21	1.61	1.32	1.14	1.53	1.19	1.03	1.39
Pain							2.14	1.68	2.74	1.87	1.44	2.44
TBMS (Kg)							0.98	0.97	0.99	0.99	0.98	0.99
SPPB										0.76	0.73	0.80

OR= Odds Ratio; BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

4.3 SUMMARY

This chapter started by describing the subjects' characteristics. Also, it analyzed all three hypotheses of Aim 1. The findings are as follows:

1- Arthritis was associated with greater impairment (pain and low upper muscle strength).

2- Arthritis was associated with greater functional limitation (represented by SPPB score).

3- Arthritis was associated with disability (any ADL and IADL limitations).

Analyses and findings for Aim 2 are presented in Chapter 5. A discussion of the outcomes of this study is presented in Chapter 7.

5.0 THE IMPACT OF ARTHRITIS AND THE DISABLEMENT PROCESS ON PHYSICAL HEALTH-RELATED QUALITY OF LIFE

This chapter is composed of two main sections: (5.1) Results of Specific Aim 2, a) the relationship between arthritis and physical HRQoL, b) the relationship between impairment and physical HRQoL, c) the relationship between functional limitation and physical HRQoL, and d) the relationship between disability and physical HRQoL; and (5.2) Summary of the Results.

5.1 SPECIFIC AIM 2

To examine the association between arthritis and stages of disablement (impairment, functional limitation, and disability) on physical HRQoL, as measured by SF-36 Physical Component Summary (PCS) among older Mexican-Americans, over three points of time (2000-2001, 2001-2002, and 2006).

Hypothesis 2.a:
Arthritis would be associated with poorer physical HRQoL.

Table 5.1 shows the general linear mixed model estimates for PCS score as a function of arthritis over three time points. Two models assessed this association. Model 1 included time, arthritis, and all sociodemographic variables (age, gender, marital status, education, nativity, and language of interview). In Model 2, comorbid conditions (BMI, depressive symptoms, and medical conditions) were added to the variables in Model 1. There was a negative association between arthritis and PCS (Estimate= -4.89, SE= 0.59, $p < .001$) in Model 1. This relationship decreased slightly by 0.4 points in Model 2, but remained statistically significant. Sensitivity analyses, using estimates obtained from

complete cases, showed approximately the same findings for the relative direction and magnitude of the estimate between arthritis and PCS (see Appendix B – Table B.2.1).

Other factors such as age, high BMI, depressive symptoms, and medical conditions were negatively associated with PCS, while being male was positively associated. No interaction effect between time and arthritis on PCS was found (F= 0.34, df= 2, p= 0.71) (see Appendix C). Sensitivity analysis confirmed these findings.

Moreover, all analyses were reevaluated with unadjusted GEE. With the PCS variable dichotomized (Better vs. Worse physical HRQoL) arthritis was negatively associated with better physical HRQoL (OR = 0.45; 95% CI = 0.36 – 0.56) (data not shown). Better and worse scores were divided by the median PCS: 42.43. After controlling for all covariates, this association remained significant (OR = 0.49; 95% CI = 0.39 – 0.62).

Table 5.1 General linear mixed models estimates for physical health-related quality of life (PCS) as a function of pathology (arthritis) over three points of time

Explanatory variables	**Model 1**			**Model 2**		
	β	(SE)	P-value	β	(SE)	P-value
Intercept	72.7	6.66	<.001	84.3	6.89	<.001
Time 1 vs. Time 0	-0.34	0.45	0.45	-0.19	0.45	0.67
Time 2 vs. Time 0	-3.00	0.72	<.001	-1.50	0.71	0.04
Age	-0.40	0.08	<.001	-0.45	0.08	<.001
Male vs. Female	3.27	0.91	<.01	2.32	0.85	0.01
Married (Yes vs. No)	-0.45	0.81	0.58	-0.40	0.77	0.60
Education	0.19	0.11	0.09	0.18	0.11	0.09
Nativity (foreign born vs. US born)	0.90	0.88	0.30	0.92	0.82	0.26
Interviewed in English (Yes vs. No)	-1.59	0.90	0.08	-1.40	0.87	0.11
Arthritis (Yes vs. No)	-4.89	0.59	<.001	-4.51	0.58	<.001
BMI (Kg/m2)				-0.15	0.07	0.02
Depressive symptoms (Yes vs. No)				-4.17	0.79	<.001
Medical conditions				-2.49	0.33	<.001

BMI= Body Mass Index

5.1.1 Hypothesis 2.b:
Greater impairment would be associated with poorer physical HRQoL.

Table 5.2 shows the general linear mixed model estimates for PCS score as a function of impairment (pain, Total Body Muscle Strength (TBMS)) over three time points. Three models assessed this association. Model 1 included time, pain, TBMS, and all sociodemographic variables. In Model 2, comorbid conditions (BMI, depressive symptoms, and medical conditions) were added to the variables in Model 1. In Model 3, arthritis was added to the variables from Models 1 and 2.

There was a negative association between pain and PCS (Estimate= -7.60, SE= 0.52, p <.001) in Model 1. This association decreased slightly by 1.15 points in Model 3

but remained statistically significant. Furthermore, there was a positive association between high total body muscle strength and PCS (Estimate= 0.13, SE= 0.01, p <.001) in Model 1. This association remained statistically significant in Model 3.

Sensitivity analyses using estimates obtained from complete cases showed similar findings for the relative direction and magnitude of the estimate between the impairment variables and PCS (see Appendix B – Table B.2.2).

Other factors, such as age, high BMI, depressive symptoms, medical conditions, and arthritis were negatively associated with PCS. No interaction effect was observed between time and pain (F= 1.55, df= 2, p= 0.21) and between time and TBMS quartiles (F= 2.1, df= 6, p= 0.05), respectively, on PCS (see Appendix C). Sensitivity analysis confirmed these findings.

Furthermore, all analyses were reevaluated with unadjusted GEE. When the PCS variable was dichotomized (Better vs. Worse physical HRQoL), pain was negatively associated with better physical HRQoL (OR = 0.25; 95% CI = 0.20 – 0.30) and positively associated with higher TBMS (OR = 1.97; 95% CI = 1.59 – 2.43) (data not shown). Better and worse scores were divided by the median PCS: 42.43. After controlling for all covariates, this association remained significant for the impairment variables pain (OR = 0.28; 95% CI = 0.23 – 0.36) and TBMS (OR = 1.82; 95% CI = 1.43 – 2.33).

Table 5.2 General linear mixed models estimates for physical health-related quality of life (PCS) as a function of impairment (pain, Total Body Muscle Strength) over three points of time

Explanatory variables	Model 1			Model 2			Model 3		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	57.4	6.15	<.001	69.0	6.35	<.001	69.1	6.26	<.001
Time 1	-0.46	0.44	0.30	-0.32	0.44	0.47	-0.13	0.44	0.76
Time 2	-2.51	0.68	<.01	-1.30	0.68	0.06	-1.24	0.67	0.07
Age	-0.28	0.07	<.01	-0.33	0.07	<.001	-0.32	0.07	<.001
Male	0.40	0.86	0.64	-0.46	0.81	0.57	-0.75	0.80	0.35
Married	-0.27	0.73	0.72	-0.19	0.70	0.79	-0.17	0.69	0.80
Education	0.14	0.10	0.16	0.13	0.09	0.18	0.11	0.09	0.24
Nativity	1.01	0.77	0.19	1.05	0.72	0.14	0.93	0.71	0.19
Interviewed in English	-1.37	0.84	0.11	-1.25	0.82	0.13	-1.27	0.81	0.12
Pain (Yes vs. No)	-7.60	0.52	<.001	-7.02	0.52	<.001	-6.45	0.52	<.001
TBMS (Kg)	0.13	0.01	<.001	0.13	0.01	<.001	0.12	0.01	<.001
BMI (Kg/m2)				-0.18	0.06	<.01	-0.15	0.06	0.01
Depressive symptoms				-3.65	0.76	<.001	-3.61	0.75	<.001
Medical conditions				-2.09	0.31	<.001	-2.00	0.31	<.001
Arthritis							-3.20	0.56	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength.

5.1.2 Hypothesis 2.c:
Greater functional limitation would be associated with poorer physical HRQoL.

Table 5.3 shows the general linear mixed model estimates for the PCS score as a function of functional limitation, as measured by the Short Physical Performance Battery (SPPB) over three points of time. Four models assessed this association.

Model 1 included time, SPPB, and all sociodemographic variables. In Model 2, comorbid conditions (BMI, depressive symptoms, and medical conditions) were added to the variables in Model 1. In Model 3, arthritis was added to the variables in Model 2.

Lastly, in Model 4 the impairment variables (pain and TBMS) were added to variables in Model 3.

There was a positive association between SPPB and PCS (Estimate= 1.89, SE= 0.08, $p < .001$) in Model 1. This relationship decreased slightly by 0.4 points in Model 4, but remained statistically significant. Sensitivity analyses, using estimates obtained from complete cases, showed approximately the same findings for the relative direction and magnitude of the estimate of the association between SPPB and PCS (see Appendix B – Table B.2.3).

Other factors such as depressive symptoms, medical conditions, arthritis, and pain were negatively associated with PCS, while TBMS was positively associated with PCS. No interaction effect between time and SPPB quartiles on PCS was found (F= 1.23, df= 6, p= 0.29) (see Appendix C). However, sensitivity analysis showed a significant interaction effect between time and SPPB quartiles on PCS (F= 3.65, df= 6, p< 0.01) (Appendix B – Table B.2.3).

All analyses were reevaluated with unadjusted GEE with the PCS variable dichotomized (Better vs. Worse physical HRQoL). Better physical HRQoL was positively associated with SPPB (OR = 4.70; 95% CI = 3.56 – 6.17) (data not shown). 'Better' and 'Worse' scores were divided by the median PCS: 42.43. After controlling for all covariates, this association remained significant (OR = 3.78; 95% CI = 2.73 – 5.23).

5.1.3 Hypothesis 2.d:
Greater disability (ADL and IADL) would be associated with poorer physical HRQoL (lower PCS score).

5.1.3.1 Part I

I- Presence of any ADL limitation (i.e., bathing, dressing, transferring from bed to a chair, using the toilet, or eating) would be associated with poorer physical HRQoL.

Table 5.4 shows the general linear mixed model estimates for PCS score as a function of ADL limitation over three points of time. Five models assessed this association.

Model 1 included time, ADL limitation, and all sociodemographic variables. In Model 2, comorbid conditions (i.e., BMI, depressive symptoms, and medical conditions) were added to the variables in Model 1. In Model 3, arthritis was added to the variables in Model 2. In Model 4 the impairment variables (pain and TBMS) were added to the variables in Model 3. Lastly, in Model 5 the functional limitation (SPPB) variable was added to the variables in Model 4.

There was a negative association between any ADL limitation and PCS (Estimate= -14.4, SE= 0.64, p <.001) in Model 1. This association decreased by 2.5 points in Model 4 when the impairment variables were added, but remained statistically significant. However, this association decreased dramatically (4.22 points) in Model 5 when SPPB was added. However, it remained statistically significant.

Sensitivity analyses, using estimates obtained from complete cases, showed roughly the same findings for the relative direction and magnitude of the estimated correlation between ADL and PCS (see Appendix B – Table B.2.4.1). Other factors such as medical conditions, interviewed in English, arthritis, and pain were negatively associated with PCS, while TBMS and SPPB were positively associated. No interaction effect between time and ADL limitation on PCS was found (F= 1.92, df= 2, p= 0.15) (see Appendix C). Sensitivity analysis confirmed these findings.

All analyses were reevaluated with unadjusted GEE. With PCS dichotomized (Better vs. Worse physical HRQoL), better physical HRQoL was found to be negatively associated with any ADL limitation (OR = 0.05; 95% CI = 0.03 – 0.07) (data not shown). 'Better' and 'Worse' scores were divided by the median of PCS, 42.43. After controlling for all covariates, this association remained significant (OR = 0.07; 95% CI = 0.04 – 0.11).

5.1.3.2 Part II

II- Presence of any IADL limitation (e.g., meal preparation, shopping for groceries, money management, using telephone, or light housework) would be associated with poorer physical HRQoL.

Table 5.5 shows the general linear mixed model estimates for PCS score as a function of IADL limitation over three points of time. Five models assessed this association. Model 1 included time, IADL limitation, and all sociodemographic variables. In Model 2, comorbid conditions (BMI, depressive symptoms, and medical conditions) were added to the variables in Model 1. In Model 3, arthritis was added to the variables in Model 2. In Model 4, the impairment variables (pain and TBMS) were added to the variables in Model 3. Lastly, in Model 5 the functional limitation (SPPB) variable was added to the variables in Model 4.

There was a negative association between any IADL limitation and PCS (Estimate= -13.3, SE= 0.64, p <.001) in Model 1. When adding the impairment variables, this association decreased by 2.3 points in Model 4 (remaining statistically significant). The association decreased dramatically (2.7 points) in Model 5, but when SPPB was added it remained statistically significant. Sensitivity analyses, using estimates obtained

from complete cases, showed roughly the same findings for the relative direction and magnitude of the estimate between IADL and PCS (see Appendix B – Table B.2.4.2).

Other factors, such as medical conditions, arthritis, and pain were negatively associated with PCS while TBMS and SPPB were positively associated with PCS. No interaction effect between time and disability on PCS was found (F= 1.15, df= 2, p= 0.31) (see Appendix C). Sensitivity analysis confirmed these findings.

All analyses were reevaluated (with unadjusted GEE) when the PCS variable was dichotomized (Better vs. Worse physical HRQoL), suggesting that better physical HRQoL was negatively associated with any IADL limitation (OR = 0.07; 95% CI = 0.05 – 0.09) (data not shown). 'Better' and 'Worse' scores were divided by the median of PCS, 42.43. After controlling for all covariates, this association remained significant (OR = 0.10; 95% CI = 0.08 – 0.15).

Table 5.3 General linear mixed models estimates for physical health-related quality of life (PCS) as a function of functional limitation (Short Physical Performance Battery) over three points of time

Explanatory variables	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	33.4	5.30	<.001	45.4	5.81	<.001	46.0	5.65	<.001	38.7	5.26	<.001
Time 1	-0.21	0.45	0.63	-0.13	0.44	0.78	0.10	0.44	0.82	0.06	0.43	0.89
Time 2	-1.32	0.62	0.03	-0.51	0.62	0.41	-0.43	0.62	0.49	-0.39	0.59	0.51
Age	-0.10	0.06	0.14	-0.16	0.06	0.01	-0.15	0.06	0.02	-0.08	0.06	0.15
Male	2.66	0.69	<.01	2.09	0.68	<.01	1.64	0.66	0.01	-0.42	0.65	0.52
Married	-0.56	0.65	0.39	-0.49	0.63	0.44	-0.44	0.62	0.48	-0.26	0.56	0.64
Education	0.21	0.09	0.02	0.19	0.08	0.02	0.16	0.08	0.05	0.11	0.07	0.14
Nativity	0.64	0.67	0.34	0.72	0.65	0.27	0.55	0.63	0.38	0.61	0.56	0.28
Interviewed in English	-1.06	0.77	0.17	-1.01	0.76	0.18	-1.01	0.74	0.17	-1.00	0.69	0.15
SPPB	1.89	0.08	<.001	1.76	0.08	<.001	1.71	0.08	<.001	1.53	0.07	<.001
BMI (Kg/m2)				-0.13	0.06	0.02	-0.10	0.05	0.08	-0.08	0.05	0.09
Depressive symptoms				-2.08	0.73	<.01	-2.00	0.72	0.01	-1.66	0.68	0.02
Medical conditions				-1.67	0.29	<.001	-1.53	0.29	<.001	-1.20	0.27	<.001
Arthritis							-3.86	0.51	<.001	-2.64	0.50	<.001
Pain										-5.60	0.48	<.001
TBMS (Kg)										0.09	0.01	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

Table 5.4. General linear mixed models estimates for physical health-related quality of life (PCS) as a function of ADL limitation over three points of time

Explanatory variables	**Model 1**			**Model 2**			**Model 3**			**Model 4**			**Model 5**		
	β	(SE)	*P-value*	β	(SE)	*P-value*	β	(SE)	*P-value*	β	(SE)	*P-value*	β	(SE)	*P-value*
Intercept	56.7	5.35	<.001	68.8	5.80	<.001	68.8	5.62	<.001	56.9	5.22	<.001	40.0	4.93	<.001
Time 1	-0.30	0.44	0.50	-0.20	0.44	0.65	0.03	0.43	0.94	0.02	0.42	0.97	0.05	0.41	0.90
Time 2	-1.18	0.65	0.07	-0.29	0.65	0.65	-0.19	0.64	0.76	-0.17	0.61	0.78	-0.06	0.57	0.92
Age	-0.19	0.07	0.01	-0.26	0.07	<.01	-0.24	0.06	<.01	-0.15	0.06	0.01	-0.04	0.05	0.43
Male	3.01	0.72	<.001	2.33	0.70	<.01	1.87	0.68	0.01	-0.56	0.66	0.40	-0.33	0.61	0.59
Married	-0.56	0.68	0.41	-0.45	0.66	0.49	-0.39	0.64	0.54	-0.19	0.58	0.74	-0.25	0.53	0.63
Education	0.18	0.09	0.05	0.16	0.09	0.06	0.13	0.08	0.11	0.08	0.08	0.28	0.09	0.07	0.18
Nativity	0.47	0.70	0.50	0.59	0.67	0.38	0.43	0.65	0.51	0.50	0.58	0.38	0.45	0.53	0.40
Interviewed in English	-1.85	0.80	0.02	-1.77	0.78	0.02	-1.74	0.76	0.02	-1.70	0.70	0.02	-1.39	0.65	0.03
ADL Limitation	-14.4	0.64	<.001	-13.3	0.65	<.001	-13.0	0.64	<.001	-11.9	0.61	<.001	-7.68	0.66	<.001
BMI (Kg/m2)				-0.16	0.06	<.01	-0.13	0.06	0.02	-0.12	0.05	0.03	-0.08	0.05	0.11
Depressive symptoms				-2.10	0.75	0.01	-2.04	0.73	0.01	-1.67	0.69	0.02	-0.86	0.66	0.19
Medical conditions				-1.82	0.30	<.001	-1.68	0.29	<.001	-1.29	0.27	<.001	-0.96	0.25	<.01
Arthritis							-3.84	0.53	<.001	-2.57	0.50	<.001	-2.40	0.47	<.001
Pain										-5.81	0.48	<.001	-5.36	0.46	<.001
TBMS (Kg)										0.10	0.01	<.001	0.08	0.01	<.001
SPPB													1.08	0.08	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

Table 5.5. General linear mixed models estimates for physical health-related quality of life (PCS) as a function of IADL limitation over three points of time

Explanatory variables	**Model 1**			**Model 2**			**Model 3**			**Model 4**			**Model 5**		
	β	(SE)	*P-value*	β	(SE)	*P-value*	β	(SE)	*P-value*	β	(SE)	*P-value*	β	(SE)	*P-value*
Intercept	60.0	5.21	<.001	70.6	5.61	<.001	70.6	5.48	<.001	59.0	5.12	<.001	39.6	4.74	<.001
Time 1	0.11	0.44	0.81	0.20	0.43	0.65	0.39	0.43	0.37	0.34	0.42	0.41	0.30	0.40	0.45
Time 2	0.06	0.65	0.93	0.99	0.64	0.13	1.01	0.64	0.11	0.85	0.61	0.17	0.87	0.56	0.12
Age	-0.17	0.07	0.01	-0.23	0.06	<.01	-0.22	0.06	<.01	-0.13	0.06	0.02	-0.01	0.05	0.85
Male	1.75	0.71	0.01	1.08	0.68	0.11	0.70	0.67	0.29	-1.58	0.66	0.02	-0.99	0.59	0.09
Married	-0.25	0.66	0.70	-0.23	0.64	0.71	-0.18	0.62	0.77	-0.04	0.57	0.95	-0.20	0.51	0.69
Education	0.08	0.09	0.34	0.08	0.08	0.37	0.05	0.08	0.52	0.01	0.07	0.93	0.03	0.07	0.62
Nativity	0.19	0.68	0.78	0.26	0.65	0.68	0.14	0.63	0.82	0.26	0.57	0.64	0.19	0.50	0.70
Interviewed in English	-0.49	0.78	0.53	-0.40	0.76	0.60	-0.37	0.75	0.62	-0.33	0.69	0.64	-0.41	0.63	0.52
IADL Limitation	-13.3	0.55	<.001	-12.6	0.55	<.001	-12.2	0.55	<.001	-11.0	0.53	<.001	-8.31	0.52	<.001
BMI (Kg/m2)				-0.13	0.06	0.02	-0.10	0.06	0.06	-0.10	0.05	0.04	-0.06	0.05	0.20
Depressive symptoms				-2.91	0.73	<.001	-2.83	0.72	<.001	-2.38	0.68	<.01	-1.04	0.64	0.10
Medical conditions				-1.93	0.29	<.001	-1.82	0.28	<.001	-1.46	0.27	<.001	-0.99	0.24	<.001
Arthritis							-3.40	0.52	<.001	-2.28	0.50	<.001	-2.07	0.46	<.001
Pain										-5.28	0.48	<.001	-4.79	0.45	<.001
TBMS (Kg)										0.10	0.01	<.001	0.07	0.01	<.001
SPPB													1.15	0.07	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery

5.2 SUMMARY

In this chapter, all four hypotheses of Aim 2 were tested. The results demonstrate that:

1- Arthritis was associated with lower physical HRQoL score.

2- The presence of impairment (pain and total body muscle strength) was associated with lower physical HRQoL score.

3- Greater functional limitation (lower SPPB score) was associated with lower physical HRQoL score.

4- The presence of disability (ADL or IADL limitations) was associated with lower physical HRQoL score.

Analyses and findings for Aim 3 are presented in Chapter 6. A discussion of the outcomes of this study is presented in Chapter 7.

6.0 THE IMPACT OF ARTHRITIS AND THE DISABLEMENT PROCESS ON MENTAL HEALTH-RELATED QUALITY OF LIFE

This chapter is composed of two main sections: (6.1) Results of Specific Aim 2 – a) the relationship between arthritis and mental HRQoL, b) the relationship between impairment and mental HRQoL, c) the relationship between functional limitation and mental HRQoL, and d) the relationship between disability and mental HRQoL; and (6.2) Summary of the Results.

6.1 SPECIFIC AIM 3

The third aim was to examine the association between arthritis and stages of the disablement process (impairment, functional limitation, and disability) on **mental** HRQoL over three points of time (2000-2001, 2001-2002, and 2006) among older Mexican-Americans.

6.1.1 Hypothesis 3.a:
Arthritis would be associated with poorer mental HRQoL.

Table 6.1 shows the general linear mixed model estimates for the MCS score as a function of arthritis over three points of time. Two models assessed this association. Model 1 included time, arthritis, and all sociodemographic variables (i.e., age, gender, marital status, education, nativity, and language of the interview). In Model 2, comorbid conditions (i.e., BMI, depressive symptoms, and medical conditions) were added to those included in Model 1. There was no association between arthritis and MCS in either model. Sensitivity analyses, using estimates obtained from complete cases, showed

almost the same findings for the relative direction and magnitude of the estimate between arthritis and MCS (see Appendix B – Table B.3.1).

As expected, depressive symptoms were negatively associated with MCS. No interaction effect between 'time' and 'arthritis' on lower body function was found (F= 1.68, df= 2, p= 0.19) (see Appendix C). Sensitivity analysis confirmed these findings.

All analyses were reevaluated with unadjusted GEE. When MCS was dichotomized (Better vs. Worse mental HRQoL), better mental HRQoL was not significantly associated with arthritis (OR = 0.81; 95% CI = 0.66 – 1.02) (data not shown). 'Better' and 'Worse' scores were divided by the median MCS, 55.3. After controlling for all covariates, this association remained the same: not significant (OR = 0.89; 95% CI = 0.70 – 1.13).

Table 6.1 General linear mixed models estimates for mental health-related quality of life (MCS) as a function of pathology (arthritis) over three points of time

Explanatory variables	**Model 1**			**Model 2**		
	β	(SE)	*P-value*	β	(SE)	*P-value*
Intercept	58.5	4.32	<.001	54.0	4.07	<.001
Time 1 vs. Time 0	1.40	0.42	<.01	1.28	0.39	<.01
Time 2 vs. Time 0	-0.53	0.62	0.39	0.23	0.54	0.67
Age	-0.06	0.05	0.29	0.01	0.05	0.76
Male vs. Female	-0.11	0.58	0.85	-0.60	0.49	0.22
Married (Yes vs. No)	1.26	0.56	0.02	0.68	0.47	0.15
Education	0.04	0.07	0.61	0.02	0.06	0.77
Nativity (foreign born vs. US born)	1.19	0.55	0.03	0.75	0.46	0.11
Interviewed in English (Yes vs. No)	-1.24	0.69	0.07	-0.26	0.59	0.65
Arthritis (Yes vs. No)	-0.25	0.47	0.60	0.09	0.42	0.84
BMI (Kg/m2)				0.05	0.04	0.26
Depressive symptoms (Yes vs. No)				-12.83	0.60	<.001
Medical conditions				-0.42	0.22	0.06

BMI= Body Mass Index

6.1.2 Hypothesis 3.b:
Greater impairment would be associated with poorer mental HRQoL.

Table 6.2 shows the general linear mixed model estimates for MCS score as a function of impairment (pain on weight-bearing and TBMS) over three points of time. Three models assessed this association. Model 1 included time, pain, TBMS, and all sociodemographic variables. In Model 2, comorbid conditions (BMI, depressive symptoms, and medical conditions) were added to the variables in Model 1. In Model 3, arthritis was added to the variables in Model 2.

There was a negative association between pain and MCS (Estimate= -1.56, SE= 0.45, p <.01) in Model 1. This association decreased slightly (0.59) points in Model 3 but remained statistically significant. Additionally, high total body muscle strength (TBMS) was positively associated with MCS (Estimate= 0.04, SE= 0.01, p <.001) in Model 1. This association remained statistically significant in Model 3. However, sensitivity analyses using estimates obtained from complete cases showed no significant association between the impairment variables and MCS (see Appendix B – Table B.3.4.2).

Other factors, such as being married (vs. otherwise) and depressive symptoms were negatively associated with MCS while Time 1 was positively associated with MCS.

There was a significant interaction between time and pain on MCS (F= 3.21, df= 2, p=0.04), which means that the pattern of change for subjects with and without pain differed (significantly at Time 0, Time 1 or Time 2). Figure 6.1 shows the adjusted mean distribution of MCS over the three points of time by pain condition, using the least-squares means for fixed effects. To explore the interaction further, post hoc analyses were conducted using Tukey test. These analyses showed no significant difference between subjects with and without pain at Time 0 (baseline), but significant group differences at

Time 1 (t-test= 2.4, p= 0.02) and Time 2 (t-test= 2.6, p < 0.01). Thus, subjects with pain are more likely to have significantly lower MCS scores than those without pain later in life. Furthermore, MCS scores decreased over time (between Time 0 and Time 2) for subjects with pain by 2.5 points (t-test= 3.6, p < 0.01).

However, no interaction effect between time and TBMS quartiles on MCS was found (F= 2.06, df= 6, p= 0.05) (see Appendix C). According to sensitivity analyses, there was no interaction effect between time and either impairment variable on MCS (see Appendix B – Table B.2.4.2).

All analyses were reevaluated (with unadjusted GEE) and, when the MCS variable was dichotomized (Better vs. Worse mental HRQoL), the data suggested that better mental HRQoL was negatively associated with pain (OR = 0.63; 95% CI = 0.50 – 0.78) and positively associated with higher total body muscle strength (OR = 1.32; 95% CI = 1.06 – 1.64) (data not shown). 'Better' and 'Worse' scores were divided by the median of MCS –55.3. After controlling for all covariates, this association remained significant for the impairment variables (pain and TBMS) (OR = 0.69; 95% CI = 0.54 – 0.88), and (OR = 1.36; 95% CI = 1.05 – 1.76), respectively.

Table 6.2 General linear mixed models estimates for mental health-related quality of life (MCS) as a function of impairment (pain, lower and upper extremities muscle strength) over three points of time

Explanatory variables	Model 1			Model 2			Model 3		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	53.7	4.57	<.001	50.4	4.25	<.001	50.3	4.25	<.001
Time 1	1.40	0.41	<.01	1.29	0.39	<.01	1.27	0.39	<.01
Time 2	-0.48	0.62	0.44	0.18	0.54	0.74	0.18	0.54	0.74
Age	-0.02	0.05	0.75	0.04	0.05	0.36	0.04	0.05	0.37
Male	-1.18	0.64	0.07	-1.31	0.55	0.02	-1.28	0.55	0.02
Married	1.27	0.55	0.02	0.70	0.47	0.14	0.70	0.47	0.14
Education	0.02	0.07	0.80	0.01	0.06	0.92	0.01	0.06	0.89
Nativity	1.23	0.55	0.03	0.76	0.46	0.10	0.78	0.46	0.09
Interviewed in English	-1.25	0.68	0.07	-0.31	0.59	0.60	-0.31	0.59	0.60
Pain	-1.56	0.45	<.01	-0.88	0.41	0.03	-0.97	0.42	0.02
TBMS (Kg)	0.04	0.01	<.01	0.03	0.01	0.01	0.03	0.01	0.01
BMI (Kg/m2)				0.05	0.04	0.25	0.05	0.04	0.28
Depressive symptoms				-12.7	0.60	<.001	-12.7	0.60	<.001
Medical conditions				-0.31	0.23	0.17	-0.32	0.23	0.16
Arthritis							0.39	0.43	0.36

BMI= Body Mass Index; TBMS= Total Body Muscle Strength.

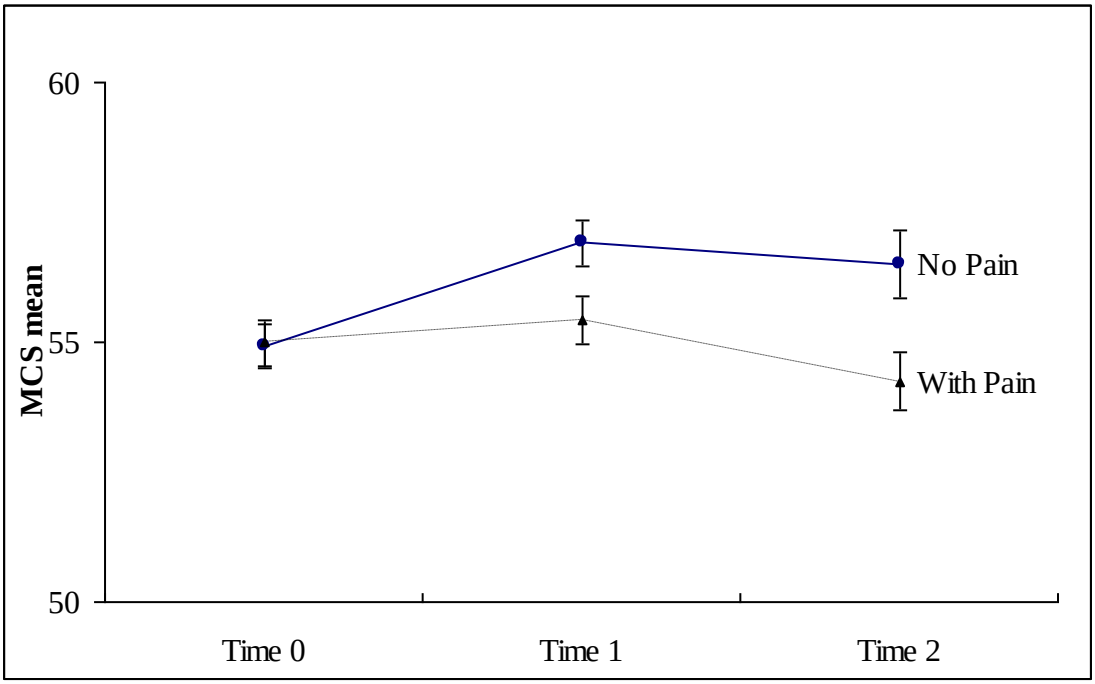

Figure 6.1 Adjusted MCS mean and standard errors over time for subjects with and without pain

6.1.3 Hypothesis 3.c:
Greater functional limitation would be associated with poorer mental HRQoL.

Table 6.3 shows the general linear mixed model estimates for MCS score as a function of functional limitation, as measured by the Short Physical Performance Battery (SPPB) over three points of time. Four models assessed this association. Model 1 included time, SPPB, and all sociodemographic variables. In Model 2, comorbid conditions (BMI, depressive symptoms, and medical conditions) were added to the variables in Model 1. In Model 3, arthritis was added to the variables in Model 2. In Model 4, the impairment variables (pain and TBMS) were added to the variables in Model 3.

There was a positive association between SPPB and MCS (Estimate= 0.69, SE= 0.07, p <.001) in Model 1. This relationship decreased by 0.27 points in Model 4, but remained statistically significant. Sensitivity analyses, using estimates obtained from complete cases, showed roughly the same findings for the relative direction and magnitude of the estimate between SPPB and MCS (see Appendix B – Table B.3.3).

Presence of depressive symptoms was negatively associated with MCS. No interaction effect between time and SPPB quartiles on MCS was found (F= 1.18, df= 6, p= 0.31) (see Appendix C). Sensitivity analysis confirmed these findings.

All analyses were reevaluated with unadjusted GEE. When the MCS variable was dichotomized (Better vs. Worse mental HRQoL), mental HRQoL was positively associated with SPPB (OR = 3.07; 95% CI = 2.35– 4.00) (data not shown). ‘Better’ and ‘Worse’ scores were divided by the median of MCS, 55.3. After controlling for all covariates, this association remained significant (OR = 2.56; 95% CI = 1.93 – 3.41).

6.1.4 Hypothesis 3.d:
Greater disability (ADL and IADL) would be associated with poorer mental HRQoL (lower MCS score).

6.1.4.1 Part I
I- Presence of any ADL limitation (i.e., bathing, dressing, transferring from bed to a chair, using the toilet, or eating) would be associated with poorer mental HRQoL.

Table 6.4 shows the general linear mixed model estimates for MCS score as a function of ADL limitation over three points of time. Five models assessed this association. Model 1 included time, ADL limitation, and all sociodemographic variables. In Model 2, comorbid conditions (BMI, depressive symptoms, and medical conditions) were added to the variables in Model 1. In Model 3, arthritis was added to the variables in Model 2. In Model 4 the impairment variables (pain and TBMS) were added to the variables in Model 3. Lastly, in Model 5, the functional limitation (SPPB) variable was added to the variables in Model 4.

There was a negative association between ADL limitation and MCS (Estimate= -4.59, SE= 0.56, $p < .001$) in Model 1. This association decreased by 2.5 points in Model 4 when the impairment variables (pain and TBMS) were added, although it remained statistically significant. However, when adding SPPB to Model 5, the association between ADL limitation and MCS decreased by about 1.65 points compared to Model 4, but this combination was not statistically significant. Sensitivity analyses using estimates obtained from complete cases showed no significant association between ADL and MCS (see Appendix B – Table B.3.4.1).

Presence of depressive symptoms was negatively associated with MCS while Time 1, age, and SPPB were positively associated with MCS. No interaction effect

(between time and ADL limitation) on MCS was found (F= 1.11, df= 2, p= 0.34) (see Appendix C). Sensitivity analysis confirmed these findings.

Furthermore, all analyses were reevaluated with unadjusted GEE. When the MCS variable was dichotomized (Better vs. Worse mental HRQoL), better mental HRQoL was negatively associated with any ADL limitation (OR = 0.42; 95% CI = 0.32– 0.54) (data not shown). 'Better' and 'Worse' scores were divided by the median of MCS, 55.3. After controlling for all covariates, this association did not remain significant (OR = 0.54; 95% CI = 0.54– 1.00).

6.1.4.2 Part II

II- Presence of any IADL limitation (i.e., meal preparation, shopping for groceries, money management, using telephone, or light housework) would be associated with poorer mental HRQoL.

Table 6.5 shows the general linear mixed model estimates for MCS score as a function of IADL limitation over three points of time. Five models assessed this association. Model 1 included time, IADL limitation, and all sociodemographic variables. In Model 2, comorbid conditions (BMI, depressive symptoms, and medical conditions) were added to the variables in Model 1. In Model 3, arthritis was added to the variables in Model 2. In Model 4 the impairment variables (pain and TBMS) were added to the variables in Model 3. Lastly, in Model 5, the functional limitation (SPPB) variable was added to the variables in Model 4.

There was a negative association between IADL limitation and MCS (Estimate= -3.53, SE= 0.48, p < .001) in Model 1. This association decreased by 1.53 points in Model 4, when the impairment variables (pain and TBMS) were added, yet it remained statistically significant. After adding SPPB in Model 5, the association between IADL

limitation and MCS decreased by about 1 point, as compared to Model 4 but remained statistically significant. However, sensitivity analyses using estimates obtained from complete cases showed no significant association between IADL and MCS (see Appendix B – Table B.3.4.2).

Presence of depressive symptoms and male gender were negatively associated with MCS while Time 1, age, and SPPB were positively associated with MCS. No interaction effect between time and IADL limitation on MCS was found (F= 1.14, df= 2, p= 0.22) (see Appendix C). Sensitivity analysis confirmed these findings.

All analyses were reevaluated with unadjusted GEE. When the MCS variable was dichotomized (Better vs. Worse mental HRQoL), better mental HRQoL was negatively associated with any IADL limitation (OR = 0.35; 95% CI = 0.28 – 0.45) (data not shown). 'Better' and 'Worse' scores were divided by the MCS median: 55.3. After controlling for all covariates, this association remained significant (OR = 0.52; 95% CI = 0.40 – 0.68).

Table 6.3 General linear mixed models estimates for mental health-related quality of life (MCS) as a function of functional limitation (Short Physical Performance Battery) over three points of time

Explanatory variables	Model 1			Model 2			Model 3			Model 4		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	45.7	4.30	<.001	44.1	4.21	<.001	44.0	4.22	<.001	42.9	4.34	<.001
Time 1	1.41	0.41	<.01	1.30	0.39	<.01	1.28	0.39	<.01	1.27	0.39	<.01
Time 2	0.10	0.61	0.87	0.39	0.53	0.46	0.39	0.53	0.47	0.36	0.53	0.50
Age	0.05	0.05	0.37	0.09	0.05	0.05	0.09	0.05	0.06	0.10	0.05	0.04
Male	-0.55	0.55	0.32	-0.78	0.48	0.10	-0.74	0.48	0.12	-1.06	0.54	0.05
Married	1.12	0.53	0.04	0.63	0.46	0.17	0.63	0.46	0.17	0.65	0.46	0.16
Education	0.02	0.07	0.77	0.01	0.06	0.87	0.01	0.06	0.83	0.01	0.06	0.90
Nativity	1.13	0.53	0.03	0.69	0.45	0.13	0.71	0.45	0.12	0.72	0.46	0.11
Interviewed in English	-1.16	0.66	0.08	-0.28	0.58	0.63	-0.28	0.58	0.63	-0.29	0.58	0.61
SPPB	0.69	0.07	<.001	0.45	0.06	<.001	0.45	0.06	<.001	0.42	0.06	<.001
BMI (Kg/m2)				0.07	0.04	0.07	0.07	0.04	0.09	0.07	0.04	0.10
Depressive symptoms				-12.0	0.60	<.001	-12.0	0.60	<.001	-11.9	0.60	<.001
Medical conditions				-0.11	0.22	0.61	-0.13	0.22	0.57	-0.10	0.22	0.67
Arthritis							0.38	0.41	0.36	0.53	0.43	0.21
Pain										-0.56	0.42	0.18
TBMS (Kg)										0.01	0.01	0.21

BMI= Body Mass Index; TBMS = Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

Table 6.4. General linear mixed models estimates for mental health-related quality of life (MCS) as a function of ADL limitation over three points of time

Explanatory variables	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	54.4	4.25	<.001	51.1	4.11	<.001	51.1	4.11	<.001	48.6	4.27	<.001	43.0	4.35	<.001
Time 1	1.41	0.41	<.01	1.29	0.39	<.01	1.27	0.39	<.01	1.26	0.39	<.01	1.27	0.39	<.01
Time 2	0.02	0.61	0.98	0.37	0.53	0.49	0.36	0.53	0.50	0.31	0.54	0.57	0.37	0.53	0.48
Age	0.01	0.05	0.88	0.05	0.05	0.27	0.05	0.05	0.28	0.07	0.05	0.16	0.10	0.05	0.04
Male	-0.35	0.57	0.53	-0.68	0.49	0.16	-0.65	0.49	0.19	-1.16	0.55	0.03	-1.05	0.54	0.05
Married	1.17	0.55	0.03	0.67	0.47	0.15	0.67	0.47	0.16	0.68	0.47	0.15	0.65	0.46	0.16
Education	0.02	0.07	0.77	0.01	0.06	0.88	0.01	0.06	0.85	<.01	0.06	0.93	0.01	0.06	0.91
Nativity	1.04	0.54	0.06	0.66	0.46	0.15	0.68	0.46	0.14	0.71	0.46	0.13	0.71	0.46	0.12
Interviewed in English	-1.37	0.67	0.04	-0.38	0.59	0.51	-0.39	0.59	0.51	-0.40	0.59	0.49	-0.32	0.58	0.59
ADL Limitation	-4.59	0.56	<.001	-2.36	0.51	<.001	-2.40	0.52	<.001	-2.10	0.53	<.001	-0.45	0.60	0.45
BMI (Kg/m2)				0.06	0.04	0.15	0.06	0.04	0.17	0.06	0.04	0.19	0.07	0.04	0.10
Depressive symptoms				-12.3	0.61	<.001	-12.3	0.61	<.001	-12.2	0.61	<.001	-11.9	0.61	<.001
Medical conditions				-0.23	0.23	0.30	-0.24	0.23	0.28	-0.19	0.23	0.40	-0.08	0.23	0.71
Arthritis							0.29	0.42	0.48	0.50	0.43	0.24	0.55	0.43	0.20
Pain										-0.74	0.42	0.08	-0.54	0.42	0.20
TBMS (Kg)										0.02	0.01	0.05	0.01	0.01	0.23
SPPB													0.39	0.07	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

Table 6.5 General linear mixed models estimates for mental health-related quality of life (MCS) as a function of IADL limitation over three points of time

Explanatory variables	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	55.7	4.14	<.001	51.3	4.01	<.001	51.3	4.01	<.001	49.0	4.20	<.001	43.1	4.32	<.001
Time 1	1.52	0.42	<.01	1.36	0.39	<.01	1.34	0.40	<.01	1.33	0.39	<.01	1.30	0.39	<.01
Time 2	0.31	0.62	0.62	0.62	0.54	0.25	0.62	0.54	0.25	0.53	0.54	0.32	0.52	0.54	0.33
Age	0.01	0.05	0.94	0.06	0.05	0.22	0.06	0.05	0.23	0.07	0.05	0.13	0.10	0.05	0.03
Male	-0.65	0.56	0.24	-0.89	0.48	0.06	-0.85	0.48	0.08	-1.31	0.54	0.01	-1.10	0.54	0.04
Married	1.21	0.54	0.02	0.66	0.46	0.15	0.66	0.46	0.15	0.68	0.46	0.14	0.64	0.46	0.16
Education	0.00	0.07	0.97	-0.01	0.06	0.90	-0.01	0.06	0.93	-0.01	0.06	0.88	0.00	0.06	0.98
Nativity	0.96	0.53	0.07	0.59	0.45	0.19	0.61	0.45	0.18	0.64	0.46	0.16	0.66	0.45	0.15
Interviewed in English	-0.93	0.67	0.16	-0.09	0.58	0.88	-0.09	0.58	0.88	-0.14	0.58	0.81	-0.21	0.58	0.71
IADL Limitation	-3.53	0.48	<.001	-2.22	0.44	<.001	-2.27	0.44	<.001	-2.00	0.45	<.001	-1.04	0.48	0.03
BMI (Kg/m2)				0.07	0.04	0.12	0.06	0.04	0.14	0.06	0.04	0.16	0.07	0.04	0.08
Depressive symptoms				-12.4	0.60	<.001	-12.4	0.60	<.001	-12.4	0.60	<.001	-11.9	0.60	<.001
Medical conditions				-0.23	0.22	0.30	-0.24	0.22	0.27	-0.20	0.22	0.38	-0.06	0.22	0.78
Arthritis							0.37	0.42	0.37	0.55	0.43	0.20	0.60	0.43	0.16
Pain										-0.65	0.42	0.12	-0.44	0.42	0.29
TBMS (Kg)										0.02	0.01	0.06	0.01	0.01	0.30
SPPB													0.37	0.07	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

6.2 SUMMARY

This chapter tested four hypotheses of Aim 3. The results are as follows:

1- Arthritis was not associated with lower mental HRQoL score.

2- The presence of impairment (pain and total body muscle strength) was associated with lower mental HRQoL score.

3- Greater functional limitation (lower SPPB score) was associated with lower mental HRQoL score.

4- The presence of any IADL limitations was associated solely with lower mental HRQoL score.

A discussion of this study's outcomes is presented in Chapter 7.

7.0 DISCUSSION

The purpose of this study was to examine the impact of arthritis on physical function, disability, and health-related quality of life over time among older Mexican-Americans. The following discussion is based on each Specific Aim of this research, followed by the limitations and strengths of the study; implications and recommendations for future research; and the conclusion.

7.1 SPECIFIC AIM 1

The first Aim was to examine the association between arthritis and the three stages of the disablement process (i.e., impairment, functional limitation, and disability) over time among older Mexican-Americans.

The primary finding for this specific aim was that arthritis is associated with greater impairment, greater functional limitation, and more disability. The following sub-sections discuss the three hypotheses of Aim 1.

7.1.1 Hypothesis 1.a

Arthritis would be associated with greater impairment.

As discussed earlier, impairment was addressed through three variables: I- presence of pain on weight-bearing, II- lower extremity muscle strength (weakness) and III- upper extremity muscle strength (weakness). Accordingly, the impact of arthritis on each impairment variable is discussed next.

I- Arthritis would be associated with the presence of pain on weight-bearing.

This hypothesis was confirmed using the GEE model. After adjustment for sociodemographic variables and comorbid conditions, arthritis was significantly associated with the presence of pain on weight-bearing, at an odds ratio of 2.96 (95 % CI= 2.36-3.72). This finding is concordant with the literature that arthritis is associated with joint pain [223, 224]. For example, in a longitudinal analysis, the adjusted OR of having pain on weight-bearing, over time, was 7.1 (95 % CI= 6.3-8.0) among older Mexican-Americans [225]. Al Snih et al. (2005) [226] conducted a cross-sectional study to find that 72% of older Mexican-American subjects with pain reported having arthritis.

Pain is both the most common symptoms of arthritis and the primary reason for older arthritic subjects to seek medical intervention [51, 227]. However, the manifestation of pain is different for each type of arthritis. For example, subjects with osteoarthritis suffer from localized pain that occurs during movement (weight-bearing) [228, 229]; conversely, subjects with rheumatoid arthritis suffer from pain that actually improves with movement [229-231].

II- Arthritis would be associated with poorer lower extremity muscle strength (LEMS).

In a model adjusts for sociodemographic variables, this hypothesis was confirmed. Arthritis was associated with poorer lower extremity muscle strength. Adding other comorbid conditions (i.e., BMI, low cognitive status, high depressive symptoms, and medical conditions) to the model slightly decreased the magnitude of association, although this association was not statistically significant. Interestingly,

according to the results from the complete case analyses, this hypothesis was confirmed.

III- Arthritis would be associated with poorer upper extremity muscle strength (UEMS).

As hypothesized, a statistically significant association was found between arthritis and subsequent decline in upper extremity muscle strength over time in older Mexican-Americans. The association remained significant after adjusting for potentially confounding variables such as age, sex, education, marital status, BMI high depressive symptoms, and medical conditions.

Generally, a decrease in muscle strength, either on LEMS or UEMS, was expected to be associated with arthritis or to confirm the results of other studies [232-240]. For example, in a case control study, Ekdahl et al. (1989) [233] found that roughly 80% of patients with large joints of the lower extremity (affected by OA or RA) had significantly poorer muscle strength than that of healthy subjects. For upper extremity muscle strength, data from a case control study showed that grip strength was significantly lower among OA patients than in the control group [240].

In regards to the association between time and muscle strength, a relation between Time 2 (vs. Time 0) with increased LEMS and UEMS was surprising. Theses associations were also confirmed when complete cases were analyzed. Such a finding differs from what most studies have reported: specifically, that decreases in muscle strength are a normal manifestation of the aging process [241].

Using a sample of 27 for lay examiners (non-clinicians) and 63 for Hispanic EPESE subjects, Ottenbacher et al. (2004) [156] reported that the device used in this

study to measure muscle strength (Nicholas Manual Muscle Tester) provided stable and consistent information for LEMS and UEMS. The researchers also discovered no examiner gender differences in intra-class correlation coefficients (ICCs). While non-clinician examiners received a single intensive training session in manual muscle testing for a field-based assessment and interview of older adults and 63 Mexican-American subjects at Time 0 (2000-2001) [156], the fact that a) they were not clinicians, and b) six years passed between Time 0 (2000-2001) and Time 2 (2006) may have affected the measurement's reliability and validity over time. These data collection limitations could explain the observed increase in muscle strength (e.g., knee extension, hip flexion, and shoulder abduction) between Time 0 and Time 2.

Based on these findings and the way the study was conducted, future best-practices should adhere to the following methods, especially when testing for research as opposed to in clinical practice [242]. First, one should take muscle strength measurements from both the dominant and non-dominant extremity, repeatedly if possible (e.g., right hand vs. left hand) [243]. Second, one should know whether these measurements were obtained from the affected (including the arthritic joint) or unaffected extremity [237]. Third, the subject's apprehension, motivation, and pain level should be recorded [244, 245]. Fourth, examiner's gender should be controlled, as gender-specific strength variables have been known to affect the force applied to muscles during testing [246]. Finally, in longitudinal studies, non-clinician examiners need to be trained regularly to ensure unbiased results about such association between arthritis and muscle strength.

7.1.2 Hypothesis 1.b

Arthritis would be associated with greater functional limitation, as measured by SPPB.

Adjusted linear mixed models revealed a significant association between having arthritis and lower SPPB score, the latter indicating greater functional limitation. This association was reexamined by performing complete case analysis and found to be significant. Thus, this hypothesis was confirmed; the finding is consistent with that of other studies.

Literature has shown that arthritis is associated with limitations in physical function [247-249]. In a cross-sectional study, Escalante et al. (2005) [247] used the disablement process model and structural equation model to study the impact of RA on functional limitation. The research team measured functional limitation using three performance-based rheumatology function tests: grip strength, gait speed, and a timed button test. The researchers found that both pathology (RA) and impairment displayed strong direct-paths toward functional limitation (standardized regression coefficients of -0.576 and -0.564, respectively, $p \leq 0.001$ for each), and explained 65% of the variance [247].

Other studies have evaluated the impact of arthritis on functional limitation using performance-based measures, self-report scales, or both. However, no previous study has used SPPB to measure functional limitation in very-old arthritic subjects. As expected there was a negative association between Time 2 and the SPPB score. This counters the relationship direction between Time 2 and muscle strength (LEMS and UEMS), as discussed earlier. Using such performance-based measures may confirm the need for regular training for non-clinician examiners.

7.1.3 Hypothesis 1.c

Arthritis would be associated with greater disability.

This hypothesis was confirmed. Consistent with most previous studies [7, 250-254], the findings of this longitudinal study indicate a significant relationship between arthritis and disability in ADL (OR= 1.51; 95 % CI= 1.05 - 2.18) and IADL (OR= 1.47 ; 95 % CI= 1.11- 1.93). This positive association between arthritis and disability were seen as weak on the national level [12]. For example, recent data from the National Health Interview Survey (NHIS), showed that about 41% of the 46 million adults with arthritis reported limitations in their normal activities because of arthritis [12].

Additionally, in a prospective cohort study, Song et al. (2007) [250] examined the racial/ethnic differences in ADL disability onset among older Americans with arthritis. The adjusted disability hazard ratios (HR) were significantly greater among African Americans (HR= 1.94, 95% CI= 1.51-2.38) and Hispanic subjects interviewed in Spanish (HR= 2.03, 95% CI= 1.35-2.71), but not for Hispanic subjects interviewed in English (HR= 1.41, 95% CI= 0.82-2.00) compared to White subjects [250].

In another longitudinal study, Al Snih et al. (2001) [252] investigated the impact of arthritis at baseline on the two year incidence of ADL and IADL limitations in non-disabled, older Mexican-American subjects. They found that, among those tested at baseline, 11.2% of arthritic subjects reported at least one ADL limitation after two years, compared to 6.9% of subjects without arthritis. Similarly, among non-disabled subjects at baseline, 34.7% of arthritic subjects reported at least one IADL limitation after two years, compared to 27.0% of subjects without arthritis.

7.2 SPECIFIC AIMS 2 AND 3

AIM 2: To examine the association between arthritis and stages of the disablement process (impairment, functional limitation, and disability) on physical HRQoL among older Mexican-American, as measured by SF-36 Physical Component Summary (PCS) over three points of time (2000-2001, 2001-2002, and 2006).

AIM 3: To examine the association between arthritis and stages of the disablement process (impairment, functional limitation, and disability) on mental HRQoL among older Mexican-Americans, as measured by SF-36 Mental Component Summary (MCS) over three points of time (2000-2001, 2001-2002, and 2006).

Both Specific Aim 2 and 3 have four hypotheses that are discussed together in the following sub-sections.

7.2.1 Hypotheses A

Hypothesis 2.a: Arthritis would be associated with poorer physical HRQoL.

Hypothesis 3.a: Arthritis would be associated with poorer mental HRQoL.

The present study confirmed that arthritis is associated with poorer physical HRQoL (OR = 0.49; 95% CI = 0.39 – 0.62) but not with poorer mental HRQoL (OR = 0.89; 95% CI = 0.70 – 1.13).

As in studies that used other HRQoL measures, these findings highlight that arthritis impacts physical HRQoL more than mental HRQoL, especially among older adults [5, 30]. For example, a study of 41,467 older subjects using Medicare data found that arthritic patients had a poorer HRQoL than those without arthritis [30]. Likewise, in a cross-sectional study, Alishiri et al. (2008) [255] developed two logistic regression models to predict physical and mental HRQoL among RA patients by using the first quartiles of PCS and MCS scores (33.4 and 36.8, respectively) as cut-off points. After

controlling for all covariates, they found that having RA was associated with poorer physical and mental HRQoL [255].

A recent study by Slatkowsky-Christensen et al. compared HRQoL using the SF-36 for female patients with hand RA (n= 194) and OA (n= 190) against the general population (n= 144) [256]. They found that both hand RA and OA were associated with a consistent burden of disease across all dimensions of the SF-36, as compared with population subjects [256]. Ethgen et al. (2007) [257] confirmed these findings through a longitudinal study of 642 patients with RA and 395 patients with OA.

7.2.2 Hypotheses B

Hypothesis 2.b: Greater impairment would be associated with poorer physical HRQoL.

Hypothesis 3.b: Greater impairment would be associated with poorer mental HRQoL.

The present longitudinal study confirmed that the presence of impairment (pain and total body muscle weakness) was associated with poorer physical and mental HRQoL, even after controlling for arthritis effect.

Many studies have examined the impact of chronic pain on HRQoL [258]. Zanocchi et al. (2007) [258] examined the influence of chronic pain on HRQoL among old patients in nursing homes (n = 105, mean age 82.2 ± 9 years). They used three different pain measurements: the McGill Pain Questionnaire (MGPQ), the Visual Analogical Scale (VAS), and the Face Pain Scale (FPS). They found that increasing levels of pain were associated with poorer HRQoL [258].

However, the association between impairment (i.e., pain and muscle strength) and HRQoL can be explained by looking at how decreasing pain and strengthening muscles improve HRQoL in patients with fibromyalgia (FM). Chronic pain and muscle weakness

are common in patients with FM [259-261]. A randomized clinical trial evaluated the short- and long-term efficacy of hydrotherapy (pool-exercise) in thirty-four women with FM [261]. They measured patients' pain level, LEMS and UEMS (i.e., knee extensors and flexors, shoulder abductors, and adductors) and HRQoL using the Spanish version of the European quality of life measure (EQ-5D) [261]. After the 12-week hydrotherapy program, they found a significant decrease in pain level and a significant improvement in LEMS strength, but not in that of UEMS. The latter did not improve because the absence of water resistance above the waist limited the effects on upper-body muscles [261]. Overall, this study reported significant improvements in EQ-5D dimensions for the exercise group, and no change for the control group [261].

Finally, no previous longitudinal study has looked at the impact of pain on weight-bearing and total body muscle weakness on physical and mental HRQoL independently among older adults. However, Peek et al. (2005) [262] studied cross-sectionally the association between disability stages and HRQoL, although they addressed impairment stage through muscle strength only.

7.2.3 Hypotheses C

Hypothesis 2.c: Greater functional limitation would be associated with poorer physical HRQoL.

Hypothesis 2.c: Greater functional limitation would be associated with poorer mental HRQoL.

The current study confirmed that greater functional limitation, as noted by a low SPPB score, is associated with poorer physical and mental HRQoL independently, even after controlling for the effects of arthritis and impairment. This finding was consistent

the previous finding that a lower SPPB score is associated with lower HRQoL among older subjects [263, 264]. Groessl et al. (2007) [263] examined the association of HRQoL in older subjects (n= 424, aged 70 to 89) with functional limitation, finding a positive association between SPPB and HRQoL.

Groessl et al. (2007) further examined the association cross-sectionally in order to assess HRQoL using the Quality of Well-Being Scale-Self-Administered (QWB-SA) [263]. Their cross-sectional design limited causal inference because the QWB-SA (unlike the SF-36) combines preference-weighted values for symptoms and functioning [263, 265]. Also, the researchers did not control for other risk factors (e.g., BMI, pain, muscle strength, depression) that would help explain variance in the HRQoL [263].

7.2.4 Hypotheses D

Hypothesis 2.d: Greater disability (ADL and IADL) would be associated with poorer physical HRQoL (lower PCS score).

Hypothesis 3.d: Greater disability (ADL and IADL) would be associated with poorer mental HRQoL (lower MCS score).

The current longitudinal study found that the presence of any ADL or IADL limitation was independently associated with poorer physical and mental HRQoL even after adjustment for the independent role of arthritis and impairment. However, only the presence of IADL limitation was associated with poorer mental HRQoL after adjustment for arthritis, impairment, and functional limitation.

These findings are consistent with previous randomized trials [266, 267]. Peri et al. (2008) [266] designed a randomized trial to test the impact of a repetitive ADL exercise program on HRQoL among 149 older subjects (mean age 84.7 years). At

baseline, subjects had no significant differences in their PCS and MCS scores. After three months, subjects who received the repetitive ADL exercise interventions had better physical HRQoL than those in the control group. Interestingly, there was no difference or change in MCS score [266].

Hagsten et al. 2006 [267] conducted a trial to examine the effects of an individualized occupational therapy (OT) program on 100 aged patients with hip fracture(s). They measured patients' ADL, IADL, and HRQoL levels and after month two found that the control patients had more IADL limitations and poorer HRQoL than those in the OT group [267]. However, after discharge both groups had roughly the same level of ADL limitations [267]. In short, data from this trial imply that HRQoL is associated with IADL more than ADL limitations.

7.3 LIMITATIONS OF THE STUDY

The following section recapitulates the limitations of the present research. These include limitations related to the study's design, measures, and generalizability.

First, the prevalence of arthritis was high (56%) at baseline of the current study, which is a sub-sample from Wave 4 of the Hispanic EPESE. Therefore, designing the current study as an inception-cohort study was not feasible.

Second, some researchers have indicated that self-reported data from non-English speakers can hinder the accumulation of reliable and valid information [268]. Simple or unprofessional translations may lead to measurement errors which consequently bias the results [268]. Most Hispanic EPESE participants chose to answer the self-reported questionnaires in Spanish. Therefore, to minimize any potential bias, this study performed the following analyses: 1) DIF analyses using DIFwithpar program for the

PCS and MCS (the two outcome variables), as discussed previously; 2) Controlling for the effect of language (English vs. Spanish) as a covariate in every model.

Third, medical records and x-rays were not available to confirm the arthritis and other comorbid condition diagnoses; although using self-reported data without clinical evaluations is a common methodology in epidemiological research. This practice has been documented as reliable, especially in relation to sociodemographic and health-related items (such as arthritis, pain, disability) [269-271]. To minimize any possible bias associated with self-reported data and to better estimate the impact of arthritis on HRQoL, matching data from this sub-sample of older Mexican-Americans with Medicare data would help confirm the diagnosis of arthritis and its type and severity.

Fourth, aged subjects make follow-up studies inherently biased, as less healthy subjects were less likely to be included. Fifth, since this Mexican-American sub-sample was randomly selected from 10-year survivors of the original Hispanic EPESE, the findings from this sample may not be generalizable to other populations.

Due to the above limitations, this study's results should be interpreted with regard to their applicability. Replicating the findings with other measures of physical function, disability, and HRQoL is crucial. Additionally, larger population-based studies are essential to ensure generalizability of these findings to the older Mexican-American population.

7.4 STRENGTHS OF THE STUDY

As highlighted throughout this paper, this study has several significant strengths. First, and most importantly, the data of this study come from the Hispanic EPESE, the largest, most reliable population-based study of older Mexican-Americans in the US [42].

The current study is the first investigation to examine the longitudinal associations between arthritis, physical function, disability, and HRQoL in older Mexican-Americans. In addition, these associations were examined using a conceptual model that adapted two prominent disability models, DPM [124] and EDM [125].

Moreover, whereas most epidemiological studies depend on self-reported data, the current study used a combination of self-reported and physical-performance measures. For instance, SF-36 and muscle strength (e.g., knee, hip, shoulder joints) measures were collected in this sub-sample but not in any previous Hispanic EPESE wave.

Since it is common in longitudinal epidemiological studies to have some missing data [192, 193], this current study addressed missing data appropriately by using the multiple imputation technique. Also, this current investigation was unique in utilizing sophisticated longitudinal analyses such as mixed and GEE models as opposed to the traditional repeated ANOVA/ANCOVA method.

Additionally, all results were screened and reexamined twice by dichotomizing continuous outcome variables and by using complete case analysis. Finally, this study conformed to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cohort studies [272].

7.5 IMPLICATIONS

The findings of the present study provide important information about the impact of arthritis on physical function, disability, and HRQoL among older Mexican-Americans, a segment of the US population with the highest rate of arthritis of all

racial/ethnic groups [16]. The implications of these findings can be categorized into three areas: theory, health care, and policy.

7.5.1 Theory

The results of this investigation bring forth empirical support for the Verbrugge and Jette (1994) model (DPM) [124] and the Institute of Medicine model (EDM) [125]. For all Specific Aims of this study, the models were combined and modified to guide the analyses.

Specific Aim 1 used the DPM [124], which has four basic components: 1) pathology, represented by arthritis; 2) impairment, represented by pain and muscle strength; 3) functional limitation, represented by lower body limitation; and 4) disability, represented by any ADL or IADL limitations. For Specific Aims 2 and 3, EDM [125] includes HRQoL as an independent component affected by stage of disability. Thus, HRQoL was addressed using the physical and mental summary scores of SF-36.

This study's conceptual model agrees with the previous two models [124, 125] and their modifications [262, 273]. Most importantly, this conceptual model offers an example for future investigations of how HRQoL can be impacted by a pathology, functional limitation, and disability, cross-sectionally or longitudinally.

7.5.2 Health Care

Arthritis is a major health problem with a sizeable impact on the growing population of older US adults [4-6]. Arthritis also constitutes the most common reason for disability in the US [7, 8]. The present study's findings suggest a strong relationship between arthritis and physical function, disability, and HRQoL in older Mexican-Americans from southwestern US. The findings emphasize the need for multidisciplinary

clinical and public health interventions in the population under study. Therefore, the following strategies are suggested to decrease the impact of arthritis in this segment of the population:

I) Improving functional independence through:

a) Decreasing pain [274].

b) Improving upper and lower extremities muscle strength [275].

c) Improving standing balance and walking speed [276].

d) Offering a choice of joint replacement surgery, as needed [277, 278].

e) Screening for risks of falling [279].

f) Screening and decreasing depression and mental problems [280-283].

g) Enhancing social support [284, 285].

h) Minimizing environmental barriers [286, 287].

II- Enhancing self-management:

Research has shown that self-management is one of the effective ways to limit the negative impact of arthritis on physical function, disability, and HRQoL [111, 288]. Self-management includes education and physical activity [289].

7.5.3 Policy

In the era of cost-effectiveness and evidence-based healthcare practices, the current study offers empirical evidence of a need to improve HRQoL and eliminate disparities among older Mexican-Americans.

The present study provides valuable information relevant to the two goals of the Healthy People 2010 initiative [22] and to the mission and strategy of the Arthritis Foundation [27]. The two goals of the Healthy People 2010 initiative that will benefit

from the findings of this study are: to increase the quality and years of healthy life; and to eliminate disparities in health among different racial/ethnic groups [22].

The three-fold mission of the Arthritis Foundation is research, prevention, and improved quality of life [27]. The Arthritis Foundation will benefit from these findings in implementing its public health strategy, entitled the National Arthritis Action Plan (NAAP) [27]. Based on this national plan, state health departments have started physical activity program directed to adult Hispanics, aged 45 to 64 years, called "Buenos Días, Artritis". However, this program needs to consider including the older arthritic Hispanics, along with those aged 45 to 64 years, since arthritis is highly prevalent in older Hispanics.

7.6 RECOMMENDATIONS FOR FUTURE RESEARCH

The replication of research strengthens the findings of studies. Therefore, similar studies should be conducted to evaluate the association between arthritis, physical functional, disability, and HRQoL among other older racial/ethnic adults.

Another area of future research that might be explored is that of instrument-testing, performed using item response theory and differential item functioning. The Hispanic EPESE data offers a unique and exceptional opportunity to use these procedures to find answers for many questions.

As previously mentioned, to establish accurate causality, an inception cohort study should be implemented. Such research design, along with the use of powerful analyses such as mixed and GEE models and structural equation modeling (SEM) will encourage confirmatory modeling [273].

Finally, this study's conceptual model is not intended to be used for interventional research, such as randomized clinical trials. Therefore, developing interventional programs directed at older adults with arthritis would help improve their physical function and HRQoL and accordingly help establish causality [290].

7.7 CONCLUSION

Using a population based cohort, the overall findings indicate that arthritis is a highly prevalent medical condition in this segment of the older US population. Also, arthritis has a significant impact on older Mexican-Americans' physical function, disability, and health-related quality of life. Finally, the study found that impairment, functional limitation, and disability are associated with poorer physical and mental HRQoL scores.

Most importantly, these findings could guide efforts to reach the goals of the National Arthritis Action Plan as well as the Healthy People 2010 initiative goals of increasing quality of life and elimination health disparities, especially in older Mexican-Americans, one of the fastest growing ethnic groups in the US. The solution should be multi-faceted, including responsible agency from the afflicted group (via lifestyle changes and disease self-management).

APPENDIX A

APPENDIX A: UNIVARIATE, CORRELATION, AND DIF ANALYSES

Tables A.1 through A.3 for univariate analyses at each Wave.

Tables A.4 through A.6 for correlation analyses at each Wave.

Tables A.7 and A.8 for DIF analyses for both PCS and MCS at baseline.

Table A.1 Univariate Statistics for the Raw Data at Wave 1 (2000-2001).

	Variable	Level of Measurement	N	No. of Missing	Mean Or %	SD	CV	Median	Min.	Max	Range	Skewness	kurtosis
Socio-demographic	Age	Cont.	621	0	78.1	5.1	6.6	77	72	96	24	1	0.5
	Sex	Binary	621	0	100%	Female= 372 (60%)							
	Married	Binary	621	0	100%	Yes= 317 (51%)							
	Edu.	Cont.	621	0	5.1	3.8	73.5	5	0	17	17	0.7	0
	US born	Binary	621	0	100%	Yes= 379 (60%)							
	Eng. Int.	Binary	621	0	100%	English= 108 (17%)							
Comorbid Conditions	BMI in kg/m^2	Cont.	576	45	28.1	5.5	19.4	27.4	14.4	55.2	40.8	0.8	1.9
	Cognitive Status	Binary	621	0	100%	Low Cognitive Status = 217 (35%)							
	Depressive Sym.	Binary	621	0	100%	High Depressive Symptoms = 73 (12%)							
	Medical Conditions	Cont.	621	0	1.1	0.9	85.8	1	0	5	5	0.6	0.1
Pathology	Arthritis	Binary	621	0	100%	Yes= 350 (56%)							
Impairment	Pain	Binary	621	0	100%	Yes= 295 (47%)							
	LEMS in kg	Cont.	566	55	28.9	11.2	38.6	27.4	6.6	75.6	69	0.9	1.3
	UEMS in kg	Cont.	551	70	38.6	13	33.7	37.2	5.8	88.6	82.8	0.7	0.6
Functional Limitation	SPPB	Cont.	620	1	7	3.4	48.5	8	0	12	12	-0.7	-0.5
Disability	ADL	Binary	621	0	100%	Any ADL Limitation= 116 (19%)							
	IADL	Binary	621	0	100%	Any IADL Limitation= 284 (46%)							
HRQoL	PCS	Cont.	614	7	41.4	12.6	30.5	43.5	9	63.2	54.2	-0.5	-0.9
	MCS	Cont.	614	7	55.1	8.5	15.5	56.7	8.9	74.5	65.6	-1.2	2.3

SD= Standard Deviation; CV= Coefficient of Variation; Min=Minimum; Max= Maximum; Cont= Continuous; Edu= years of education; Eng. Int. = English Interviewed; BMI= Body Mass Index; LEMS = Lower Extremity Muscle Strength; UEMS = Upper Extremity Muscle Strength; SPPB= Short Physical Performance Battery; ADL= Activities of Daily Living; IADL= Instrumental Activities of Daily Living; HRQoL= Health-Related Quality of Life; PCS= Physical Component Summary; MCS= Mental Component Summary.

Table A.2 Univariate Statistics for the Raw Data at Wave 2 (2001-2002).

	Variable	Level of Measurement	N	No. of Missing	Mean Or %	SD	CV	Median	Min.	Max	Range	Skewness	kurtosis
Socio-demographic	Age	Cont.	549	0	79	5	6.4	78	73	97	24	1	0.5
	Sex	Binary	549	0	100%	Female= 327 (60%)							
	Married	Binary	549	0	100%	Yes= 273 (50%)							
	Edu.	Cont.	549	0	5.2	3.8	73.1	5	0	17	17	0.7	-0.1
	US born	Binary	549	0	100%	Yes= 336 (61%)							
	Eng. Int.	Binary	549	0	100%	English= 78 (14%)							
Comorbid Conditions	BMI in kg/m^2	Cont.	499	50	27.8	5.4	19.3	27.4	5.9	48.9	43	0.4	1.1
	Cognitive Status	Binary	549	0	100%	Low Cognitive Status = 145 (26%)							
	Depressive Sym.	Binary	549	0	100%	High Depressive Symptoms = 63 (11%)							
	Medical Conditions	Cont.	549	0	1.2	1	82.3	1	0	4	4	0.5	-0.4
Pathology	Arthritis	Binary	549	0	100%	Yes= 347 (63%)							
Impairment	Pain	Binary	549	0	100%	Yes= 264 (48%)							
	LEMS in kg	Cont.	482	67	28.4	11.2	39.3	27.2	6.2	74	67.8	0.8	1.2
	UEMS in kg	Cont.	463	86	37.6	13.4	35.5	35.6	8.8	103.5	94.7	0.8	1.2
Functional Limitation	SPPB	Cont.	548	1	6.7	3.7	55.1	8	0	12	12	-0.5	-1
Disability	ADL	Binary	549	0	100%	Any ADL Limitation= 116 (21%)							
	IADL	Binary	549	0	100%	Any IADL Limitation= 282 (51%)							
HRQoL	PCS	Cont.	541	8	40.6	12.8	31.6	44.7	7.9	59.8	52	-0.6	-0.9
	MCS	Cont.	541	8	56.4	7.9	14.1	58.6	20.7	72.6	51.9	-1.5	2.8

SD= Standard Deviation; CV= Coefficient of Variation; Min=Minimum; Max= Maximum; Cont= Continuous; Edu= years of education; Eng. Int. = English Interviewed; BMI= Body Mass Index; LEMS = Lower Extremity Muscle Strength; UEMS = Upper Extremity Muscle Strength; SPPB= Short Physical Performance Battery; ADL= Activities of Daily Living; IADL= Instrumental Activities of Daily Living; HRQoL= Health-Related Quality of Life; PCS= Physical Component Summary; MCS= Mental Component Summary.

Table A.3 Univariate Statistics for the Raw Data at Wave 3 (2006).

	Variable	Level of Measurement	N	No. of Missing	Mean Or %	SD	CV	Median	Min.	Max	Range	Skewness	kurtosis
Socio-demographic	Age	Cont.	359	0	82.4	4.3	5.3	81	76	96	20	0.9	0.2
	Sex	Binary	359	0	100%	Female= 221 (62%)							
	Married	Binary	359	0	100%	Yes= 149 (42%)							
	Edu.	Cont.	359	0	5.4	3.8	71.4	5	0	17	17	0.7	0
	US born	Binary	359	0	100%	Yes= 207 (58%)							
	Eng. Int.	Binary	359	0	100%	English= 63 (18%)							
Comorbid Conditions	BMI in kg/m^2	Cont.	316	43	27.7	5.1	18.5	27.4	13.3	48.9	35.6	0.7	1.4
	Cognitive Status	Binary	359	0	100%	Low Cognitive Status = 112 (31%)							
	Depressive Sym.	Binary	359	0	100%	High Depressive Symptoms = 61 (17%)							
	Medical Conditions	Cont.	359	0	1.5	1	66.7	1	0	4	4	0.3	-0.4
Pathology	Arthritis	Binary	359	0	100%	Yes= 223 (62%)							
Impairment	Pain	Binary	359	0	100%	Yes= 212 (59%)							
	LEMS in kg	Cont.	318	41	30.7	14.1	45.9	27.9	8.2	96.4	88.2	1.3	2.1
	UEMS in kg	Cont.	311	48	36.5	13.6	37.3	34.3	11.7	83.9	72.3	0.8	0.7
Functional Limitation	SPPB	Cont.	358	1	5.7	3.7	65.3	6	0	12	12	-0.1	-1.2
Disability	ADL	Binary	359	0	100%	Any ADL Limitation= 125 (35%)							
	IADL	Binary	359	0	100%	Any IADL Limitation= 263 (73%)							
HRQoL	PCS	Cont.	356	3	37.3	12.4	33.2	38.3	10.4	58.6	48.3	-0.2	-1.1
	MCS	Cont.	356	3	54.7	10.6	19.3	58	13.4	73.4	60	-1.2	1.1

SD= Standard Deviation; CV= Coefficient of Variation; Min=Minimum; Max= Maximum; Cont= Continuous; Edu= years of education; Eng. Int. = English Interviewed; BMI= Body Mass Index; LEMS = Lower Extremity Muscle Strength; UEMS = Upper Extremity Muscle Strength; SPPB= Short Physical Performance Battery; ADL= Activities of Daily Living; IADL= Instrumental Activities of Daily Living; HRQoL= Health-Related Quality of Life; PCS= Physical Component Summary; MCS= Mental Component Summary.

Table A.4 Correlations between study variables at Wave 1 (N=621)

NAME	Age	Sex	mar	edu	Nativ.	lang	bmi	CF	Dep	med	arth	pain	lower	upper	sppb	adl	iadl	pcs	mcs
age	1																		
sex	-0.003	1																	
mar	-0.159	0.394	1																
edu	-0.143	0.007	0.074	1															
Nativity	-0.058	-0.078	-0.006	0.198	1														
lang	-0.027	0.006	0.024	0.25	0.22	1													
bmi	-0.188	-0.054	0.025	-0.005	0.07	-0.051	1												
cf	0.243	0	-0.1	-0.301	-0.056	-0.007	-0.085	1											
dep	0.095	-0.105	-0.083	0	-0.035	0.083	-0.037	0.047	1										
med	-0.078	-0.143	0.003	0.013	0.036	0.037	0.124	-0.029	0.157	1									
arth	0.049	-0.155	-0.024	-0.081	-0.014	-0.025	0.119	0.059	0.069	0.135	1								
pain	0.076	-0.061	0.003	-0.103	0.003	0.006	0.099	0.06	0.103	0.134	0.291	1							
lower	-0.15	**0.45**	0.205	0.018	-0.017	0.065	0.069	-0.176	-0.081	-0.104	-0.152	-0.157	1						
upper	-0.219	**0.638**	0.256	0.057	-0.026	0.025	0.081	-0.14	-0.111	-0.132	-0.193	-0.108	**0.724**	1					
sppb	-0.238	0.096	0.085	0.05	0.037	0.053	-0.018	-0.198	-0.175	-0.215	-0.113	-0.188	0.327	0.332	1				
adl	0.218	-0.072	-0.051	-0.069	-0.064	-0.056	0.031	0.151	0.197	0.178	0.18	0.231	-0.244	-0.276	**-0.559**	1			
iadl	0.216	-0.164	-0.103	-0.079	-0.045	0.056	0.064	0.202	0.217	0.235	0.169	0.234	-0.272	-0.34	-0.475	0.423	1		
pcs	-0.177	0.143	0.084	0.076	0.035	-0.005	-0.101	-0.232	-0.169	-0.284	-0.305	**-0.404**	0.383	0.37	**0.552**	**-0.552**	**-0.637**	1	
mcs	-0.078	0.028	0.107	-0.006	0.009	-0.107	0.049	-0.06	**-0.385**	-0.066	0.017	-0.044	0.096	0.099	0.214	-0.168	-0.231	0.117	1

Table A.5 Correlations between study variables at Wave 2 (N=549)

NAME	Age	Sex	mar	edu	Nativ.	lang	bmi	CF	Dep	med	arth	pain	lower	upper	sppb	adl	iadl	pcs	mcs
age	1																		
sex	0.031	1																	
mar	-0.166	**0.409**	1																
edu	-0.161	0.026	0.042	1															
Nativity	-0.072	-0.071	-0.031	0.204	1														
lang	-0.105	-0.026	0.044	0.317	0.249	1													
bmi	-0.18	-0.113	0.013	-0.073	0.032	0.011	1												
cf	0.166	-0.045	-0.083	-0.273	-0.133	-0.031	-0.039	1											
dep	0.143	-0.051	-0.152	-0.063	-0.018	0.017	-0.029	0.251	1										
med	-0.095	-0.185	-0.064	0.011	0.087	0.068	0.174	0.086	0.125	1									
arth	0.054	-0.144	-0.072	-0.077	-0.104	-0.047	0.12	0.114	0.121	0.14	1								
pain	0.031	-0.143	-0.082	-0.07	-0.019	0.016	0.212	0.085	0.1	0.175	0.387	1							
lower	-0.141	0.366	0.174	0.065	-0.127	0.064	0.08	-0.133	-0.057	-0.143	-0.056	-0.115	1						
upper	-0.246	**0.603**	0.276	0.053	-0.031	0.045	0.094	-0.154	-0.196	-0.185	-0.11	-0.166	**0.655**	1					
sppb	-0.215	0.143	0.141	0.053	0.008	0.007	-0.109	-0.261	-0.325	-0.232	-0.25	-0.313	0.184	0.342	1				
adl	0.19	-0.097	-0.113	-0.057	-0.073	-0.057	0.035	0.267	0.346	0.236	0.173	0.234	-0.151	-0.258	**-0.67**	1			
iadl	0.166	-0.167	-0.118	-0.162	-0.102	-0.022	0.051	0.285	0.27	0.198	0.263	0.324	-0.135	-0.319	**-0.571**	**0.468**	1		
pcs	-0.156	0.166	0.103	0.082	0.064	0.02	-0.123	-0.306	-0.283	-0.3	-0.326	**-0.478**	0.3	0.345	**0.708**	**-0.648**	**-0.651**	1	
mcs	-0.045	0.008	0.093	0.063	0.075	-0.002	0.023	-0.264	**-0.561**	-0.086	-0.109	-0.143	0.014	0.063	0.32	-0.299	-0.26	0.272	1

Table A.6 Correlations between study variables at Wave 3 (N=359)

NAME	Age	Sex	mar	edu	Nativ.	lang	bmi	CF	Dep	med	arth	pain	lower	upper	sppb	adl	iadl	pcs	mcs
age	1																		
sex	-0.008	1																	
mar	-0.202	0.368	1																
edu	-0.155	-0.013	0.032	1															
Nativity	-0.043	-0.098	0.024	0.197	1														
lang	-0.022	-0.028	-0.002	0.222	0.292	1													
bmi	-0.235	0.013	0.079	-0.112	0.003	-0.08	1												
cf	0.197	0.007	-0.055	-0.221	-0.08	0.005	-0.152	1											
dep	0.029	-0.063	0.01	-0.058	-0.138	-0.053	-0.053	0.192	1										
med	-0.135	-0.109	0.026	0.024	-0.001	-0.12	0.086	0.04	0.206	1									
arth	0.022	-0.077	-0.088	-0.083	-0.03	-0.032	0.116	0.067	0.048	0.145	1								
pain	-0.043	-0.074	0.058	-0.078	-0.06	-0.033	0.173	0.047	0.196	0.19	0.261	1							
lower	-0.184	0.27	0.232	0.043	0.044	0.106	0.036	-0.114	-0.085	-0.06	-0.084	-0.083	1						
upper	-0.236	**0.569**	0.26	0.041	0.024	0.018	0.103	-0.143	-0.112	-0.184	-0.189	-0.077	**0.746**	1					
sppb	-0.209	0.052	0.039	0.114	0.066	0.003	-0.091	-0.332	-0.31	-0.207	-0.145	-0.264	0.249	0.343	1				
adl	0.132	-0.065	-0.058	-0.15	-0.072	-0.122	0.143	0.278	0.245	0.226	0.173	0.276	-0.282	-0.295	**-0.652**	1			
iadl	0.145	-0.164	-0.066	-0.144	-0.097	-0.019	0.139	0.162	0.173	0.13	0.216	0.316	-0.239	-0.325	**-0.496**	**0.402**	1		
pcs	-0.131	0.129	0.059	0.148	0.083	0.043	-0.114	-0.207	-0.318	-0.219	-0.258	**-0.477**	0.301	0.366	**0.661**	**-0.648**	**-0.606**	1	
Mcs	-0.004	0.027	-0.04	0.045	0.168	0.135	0.081	-0.113	**-0.683**	-0.203	-0.058	-0.202	0.162	0.155	0.363	-0.244	-0.224	0.331	1

Table A.7 Presence of Differential Item Functioning Related To Language, Age, and Sex Covariates in PCS-SF-36 Items at Wave 1 as Assessed By Difwithpar.

Item	Abbreviated Content	Language		Age (85+ Yr)		Sex	
		Uniform	Nonuniform	Uniform	Nonuniform	Uniform	Nonuniform
PF1	Vigorous Activities	-0.001	0.368	0.003	0.134	-0.011	**0.003**
PF2	Moderate Activities	0.009	0.875	-0.002	0.633	0.000	**0.029**
PF3	Lift, Carry Groceries	0.000	0.994	0.001	0.210	-0.002	0.148
PF4	Climb Several Flights	0.021	0.609	-0.002	**0.009**	-0.006	**0.015**
PF5	Climb One Flight	0.000	0.552	0.001	0.166	0.011	0.516
PF6	Bend, Kneel	0.004	0.070	-0.002	0.944	-0.004	0.067
PF7	Walk Mile	0.044	0.964	-0.002	0.210	-0.007	**0.022**
PF8	Walk Several Blocks	0.030	0.894	-0.001	0.563	0.005	0.050
PF9	Walk One Block	0.003	0.856	-0.003	0.461	0.004	0.433
PF10	Bathe, Dress	0.000	0.437	-0.010	0.518	0.019	0.427
RP1	Cut Down Time	-0.001	0.730	0.034	0.899	-0.001	0.070
RP2	Accomplish Less	-0.002	0.385	-0.002	0.681	-0.004	0.551
RP3	Limited in Kind	0.008	0.270	0.016	0.111	0.001	0.846
RP4	Had Difficulty	0.009	0.822	0.011	0.198	-0.002	0.716
BP1	Pain Severity	0.006	0.924	-0.003	0.322	-0.004	0.268
BP2	Pain Limitations	0.010	0.671	-0.003	0.394	-0.001	0.211
GH1	General Health	0.004	0.589	0.007	0.977	0.002	0.126
GH2	Sick Easier	0.000	0.873	0.006	0.855	0.001	0.761
GH3	As Healthy as Others	0.000	0.075	0.005	0.215	0.016	0.467
GH4	Health to Get Worse	0.005	0.326	-0.005	0.074	0.008	0.714
GH5	Health Excellent	0.000	0.141	0.006	0.072	0.017	0.721
VT1	Full of Pep	0.000	**0.039**	-0.005	0.965	0.008	0.461
VT2	Lot of Energy	0.001	0.060	-0.005	0.737	0.009	0.914
VT3	Worn Out	0.009	0.458	0.017	0.634	-0.013	0.658
VT4	Tired	0.000	0.546	0.000	0.733	-0.017	0.836
SF1	Social-Extent	0.005	0.395	-0.009	0.063	-0.003	0.266
SF2	Social-Frequency	0.000	0.414	-0.007	0.367	0.000	0.693
RE1	Cut Down Time	0.022	0.569	-0.001	0.747	0.003	0.773
RE2	Accomplish Less	0.005	0.881	0.000	0.980	-0.001	0.965
RE3	Not Careful	0.010	0.307	-0.002	0.509	-0.009	0.469
MH1	Nervous	0.005	0.545	-0.005	0.384	-0.061	0.708
MH2	Down in Dumps	0.001	0.617	-0.026	0.409	0.027	0.259
MH3	Calm and Peaceful	0.000	0.811	-0.028	0.319	-0.013	0.399
MH4	Downhearted/Blue	0.000	0.883	-0.025	0.180	-0.008	0.351
MH5	Happy	0.000	0.946	-0.031	0.286	0.010	0.667

PF = physical functioning, RP = role limitations due to physical functioning, BP = bodily pain, GH = general health, VT = vitality, SF = social functioning, RE = role limitations due to emotional problems, MH = mental health, PCS = standardized physical composite scale.

Table A.8 Presence of Differential Item Functioning Related To Language, Age, and Sex Covariates in MCS-SF-36 Items at Wave 1 as Assessed By Difwithpar

Item	Abbreviated Content	Language		Age (85+ Yr)		Sex	
		Uniform	Nonuniform	Uniform	Nonuniform	Uniform	Nonuniform
PF1	Vigorous Activities	**-0.127**	0.591	**-0.132**	0.472	-0.066	0.735
PF2	Moderate Activities	0.056	0.688	-0.056	0.140	-0.002	0.818
PF3	Lift, Carry Groceries	0.005	0.594	-0.039	0.454	-0.011	0.555
PF4	Climb Several Flights	**0.143**	0.907	**-0.141**	0.478	-0.072	0.640
PF5	Climb One Flight	0.003	0.417	-0.061	0.625	-0.011	0.524
PF6	Bend, Kneel	0.045	0.612	-0.028	0.283	-0.010	0.831
PF7	Walk Mile	**0.179**	0.818	-0.087	0.315	-0.020	0.586
PF8	Walk Several Blocks	0.081	0.789	-0.064	0.298	-0.015	0.969
PF9	Walk One Block	0.033	0.959	-0.039	0.302	-0.013	0.924
PF10	Bathe, Dress	0.020	0.360	-0.015	0.568	0.000	0.773
RP1	Cut Down Time	0.001	0.128	-0.002	0.408	-0.004	0.220
RP2	Accomplish Less	0.002	0.681	-0.010	0.652	0.004	0.883
RP3	Limited in Kind	-0.023	0.503	-0.007	0.466	-0.003	0.881
RP4	Had Difficulty	-0.025	0.811	-0.007	0.299	0.000	0.523
BP1	Pain Severity	-0.017	0.516	-0.026	0.354	-0.004	0.682
BP2	Pain Limitations	-0.011	0.798	-0.019	0.991	0.006	0.130
GH1	General Health	0.042	0.753	-0.005	0.940	-0.004	0.156
GH2	Sick Easier	0.008	0.326	-0.004	0.385	-0.001	0.930
GH3	As Healthy as Others	0.017	0.660	-0.001	0.482	0.000	0.457
GH4	Health to Get Worse	-0.009	**0.014**	-0.003	**0.020**	-0.003	0.687
GH5	Health Excellent	0.003	0.637	-0.002	0.382	-0.001	0.904
VT1	Full of Pep	0.006	0.918	-0.005	0.387	0.001	**0.022**
VT2	Lot of Energy	0.027	0.086	-0.005	0.550	0.000	0.510
VT3	Worn Out	-0.006	0.777	0.007	0.975	0.002	0.259
VT4	Tired	0.008	0.347	-0.002	0.099	0.011	0.985
SF1	Social-Extent	0.001	0.500	-0.005	0.334	-0.001	0.819
SF2	Social-Frequency	-0.005	0.171	-0.006	0.481	-0.003	0.269
RE1	Cut Down Time	-0.004	0.222	-0.001	0.641	-0.001	0.387
RE2	Accomplish Less	0.025	0.200	0.000	0.522	0.000	0.219
RE3	Not Careful	0.020	0.796	0.000	0.939	0.002	0.094
MH1	Nervous	-0.001	**0.000**	0.001	0.876	0.006	0.113
MH2	Down in Dumps	0.005	0.365	-0.005	0.853	0.010	0.098
MH3	Calm and Peaceful	0.009	0.123	-0.002	0.327	0.000	0.104
MH4	Downhearted/Blue	0.012	0.337	-0.003	0.492	-0.002	**0.022**
MH5	Happy	0.015	0.146	-0.005	0.558	-0.001	0.292

PF = physical functioning, RP = role limitations due to physical functioning, BP = bodily pain, GH = general health, VT = vitality, SF = social functioning, RE = role limitations due to emotional problems, MH = mental health, MCS = standardized mental composite scale.

APPENDIX B

APPENDIX B: SENESITIVITY ANALYSES (COMPLETE CASE ANALYSES)

For all three Specific Aims (N= 342)

Specific Aim 1: Tables B.1.1.1 through B.1.3.1

Specific Aim 2: Tables B.2.1 through B.2.4.2

Specific Aim 3: Tables B.3.1 through B.3.4.2

For Specific Aim 1:

Table B.1.1.1. General Estimation Equations (GEE) models for impairment (pain on weight-bearing) as a function of arthritis over three points of time (sensitivity analysis).

Explanatory variables	**Model 1**			**Model 2**		
	OR	**95 % CI**		**OR**	**95 % CI**	
Time 1 vs. Time 0	0.48	0.97	0.13	0.48	0.23	1.00
Time 2 vs. Time 0	0.89	1.85	0.73	0.76	0.36	1.63
Age	0.99	0.96	1.03	1.00	0.97	1.04
Male vs. Female	0.62	0.43	0.89	0.66	0.46	0.96
Married (Yes vs. No)	1.21	0.90	1.65	1.22	0.89	1.67
Education	0.96	0.92	1.00	0.97	0.93	1.01
Nativity (foreign born vs. US born)	0.94	0.69	1.29	0.93	0.67	1.29
Interviewed in English (Yes vs. No)	0.95	0.60	1.52	1.02	0.63	1.65
Arthritis (Yes vs. No)	3.58	2.73	4.69	3.48	2.65	4.57
BMI (Kg/m2)				1.06	1.03	1.09
Low cognitive status (Yes vs. No)				1.30	0.96	1.78
Depressive symptoms (Yes vs. No)				1.86	1.20	2.87
Medical conditions (Total number)				1.29	1.10	1.51

BMI= Body Mass Index.

	DF	F	*P*
time*arthritis	2	3.25	0.0394

Table B.1.1.2. General linear mixed models estimates for impairment (lower extremity muscle strength (Kg)) as a function of arthritis over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2		
	β	(SE)	P-value	β	(SE)	P-value
Intercept	42.5	7.76	<.001	39.5	8.87	<.001
Time 1 vs. Time 0	2.79	2.32	0.23	1.57	2.37	0.51
Time 2 vs. Time 0	5.82	2.33	0.01	5.02	2.39	0.04
Age	-0.22	0.09	0.02	-0.17	0.10	0.08
Male vs. Female	0.99	0.81	0.22	0.85	0.83	0.30
Married (Yes vs. No)	4.38	0.81	<.001	4.22	0.83	<.001
Education	0.01	0.11	0.98	0.01	0.11	0.99
Nativity (foreign born vs. US born)	-0.55	0.82	0.50	-0.47	0.84	0.58
Interviewed in English (Yes vs. No)	1.33	1.07	0.22	0.89	1.10	0.42
Arthritis (Yes vs. No)	-2.09	0.80	0.01	-1.79	0.83	0.03
BMI (Kg/m2)				0.06	0.08	0.49
Low cognitive status (Yes vs. No)				-1.99	0.97	0.04
Depressive symptoms (Yes vs. No)				-1.06	1.40	0.45
Medical conditions (Total number)				-1.11	0.44	0.01

BMI= Body Mass Index.

	DF	F	*P*
Time*arthritis	2	0.95	0.3866

Table B.1.1.3. General linear mixed models estimates for impairment (upper extremity muscle strength) as a function of arthritis over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2		
	β	(SE)	P-value	β	(SE)	P-value
Intercept	70.7	8.26	<.001	67.6	9.33	<.001
Time 1 vs. Time 0	3.90	2.45	0.11	3.64	2.45	0.14
Time 2 vs. Time 0	4.51	2.47	0.07	5.90	2.47	0.02
Age	-0.48	0.10	<.001	-0.47	0.10	<.001
Male vs. Female	3.74	0.85	<.001	3.82	0.85	<.001
Married (Yes vs. No)	5.56	0.85	<.001	5.26	0.86	<.001
Education	-0.04	0.11	0.71	-0.09	0.12	0.45
Nativity (foreign born vs. US born)	-0.59	0.86	0.49	-0.13	0.86	0.88
Interviewed in English (Yes vs. No)	0.23	1.13	0.84	0.15	1.14	0.90
Arthritis (Yes vs. No)	-3.60	0.84	<.001	-3.00	0.86	<.01
BMI (Kg/m2)				0.19	0.09	0.03
Low cognitive status (Yes vs. No)				-2.09	1.00	0.04
Depressive symptoms (Yes vs. No)				-2.46	1.47	0.09
Medical conditions (Total number)				-2.40	0.46	<.001

BMI= Body Mass Index.

	DF	F	P
time*arthritis	2	0.20	0.8159

Table B.1.2. General linear mixed models estimates for functional limitation (Short Physical Performance Battery) as a function of arthritis over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	14.9	2.75	<.001	16.8	2.60	<.001	13.8	2.59	<.001
Time 1	-1.49	0.49	<.01	-0.63	0.47	0.19	-0.38	0.50	0.45
Time 2	-0.17	0.46	0.71	0.09	0.45	0.84	0.47	0.48	0.33
Age	-0.10	0.03	<.01	-0.09	0.03	<.01	-0.08	0.03	0.01
Male	0.14	0.16	0.38	0.23	0.16	0.14	0.25	0.16	0.13
Married	0.33	0.27	0.21	0.39	0.24	0.10	0.24	0.23	0.30
Education	0.07	0.04	0.08	0.05	0.03	0.15	0.04	0.03	0.24
Nativity	0.09	0.31	0.78	0.23	0.26	0.38	0.25	0.25	0.31
Interviewed in English	-0.22	0.22	0.31	-0.12	0.21	0.58	-0.03	0.23	0.90
Arthritis	-0.44	0.21	0.03	-0.48	0.20	0.02	-0.30	0.21	0.04
BMI (Kg/m2)				-0.05	0.02	0.03	-0.06	0.02	0.02
Low cognitive status				-0.96	0.23	<.001	-0.81	0.23	<.01
Depressive symptoms				-1.21	0.30	<.001	-0.58	0.32	0.07
Medical conditions				-0.49	0.11	<.001	-0.25	0.12	0.03
Pain							-0.70	0.20	<.01
TBMS (Kg)							0.03	<.01	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength.

	DF	F	P
time*arthritis	2	2.37	0.0945

Table B.1.3.1. General Estimation Equations (GEE) models for Disability (activities of daily living (ADL)) as a function of arthritis over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3			Model 4		
	OR	95 % CI		OR	95 % CI		OR	95 % CI		OR	95 % CI	
Time 1	1.16	0.40	3.30	1.23	0.41	3.66	1.41	0.41	4.82	0.36	0.09	1.47
Time 2	2.98	1.03	8.68	2.52	0.83	7.66	2.97	0.86	10.27	0.68	0.17	2.71
Age	1.04	0.99	1.09	1.06	1.01	1.11	1.05	1.00	1.11	1.02	0.96	1.08
Male	0.74	0.46	1.19	0.87	0.53	1.42	1.58	0.89	2.79	1.21	0.67	2.19
Married	0.76	0.49	1.18	0.72	0.45	1.14	0.73	0.45	1.16	0.76	0.44	1.32
Education	0.94	0.89	1.00	0.96	0.91	1.02	0.97	0.91	1.03	0.97	0.90	1.04
Nativity	0.81	0.52	1.26	0.89	0.57	1.38	0.91	0.57	1.44	0.78	0.47	1.30
Interviewed in English	0.59	0.33	1.04	0.61	0.33	1.12	0.56	0.29	1.10	0.33	0.16	0.71
Arthritis	1.73	1.24	2.40	1.65	1.17	2.33	1.35	0.93	1.96	1.24	0.79	1.96
BMI (Kg/m2)				1.04	1.00	1.08	1.04	1.00	1.08	1.04	0.99	1.09
Low cognitive status				1.60	1.08	2.37	1.53	1.03	2.27	1.29	0.81	2.04
Depressive symptoms				2.02	1.32	3.08	1.84	1.20	2.81	1.03	0.59	1.80
Medical conditions				1.56	1.29	1.90	1.52	1.23	1.86	1.36	1.06	1.74
Pain							2.58	1.77	3.76	2.47	1.62	3.75
TBMS (Kg)							0.98	0.96	0.99	0.98	0.97	1.00
SPPB										0.60	0.55	0.66

OR= Odds Ratio; BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

	DF	F	P
time*arthritis	2	1.71	0.1827

Table B.1.3.2. General Estimation Equations (GEE) models for Disability (instrumental activities of daily living (IADL)) as a function of arthritis over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3			Model 4		
	OR	95 % CI		OR	95 % CI		OR	95 % CI		OR	95 % CI	
Time 1	0.79	0.44	1.43	0.84	0.44	1.57	1.02	0.53	1.96	0.91	0.43	1.93
Time 2	2.52	1.34	4.74	2.25	1.14	4.43	2.83	1.40	5.72	2.43	1.11	5.34
Age	1.06	1.01	1.11	1.07	1.02	1.13	1.07	1.02	1.12	1.05	1.00	1.10
Male	0.40	0.26	0.61	0.44	0.29	0.67	0.65	0.41	1.02	0.60	0.39	0.94
Married	1.32	0.92	1.88	1.36	0.95	1.94	1.33	0.92	1.93	1.48	1.00	2.17
Education	0.93	0.88	0.97	0.94	0.89	0.99	0.94	0.90	0.99	0.94	0.90	0.99
Nativity	0.60	0.41	0.88	0.57	0.38	0.84	0.56	0.37	0.84	0.52	0.35	0.78
Interviewed in English	1.09	0.71	1.67	1.19	0.78	1.82	1.31	0.85	2.02	1.32	0.81	2.15
Arthritis	1.86	1.41	2.47	1.87	1.40	2.48	1.49	1.10	2.02	1.55	1.12	2.14
BMI (Kg/m2)				1.03	0.99	1.07	1.03	0.99	1.07	1.02	0.98	1.06
Low cognitive status				1.67	1.20	2.31	1.60	1.14	2.25	1.51	1.03	2.21
Depressive symptoms				1.95	1.37	2.78	1.87	1.29	2.71	1.64	1.01	2.67
Medical conditions				1.45	1.21	1.73	1.39	1.16	1.67	1.29	1.07	1.56
Pain							2.35	1.74	3.18	2.06	1.49	2.85
TBMS (Kg)							0.99	0.98	0.99	0.99	0.98	1.00
SPPB										0.78	0.74	0.82

OR= Odds Ratio; BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

	DF	F	P
time*arthritis	2	0.48	0.6206

For Specific Aim 2:

Table B.2.1. General linear mixed models estimates for physical health-related quality of life (PCS) as a function of pathology (arthritis) over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2		
	β	(SE)	P-value	β	(SE)	P-value
Intercept	54.8	9.72	<.001	67.9	10.04	<.001
Time 1	1.48	1.46	0.31	1.40	1.45	0.34
Time 2	-2.81	1.61	0.08	-1.65	1.60	0.30
Age	-0.18	0.12	0.14	-0.25	0.12	0.03
Male	0.56	0.51	0.27	0.57	0.51	0.26
Married	0.99	0.94	0.29	0.90	0.90	0.32
Education	0.19	0.14	0.19	0.15	0.13	0.26
Nativity	1.93	1.09	0.08	1.99	1.02	0.05
Interviewed in English	0.46	0.70	0.51	0.34	0.69	0.62
Arthritis	-4.53	0.70	<.001	-4.41	0.69	<.001
BMI (Kg/m2)				-0.16	0.09	0.08
Depressive symptoms				-3.58	0.97	<.01
Medical conditions				-2.15	0.40	<.001

BMI= Body Mass Index

	DF	F	P
time*arthritis	2	1.10	0.3340

Table B.2.2. General linear mixed models estimates for physical health-related quality of life (PCS) as a function of impairment (pain, Total Body Muscle Strength) over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	46.2	8.52	<.001	59.0	8.93	<.001	59.6	8.87	<.001
Time 1	0.37	1.43	0.80	0.27	1.42	0.85	0.35	1.41	0.80
Time 2	-3.18	1.54	0.04	-2.35	1.53	0.13	-2.32	1.53	0.13
Age	-0.13	0.10	0.20	-0.20	0.10	0.05	-0.20	0.10	0.05
Male	0.40	0.50	0.42	0.37	0.50	0.46	0.37	0.49	0.45
Married	0.46	0.84	0.59	0.41	0.81	0.62	0.30	0.81	0.71
Education	0.14	0.12	0.23	0.11	0.11	0.35	0.09	0.11	0.41
Nativity	2.05	0.92	0.03	2.10	0.87	0.02	1.99	0.87	0.02
Interviewed in English	0.01	0.68	1.00	-0.08	0.67	0.91	-0.13	0.67	0.85
Pain	-7.66	0.62	<.001	-7.29	0.62	<.001	-6.69	0.63	<.001
TBMS (Kg)	0.11	0.02	<.001	0.11	0.02	<.001	0.10	0.02	<.001
BMI (Kg/m2)				-0.18	0.08	0.03	-0.15	0.08	0.06
Depressive symptoms				-2.87	0.93	<.01	-2.94	0.93	<.01
Medical conditions				-1.60	0.37	<.001	-1.57	0.37	<.001
Arthritis							-2.75	0.66	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength.

	DF	F	P
time*pain	2	1.86	0.1570
time*TBMS Quartiles	6	2.01	0.0622

Table B.2.3. General linear mixed models estimates for physical health-related quality of life (PCS) as a function of functional limitation (Short Physical Performance Battery) over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3			Model 4		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	22.6	7.63	<.01	34.3	8.39	<.001	36.4	8.15	<.001	34.2	7.40	<.001
Time 1	2.29	1.44	0.11	2.03	1.43	0.16	1.87	1.42	0.19	0.61	1.37	0.66
Time 2	0.18	1.52	0.91	0.54	1.51	0.72	0.35	1.51	0.82	-0.72	1.44	0.62
Age	0.02	0.09	0.80	-0.04	0.09	0.65	-0.04	0.09	0.65	-0.02	0.08	0.79
Male	0.63	0.50	0.21	0.55	0.50	0.27	0.46	0.50	0.36	0.05	0.48	0.91
Married	0.71	0.76	0.35	0.69	0.75	0.36	0.54	0.73	0.46	0.19	0.67	0.78
Education	0.12	0.11	0.28	0.09	0.11	0.39	0.06	0.10	0.54	0.03	0.09	0.76
Nativity	1.86	0.82	0.03	1.94	0.81	0.02	1.74	0.78	0.03	1.76	0.69	0.01
Interviewed in English	1.06	0.68	0.12	0.92	0.68	0.18	0.75	0.67	0.26	0.33	0.65	0.61
SPPB	1.78	0.09	<.001	1.68	0.10	<.001	1.64	0.09	<.001	1.45	0.09	<.001
BMI (Kg/m2)				-0.13	0.08	0.08	-0.10	0.07	0.18	-0.08	0.07	0.23
Depressive symptoms				-1.73	0.91	0.06	-1.80	0.90	0.05	-1.36	0.86	0.11
Medical conditions				-1.31	0.36	<.01	-1.22	0.35	<.01	-0.85	0.32	0.01
Arthritis							-3.85	0.62	<.001	-2.25	0.60	<.01
Pain										-5.94	0.59	<.001
TBMS (Kg)										0.07	0.01	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

	DF	F	P
time*SPPBQ	6	3.65	<.01

Table B.2.4.1. General linear mixed models estimates for physical health-related quality of life (PCS) as a function of ADL limitation over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(SE)	*P-value*	β	(SE)	*P-value*	β	(SE)	*P-value*	β	(SE)	*P-value*	β	(SE)	*P-value*
Intercept	48.6	7.84	<.001	59.5	8.45	<.001	60.4	8.18	<.001	53.6	7.34	<.001	37.8	6.92	<.001
Time 1	1.15	1.40	0.41	0.99	1.40	0.48	0.92	1.39	0.51	-0.23	1.34	0.87	0.15	1.33	0.91
Time 2	-0.89	1.51	0.55	-0.37	1.50	0.81	-0.46	1.49	0.76	-1.44	1.43	0.32	-0.65	1.40	0.64
Age	-0.09	0.10	0.37	-0.15	0.10	0.12	-0.14	0.09	0.13	-0.10	0.08	0.24	-0.01	0.07	0.95
Male	0.56	0.49	0.26	0.50	0.49	0.30	0.44	0.49	0.36	0.07	0.47	0.88	-0.02	0.47	0.97
Married	0.51	0.79	0.52	0.50	0.77	0.52	0.37	0.75	0.62	-0.03	0.68	0.97	0.01	0.63	1.00
Education	0.12	0.11	0.28	0.09	0.11	0.40	0.06	0.11	0.54	0.02	0.09	0.79	0.01	0.08	0.97
Nativity	1.31	0.86	0.13	1.40	0.84	0.10	1.24	0.81	0.13	1.32	0.70	0.06	1.39	0.64	0.03
Interviewed in English	0.18	0.67	0.79	0.09	0.66	0.90	-0.03	0.66	0.96	-0.40	0.64	0.53	-0.02	0.63	0.98
ADL Limitation	-13.9	0.78	<.001	-13.1	0.80	<.001	-12.9	0.79	<.001	-11.7	0.75	<.001	-8.08	0.82	<.001
BMI (Kg/m2)				-0.15	0.08	0.06	-0.11	0.08	0.15	-0.09	0.07	0.20	-0.05	0.06	0.40
Depressive symptoms				-2.23	0.91	0.01	-2.32	0.90	0.01	-1.86	0.86	0.03	-1.03	0.83	0.21
Medical conditions				-1.40	0.36	<.01	-1.32	0.35	<.01	-0.88	0.33	0.01	-0.59	0.31	0.05
Arthritis							-3.80	0.62	<.001	-2.21	0.60	<.01	-2.08	0.57	<.01
Pain										-6.02	0.59	<.001	-5.61	0.57	<.001
TBMS (Kg)										0.08	0.01	<.001	0.06	0.01	<.001
SPPB													0.98	0.10	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

	DF	F	P
time*ADL	2	2.07	0.1267

Table B.2.4.2. General linear mixed models estimates for physical health-related quality of life (PCS) as a function of IADL limitation over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	48.7	7.77	<.001	60.9	8.30	<.001	61.6	8.11	<.001	55.3	7.45	<.001	37.1	6.77	<.001
Time 1	1.11	1.41	0.43	1.01	1.40	0.47	0.95	1.39	0.50	0.06	1.35	0.96	0.49	1.30	0.71
Time 2	-0.16	1.51	0.92	0.51	1.50	0.73	0.35	1.49	0.81	-0.55	1.44	0.70	0.46	1.37	0.73
Age	-0.05	0.10	0.62	-0.12	0.09	0.22	-0.11	0.09	0.23	-0.08	0.08	0.35	0.03	0.07	0.73
Male	0.64	0.49	0.20	0.61	0.49	0.21	0.57	0.49	0.24	0.28	0.47	0.56	0.01	0.46	0.98
Married	1.36	0.78	0.08	1.21	0.76	0.11	1.09	0.74	0.14	0.56	0.69	0.42	0.40	0.61	0.52
Education	0.04	0.11	0.72	0.01	0.11	0.91	-0.01	0.11	0.96	-0.03	0.09	0.73	-0.06	0.08	0.50
Nativity	1.10	0.86	0.20	1.18	0.83	0.16	1.09	0.81	0.18	1.23	0.72	0.09	1.18	0.63	0.06
Interviewed in English	0.06	0.67	0.93	-0.01	0.66	0.99	-0.12	0.66	0.86	-0.39	0.64	0.55	0.15	0.61	0.81
IADL Limitation	-12.3	0.66	<.001	-11.8	0.66	<.001	-11.3	0.66	<.001	-10.0	0.64	<.001	-7.97	0.63	<.001
BMI (Kg/m2)				-0.17	0.08	0.03	-0.14	0.08	0.06	-0.13	0.07	0.07	-0.07	0.06	0.24
Depressive symptoms				-2.83	0.90	<.01	-2.87	0.89	<.01	-2.27	0.85	0.01	-1.01	0.81	0.21
Medical conditions				-1.47	0.36	<.001	-1.42	0.35	<.001	-1.02	0.33	<.01	-0.58	0.30	0.05
Arthritis							-3.12	0.62	<.001	-1.78	0.60	<.01	-1.64	0.56	<.01
Pain										-5.43	0.59	<.001	-4.93	0.55	<.001
TBMS (Kg)										0.08	0.01	<.001	0.05	0.01	<.001
SPPB													1.11	0.09	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

	DF	F	P
time*IADL	2	0.12	0.8882

For Specific Aim 3:

Table B.3.1. General linear mixed models estimates for mental health-related quality of life (MCS) as a function of pathology (arthritis) over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2		
	β	(SE)	*P-value*	β	(SE)	*P-value*
Intercept	46.4	6.03	<.001	46.9	5.45	<.001
Time 1	3.73	1.33	0.01	3.32	1.24	0.01
Time 2	0.85	1.42	0.55	1.84	1.29	0.15
Age	0.07	0.07	0.36	0.07	0.06	0.22
Male	0.04	0.47	0.93	0.19	0.44	0.66
Married	1.26	0.62	0.04	0.15	0.51	0.77
Education	0.05	0.08	0.55	0.03	0.07	0.69
Nativity	1.53	0.65	0.02	1.18	0.52	0.03
Interviewed in English	1.43	0.63	0.02	1.17	0.58	0.05
Arthritis	0.29	0.55	0.61	0.36	0.48	0.45
BMI (Kg/m2)				0.07	0.05	0.22
Depressive symptoms				-14.3	0.74	<.001
Medical conditions				-0.51	0.26	0.05

BMI= Body Mass Index.

	DF	F	P
time*arthritis	2	1.15	0.3174

Table B.3.2. General linear mixed models estimates for mental health-related quality of life (MCS) as a function of impairment (pain, lower and upper extremities muscle strength) over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	44.5	6.21	<.001	45.4	5.59	<.001	45.2	5.59	<.001
Time 1	3.52	1.33	0.01	3.16	1.24	0.01	3.14	1.24	0.01
Time 2	0.72	1.42	0.61	1.67	1.29	0.19	1.67	1.29	0.19
Age	0.08	0.07	0.27	0.09	0.06	0.16	0.08	0.06	0.16
Male	-0.04	0.47	0.93	0.09	0.44	0.83	0.10	0.44	0.82
Married	0.92	0.63	0.15	-0.01	0.52	0.98	0.01	0.52	0.98
Education	0.03	0.08	0.68	0.02	0.07	0.78	0.02	0.07	0.75
Nativity	1.56	0.65	0.02	1.16	0.53	0.03	1.20	0.53	0.02
Interviewed in English	1.33	0.63	0.04	1.12	0.58	0.05	1.13	0.58	0.05
Pain	-1.16	0.53	0.03	-0.61	0.47	0.20	-0.80	0.49	0.11
TBMS (Kg)	0.03	0.01	0.03	0.02	0.01	0.18	0.02	0.01	0.15
BMI (Kg/m2)				0.07	0.05	0.17	0.07	0.05	0.19
Depressive symptoms				-14.1	0.74	<.001	-14.1	0.74	<.001
Medical conditions				-0.42	0.26	0.11	-0.43	0.26	0.10
Arthritis							0.66	0.50	0.19

BMI= Body Mass Index; TBMS= Total Body Muscle Strength.

	DF	F	P
time*pain	2	1.63	0.1963
time*TBMSQ	6	1.90	0.0776

Table B.3.3. General linear mixed models estimates for mental health-related quality of life (MCS) as a function of functional limitation (Short Physical Performance Battery) over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3			Model 4		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	36.9	5.87	<.001	37.4	5.55	<.001	37.0	5.54	<.001	37.0	5.64	<.001
Time 1	3.77	1.30	<.01	3.42	1.21	<.01	3.43	1.21	<.01	3.39	1.21	0.01
Time 2	1.83	1.39	0.19	2.35	1.26	0.06	2.37	1.26	0.06	2.34	1.27	0.07
Age	0.13	0.07	0.07	0.14	0.06	0.02	0.13	0.06	0.02	0.14	0.06	0.03
Male	-0.16	0.46	0.73	0.05	0.43	0.90	0.07	0.43	0.88	0.05	0.43	0.91
Married	0.77	0.60	0.20	-0.07	0.50	0.89	-0.04	0.50	0.94	-0.05	0.51	0.92
Education	0.01	0.08	0.99	0.01	0.07	1.00	0.01	0.07	0.95	0.01	0.07	0.97
Nativity	1.51	0.62	0.02	1.11	0.51	0.03	1.15	0.51	0.03	1.15	0.52	0.03
Interviewed in English	1.59	0.62	0.01	1.32	0.57	0.02	1.34	0.57	0.02	1.33	0.57	0.02
SPPB	0.71	0.08	<.001	0.48	0.07	<.001	0.49	0.07	<.001	0.48	0.07	<.001
BMI (Kg/m2)				0.11	0.05	0.04	0.10	0.05	0.06	0.10	0.05	0.06
Depressive symptoms				-13.3	0.73	<.001	-13.3	0.73	<.001	-13.3	0.74	<.001
Medical conditions				-0.19	0.26	0.45	-0.21	0.26	0.41	-0.20	0.26	0.43
Arthritis							0.67	0.47	0.16	0.74	0.49	0.14
Pain										-0.22	0.49	0.65
TBMS (Kg)										0.01	0.01	0.84

BMI= Body Mass Index; TBMS = Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

	DF	F	P
time*SPPBQ	6	0.82	0.5556

Table B.3.4.1. General linear mixed models estimates for mental health-related quality of life (MCS) as a function of ADL limitation over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	45.9	5.98	<.001	45.0	5.49	<.001	44.8	5.49	<.001	43.9	5.62	<.001	37.2	5.66	<.001
Time 1	1.39	1.41	0.32	2.02	1.28	0.11	2.04	1.28	0.11	1.92	1.28	0.13	2.35	1.27	0.07
Time 2	3.57	1.31	0.01	3.22	1.23	0.01	3.23	1.23	0.01	3.13	1.23	0.01	3.38	1.21	0.01
Age	0.09	0.07	0.20	0.10	0.06	0.10	0.10	0.06	0.10	0.10	0.06	0.09	0.14	0.06	0.03
Male	-0.08	0.46	0.86	0.12	0.43	0.79	0.13	0.44	0.77	0.08	0.44	0.86	0.05	0.43	0.91
Married	0.94	0.62	0.13	0.01	0.51	0.98	0.04	0.51	0.93	-0.04	0.52	0.94	-0.05	0.51	0.92
Education	0.02	0.08	0.83	0.01	0.07	0.88	0.01	0.07	0.84	0.01	0.07	0.87	0.01	0.07	0.98
Nativity	1.30	0.65	0.05	1.02	0.53	0.05	1.05	0.53	0.05	1.07	0.53	0.04	1.13	0.52	0.03
Interviewed in English	1.34	0.62	0.03	1.11	0.58	0.06	1.12	0.58	0.05	1.10	0.58	0.06	1.32	0.57	0.02
ADL Limitation	-4.23	0.71	<.001	-2.49	0.62	<.001	-2.56	0.62	<.001	-2.37	0.64	<.01	-0.40	0.73	0.59
BMI (Kg/m2)				0.09	0.05	0.10	0.08	0.05	0.12	0.08	0.05	0.12	0.10	0.05	0.05
Depressive symptoms				-13.8	0.74	<.001	-13.8	0.74	<.001	-13.7	0.74	<.001	-13.2	0.74	<.001
Medical conditions				-0.32	0.26	0.22	-0.34	0.26	0.20	-0.30	0.26	0.26	-0.19	0.26	0.46
Arthritis							0.56	0.48	0.24	0.73	0.50	0.15	0.74	0.49	0.13
Pain										-0.49	0.50	0.33	-0.20	0.49	0.68
TBMS (Kg)										0.01	0.01	0.35	0.01	0.01	0.86
SPPB													0.46	0.09	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

	DF	F	P
Time*ADL	2	0.59	0.5543

Table B.3.4.2. General linear mixed models estimates for mental health-related quality of life (MCS) as a function of IADL limitation over three points of time (sensitivity analysis).

Explanatory variables	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value	β	(SE)	P-value
Intercept	46.4	5.83	<.001	46.0	5.41	<.001	45.8	5.40	<.001	44.8	5.54	<.001	37.1	5.64	<.001
Time 1	3.60	1.33	0.01	3.28	1.24	0.01	3.29	1.24	0.01	3.17	1.24	0.01	3.40	1.21	0.01
Time 2	1.35	1.43	0.34	2.07	1.29	0.11	2.11	1.29	0.10	1.95	1.29	0.13	2.37	1.27	0.06
Age	0.09	0.07	0.20	0.09	0.06	0.12	0.09	0.06	0.12	0.10	0.06	0.11	0.14	0.06	0.02
Male	0.01	0.47	1.00	0.14	0.44	0.76	0.15	0.44	0.73	0.09	0.44	0.84	0.05	0.43	0.91
Married	1.13	0.60	0.06	0.10	0.50	0.85	0.13	0.50	0.80	0.04	0.52	0.94	-0.04	0.51	0.93
Education	0.01	0.08	0.89	0.01	0.07	0.92	0.01	0.07	0.90	0.01	0.07	0.91	0.01	0.07	0.99
Nativity	1.30	0.63	0.04	1.02	0.52	0.05	1.04	0.52	0.05	1.07	0.52	0.04	1.13	0.52	0.03
Interviewed in English	1.31	0.63	0.04	1.14	0.58	0.05	1.16	0.58	0.05	1.13	0.58	0.05	1.33	0.57	0.02
IADL Limitation	-2.52	0.57	<.001	-1.43	0.51	0.01	-1.53	0.51	<.01	-1.31	0.53	0.01	-0.20	0.56	0.72
BMI (Kg/m2)				0.08	0.05	0.13	0.07	0.05	0.16	0.08	0.05	0.16	0.10	0.05	0.05
Depressive symptoms				-14.0	0.74	<.001	-14.0	0.74	<.001	-13.9	0.74	<.001	-13.3	0.74	<.001
Medical conditions				-0.37	0.26	0.16	-0.38	0.26	0.14	-0.34	0.26	0.19	-0.19	0.26	0.45
Arthritis							0.59	0.48	0.22	0.77	0.50	0.13	0.75	0.50	0.13
Pain										-0.54	0.50	0.28	-0.20	0.50	0.70
TBMS (Kg)										0.01	0.01	0.32	0.01	0.01	0.87
SPPB													0.47	0.08	<.001

BMI= Body Mass Index; TBMS= Total Body Muscle Strength; SPPB= Short Physical Performance Battery.

	DF	F	P
Time*IADL	2	2.76	0.0640

APPENDIX C

APPENDIX C: ALL FIGURES FOR ALL SPECIFIC AIMS

All figures for each hypothesis that show the effect of interaction with time

For Specific Aim 1: Figures C.1.1 through C.1.5

For Specific Aim 2: Figures C.2.1 through C.1.6

For Specific Aim 3: Figures C.3.1 through C.3.5

For Specific Aim 1:

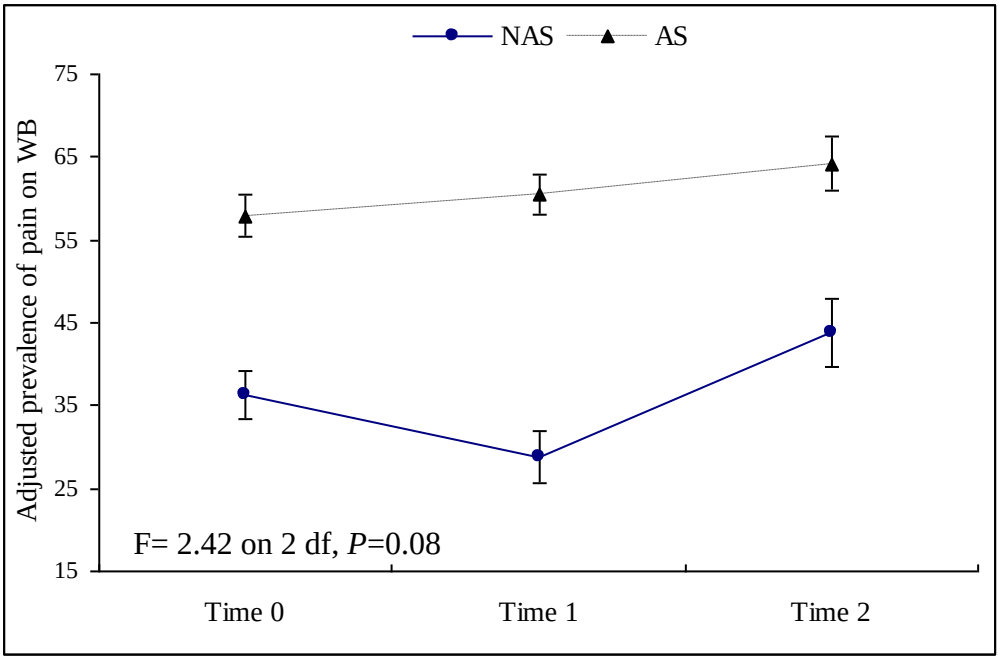

Figure C.1.1: Adjusted prevalence and standard errors of pain over time for Arthritic Subjects (AS) and Non- Arthritic Subjects (NAS).

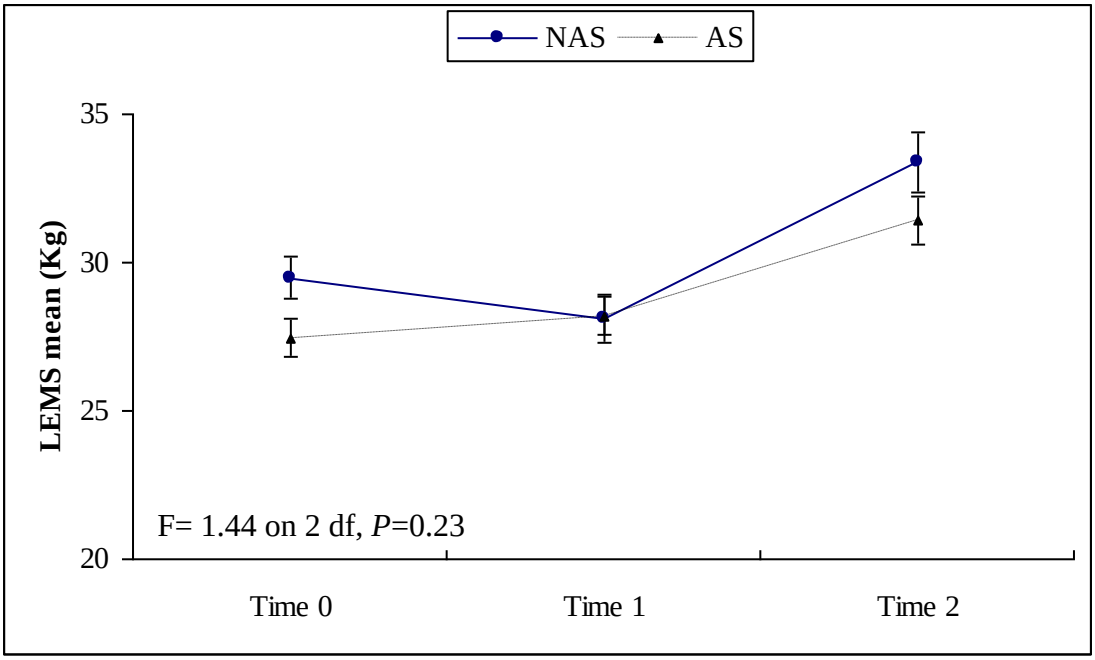

Figure C.1.2: Adjusted lower extremity muscles strength (LEMS) mean and standard errors over time for Arthritic Subjects (AS) and Non- Arthritic Subjects (NAS).

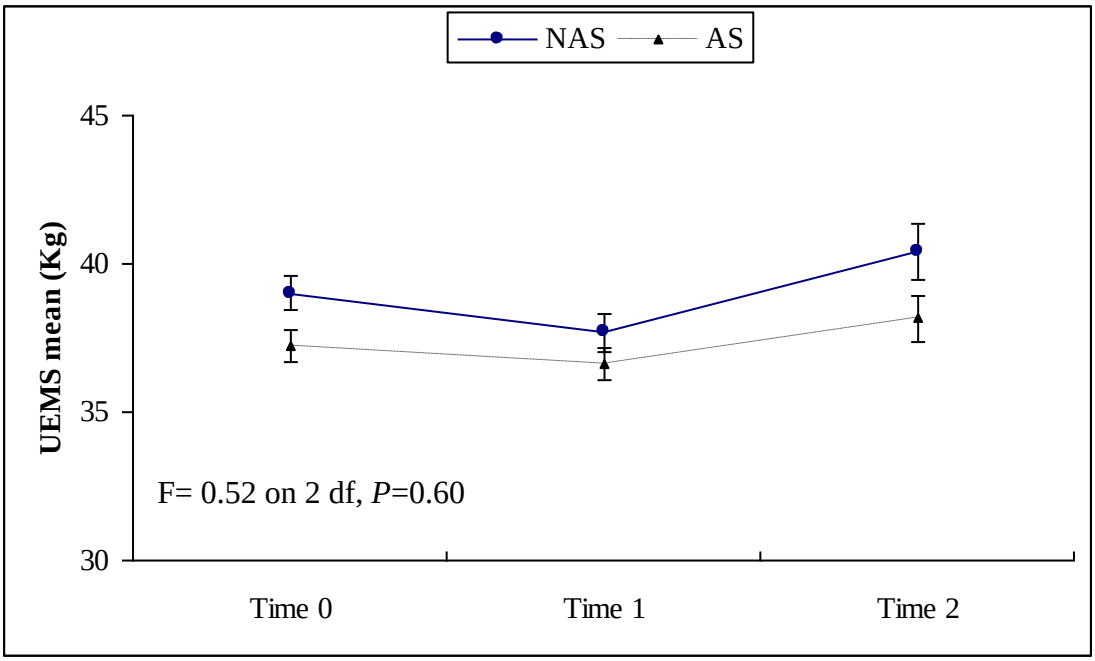

Figure C.1.3: Adjusted Upper extremity muscles strength (UEMS) mean and standard errors over time for Arthritic Subjects (AS) and Non- Arthritic Subjects (NAS).

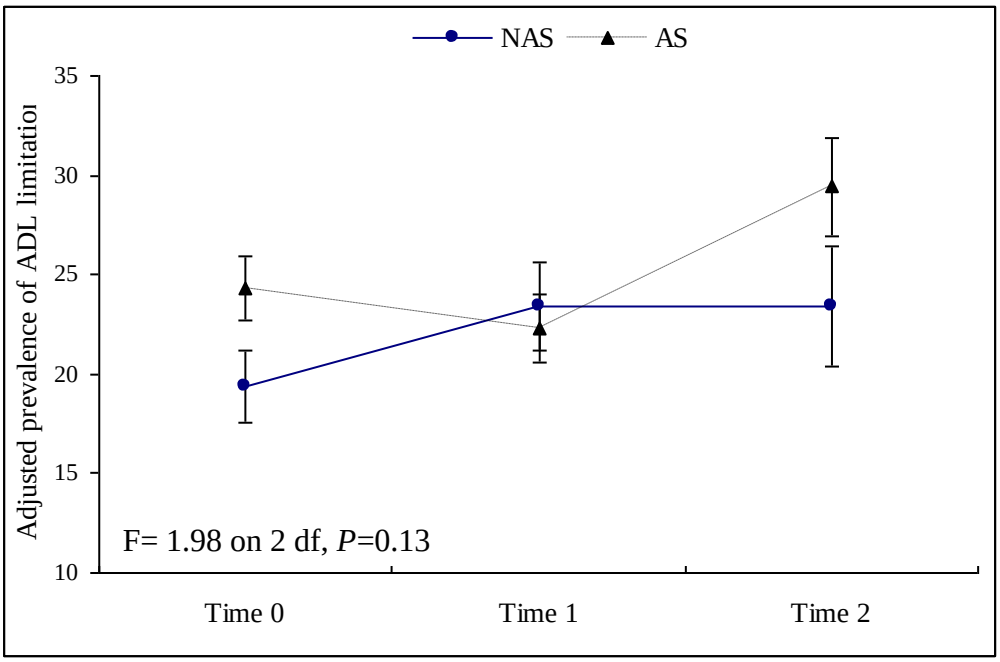

Figure C.1.4: Adjusted prevalence and standard errors of ADL disability over time for Arthritic Subjects (AS) and Non- Arthritic Subjects (NAS).

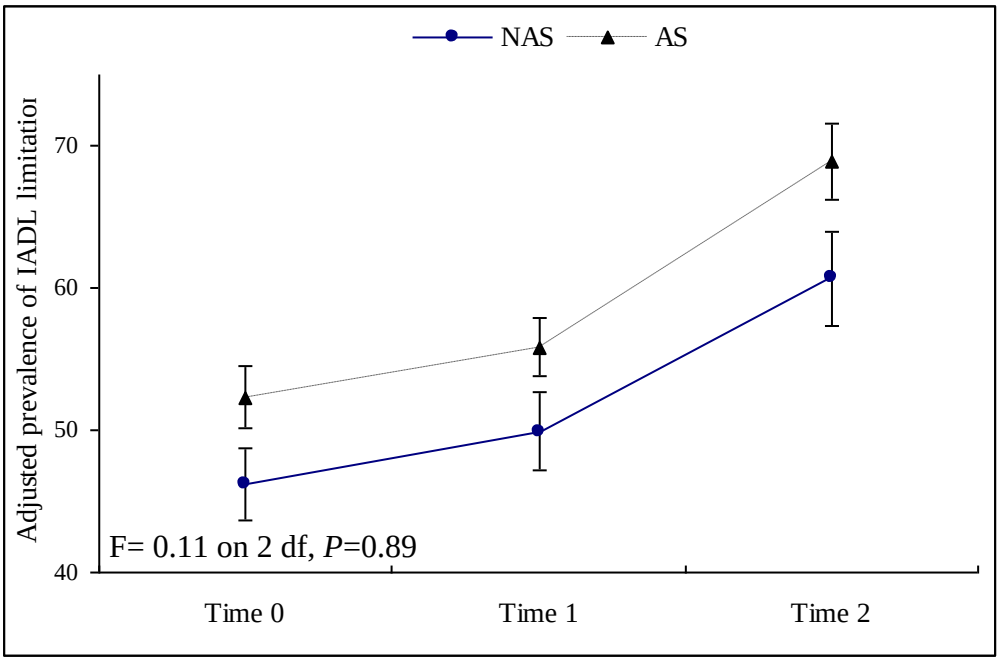

Figure C.1.5: Adjusted prevalence and standard errors of IADL disability over time for Arthritic Subjects (AS) and Non- Arthritic Subjects (NAS).

For Specific Aim 2:

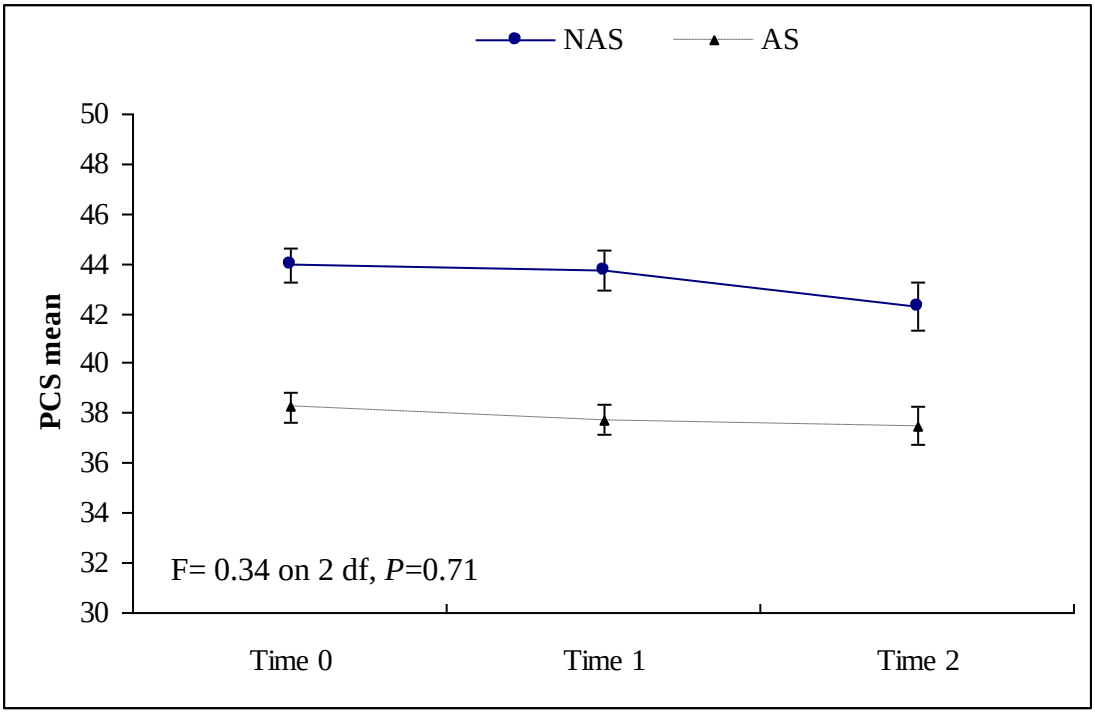

Figure C.2.1: Adjusted PCS mean and standard errors over time for Arthritic Subjects (AS) and Non- Arthritic Subjects (NAS).

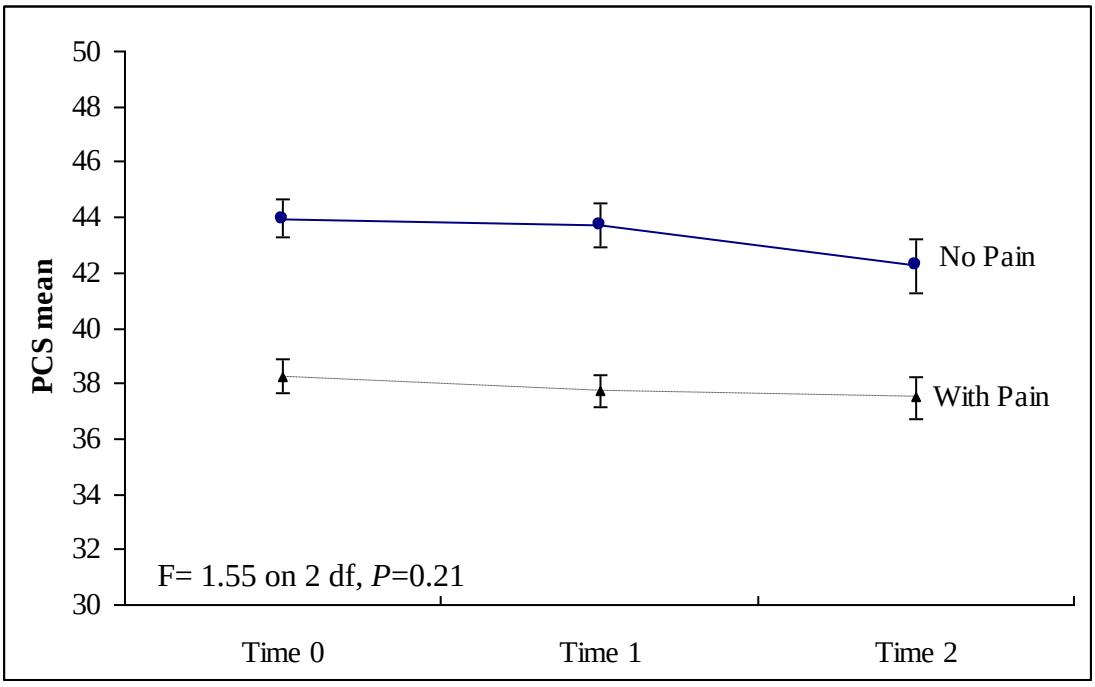

Figure C.2.2: Adjusted PCS mean and standard errors over time for subjects with and without pain.

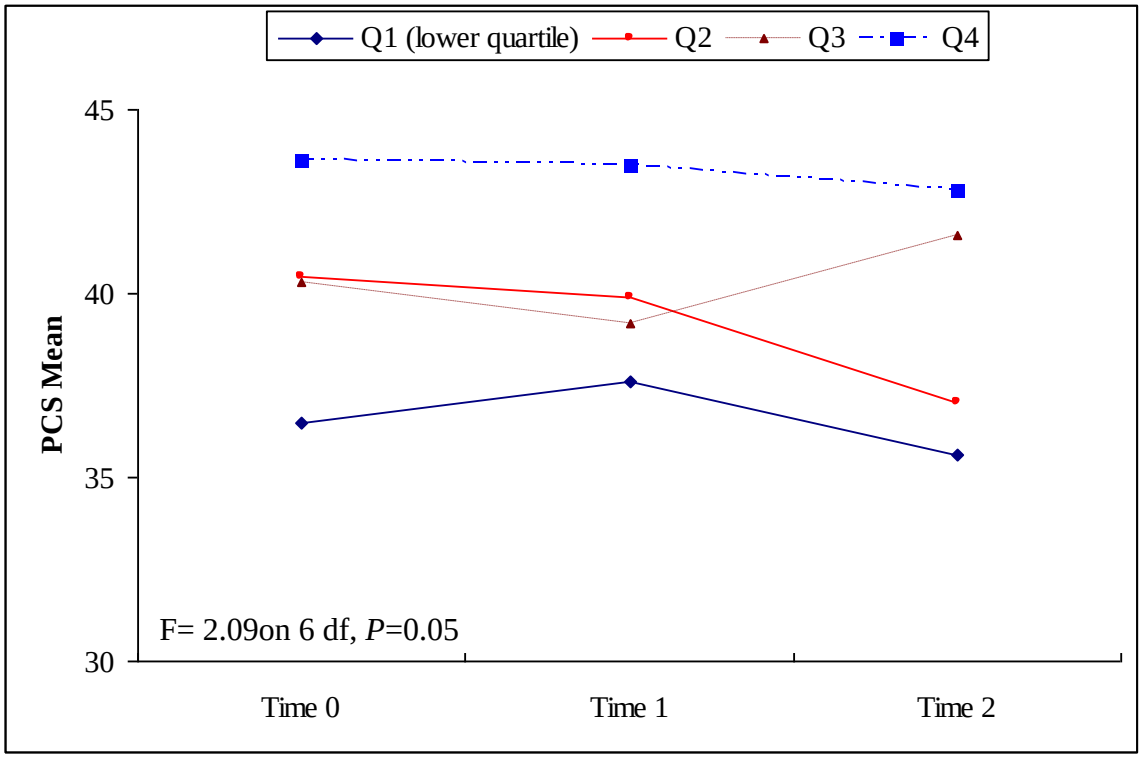

Figure C.2.3: Adjusted PCS mean over time for total body muscle strength (TBMS) quartiles.

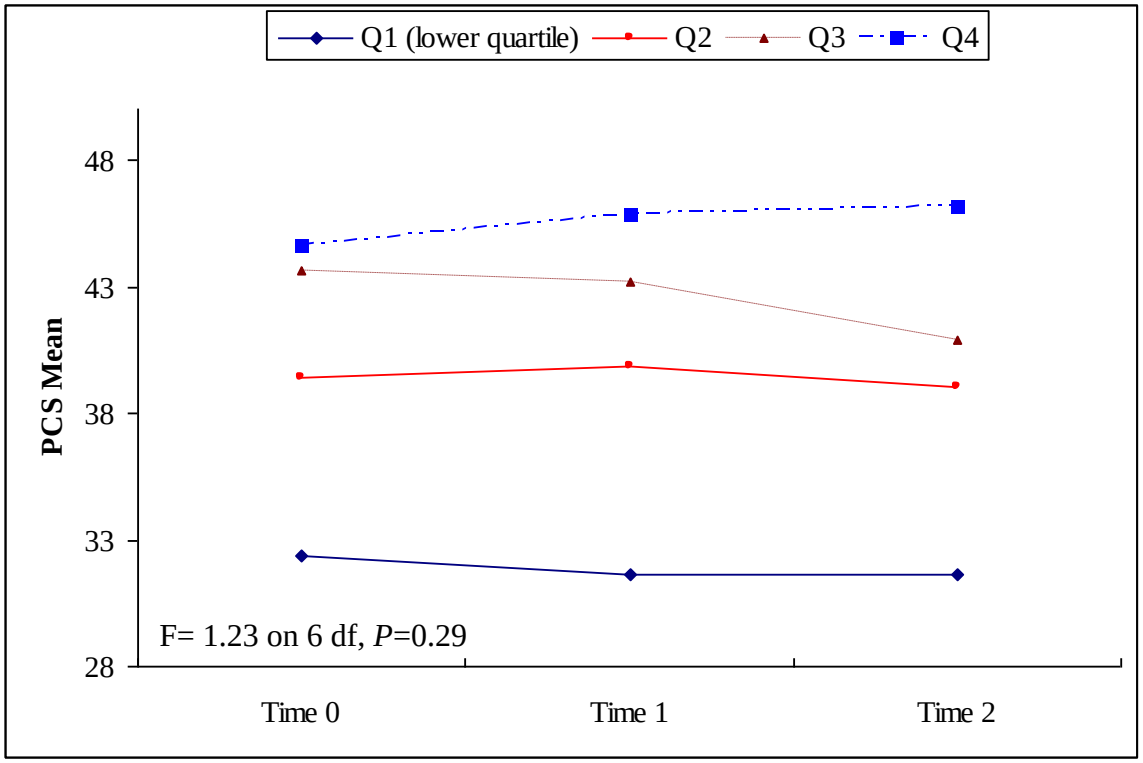

Figure C.2.4: Adjusted PCS mean over time for SPPB quartiles.

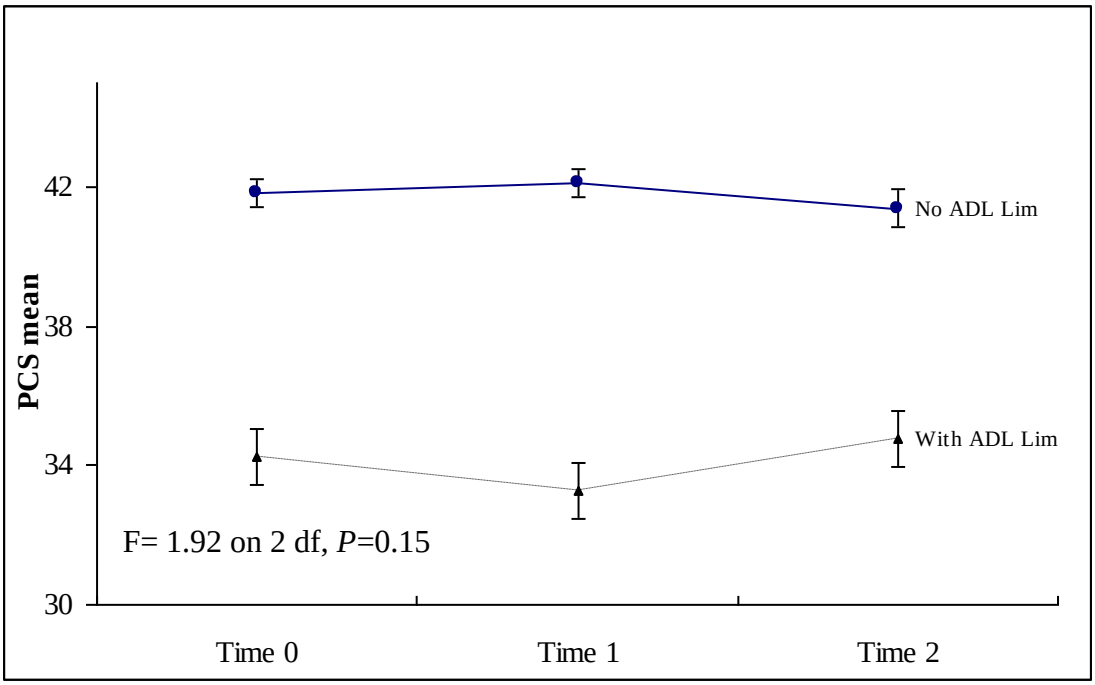

Figure C.2.5: Adjusted PCS mean over time for ADL Limitation.

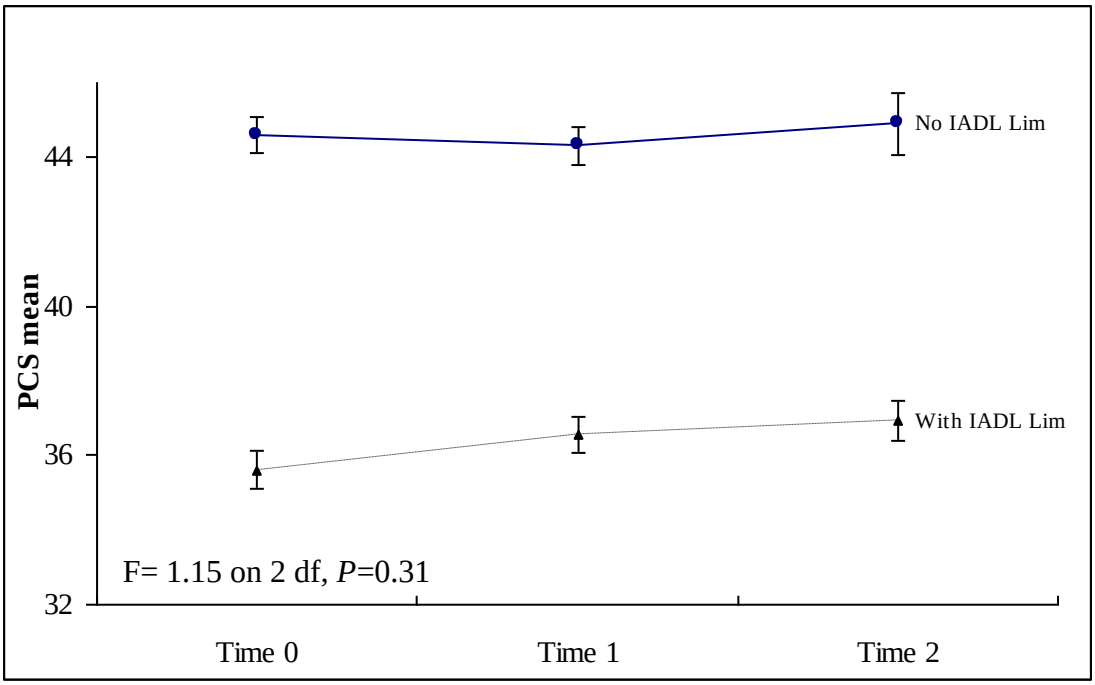

Figure C.2.6: Adjusted PCS mean over time for IADL Limitation.

For Specific Aim 3:

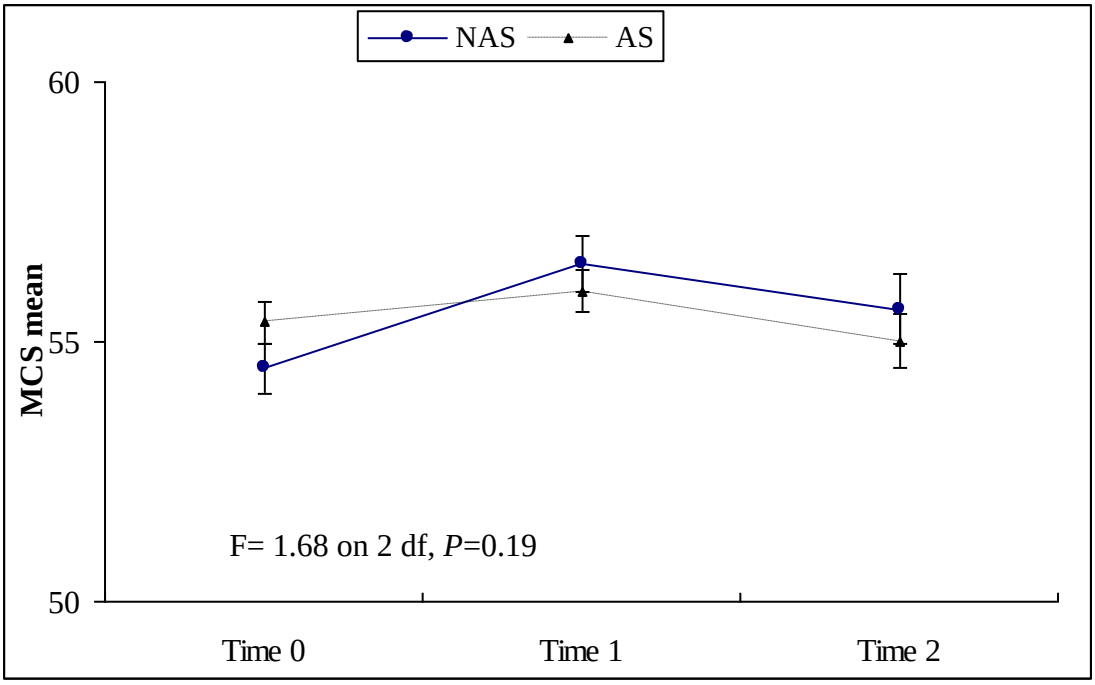

Figure C.3.1: Adjusted MCS mean and standard errors over time for Arthritic Subjects (AS) and Non- Arthritic Subjects (NAS).

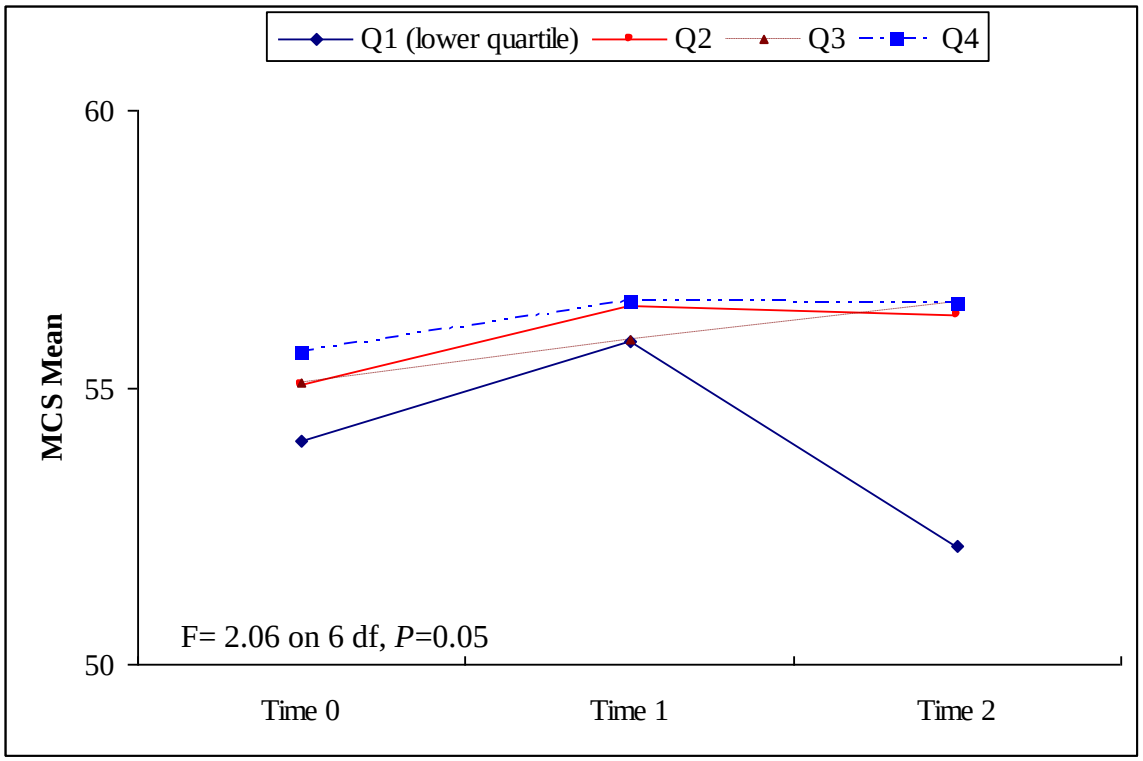

Figure C.3.2: Adjusted MCS mean over time for total body muscle strength (TBMS) quartiles.

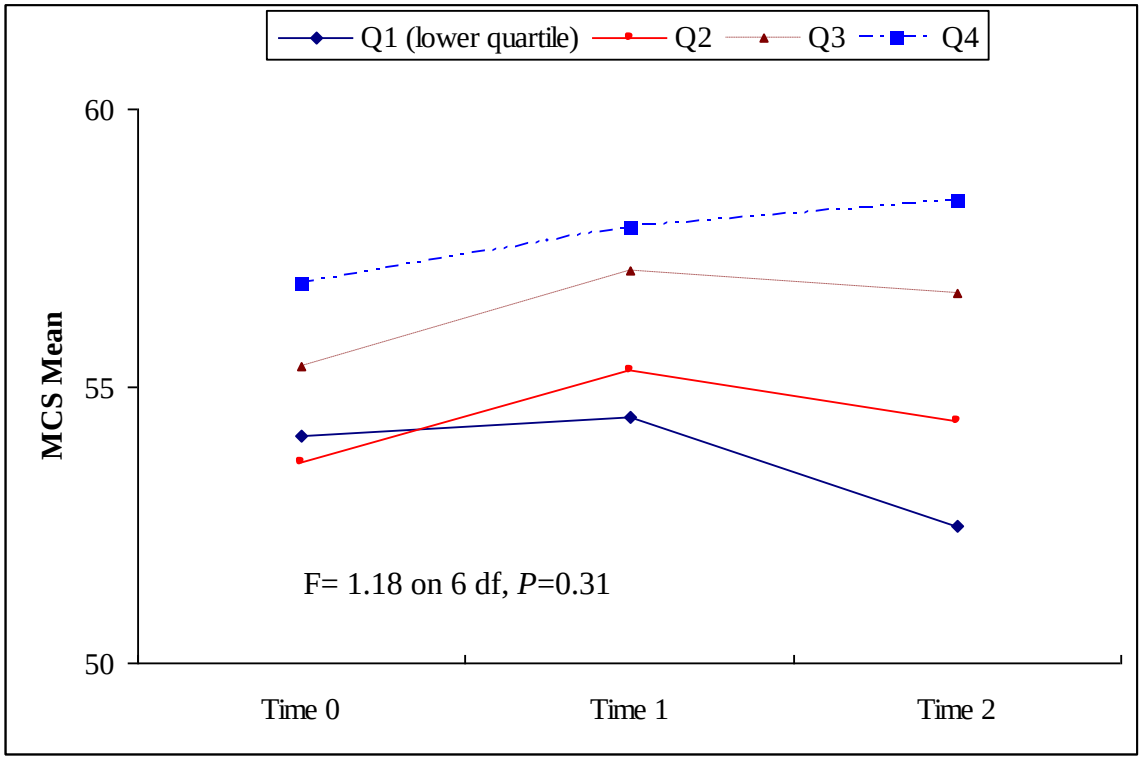

Figure C.3.3: Adjusted MCS mean over time for SPPB quartiles.

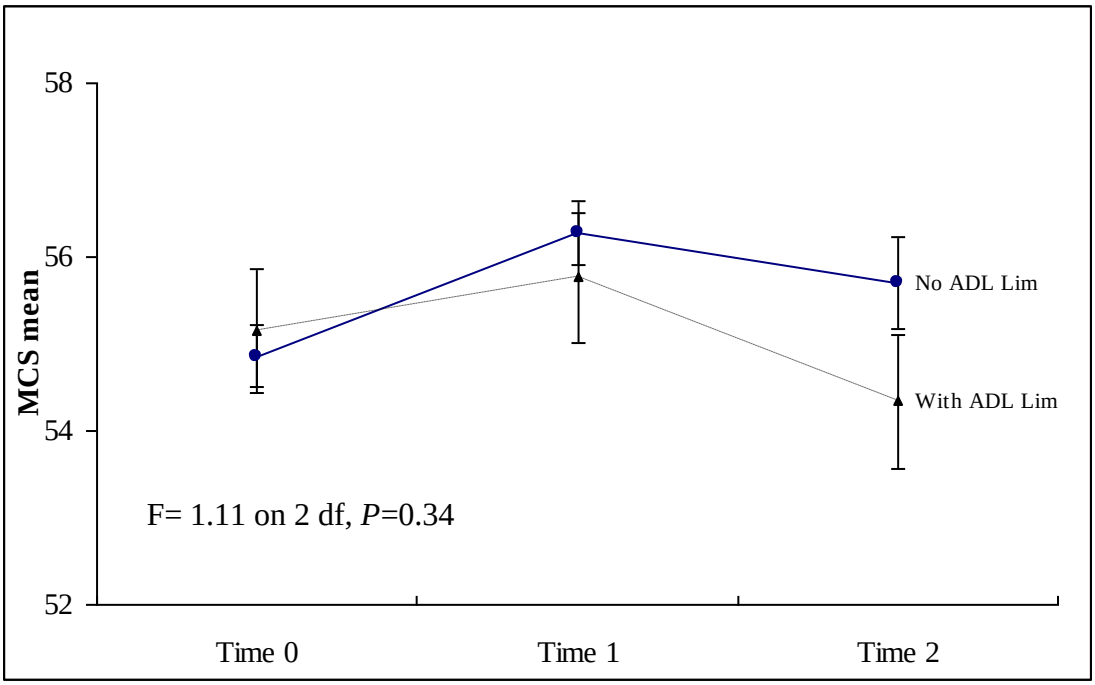

Figure C.3.4: Adjusted MCS mean over time for ADL limitation.

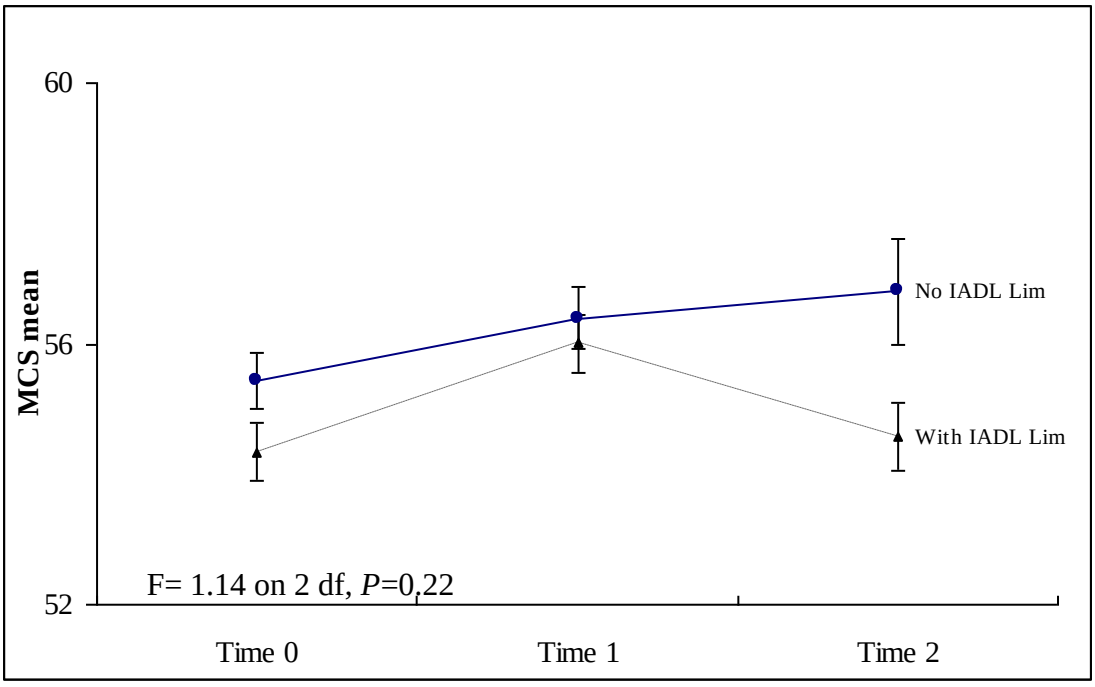

Figure C.3.5: Adjusted MCS mean over time for IADL limitation.

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Vita

Saad Mubarak Bindawas was born on May 30, 1978 in Khamis Mushait, Asser region, Saudi Arabia (SA). He was among the top 3% of high-school graduate students in Asser region of SA, in 1996. From 1997-2002, he attended the King Saud University, Riyadh, SA. He graduated with a Bachelor of Science degree in physical therapy. He spent his internship year at King Khalid University Hospital and at King Fahd National Guard Hospital, both in Riyadh, SA. He then earned his master degree in physiotherapy and occupational health in 2004 from the University of Sydney in Australia, where he helped PEDro (Physiotherapy Evidence Database) to be translated into Arabic language.

Afterward in 2004, he established a Physical Therapies Assistant (PTA) program at the Saudi German Hospital in Jeddah, SA - the largest private hospital group in the Middle East. He also, directed the continuing education committee within the Saudi Physical Therapy Association (SPTA) - Western Chapter.

In 2006, he was accepted to the doctoral program in Preventive Medicine and Community Health (PMCH) at UTMB. In May 2009, he graduated with a Ph.D. in Rehabilitation Sciences. At UTMB, he served as a vice president for the PMCH graduated student organization (2007-2008).

His professional experiences include Geriatrics, Occupational Health, and Orthopedic Rehabilitation. As a member of the AAAS, APTA, ACRM, and AGS he continually expands his training and knowledge in epidemiology, aging and rehabilitation outcome research.

He received some awards and honors, which include master and doctorate scholarships from the Saudi Ministry of Higher Education; Saudi Cultural Mission academic awards (4 times), Peyton and Lydia Schapper Endowed Scholarship (2008), Best Student Poster at the Forum on Aging (2008), the International Society for Neurochemistry assistantship (2008), and SAS student scholarships (SCSUG) (2008).

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List of Publication

Bindawas S, Al Snih S, Grady J, Protas E, Ottenbacher K. Arthritis Impact on the Health-Related Quality of Life among Older Mexican Americans. *(Submitted to the Journal of Rheumatology)*

Bindawas S, Al Snih S, Kuo F, Protas E, Markides K. Grip Strength and Gait Speed as Predictors of 12-Year Mortality in Older Men and Women. *(Ready for submission to the Journal of the American Geriatrics Society)*

Abstracts:

Bindawas S, Protas E. The role of fear-avoidance beliefs in predicating chronicity and disability in patients with acute low back pain: systemic review. Texas Physical Therapy Association 2008 Annual Conference. Oct 2007, pp 29-30; Galveston, TX, USA.

Bindawas S, Protas E. Can fear-avoidance beliefs predict chronicity and disability in patients with acute or sub-acute low back pain? The 49th Annual Meeting of the National Student Research Forum. Apr 2008, pp 109; Galveston, TX, USA.

Bindawas S, Al Snih S, Kuo F, Protas E, Markides K. Grip Strength and Gait Speed as predictors of 12-year Mortality in Older Men and Women. The 12th Annual Forum on aging poster symposium (2008). Nov 2008; Galveston, TX, USA. (Abstract Number: 15).

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Bindawas S, Al Snih S, Ottenbacher K, Protas E. The Influence of Arthritis on the Health-Related Quality of Life among Older Mexican Americans. The 2009 American Physical Therapy Association CSM. Feb 2009; Las Vegas, NV. (Control ID: 513168 ; Poster Number: 2068).

Bindawas S, Al Snih S, Kuo F, Protas E, Markides K. Grip Strength and Gait Speed as predictors of 12-year Mortality in Older Men and Women. The 2009 Annual Scientific Meeting of the American Geriatrics Society. May 2009; Chicago, IL. (Abstract Number: 587517; Poster Number: D132).

Bindawas S, Kuo Y.F, Al Snih S, Protas E.J, Ottenbacher O.J. Impact Of Lower Extremity Performance On Health-Related Quality Of Life In Older Mexican Americans. (Abstract submitted to the 50th Annual Meeting of the National Student Research Forum. Apr 2009; Galveston, TX, USA.)

NON PEER REVIEWED PUBLICATIONS

Bindawas S. Importance of implementing the evidence-based approach for the Saudi physical therapy practice. Saudi Physical Therapy Magazine (Elaj). May 2007, (2)18-19.

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