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Musculoskeletal Disorders and Health Behaviors Among U.S. Workers

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UNIVERSITY OF MIAMI

MUSCULOSKELETAL DISORDERS AND HEALTH BEHAVIORS AMONG U.S. WORKERS

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Musculoskeletal disorders (MSDs) are comprised of a wide range of pathological states including inflammatory and degenerative conditions affecting the muscles tendons, ligaments, joints, central and peripheral nerves, and supporting blood vessels of the human body. In addition, they constitute a significant proportion of all reported and/or compensable work-related diseases contributing to substantial numbers of lost work days and medical care utilization in the United States. MSDs have multiple and inter-connected risk factors, both occupational and non-occupational such as repetitive trauma, obesity, smoking, drinking, and physical activity. At the present time, the associations between US worker occupation/industry, health behaviors, health-related quality of life, geographic variations, and MSDs have not been thoroughly investigated. While the relationship between MSDs and work-related injuries has been comprehensively characterized with particular occupational exposures, this relationship in large nationally representative worker populations has not been examined. Using the 1997-2008 National Health Interview Survey (NHIS) Study Database and the 2001-2003 Medical Expenditure Panel Survey (MEPS), this dissertation examined musculoskeletal disorders in the US workforce, focusing on the under-explored associations between US worker occupation,

health behaviors (physical activity patterns, obesity, and cigarette smoking), geographical location, and health-related quality of life impact of musculoskeletal disorders .

The overall prevalence of arthritis was 21.7% with 14.2% for employed adults and variation in rates by occupation type (e.g., Computer/Mathematical occupations [11.2%] versus Healthcare support occupations [17.5%]). Overall rates of specific arthritis conditions, which also varied by occupation included: arthritis (19.3%), rheumatoid arthritis (2.3%), gout (1.4%), lupus (0.3%), and fibromyalgia (1.2%). Using a structural equation model with latent variables approach, we found that a two latent factor (gross and fine-motor functional limitations) model had good model fit among US workers with arthritis. Health behaviors mediated the relationship between occupation and both motor functional limitations. Workers with arthritis that were current smokers and did not engage in physical activity reported significantly greater levels of both types of motor functional limitations. Lastly, at age 25, blue-collar workers can expect to live 44 years of perfect health over their remaining life, while white-collar workers can expect to live 50. Among those with arthritis, QALE is 33 and 39 respectively. Said another way, blue-collar workers with arthritis can look forward to 17 fewer years of perfect health. At age 65, white-collar workers with arthritis who remain in the workforce can expect to lose just 4 QALYs relative to those without arthritis, while blue-collar workers lose nearly 6 of their remaining years of perfect health measured in QALYs. Musculoskeletal disorders are prevalent in the US workforce, vary by occupation/industry type, and can become disabling conditions that both consume a large proportion of health care resources and are the leading cause of functional loss in adults. Health behaviors appear to partially mediate the relationship between musculoskeletal conditions and functional limitations. Work disability related to MSDs is a challenge to employability, business productivity, and the capacity of health and social security systems. Preventive efforts to decrease sick leave due to MSDs may include measures to increase the occurrence of positive health behaviors at work and to minimize repetitive work procedures. Targeted research efforts among workers with arthritis that reduce the presence of harmful workplace exposures, enhance workplace accommodations and educate on the deleterious effects of negative health behaviors are warranted. Future occupational surveillance systems should develop robust self-reported and biological measurements to document and examine MSDs in the US workforce.

DEDICATION

This dissertation is dedicated to my loving grandparents, Mr. Manuel Mayon Martinez and Mrs Georgina Rego-Estrada, whose unconditional love filled my childhood with happiness. To my mother who always supported and encouraged me to pursue whatever made me happy. And most wholeheartedly to Dr. Lora E. Fleming and Dr. David J. Lee (my scientific mother and father) who will never know how much their passion, dedication, and enthusiasm for epidemiology and public health fueled my interest to become a scientist.

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Chapter I. Introduction & Background

I. Overview

Musculoskeletal disorders (MSDs) represent a broad range of conditions including, inflammatory and degenerative disorders affecting not only muscles, tendons, ligaments, and joints, but also peripheral nerves and supporting blood vessels (Punnett 1996; Smolen and Aletaha 2008). In addition, these disorders constitute a major proportion of all reported and/or compensable work-related diseases contributing to substantial numbers of lost work days and medical care utilization in the United States (Zirkzee, Sneep et al. 2008; Allaire, Wolfe et al. 2009; Wallenius, Skomsvoll et al. 2009; Sokka, Kautiainen et al. 2010). MSDs have multiple and inter-connected risk factors, both occupational and non-occupational, such as repetitive trauma, obesity, smoking, and physical activity (Morales-Romero, Gonzalez-Lopez et al. 2006; Song, Chang et al. 2006; James, Miller et al. 2008; Tourinho, Capp et al. 2008; Allaire, Wolfe et al. 2009; Nissen, Gabay et al. 2010). At the present time, the associations between US worker occupation/industry, health behaviors, health-related quality of life, geographic variations, and MSDs have not been thoroughly investigated. While the relationship between MSDs and work-related injuries have been comprehensively characterized with particular occupational exposures (Stetler, Burns et al. 2003; Alnaser 2009; Darragh, Huddleston et al. 2009; King, Huddleston et al. 2009), the relationships between occupation/industry, health behaviors and health-related quality of life measures in large nationally representative worker populations have not been studied.

In order to characterize and describe the analyses of the abovementioned relationships, this dissertation has been organized into six chapters. The objective of chapter 1 is to provide a broad overview of the current scientific literature on the relationship between MSDs, health behaviors, and occupation/industry as well as briefly introduce the specific aims and hypothesis for each of the three papers/studies. Chapter 2 describes the methodology and the analytic approach used to construct the study databases, develop study measures and the algorithm to build analytic statistical models to test each of the study hypotheses. Chapters 3 to 5 layout the introduction, specific methods, results and conclusions for each of the three papers / specific aims addressed in this dissertation. Lastly, chapter 6 is a synthesis of the results of this dissertation, a scientific reflection in the broader context of the study results and its relation to the current scientific evidence. Chapter 6 also provides observations and suggestions from the vantage point of this dissertation's findings to further enhance our scientific understanding of the complex problem that is musculoskeletal disorders and related health behaviors in U.S. workers.

II. Musculoskeletal Disorders and US Health Care Expenditures

Musculoskeletal disorders often manifest with the onset of pain and resulting physical limitations (Veale, Woolf et al. 2008; Damsgard, Thrane et al. 2010). Musculoskeletal pain is almost inevitable in an individual's lifetime (Zanoli, Stromqvist et al. 2002; Meleger and Krivickas 2007; Damsgard, Thrane et al. 2010).

It is one of the most common reasons for self-medication and entry into the health care system (Cooper 2000; Book, Karlsson et al. 2008; Pascual-Ramos, Contreras-Yanez et al. 2009). Musculoskeletal pain affects 1 in 4 adults, and is the most common source of serious long-term pain and physical disability (Veale, Woolf et al. 2008; Damsgard, Thrane et al. 2010). The enormous impact of musculoskeletal disorders is now recognized by the United Nations, the World Health Organization, the World Bank, the National Academies of Sciences, and numerous governments throughout the world (Dingell 1984; Badley and Crotty 1995; Walsh, Brooks et al. 2008). For example, in 2006, musculoskeletal disorders accounted for nearly 70 million physician office visits in the United States, and approximately 130 million in total health care encounters (including outpatient, hospital, and emergency room visits) (Fries, Williams et al. 1996; Ward 1997; Kobelt 2007; Theis, Helmick et al. 2007; Kobelt and Jonsson 2008; Bansback, Marra et al. 2009).

More than one million workers miss time from their jobs due to musculoskeletal-related conditions at a cost of more than $50 billion a year (Eberhardt, Larsson et al. 2007; Zirkzee, Sneep et al. 2008). Nearly 1 million people each year report taking time away from work to treat and recover from musculoskeletal pain or loss of function due to overexertion or repetitive motion either in the low back or upper extremities (Houtman, Bongers et al. 1994; Morse, Dillon et al. 2005; Menzel 2008). Compounded with the indirect costs of reduced productivity, replacement labor, and business interruption costs, the total yearly estimated cost of workplace musculoskeletal injuries increases to more than $1 trillion or 10 percent of U.S. gross domestic product (Kvien 2004; Maetzel, Li et al. 2004; Ozminkowski, Burton et al. 2006). Although there is a risk of long-term disability in both types of disorder (occupational and non-occupational related musculoskeletal disorders), the majority of individuals return to work within 31 days (Straaton, Maisiak et al. 1996; Allaire, Wolfe et al. 2008). The contribution of work to the development of musculoskeletal disorders and the economic burden of MSDs have been well established by various epidemiological and clinical laboratory-based research, with some authors finding that up to 40% of these disorders may be attributable to work in the US population, significantly driving up US health care expenditures (Callahan 1998; Soderlin, Kautiainen et al. 2004; Ozminkowski, Burton et al. 2006).

III. Musculoskeletal Disorders and Epidemiologic Considerations

As with most chronic diseases, musculoskeletal disorders have multiple risk factors, both occupational and non-occupational (Houtman, Bongers et al. 1994; Eurenius and Stenstrom 2005; Feinglass, Thompson et al. 2005; Morse, Dillon et al. 2005; Song, Chang et al. 2006). In addition to work demands, other aspects of daily life, such as sports and housework, may present physical stressors to the musculoskeletal tissues (Keefe, Kashikar-Zuck et al. 1996; MMWR 2008). The musculoskeletal and peripheral nerve tissues are also affected by systemic diseases (such as rheumatoid arthritis, gout, lupus, and diabetes). The risk for these debilitating disorders varies by age, gender, socioeconomic status, and ethnicity. Other suspected risk factors include obesity, smoking, muscle strength, and other aspects of work capacity and job characteristics that have not been thoroughly examined (Verbrugge, Gates et al. 1991; Voigt, Koepsell et al. 1994; Okoro, Hootman et al. 2004; MMWR 2008; Stavropoulos-Kalinoglou, Metsios et al. 2009). Musculoskeletal disorders have been shown to occur in certain worker groups and occupations, with rates up to three or four times higher than the overall frequency (Abraido-Lanza, White et al. 2006; Menzel 2008; Darragh, Huddleston et al. 2009; King, Huddleston et al. 2009; Wang, Rempel et al. 2009).

One method of gathering data on the prevalence of musculoskeletal conditions is via self-reported population-based surveys (Schierhout and Myers 1996; Brady and Sniezek 2003; Fontaine and Heo 2005). Currently, based on these types of surveys, the estimated prevalence of musculoskeletal diseases varies between 2% and 65%, which is also affected by other survey design factors and the age of the study population (Veale, Woolf et al. 2008; Cote, van der Velde et al. 2009; MMWR 2009; Khang and Kim 2010). Epidemiologic research also points to environmental exposures including climate differences, soil composition (such as silica), lifestyle factors (such as diet and physical activity), and socioeconomic factors as possibly playing an important role in MSD susceptibility, such as arthritis (Edwards and Cooper 2006; Edwards and Cooper 2006; Masi, Aldag et al. 2006; Jordan and Callahan 2007). Using a large nationally representative worker population may provide a unique opportunity to examine quality data concerning health behaviors, health-related quality of life measures and arthritis.

IV. Musculoskeletal Disorders and Health Behaviors

Most studies suggesting an association between musculoskeletal disorders and specific health behaviors (physical activity patterns, obesity, risky alcohol consumption, and tobacco exposure) have been conducted in specific occupational settings (Hunter, March et al. 2002; Manek, Hart et al. 2003; Symmons 2003; Okoro, Hootman et al. 2004; Feinglass, Thompson et al. 2005; Greene, Haldeman et al. 2006; Shih, Hootman et al. 2006; Bajwa and Rogers 2007; Eurenius, Brodin et al. 2007; Stavropoulos-Kalinoglou, Metsios et al. 2009). However such studies do not estimate the overall burden of work-related musculoskeletal disorders within a general working population, nor do they compare this burden across occupations. The few published general population studies have mostly investigated occupational associations with self-reported pain in single upper limb areas or the neck and alcohol consumption (Meleger and Krivickas 2007; Cote, van der Velde et al. 2009; Kallberg, Jacobsen et al. 2009; Wang, Rempel et al. 2009; Maxwell, Gowers et al. 2010). One recent population study assessed the association of repetitive strain injuries and workplace factors, but drew on respondents' own causal attribution of injury to repetitive activities; associations were therefore mediated, and possibly confounded, by individuals' own assessment of causal factors (e.g. lack of physical activity) (McBeth, Harkness et al. 2003). Estimates of the burden of musculoskeletal disorders, require a sampling frame that captures a complete working age range, and includes the gambit of current, young and retired workers.

V. Musculoskeletal Disorders and Physical Activity

Despite considerable knowledge about musculoskeletal disorders and physical, psychosocial and individual risk factors (Smedstad, Kvien et al. 1995; Walker, Keegan et al. 1997; Vali and Walkup 1998; Escalante and del Rincon 1999; Pope, Silman et al. 2001), little is known about physical activity as a factor in preventing musculoskeletal disorders. The definition of physical activity has varied between numerous investigators, and has also resulted in a high degree of variability of measurable units (Robbins, Pis et al. 2004; Kendzierski and Morganstein 2009). "Leisure-time physical activity" is one measure that includes all leisure-time activities that are at least moderate to vigorous in intensity, and can be planned or unplanned activities that are part of everyday life (Caban-Martinez, Lee et al. 2007).

Physical activity is often recommended for preventing several diseases, including MSD, and incontrovertible evidence indicates that regular physical activity contributes to preventing cardiovascular disease and other chronic conditions (Sothern, Loftin et al. 1999; Prentice, Willett et al. 2004; Rhodes and Blanchard 2007). Review studies have concluded that dose-response relationships are evident between physical activity and a variety of health outcomes (Simons-Morton 1998; Al-Ajlan and Mehdi 2005; Kim, Shin et al. 2008; Hamer, Stamatakis et al. 2009; LeBlanc and Janssen 2010). Current US guidelines on physical activity recommend longer duration of moderate-intensity physical activity to achieve the same health benefits as for vigorous intensive activities(Moore, Fulton et al. 2010). However, the strength of the association between physical activity levels and musculoskeletal disorders has not been demonstrated in a nationally representative sample of US workers.

VI. Musculoskeletal Disorders and Health Related Quality of Life

An estimated 49.9 million Americans were afflicted with some form of arthritis from 2007-2009; due to the increasing average age of the population, this total is expected to rise to 67 million by the year 2030 (Reginster 2002; Kvien 2004; Theis, Helmick et al. 2007; Cheng, Hootman et al. 2010). Consistent with this, it was recently estimated that, since 1990, the prevalence of arthritis has increased by 750,000 cases per year (Theis, Helmick et al. 2007). Although the medical and economic consequences of arthritis are of great concern to researchers and clinicians, this disease also affects an individual's capacity to live a full and active life (Kobelt and Jonsson 2008; Lundkvist, Kastang et al. 2008; Lundqvist, Kastang et al. 2008). Thus, it has increasingly become clear that the problems associated with arthritis are not simply medical ones; it also appears to have a substantial impact on a person's functional capacity and quality of life (Kobelt and Jonsson 2008; Lundkvist, Kastang et al. 2008).

Data from 32,322 adults in 11 states from the 1998 Behavioral Risk Factor Surveillance Survey (BRFSS), a health survey conducted annually in the United States, indicates that adults with arthritis report significantly greater Health Related Quality of Life (HRQL) impairment compared to adults without arthritis (Ahluwalia, Holtzman et al. 2003). Specifically, those who have arthritis reported fair to poor health approximately three times more often than did those without arthritis (28.6% vs. 8.3%, respectively). They also reported a significantly greater number of days when physical and mental health was not good, and when usual activities were limited (Ahluwalia, Holtzman et al. 2003). It seems particularly appropriate to measure HRQL in arthritis patients because the chronic debilitating nature of this disease likely has a significant impact on their HRQL (Filocamo, Schiappapietra et al. 2010; Garip, Eser et al. 2010; Picchianti-Diamanti, Germano et al. 2010). If this is indeed the case, then the assessment of HRQL in arthritis patients is critical because this chronic disease does not typically cause death, but has a substantial effect on health, fitness, and physical, emotional, and social functioning (Soderlin, Kautiainen et al. 2004; Abell, Hootman et al. 2005; Bazzichi, Maser et al. 2005; Chmidling, Vradenburg et al. 2005; Lillegraven and Kvien 2007; Arne, Janson et al. 2009; Wallenius, Skomsvoll et al. 2009; Wallenius, Skomsvoll et al. 2009; Picchianti-Diamanti, Germano et al. 2010). Therefore, HRQL is likely to be a good indicator of both the global effects of arthritis on an individuals' life, as well as the effects of treatment.

VII. Musculoskeletal Disorders and Quality-Adjusted Life Years (QALYs)

As one of the most widespread public health problems facing the United States today, arthritis makes an interesting case study (from the musculoskeletal disorders spectrum) in the use of quality-adjusted life-year (QALY) estimates to measure morbidity losses from arthritic disease (Suarez-Almazor and Conner-Spady 2001), given that among these persons with arthritis, 38% are limited in their physical activities (CDC 1997; Heesch and Brown 2008). In 1997, the monetary cost of arthritis was $86.2 billion, with $51.1 billion attributable to direct costs (eg, medical costs) and another $35.1 billion attributable to indirect costs (e.g., lost productivity) (Wong, Ramey et al. 2001; Gabriel, Drummond et al. 2003; Kobelt 2007). Nevertheless, these figures underestimate the true economic burden of arthritis, as they do not include the impact of arthritis on quality of life (Bansback, Marra et al. 2009). These less tangible costs of arthritis are typically incorporated into cost-effectiveness analyses using QALYs or other health measures (Adams, Walsh et al. 2010; Lekander, Borgstrom et al. 2010; Wolfe, Michaud et al. 2010; Yuan, Trivedi et al. 2010) in order to compare the costs and outcomes associated with a particular treatment or intervention. The large economic burden associated with arthritis suggests that any bias in measures of health loss due to arthritis could have a significant effect on program evaluation, in other words the costs due to arthritis may be underestimated (Alderson, Starr et al. 1999; Schoster, Callahan et al. 2005; Hurley, Walsh et al. 2007; Lovisi Neto, Jennings et al. 2009). Although QALY methods vary (e.g., measurement of patient preferences; generic vs. disease specific health status measures), a common element of all QALY methods is the discrete and subjective assessment of health consequences that can be used to assess for specific musculoskeletal conditions or limitations (Boonen, van der Heijde et al. 2007; Barton, Sach et al. 2008; Linde, Sorensen et al. 2008).

There are a number of advantages to this approach. First, health status is generally estimated to be between 0 (utility in death) and 1 (utility in the perfect health state) (Hurst, Kind et al. 1997; Ko and Coons 2006). This boundary limits potential bias that might arise due to the survey format. Second, QALYs include losses due to pain and suffering in addition to changes in mortality, which is especially important for conditions such as arthritis where the largest share of utility loss can be attributed to pain and suffering (Gulfe, Kristensen et al. 2010). Finally, QALYs are relatively easy to compute. Catalogs of QALY losses for various symptoms and disability levels can be used to quickly estimate the loss associated with a given musculoskeletal condition (Doctor, Bleichrodt et al. 2004; McKenna, Michaud et al. 2005; McGregor and Caro 2006). Given the increasing demand for accurate health loss estimates that has accompanied the growing need for program evaluations to justify expenditures on health, developing national QALYS estimates for specific musculoskeletal conditions would be an important contribution (Zajac 2009; Greenfield 2010).

VIII. Musculoskeletal Disorders and Health Disparities

Socio-economic and ethnic health disparities in the incidence and outcome of some arthritis and musculoskeletal conditions have been noted, but they are not as consistently present among the least advantaged as they are for some other medical conditions (Bruce, Fries et al. 2007; Song, Chang et al. 2007; Bolen, Schieb et al. 2010). Ethnic disparities exist in the prevalence and severity of non-autoimmune musculoskeletal conditions, such as osteoarthritis (Dominick, Bosworth et al. 2004; Allen 2010; Kalichman, Malkin et al. 2010). For example, African American women may be 2–3 times as likely as Caucasian women to have radiographic osteoarthritis of the knee, and it has recently been shown that African American women also have a higher prevalence of radiographic knee osteoarthritis than do Mexican American women (Dominick, Bosworth et al. 2004; Allen 2010; Kalichman, Malkin et al. 2010). In the Johnston County Osteoarthritis Project, a population-based study of osteoarthritis in a rural North Carolina county, more severe and bilateral radiographic knee osteoarthritis was documented both in African American women and in African American men, as compared with Caucasians (Chen, Linnan et al. 2007; Jordan, Helmick et al. 2007). In addition, African American men were more likely than Caucasian men to have both radiographic hip osteoarthritis and bilateral hip osteoarthritis, a result found only in those in the lower SES group (Jordan, Helmick et al. 2007). For situations in which data about disparities are limited or nonexistent (such as osteoarthritis in Hispanics, Asians, or Native Americans), nationally representative databases such the National Health Interview Survey (NHIS) and the related Medical Expenditure Panel Survey (MEPS) database provide a source from which one can examine and explore disparities at the population level.

IX. A Lens for Musculoskeletal Disorders

There are a significant number of medical conditions that fall under the musculoskeletal disorders umbrella (Hagberg 1984; Van Eerd, Beaton et al. 2003; D'Souza, Franzblau et al. 2005; da Costa and Vieira 2010). For the purposes of this dissertation, the focus will be on arthritis and specific arthritis conditions (e.g. rheumatoid arthritis, gout, lupus, or fibromyalgia). Arthritis is a disabling condition that has been shown to decrease workforce productivity (Schneeberger, Citera et al. 2010; Sokka, Kautiainen et al. 2010; van der Leeden, Dahmen et al. 2010), increase episodes of sick leave from work (Zirkzee, Sneep et al. 2008), and in serve cases, withdrawing from the workforce (Cote, van der Velde et al. 2009; Zhang, Gignac et al. 2010). While there are many MSDs that affect the American workforce, this dissertation will largely focus on the effects of doctor diagnosed arthritis on health behaviors and occupation.

X. Dissertation Objectives

Using the 2004-2008 National Health Interview Survey (NHIS) Study Database and the 2001-2003 Medical Expenditure Panel Survey (MEPS), the below mentioned associations were explored through the following specific aims and hypotheses:

Specific Aim 1 – Using the 2004-2008 NHIS, document and compare the prevalence, trends, and geographical variation of rheumatic diseases (e.g. “EVER” diagnosis of arthritis, as well as specific arthritic conditions such as rheumatoid arthritis, gout, lupus, or fibromyalgia with a subset of the 2007-2008 NHIS) as well as describe the association between arthritis and socio-demographic correlates for all US workers, youth workers and older workers by occupation/ industry, National Occupational Research Agenda (NORA) sector, age, gender, race, and ethnicity.

Specific Aim 2 – Using the 2004-2008 NHIS, assess the differential health impacts of arthritis and functional limitations of US worker health behaviors (physical activity patterns, obesity, alcohol use, and tobacco exposure) by occupation and NORA Industry sector.

H_{2-1}: Within each NORA Sector, smoking and alcohol use will be higher in workers with osteoarthritis who report higher functional limitation relative to workers with arthritis and lower functional limitation.

H_{2-2}: Self-report of musculoskeletal disorders (e.g. arthritis) will be lower among occupations that report higher levels of leisure-time physical activity.

Specific Aim 3 – Estimate the health-related quality of life effects of having musculoskeletal disorders using Quality Adjusted Life Years (QALYS) by occupation and NORA Industry sector.

H_{3-1}: Relative to the general population of workers without arthritis, the incremental Quality Adjusted Life Years lost among workers with arthritis who are employed in blue collar occupations will be significantly greater than the incremental QALYS lost by white-collar workers with arthritis.

XI. Summary

Musculoskeletal diseases are the most common cause of chronic disability worldwide and will become increasingly important as aging populations require relief from chronic pain and disability (Cote, van der Velde et al. 2009). One of the characteristics of musculoskeletal diseases is that they are not fatal and do not have the high profile of other conditions, such as cancer and heart disease (Keyserling 2000; da Costa and Vieira 2010). Nonetheless, MSDs are preventable in many cases, and simple interventions, such as maintaining ideal body weight and participating in an exercise program, may have a significant effect on long-term morbidity (Amell and Kumar 2001; Rosenblum 2006). Furthermore, the field of musculoskeletal disease is limited by a significant lack of epidemiological and outcome data across a broad spectrum of occupational/industry sector, geographical coding, health behavioral, and economic assessment. To date, the associations between US worker occupation/industry, health behaviors, health-related quality of life, geographical variation and MSDs have not been thoroughly investigated. While the relationship between musculoskeletal disorders and work-related injuries and illnesses have been comprehensively characterized, this relationship with occupation/industry, geographical location, health behaviors and health-related quality of life in large nationally representative worker populations have not been studied.

Chapter II - Methodology

I. Overview

This chapter is divided into two general sections. In the first section, a broad overview of each data source namely, the National Health Interview Survey (NHIS), the Medical Expenditures Panel Survey (MEPS), and the National Death Index (NDI) utilized in this dissertation are discussed. Datasets created from these three data sources are publically available but require specific merging techniques and sample design estimation algorithms in order to properly describe population level estimates. The first section of this methodology chapter will also describe were a researcher can access additional resources should they want to analyze data outside the scope of the survey years collected and used for this dissertation. The second section provides detailed instruction on how the data was obtained, organized, and maintained for the specific aims of this dissertation, the statistical packages used, storage and maintenance of the data as well as the analytic approach used to test the proposed hypothesis for each aim.

In general, comprehensive population-level information on health status, behaviors and conditions for US workers is limited (Thacker and Stroup 1996; Hughes, McCracken et al. 2006; Chowdhury, Balluz et al. 2007; Uscher-Pines, Farrell et al. 2009). Several national U.S. surveys collect general employment statistics and health information relating to the direct care US workforce members receive from occupational injuries and select illnesses, however the data collected are not inclusive of all worker groups, and the terminology and definitions the surveys use are not necessarily consistent from one survey to the next or with current workforce conditions (Buehler, Ward et al. 1993). Traditionally, studies of musculoskeletal disorders in worker groups have focused on a single worker group (Swanson, Schwartz et al. 1984; Burns and Swanson 1991; Chen and Jenkins 2007). Only until recently have researchers begun to examine the psychosocial effects of these disorders on employment status and occupation type (Nieuwenhuijsen, Bruinvels et al. 2010). Pooling existing population-level data collected from primarily three national health databases sponsored by the US federal government is a novel approach to examining the three specific aims proposed for this dissertation (Botman and Jack 1995). Each database NHIS, MEPS, and NDI was selected for its appropriateness to address the research question.

II. The Study Databases

a. ***The National Health Interview Survey* –** The National Health Interview survey (NHIS) collects information on the amount and distribution of illness and disability in the United States. Established in 1956, by the US National Health Survey Act, and administered by the National Center for Health Statistics (NCHS) in the Centers for Disease Control and Prevention (CDC) since 1960, the NHIS collects health information on the civilian non-institutionalized population of the United States (Massey 1989). This data is most frequently used by various governmental, public and private entities to characterize various health condition, and demographic trends in the US (NCHS 1999). A significant amount of the data (minus specific demographic, geographical and potential identifier variables) collected for this NHIS is publicly available for download at the NCHS website (Statistics 2010). One of the major advantages and strengths of this survey in addressing the specific aims and hypotheses proposed in this dissertation lies in the data collected on these health characteristics which can be examined by many demographic and socioeconomic correlates in detail as well as by simple and complex occupational and industry groups.

i. **Survey Organization –** For the purposes of this dissertation, it is important to note, that in 1997 the NHIS was redesigned primarily to enhance health topic coverage, and address the increasingly important health issues in changes of population demographics occurring in the United States (Fowler 1996). Since the latest redesign, the NHIS consists of a basic module or core set of questions with varying supplements from year to year (NCHS 1999). The basic module is comprised of three components, the family core, the sample adult core, and the sample child core. In this dissertation, data primarily from the family and sample adult core was utilized. The family core collects data on everyone in the family including data on household composition and socio-demographic characteristics, tracking information, data to match other administrative data bases (e.g. social security, claims data, death data), and basic indicators on health status, activity limitations, injuries, health insurance coverage, and use of health care services.

ii. ***Sampling Frame*** Like the MEPS, and by virtue of its linkage, the NDI, and the NHIS sampling plan follows a multistage area probability design that permits the representative sampling of households and non-institutional groups such as individuals residing in long-term care facilities, persons on active duty with the armed forces (although their dependents are included), individuals in jail; and US nationals living in foreign countries) (Fowler 1996). From each family selected to participate in NHIS, one sample adult and one sample child are randomly selected to answer additional questions. To achieve survey objectives subject to resource constraints, the NHIS uses methods of clustering, stratification, and oversampling of specific population subgroups. First, the target universe of individuals is partitioned into primary sampling units (PSUs), which are comprised of single US counties, groups of adjacent counties, or metropolitan areas. These PSUs vary in population size and number of jurisdictions. The U.S. Bureau of the Census partitions each selected PSU into substrata based on Census blocks or combined blocks comprised of concentrations of Black, Asian, and Hispanic persons. These race and ethnicity density substrata are defined according to the population concentrations from the 2000 Decennial Census used for this dissertation. Sampling within the PSU substrata is complex and sometimes involves clustering dwelling units within each substratum.

iii. ***Analytic Sample Size* -** In this dissertation, a majority of the NHIS data utilized is from the 1997 to 2008 NHIS. Variation in the number of households sampled from year to year is largely based on the funding available to NCHS for this survey. For example in 2007, NHIS personnel interviewed approximately 29,266 households, yielding 75,764 persons in 29,915 families. From the sample adult core in that same survey year, 23,393 adults 18 and over provided self-reported information to the questionnaire. The sample response rate from 1997 to 2008 has ranged from 62.6 to 80.4% (Bloom and Tonthat 2002; Barnes, Adams et al. 2003; Blackwell and Tonthat 2003; Pleis and Coles 2003; Schoenborn, Adams et al. 2003; Schiller and Bernadel 2004; Schiller, Adams et al. 2005; Adams and Barnes 2006; Adams, Dey et al. 2007; Adams, Lucas et al. 2008; Bloom, Cohen et al. 2009). In section two of this chapter, the analytic sample size by specific aim will be presented.

iv. ***Data Collection Procedures* -** Data are collected through a personal household interview conducted by interviewers employed and trained by the U.S. Bureau of the Census according to procedures specified by the NCHS (NCHS 1999). The interviewer uses a computer assisted personal interviewing (CAPI) mode. The CAPI version of the NHIS questionnaire is administered using a laptop computer; interviewers enter responses directly into the computer during the interview. For the sample adult questionnaire, one adult per family is randomly selected; generally, this individual must self-report responses to questions in this section.

b. ***Medical Expenditure Panel Survey* –** The Medical Expenditure Panel Survey (MEPS) is largely funded and conducted by the U.S. Department of Health and Human Service's Agency for Health Care Research and Quality (AHRQ) and NCHS (Cohen, Monheit et al. 1996; Cohen 2003). MEPS data is collected as a subset from the NHIS pool of participants; as such it provides nationally representative estimates of health care use, health care expenditures, sources of payment, health insurance coverage, and health status for the US civilian non-institutionalized population. This survey has been administered since 1996, and its data can be used to estimate the impact of changes in sources of payment and insurance coverage on different economic groups or special populations of interest (such as the poor, elderly, families, veterans, the uninsured, and racial and ethnic minorities) (Cohen 2003). A major strength of this survey lies in its ability to facilitate research on relationships between individual characteristics, health conditions and health care utilization. This dissertation bridges self-reported health status data from the 2001-2003 MEPS (e.g. health related quality of scores in the form of EQ-5D) to the NHIS participants.

i. ***Sampling Frame* -** The set of households selected for any given year in MEPS is a random subsample of those participating in the NHIS (Cohen

2003). The MEPS household component consists of an overlapping panel design in which each sample panel is interviewed a total of five times over 30 months to yield annual use and expenditure data for two calendar years. For example, design specifications for the 2000 MEPS required that the full series of interviews necessary to acquire information for calendar year 2000 be completed in approximately 9,000 households. The same panel of households was interviewed in person three times over the course of the survey to obtain data on members' health care experience for 2000. The 2000 MEPS household component sample was selected from households that responded to the 1999 NHIS. More specifically, the 2000 MEPS household component sample was selected from a nationally representative NHIS subsample from two out of four NHIS panels to represent the U.S. population. It encompassed half of the participating households in the NHIS sample during the second and third quarters of 1999. NHIS was designed to permit nationally representative subsamples to be selected by restricting the sample to one of four distinct panels. Any combination of one to four panels will provide a nationally representative sample of households. Furthermore, each NHIS panel subsample for a given quarter of a calendar year is nationally representative. For the purposes of this dissertation, we used MEPS survey years that were sampled from 2000 to 2003.

ii. ***Questions Administered* -** MEPS currently has two major components: the household component and the insurance component however for the purposes of this dissertation we utilized data from the household component only (Cohen 2003). The Household component provides data from individual households and their members, which are supplemented by data from their medical providers. During the household interviews, MEPS collects detailed information for each person in the household on the following: demographic characteristics, health conditions, health status, use of medical services, charges and source of payments, access to care, satisfaction with care, health insurance coverage, income, and employment.

iii. ***Data Collection Procedures* -** MEPS is a large-scale and comprehensive data collection effort that includes many types of survey questions, some of which only pertain to subsets of the diverse respondents participating in the survey. To accommodate the extensive array of questions covered, yet minimize the number of questions asked of each respondent, data are collected using an intricate system of skip patterns and questionnaire modules grouped into sections. They use computer-assisted personal interviewing (CAPI) using a laptop computer to field a complex data collection instrument. Since data are collected using CAPI, rather than a hard copy questionnaire, the data collection instrument actually consists of sections that are composed of a series of computer screens containing questions, interviewing instructions, and skip pattern directions, as well as computer programming notes embedded along with each data item. For this dissertation we obtained demographic measures as well as individual and composite health-related quality of life scores (e.g. EQ-5D) administered to study participants.

c. ***National Death Index –*** The NCHS collects death information from each State's office of vital statistics (MacMahon 1983; Fillenbaum, Burchett et al. 2009). This data is computerized and indexed into the National Death Index (NDI). The NDI contains records on virtually all deaths in the United States since 1979 (MacMahon 1983). About 2.4 million death records are added to the file each year. Since 1982, the NDI database has implemented standardized measures to facilitate retrospective and prospective studies in medical and health research. These measures reduce the time, expense, and effort involved in ascertaining information about deaths, either for an entire study population or just for those subjects who could not be contacted.

Records from the NDI database can be linked with the records for the NHIS. At the time of developing this dissertations study aims, the NCHS updated the mortality linkage of the NHIS years including 1986-2004 death certificate data found in the NDI. The updated NHIS Linked Mortality Files provide mortality follow-up data from the date of NHIS interview through December 31, 2006. Mortality ascertainment is based primarily upon the results from a probabilistic match between NHIS and NDI death certificate records.

Linkage of the NHIS survey participants with the NDI provides the opportunity to conduct studies designed to investigate the association of a variety of health factors with mortality, using the richness of the NHIS questionnaires (Calle and Terrell 1993; James, Miller et al. 1997; Nakhaee, McDonald et al. 2007). There are two versions of the NHIS Linked Mortality Files: public-use files that include a limited set of mortality variables for adult NHIS participants and restricted-use files that include more detailed mortality information and mortality follow-up for children (NCHS 2010).

For this dissertation, specifically for paper #3, we merged data from the public-use NDI with NHIS using linkage files provided by the Agency for Healthcare Research and Quality. Detailed information on using the AHRQ linkage files and the merger process is described in the methods section of paper #3. Briefly, in this dissertation, the NHIS linked mortality files provided mortality follow-up data from the date of NHIS interview through December 31, 2006. Using a key variable (i.e. PUBLICID) available in both datasets, the NHIS record was linked to the NDI record when available.

III. Data Organization and Analytic Approach by Specific Aim

a. ***Data Storage -*** All the datasets generated for analyses conducted in this dissertation were stored in the study-related password protected computer. The computer was stored in a secure research office space in the clinical research building at the University of Miami, Miller School of Medicine.

Backup copies of all study databases reside in an external Western Digital hard drive also situated at the medical campus.

b. ***Statistical Packages and Data Management*** **–** For each specific aim examined in this dissertation, three popular statistical packages were utilized for either data management or statistical analyses**,** namely the Statistical Analysis System (SAS) version 9.2., the Predictive Analytics Software (PASW) version 18.0 with the added module called Complex Samples and MPlus version 6.0. All statistical packages take into account the complex sample survey weights, stratum, and primary sampling units of the NHIS and MEPS data.

c. ***Analytic Approach by Specific Aim*** **–** All of the specific aims and hypotheses tested in this dissertation used the abovementioned databases; however, the analytic approach and measures selected for each analysis varied by the objective of each aim. The following is a comprehensive and detailed description of the analytic approach used for each specific aim and testable hypotheses:

IV. Analytic Approach for the Three Dissertation Specific Aims / Papers

This dissertation examines the associations between US worker occupation/industry, health behaviors, health-related quality of life, geographical variation and MSDs in a three paper framework. In this second section, of this methodology chapter, a detailed description of the analytic approach for each specific aim by testable hypothesis will be presented. Specifically for each paper, the specific aim will be listed first, followed by the testable hypothesis when applicable, and the analytic approach utilized to address the specific aim.

a. **AIM #1:** We examined the prevalence and trends of arthritis, rheumatoid arthritis, gout, lupus, and fibromyalgia as well as described the association between arthritis and socio-demographic correlates by occupation, NORA (the new National Institute for Occupational Safety and Health (NIOSH)'s National Occupational Research Agenda) sectors, the National Center for Health Statistics (NCHS) categories (white collar, blue collar, farming and service workers) and employment status.

b. ***Dataset Used:*** The publically available 2004-2008 National Health Interview Survey data was obtained from the NCHS website. Of note, the survey response rate for the entire 2004-2008 study period ranged from 67.8-72.5% (Bloom and Tonthat 2002; Barnes, Adams et al. 2003; Blackwell and Tonthat 2003; Pleis and Coles 2003; Schoenborn, Adams et al. 2003; Schiller and Bernadel 2004; Schiller, Adams et al. 2005; Adams and Barnes 2006; Adams, Dey et al. 2007; Adams, Lucas et al. 2008; Bloom, Cohen et al. 2009).

   i. ***Data Merger:*** The approach was to first download all the raw data in ASCII form by survey year into one computer directory. For each survey year, the family, household, person and sample adult raw

ASCII data file was downloaded. NCHS provides both SAS and SPSS syntax code for each of the ASCII raw data files so that the user can create independent datasets with each raw data file. Once all component raw data files and corresponding syntax statements for each survey year (2004-2008) were downloaded onto the study computer directly, the syntax code was run on each raw ASCII data file to create year-dependent NHIS files. Individual survey year data was merged together using the HHX, FMX, and FPX variables that are unique and available in each of the component raw data files. The merger of these unique key variables in each survey year allows for the merger of all components (family, household, person and sample adult data) into one NHIS year file. At this step one master dataset for each survey year was created such that for annual NHIS dataset contained the family, household, person and sample adult data in one file. In order to conduct a pooled analyses using all NHIS years (2004-2008) we merged all the survey years into one master dataset by using the "add cases" statement in the SPSS dropdown menu. This dataset was saved and stored as the master file to examine the objective of this paper.

ii. ***Measures:*** For this first specific aim we used 16 unique measures available in the database: general arthritis diagnosis, specific arthritis condition (rheumatoid arthritis, gout, lupus, and fibromyalgia), chronologic age, gender, race/ethnicity, marital status, education, body mass index, health insurance status, U.S. geographic location, employment status (e.g. employed or unemployed), occupation type, and industry/sector.

1. General Arthritis Status – In the 2004-2008 NHIS, arthritis status among adults 18 years and older was assessed by response to the question: "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 (fy-bro-my-AL-jee-uh)?" Participants who responded in the affirmative to this question were coded as "having arthritis." Variable name: ARTH.
2. Specific Arthritis condition – For the 2007 and 2008 NHIS only, an additional question on the specific type of arthritis was administered to those participants who responded that they had been told by their healthcare professional that they had arthritis; specifically participants were asked: "You just mentioned that you were told by a doctor or other health professional that you had some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia (fy-bro-my-AL-jee-uh). Which of these were you told you had?" Those participants who responded to a specific type of arthritis were classified as

having both arthritis as a general category, and the specific type of arthritis they reported. Variable Name: ARTHTYP2 = rheumatoid arthritis; ARTHTYP3 = gout; ARTHTYP4 =lupus; and ARTHTYP5 = fibromyalgia.

3. Age – In each survey year, participants were asked to report their chronological age at time of interview. Variable Name: AGE_P
4. Gender - In each survey year, participants were asked to report their sex at time of interview. Variable Name: SEX
5. Race/Ethnicity – In each survey year, participants were asked to self-report their race and ethnicity. The study variable was coded from two variables, namely race: White, Black, or Other; and ethnicity Hispanic versus Non-Hispanic. Variable Names: MRACBPI2 and HISPAN_I
6. Marital Status – Survey respondents were asked to report on their current marital status. We recoded survey responses as: Married/Living with partner; Widowed, Divorced or Separated; or Single. Variable Name: R_MARITL
7. Education – Survey respondents report their highest level of education at time of interview. We recoded responses into Less than High School, High School Diploma, Some College or Higher. Variable Name: EDUC

8. Body Mass Index – The NCHS made available the Body Mass Index (BMI) values for all participants. For this study, the respondents were classified as “obese” if their BMI was greater than 30.0 kg/m2; “overweight” if their BMI was between 25-29.9 kg/m2 ; and “normal weight” if their BMI was between 18.5-24.9 kg/m2 . Variable Name: BMI
9. Health insurance status – Survey participants responded if they had some type of health insurance. Variable Name: PRIVATE
10. U.S. geographic location – NCHS personnel recorded the geographic location of where the respondent was living, coded as Northeast, Midwest, South or West. Variable Name: REGION. Of note, more detailed information on geographic location is available from the Research Data Center, however special US Census Bureau clearance is needed to access this sensitive, potentially identifiable information.
11. Employment status – Employed respondents aged 18 years and older reported on their occupation for the week prior to interview. Employment status (i.e. employed versus non-employed) was specified as a dichotomous variable based on the question “What is your current working status?”. Variable Name: DOINGLWA

12. Occupation type – The NHIS has been collecting data on occupation and industry for all currently employed persons, coded to the full detail of the Census occupation codes. Codes are provided in each NHIS year in Simple (23 Levels) or Detailed (41 Levels) occupational titles. For the purposes of this pooled analyses we confined our approach to 23 levels.
13. Industry/sector – We also grouped workers into eight industrial sector classifications, which are now the focus of the National Occupational Research Agenda (NORA) at the National Institute on Occupational Safety and Health (NIOSH). For example, each NHIS year contains a variable labeled "OCCUPN1" that has a 41-level detailed occupation associated with each person-level observation. The person-level occupational data can be cross-walked to the NORA Industry depending on the survey year. For 2004-2008 NHIS, the NHIS Industry codes do not translate directly into NORA Industry Sectors, and a conversion is necessary; details about this conversion as well as a flow diagram are provided in a Monograph entitled "NORA Morbidity and Disability: The National Health Interview Survey (NHIS) 1997-2007" (Lee DJ 2009). (See Table 2.1 and Figure 2.1 – the cross walk)

14. NCHS Four group – The 23 level occupational codes have been further classified into four broad based social classes (e.g. white-collar, service, farm and blue-collar workers) largely supported by NCHS and documented in the scientific literature (Krieger, Williams et al. 1997).

iii. **Complex Sample Design Weights:** The data analysis plan sample weights were adjusted to account for the aggregation of data over multiple survey years by dividing the original weight by 5 (the number of years combined in NHIS years 2004 through 2008) or by 2 (for the 2007-2008 period estimates) when examining specific arthritis condition (Fowler 1996). In PASW, a weighted analysis plan is first created. In the complex sample menu, the “prepare for analysis” option was selected. The survey weights provided in the datasets, depending on the pooled number of survey years were divided by five or two as indicted. The specific survey weight, depending on the analyses was specified in the “analysis plan”. For this plan, the PSU and Cluster variables were also provided.

iv. **Estimating Arthritis and Specific Type Prevalence:** We first calculated the prevalence of arthritis for the entire sample regardless of employment status or occupation type, and then estimated the prevalence of arthritis by employment status (employed versus unemployed) and specific occupation type. In this study, unknown values (i.e. responses coded as "refused", "not ascertained", or "don't know") were not counted in the denominators when calculating estimates; the non-response rate was approximately 1% for the arthritis and occupational variables. In PASW, the "Plan of Analysis" is first selected to provide and inform the statistical estimation technique the type of weights, PSU and strata needed.

v. **Assessing for Trends:** To assess for 2004-2008 trends in "ever being diagnosed with arthritis" within each survey period, a weighted linear regression model was fitted to the annual design-adjusted rates within occupational groups. The weight used for each annual rate was the inverse of its design-adjusted variance. SAS procedure GLM was used to estimate trends. (SAS code available in Appendix A.1.).

vi. **Association between arthritis and socio-demographic correlates:** Univariable and multivariable logistic regression models tested the association between socio-demographic characteristics and report of arthritis diagnosis and report of specific arthritis condition while controlling for potential confounders. An alpha level of 0.05 was considered statistically significant. In PASW, the analysis plan was first selected to properly address the sample weights, PSU and Strata needed to build and test these association. Then complex sample logistic regression procedure was used to estimate the univariable and multivariable regression models.

c. **AIM #2:** We examined the association of occupation on specific functional limitations, both directly and indirectly, through health behaviors using a structural equation modeling approach in a nationally representative sample of employed U.S. adults with arthritis. We tested two hypotheses: H_{2-1}: Within each NORA Sector, smoking and alcohol use will be higher in workers with arthritis who report higher functional limitation relative to workers with arthritis and lower functional limitation. H_{2-2}: Self-report of musculoskeletal disorders (e.g. arthritis) will be lower among occupations that report higher levels of leisure-time physical activity.

   i. **Dataset Used:** For specific AIM#2 we employed again publicly available data from the 2004-2008 NHIS.

   ii. **Data Merger:** The same master database developed for specific Aim #1 was employed for this specific aim.

   iii. **Measures:** The same demographic and occupational measures used for specific aim #1 were used for this specific aim. However new measures on health behaviors (i.e. smoking, drinking, and leisure-time physical activity) and activity limitations were employed.

      1. *Health Behaviors Measures* – The health behaviors examined for these analyses included heavy drinking, smoking, and leisure-time physical activity.

         a. Heavy drinking was defined as men who consume greater than two drinks per day and women who drank greater than one drink per day (Breslow and Smothers 2005).

b. Smoking - Participants who reported smoking at least 100 cigarettes in their lifetime were asked if they now smoked every day, some days, or not at all; those responding that they smoked every day or some days were considered "current smokers. (Tindle, Rigotti et al. 2006; Backinger, Lawrence et al. 2008)"

c. Leisure-Time Physical activity - Participants were considered to have met the Healthy People 2010 regular leisure-time physical activity guidelines if they reported engaging in: either "light-moderate activity" classified as ≥ 30 min ≥ 5 times per week, "vigorous activity" ≥ 20 min ≥ 3 times per week, or qualified for both activity categories, consistent with the methods and definitions used by the National Center for Health Statistics. We reported participants that had unmet leisure-time physical activity objectives (Caban-Martinez, Lee et al. 2007).

2. *Functional Limitations Variables* – Each survey year, respondents are asked questions on activity limitations. These functional or activity limitations were asked in nine ordinal

response questions such that respondents indicate if they have any trouble walking, climbing, standing, sitting, stooping, carrying, pushing, grasping, and reaching (Milidonis and Greene 2005; Theis, Murphy et al. 2007). For example, for each measure, participants were asked "By yourself, and without using any special equipment, how difficult is it for you to... [...Walk a quarter of a mile - about 3 city blocks?, ...Walk up 10 steps without resting?, ...Stand or be on your feet for about 2 hours?, etc]. Responses were measured on a 5-point likert scale: 1=Not at all difficult; 2=Only a little difficult; 3=Somewhat difficult; 4=Very difficult; or 5=Can't do at all. We further conducted a confirmatory factor analysis (CFA) to determine if these measures loaded on a single latent factor or two specific functional limitation latent factors. We found through this CFA that the functional/activity limitations loaded best as: 1) fine-motor (i.e. grasp and reach), and 2) gross-motor functional limitations (i.e. remaining seven items).

3. *Complex Sample Design Weights:* The data analysis plan sample weights were the identical weight plan as indicated in specific aim #1 using 5 years of survey data.

4. *Examining the association between arthritis, occupation, health behaviors, and functional limitations:* As an overview to the approach, we used a five pronged framework where we 1) Described the prevalence of functional limitations and health behaviors across occupation and control variables; 2) Estimated latent variable models for the functional limitation items; 3) Estimated the effects of occupation, health behavior variables, and control variables on the functional limitations latent variables; 4) Estimated a moderation model for the effects of control variables and health behaviors on the functional limitations latent variables for each of the four occupation categories; and 5) Estimated a mediation model of the effects of occupation and control variables on health behaviors (the mediators) and functional limitations latent variables. All models controlled for covariates with alpha= 0.05.

The same master NHIS 2004-2008 dataset used in specific aim / paper #1 was employed for this analysis. We first added our new measures on functional limitations and health behaviors, expanding the total number of variables available for analyses using the PASW data management functions. We then calculated prevalence of functional limitations and health behaviors by broad NCHS occupation type (e.g. white-collar, service, farm or blue-collar worker) (Krieger and Fee 1994; Krieger, Williams et al. 1997; Krieger, Chen et al. 1999).

Converting NHIS dataset into MPlus useable dataset – Data from the organized and standardized NHIS PASW software was converted into ASCII raw data, using PASW's export function. Using SAS's data step, a tab delimited data file for MPlus was generated (See program.sas code in Appendix, A.2.) comprised of the variables used for the present analyses. Using the complex analyses functions in MPlus we conducted a confirmatory factor analysis to estimate latent variable models for the functional limitation (See appendix for, MPlus Code, A.3 to A.7). We found that the functional limitations variables loaded best as two factors and used this loading on all subsequent analyses. Specifically, we gauged model quality by overall and component fit indices: the single factor model had good fit: comparative fix index (CFI) = 0.972, Tucker-Lewis index (TLI) = 0.977, root mean square error of approximation (RMSEA) = 0.052, chi-square ($\chi 2$) = 539.25 (df=19); $P<0.001$; however, the two factor model had a slightly better model fit: CFI = 0.977, TLI = 0.979, RMSEA = 0.049, $\chi 2$ = 454.38 (df=18); P<0.001.

Our conceptual mediation path model (Figure 4.1) (including adjustments for covariates) specified that occupation had direct effects and indirect effects through health behavior mediators on gross- and fine-motor functional limitations. Our moderation model estimated the effects of these health behaviors and covariates on functional limitations for each occupation type separately. The structural equation model estimating the direct and indirect effects of occupational category on functional limitations factors had good fit: CFI = 0.92, TLI = 0.90, RMSEA = 0.04. All moderation models for specific occupational sectors fit the data very well. Covariates included age in years, gender, race (white, black, other), marital status (married/living with partner, single, or divorced/widowed/separated) and obesity status (normal weight, overweight, or obese). These models were built and run using MPlus software for which individual model coding is available in the appendix by association type. Partially standardized coefficients were used for ease of interpreting the magnitude of association with latent variables.

iv. **AIM #3:** We examined the differences in health-related quality of life by arthritis status and occupation type in a nationally representative sample of employed US adults with arthritis. We hypothesized that (relative to the general population of workers without arthritis) the incremental Quality Adjusted Life Years lost among workers with arthritis who are employed in blue collar occupations will be significantly greater than the incremental QALYS lost by white-collar workers with arthritis.

1. **Dataset:** For specific aim/paper #3 we used data from all three surveys: NHIS, MEPS and NDI. We first pooled data from the 1997 to 2004 NHIS for all adult participants, using the same steps as indicated in specific aim #1. We then downloaded and pooled 1997 to 2004 publicly available mortality data from NDI. We also obtained and pooled publicly available MEPS data (to obtain MEPS participant EQ5D scores).
2. **Data Merger:** The NHIS linked mortality data files are person-level files and were linked to the NHIS public-use files by matching on the unique person-level NHIS ID number (Variable Name: PUBLICID). Merging of the NDI and NHIS data was achieved by constructing this unique key variable in each dataset and then merging the two

independent datasets into one master dataset (NHIS-NDI) on this key variable. We further merged additional data from the MEPS dataset into the master NHIS-NDI data. Each MEPS/NHIS link file contains a crosswalk that allows for the merger of MEPS full-year public use data files to NHIS person-level public use data files that contain data collected for MEPS respondents in the year prior to their initial year of MEPS participation. The variables used to merge data from 2000-2003MEPS to NHIS are DUPERSID, HHX, PX, LINKFLAG, PANELYR, and SRVY_YR.

3. **Measures:** In the present study we used the same demographic and occupational variables as described in specific aim / paper #1; however, we now add some additional measures to test hypothesis 3-1.

    a. *Mortality* – Mortality measures for this specific aim stem from the NDI data. Specifically we used variable MORTSTAT to identify the mortality status of all linked NHIS participants that had follow up for mortality through December 2006.

    b. *Health related quality of life (HRQoL) scores* – We used the quality-adjusted life year (QALY) as an outcome measure. The QALY combines health-related quality of life with life expectancy to calculate individual quality-adjusted life expectancy (QALE) (Asim and Petrou 2005; Tsuchiya and Dolan 2005; Scuffham, Whitty et al. 2008). The data for this measure is obtained from the MEPS dataset. Specifically, the health-related quality of life scores were derived from a paper-and-pencil self-administered questionnaire assessing EQ-5D measures from participants of the MEPS dataset. The EQ-5D consists of a 5-item descriptive system that measures 5 dimensions of health status (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) with 3 levels per dimension (no problem, some problems, and extreme problems) (Rabin and de Charro 2001; Walters and Brazier 2005; Sullivan and Ghushchyan 2006; Dyer, Goldsmith et al. 2010). The combination of all possible dimensions and levels results in 243 unique health states. A multi-attribute value function is used to map preferences for these health states. From this scoring algorithm, EQ-5D index scores are calculated based on responses to the 5-item questionnaire. The range of values for the EQ-5D index scores range from 0 to 1, where 0 is death and 1 is perfect health.

c. *Quality-Adjusted Life Expectancy (QALE)* – is a variable newly constructed by using 1-year age interval and occupation specific life tables (Anderson 2000). These values provide the life-expectancy of an individual (based on their current age and occupation) that has self-reported an arthritis diagnosis by a health care professional.

d. *Incremental Quality Adjusted Life Year (QALY)* – a variable we calculated by taking the difference of the QALE from a worker at a specific age interval without arthritis from the QALE of a worker in the same age interval with arthritis. The difference results in the incremental QALYS signifying the amount of years of perfect health lost to living with arthritis.

4. **Examining the burden of disease due to arthritis among US workers by age and social class:** We used a 4-step process to estimate quality-adjusted life expectancy (QALE) and to calculate incremental QALYs arising from arthritis among employed adults over age 18 relative to employed adults without arthritis. First, we estimated 1-year age interval

and occupation type specific mean EQ-5D scores, representing our health-related quality of life measure. We then calculated 1-year age interval and occupation-specific probabilities of death using a nationally representative database of US adults. Third, we calculated 1-year age interval and occupation-specific QALE using the interval and occupation-specific point estimates developed in steps one and two. Fourth, we calculated the age- and occupation-specific differences in QALEs between workers with arthritis and workers without arthritis. The difference between QALE values yielded the incremental QALYs.

a. *Estimating Probability of Death* **-** Age and occupation-specific probabilities of death were calculated by arthritis status using the National Health Interview Survey linked with the National Death Index. We pooled the data from the 1997 to 2004 NHIS for the adults, and linked it with pooled 1997 to 2004 (with follow up through 2006) mortality data from the NDI. During this time period we observed 16,965 deaths among the 242,223 NHIS participating adults. The probability of death was calculated for all adults from 18 to 88 years old by arthritis status. We developed two logistic regression models to estimate a predicted probability of death for any specific chronological age for which we had any missing data, as well as a model for mean EQ-5D scores using SAS procedures (Surveyfreq and Surveymeans) adjusting for the complex sample designs used in both NHIS and MEPS. In these models, HRQoL scores and survival were entered as dependent variables. We estimated the effects of age upon HRQoL scores and survival probabilities using linear regression. The resulting parameter estimates from the analyses by arthritis status were used to calculate predicted HRQoL scores and survival probabilities.

b. *Quality-Adjusted Life Expectancy (QALE) Measure* **-** We constructed a total of eight life tables in 1-year age intervals using US mortality data for each of the worker groups (white-collar, service, farm, and blue-collar workers) by arthritis status (Anderson 2000). We let A_i^c be the number of the population members surviving to age *i* and c denote the worker group (white-collar, service, farm, and blue-collar workers); and B_i^c be the life years between age *i* and *i* + 1.

Denoting the mortality rate at age, we estimated B using standard life table assumptions: B_i^c = (1 – m_i/2) A_i^c (Anderson 2000). The life expectancy (LE) at age *i* is the total life years above age *i* divided by the population surviving to age *i* : $LE_i = \sum_{j \geq i} B_j^c / A_i^c$ (Anderson 2000). Since the QALYs at age *i* is B_i^c x_i, the QALE at age *i* is $QALE_i = \sum_{j \geq i} B_i^c x_j / A_i^c$. The QALE lost contributed by arthritis is $\sum_{j \geq i} B_j^c \left(\sum_k \left(x_j^o - x_j^k\right) p_j^k\right) / A_i^c$ where x_j^o and x_j^k are the mean EQ-5D scores of the reference group (i.e. workers without arthritis) and for the k^{th} level of the risk factor, arthritis, respectively for age *i* and gender j; p_{ij}^k is the proportion of the population in the same one-year age interval and risk factor level *k*. Similar to the proportion of explainable QALYs lost, we calculated the proportion of explainable QALE lost contributed by arthritis by dividing the QALE lost by the potential QALEs that would be gained if the entire population had perfect health: $\frac{\sum_{j \geq i} B_j^c \left(\sum_k \left(x_j^o - x_j^k\right) p_j^k\right) / A_i^c}{\sum_{j \geq i} B_j^c \left(\sum_k \left(1 - x_j^k\right) p_j^k\right) / A_i^c}$ x 100%.

a. *Incremental Quality-Adjusted Life Years (QALY) calculation* **-** The difference between the QALE of workers without arthritis from the QALE of workers with arthritis for any given age and occupation-specific group yields the incremental QALYs. We calculated the incremental QALYs between and across worker group categories.

This chapter has reviewed the specific data sources, data management algorithms, study variable/measurement selection, and specific analytic approach for each specific aim / paper. The following dissertation chapters (3, 4, and 5) describe in further detail the background, significance, methods, results and conclusion of each paper's specific aim and respective hypotheses.

Table 2.1.a Conversion of simple (23 level) occupational standard codes (SOC) into the National Centers for Health Statistics (NCHS) Krieger four broad worker groups.

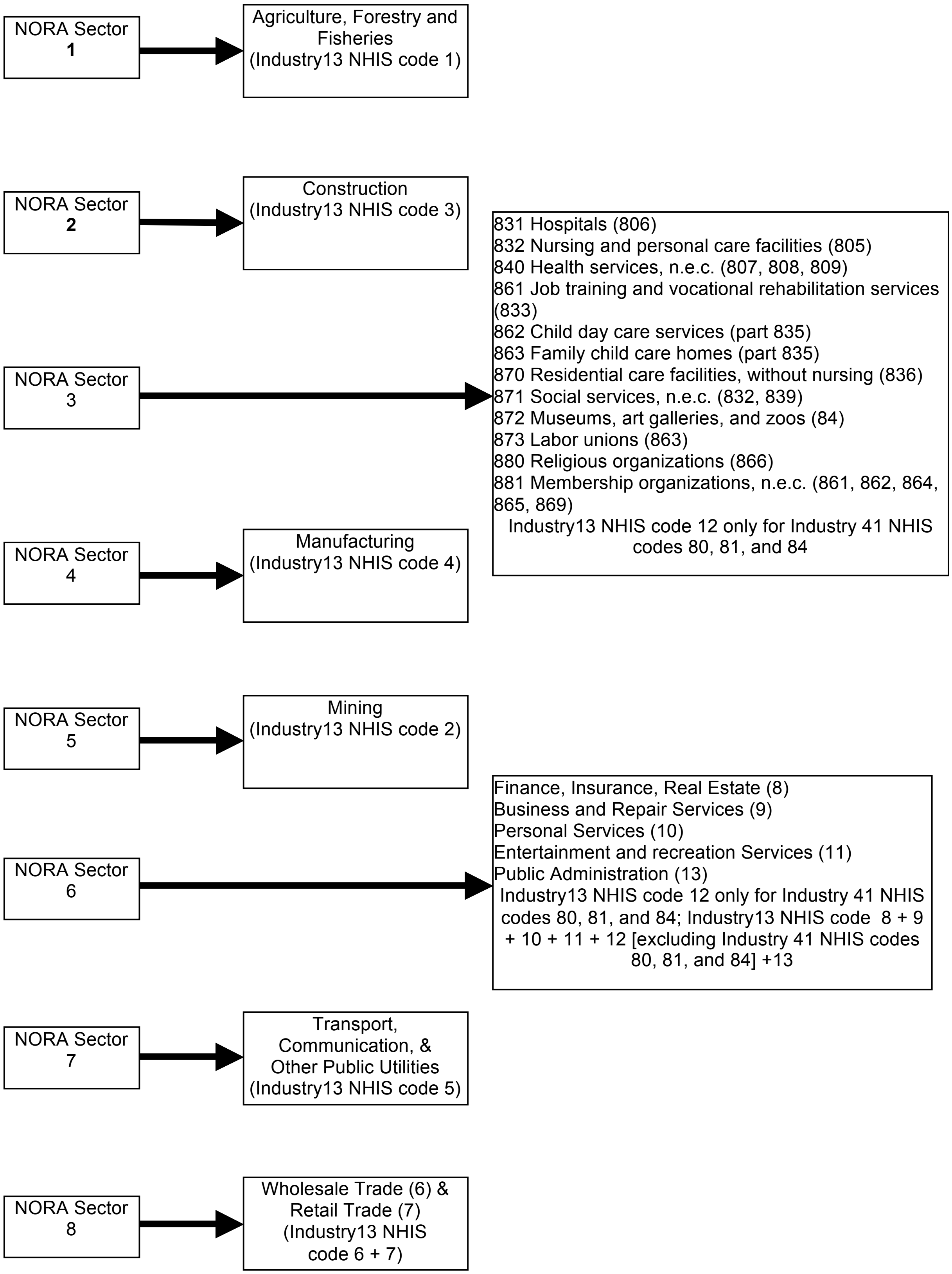
NHIS 2005 occupations

23 Occupations	Occ13
Krieger White-collar worker	
1 = Management	1
2 = Business and Financial Operations	1
3 = Computer and Mathematical	1
4 = Architecture and Engineering	2
5 = Life, Physical, and Social Science	2
6 = Community and Social Services	2
7 = Legal	2
8 = Education, Training, and Library	2
9 = Arts, Design, Entertainment, Sports, and Media	2
10 = Healthcare Practitioners and Technical	2
16 = Sales and Related	2
17 = Office and Administrative Support	3
Krieger Service Worker	
11 = Healthcare Support	6
12 = Protective Service	7
13 = Food Preparation and Serving Related	7
14 = Building and Grounds Cleaning and Maintenance	8
15 = Personal Care and Service	8
	8
	8
Krieger Farm Worker	
18 = Farming, Fishing, and Forestry	9
	9
	9
Krieger Blue-collar	
19 = Construction and Extraction	10
20 = Installation, Maintenance, and Repair	10
21 = Production	10
22 = Transportation and Material Moving	11
23 = Military Occupations	11

Table 2.1.b Conversion of detailed (41 level) occupational standard codes (SOC) into the National Centers for Health Statistics (NCHS) four Industry sectors. NHIS 1986 - 2004.

41 Occupations	Occ13
Krieger White-collar worker	
01 = Officials and administrators public admin	1
02 = Managers administrators, except public administration	1
03 = Management related	1
04 = Engineers	2
05 = Architects and surveyors	2
06 = Natural mathematical/computer scientists	2
07 = Health diagnosing	2
08 = Health assessment/treating	2
09 = Teachers, librarians, counselors	2
10 = Writers, artists, entertainers, athletes	2
11 = Other professional specialty	2
12 = Health technologists/technicians	3
13 = Technologists, technicians except health	3
14 = Supervisors and proprietors	4
15 = Sales representatives, commodities and finance	4
16 = Other sales	4
17 = Computer equipment operators	5
18 = Secretaries, stenographers and typists	5
19 = Financial records processing	5
20 = Mail and message distributing	5
21 = Other administrative support	5
Krieger Service Worker	
22 = Private household	6
23 = Police and firefighters	7
24 = Other protective service	7
25 = Food service	8
26 = Health service	8
27 = Cleaning and building service	8
28 = Personal service	8
Krieger Farm Worker	
29 = Farm operators and managers	9
30 = Farm workers and other agricultural workers	9
31 = Forestry and fishing	9
Krieger Blue-collar	
32 = Mechanics and repairers	10
33 = Construction and extractive trades	10
34 = Precision production	10
35 = Machine operators/tenderers, except precision	11
36 = Fabricators, assemblers, inspectors, samplers	11
37 = Motor vehicle operators	12
38 = Other transportation, except motor vehicles	12
39 = Material moving equipment operators	12
40 = Construction laborers	13
41 = Freight, stock, material handlers	13

Figure 2.1. Conversion of the 1986-2004 National Health Interview Survey (NHIS) industries into NORA sectors.



Chapter III – Specific Aim / Paper #1

I. Summary

Arthritis has multiple risk factors, both occupational and non-occupational that have not been thoroughly examined. Data from the 2004-2008 National Health Interview Survey, a nationally representative sample of US adults (n=131,091) were utilized to estimate prevalence and trends of rheumatic disease as well as examine associations between occupation and arthritis status among adult US workers. The overall prevalence of arthritis was 21.7±0.2% with 14.2±0.2% for employed adults and variation in rates by occupation type (e.g., Computer/Mathematical occupations [11.2±1.1%] versus Healthcare support occupations [17.5±1.0%]). Overall rates of specific arthritis conditions, which also varied by occupation included: arthritis (19.3±0.2%), rheumatoid arthritis (2.3±0.1%), gout (1.4±0.1%), lupus (0.3±0.1%), and fibromyalgia (1.2±0.1%). No significant trends were noted in study period. Self-report of arthritis status was significantly associated with unemployed (odds ratio=1.99; 95%CI=[1.90-2.09]), service (1.11;[1.04-1.19]), and blue-collar (1.13;[1.05-1.21]) workers relative to white-collar workers. Occupational surveillance for arthritis conditions may support tailored workplace health promotion programs designed to maximize worker health, productivity, and retention .

II. Background

Musculoskeletal disorders (such as arthritis, rheumatoid arthritis, gout, lupus and fibromyalgia) are becoming more prevalent, not just as the population ages(Helmick, Felson et al. 2008; Lawrence, Felson et al. 2008), but also as a consequence of environmental exposures, workplace organization, and lifestyle and health behaviors such as obesity and physical inactivity (Theis, Helmick et al. 2007; Keefe, Somers et al. 2008; Hootman and Cheng 2009). Moreover, arthritis can have significant physical and psychological repercussions (such as pain, activity limitations, fatigue, and depression) that directly impact the quality of life of afflicted individuals (Keefe, Somers et al. 2008; Dekker, van Dijk et al. 2009; Gooberman-Hill, French et al. 2009). Having arthritis can also affect the ability to remain employed (Gignac, Sutton et al. 2006). In comparison with individuals with other types of chronic disease or disabilities, arthritis appears to have a more profound impact on the ability to work and participate in other physical activities of daily living such as walking and reaching (Gignac, Sutton et al. 2007).

Consistently, research on arthritis and employment has demonstrated that having arthritis increases the risk of job loss (Gignac, Sutton et al. 2007). Traditionally studies of this association have focused on the impact of the specific disease characteristics (pain, fatigue, and activity limitations) have on meeting job demands, as well as the role of work organization and socio-demographic variables. What remains unexplored in the published literature is job-specific overall arthritis prevalence and the prevalence of other arthritis types (e.g., osteoarthritis, rheumatoid arthritis, lupus, fibromyalgia, etc) by major US occupational and industrial groups (Bradley, Young et al. 1987; Schaible, Ebersberger et al. 2002). Previous studies have found that 50% of adults with arthritis or arthritis-related disability were out of the workforce, leading to a loss of skilled workers and increasing the personal and socioeconomic burden of these diseases (Kaptein, Gignac et al. 2009). Identifying trends and occupational groups with specific arthritis conditions could inform the practice of preventive care, rheumatology and occupational medicine about working adults with arthritis.

In the present study, we 1) examine the prevalence of self-reported healthcare provider arthritis diagnosis by employment status and occupation type; and 2) describe the association between an individual's socio-demographic characteristics and self-reported arthritis, rheumatoid arthritis, gout, lupus, and fibromyalgia by occupation, NORA (the new National Institute for Occupational Safety and Health (NIOSH)'s National Occupational Research Agenda) sectors, the National Center for Health Statistics (NCHS) categories (white collar, blue collar, farming and service workers) and employment status (employed and unemployed).

III. Methods

a. *Data Source*

The prevalence and time-trends of ever being diagnosed with arthritis were analyzed using data from the 2004-2008 National Health Interview Survey (NHIS), an annual population-based survey of the resident non-institutionalized US civilian population conducted by the National Center for Health Statistics (NCHS). Interviews are conducted in-person by trained interviewers. In the Family Core component, information was collected on socio-demographic characteristics, health status and conditions, health behaviors, functional limitations, and healthcare access and utilization for all members of the household. In the Sample Adult Core component, one adult household member was randomly selected to provide more detailed personal health information. The NHIS data are cross-sectional therefore, we could not examine changes in rheumatic conditions over time at the individual level, but we could examine population level trends over time utilizing the annually representative NHIS data. More detailed information on specific rheumatic diseases were collected in years 2007 and 2008 (i.e. arthritis, rheumatoid arthritis, gout, lupus, and fibromyalgia). The survey response rate for the entire 2004-2008 study period ranged from 67.8-72.5% (Bloom and Tonthat 2002; Barnes, Adams et al. 2003; Blackwell and Tonthat 2003; Pleis and Coles 2003; Schoenborn, Adams et al. 2003; Schiller and Bernadel 2004; Schiller, Adams et al. 2005; Adams and Barnes 2006; Adams, Dey et al. 2007; Adams, Lucas et al. 2008; Bloom, Cohen et al. 2009).

b. *Arthritis Measures*

In the 2004-2008 NHIS, arthritis status among adults 18 years and older was assessed by response to the question: "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 (fy-bro-my-AL-jee-uh)?" Participants who responded in the affirmative to this question were coded as having arthritis. For the 2007 and 2008 NHIS only, an additional question on the specific type of arthritis was administered to those participants who responded they had been told by their healthcare professional that they had arthritis; specifically participants were asked: “You just mentioned that you were told by a doctor or other health professional that you had some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia (fy-bro-my-AL-jee-uh). Which of these were you told you had?”

c. *Occupational Measures*

Employed respondents aged 18 years and older reported on their occupation for the week prior to interview. Employment status (i.e. employed versus non-employed) was specified as a dichotomous variable based on the question “What is your current working status?”. Workers were grouped using the 2000 Standard Occupational Codes (SOC) into twenty-three major occupational groups (USDC 1980). We also grouped workers into eight industrial sector classifications, which are now the focus of the National Occupational Research Agenda (NORA) at the National Institute on Occupational Safety and Health (NIOSH) (Rogers 2006).

d. *Demographic Measures*

During each survey year, NHIS participants were asked their chronological age, gender, race (White, Black, or Other), ethnicity (Hispanic versus Non-Hispanic), marital status (Married/Living with partner; Widowed, Divorced or Separated; or Single) and highest educational level (Less than High School, High School Diploma, Some College or Higher) attained. The NCHS made available the Body Mass Index (BMI) values for all participants. Respondents were classified as “obese” if their BMI was greater than 30.0 kg/m^2; “overweight” if their BMI was between 25-29.9 kg/m^2 ; and “normal weight” if their BMI was between 18.5-24.9 kg/m^2.

e. *Statistical Analysis*

In this study, unknown values (i.e. responses coded as “refused”, “not ascertained”, or “don’t know”) were not counted in the denominators when calculating estimates; the non-response rate was approximately 1% for the arthritis and occupational variables. To enhance the precision of prevalence estimates, data were pooled over years 2004-2008 and 2007-2008 for the more detailed arthritic conditions assessed in the two latter survey years. For pooled prevalence estimates, sample weights were adjusted to account for the aggregation of data over multiple survey years by dividing the original weight by 5 (the number of years combined in NHIS years 2004 through 2008) or by 2 (for the 2007-2008 period estimates) (Botman and Jack 1995; Fowler 1996). Univariable and multivariable logistic regression models tested the association between socio-demographic characteristics and report of arthritis diagnosis and report of specific arthritis condition while controlling for potential confounders. An alpha level of 0.05 was considered statistically significant. Given the complex sample survey design of the NHIS, analyses were completed with the PASW Statistics 18 (formerly SPSS Statistics) and PASW

Complex Sample package to take into account sample weights and design effects (IBM 2010).

f. *Trend Analysis*

To assess for 2004-2008 trends in ever being diagnosed with arthritis within each survey period, a weighted linear regression model was fitted to the annual design-adjusted rates within occupational groups. The weight used for each annual rate was the inverse of its design-adjusted variance. The protocol was approved by the University institutional review board.

IV. Results

There were a total of 131,407 participants 18 years of age and older who reported working within the 1 week prior to their participation in the 2004-2008 NHIS (representing an estimated annual 218,721,057 US workers); 10,847 of these workers (representing an estimated annual 18,946,545 workers) self-reported ever being told by their health professional they had arthritis (Table 3.1). The overall age-adjusted prevalence of arthritis was 21.7 ± 0.2% among all adult participants with 14.2 ± 0.2% for the employed and 33.5 ± 0.3% for unemployed adults. Among the employed adults and within sub-group, arthritis was highest in those >75 years old (38.6 ± 2.3%), female (16.3 ± 0.2%), non-Hispanic whites (16.5 ± 0.2%), widowed, divorced or separated (21.6 ± 0.4%), obese (16.1 ± 0.2%), with a high school diploma (15.2 ± 0.3%), and living in the midwest region of the United States (24.0 ± 0.4%).

a. *Trend Analyses*

There were no significant overall arthritis trends across the five year NHIS study period therefore we did not adjust estimates by survey year for pooled analyses.

b. *General Arthritis Prevalence by Occupation Type*

The prevalence of general arthritis was highest among healthcare support occupations (17.0 ± 1.0%) and protective service occupations (16.7 ± 1.1%), and lowest among computer and mathematical (11.2± 1.1%) and farming, fishing and forestry occupations (11.0 ± 2.0%; Table 3.2). Males employed in community and social services (14.9 ± 1.8%) and legal occupations (14.5± 2.4%) reported the highest levels of arthritis, while males employed as food preparation and service related (5.5 ± 0.7%), and computer and mathematical occupations (10.1 ± 1.3%) reported the lowest. Among female workers, those employed in transportation and material moving (20.2 ± 1.8%) and protective service occupations (18.8 ± 2.2%) reported the highest, while females in life, physical, and social science (13.3 ± 2.1%), computer and mathematical (13.9 ± 1.8%) and food preparation and service related occupations (14.6 ± 0.9%) reported the lowest rates of arthritis. Female service (16.8 ± 0.5%) and male blue collar workers (13.2 ±0.4%) reported the highest life-time prevalence of arthritis, while male service (11.2 ±0.5%) and female white collar (16.5 ± 0.3%) reported the lowest.

c. *General Arthritis Prevalence by NORA Sector*

Among NORA sectors, arthritis, was highest among healthcare and social assistance (16.5 ± 0.5%), and transportation, warehousing, and utilities industry sectors (16.1 ± 0.7%) and lowest among construction (11.9 ± 0.6%) and wholesale and retail trade (13.4 ± 0.4%) sectors (Table 2). Males employed in the transportation, warehousing, and utilities industry (15.5 ± 0.9%) sectors reported the highest prevalence of arthritis, while males in construction (11.7 ± 0.6%) reported the lowest. Females employed in the healthcare and social assistance (17.5 ± 2.8%) sector reported the highest prevalence of arthritis while females in construction (13.2 ± 1.4%) reported the lowest.

d. *Specific Arthritis Type Prevalence by Socio-demographic Characteristics*

The prevalence rate of specific arthritis conditions varied across the subset of 2007-2008 NHIS participants: arthritis (17.5 ± 0.3%), rheumatoid arthritis (2.1 ± 0.1%), gout (1.3 ± 0.1%), lupus (0.3 ± 0.0%), and fibromyalgia (1.2 ± 0.1%; Table 3.3). Rheumatoid arthritis was highest in those >75 years old (4.7 ± 0.4%), females (2.9 ± 0.1%), non-Hispanic Blacks (2.4 ± 0.2%), widowed, divorced or separated (4.0 ± 0.2%), obese (2.7 ± 0.2%), with less than a high school diploma (3.4 ± 0.3%), unemployed (3.7 ± 0.2%), and those residing in the Midwest region (2.4 ± 0.2%) of the United States. Gout was highest among those aged 66-75 years old (2.7± 0.1%), males (2.0 ± 0.1%), non-Hispanic whites (1.4 ± 0.1%), widowed, divorced or separated (1.9 ± 0.1%), obese (2.2 ± 0.2%), with a high school diploma (1.5 ± 0.1%), unemployed

(1.7 ± 0.1%) and residing in the south (1.6 ± 0.1%) of the United States. Lupus showed little variation across demographics, with female (0.5 ± 0.1%), obese (0.4 ± 0.1%) unemployed adults (0.4 ± 0.1%) reporting the highest rates. Lastly, fibromyalgia was highest among those 46-65 years old (2.1 ± 0.2%), females (2.2 ± 0.1%), non-Hispanic Whites (1.5 ± 0.1%), widowed, divorced or separated (1.8 ± 0.2%), obese (1.9 ± 0.2%), some college or higher (1.3 ± 0.1%), unemployed (2.1 ± 0.1%), and residing in the midwest (1.5 ± 0.2%) of the United States. Among NCHS categories, white collar workers reported the highest rates of arthritis (11.6 ± 0.3%), lupus (0.3 ±0.1%) and fibromyalgia (0.3 ±0.1%), while service (1.3 ± 0.2%) and blue collar (1.6 ± 0.2%) workers reported the highest rheumatoid arthritis and gout, respectively.

e. *Association of arthritis, occupation and employment status*

In the univariable logistic regression analyses, self-report of arthritis status by a healthcare professional was not associated farming occupations relative to white-collar workers (un-adjusted odds ratio, UOR =0.71; 95% Confidence Interval, CI, [0.47-1.04], Table 3.4). However, self-report of arthritis status by a healthcare professional was significantly associated with unemployment (UOR=3.26 [3.13-3.40]), service workers (UOR=0.94 [0.88-0.99]), and blue-collar workers (UOR =0.92; [0.86-0.98]) (Table 3).

In the multivariable model, self-report of arthritis status by a healthcare professional was not significantly associated with farming occupations

(Adjusted odds ratio, AOR =1.10; 95% CI [0.74-1.63]. However, unemployed adults (AOR = 1.99 [1.90-2.09]), service workers (AOR = 1.11 [1.04-1.19]), and blue-collar workers (AOR = 1.13 [1.05-1.21]) were significantly more likely to report arthritis diagnosis by a healthcare professional relative to white-collar workers. In addition, individuals 75 years or older vs. 18-45 years old (AOR = 6.35 [5.89-6.85]; women vs. men, (AOR= 1.44 [1.39-1.50]); those who reported being divorced, widowed, or separated (vs. married/living with a partner) AOR = 1.16 [1.11-1.21], obese vs. healthy weight (AOR= 1.67 [1.59-1.76]); insured vs. no health insurance (AOR= 1.31 [1.22-1.40]); and residing in the US Midwest region vs. west (AOR= 1.17 [1.10-1.24]) were significantly more likely to report an arthritis diagnosis by a healthcare professional.

f. *Association of specific arthritis condition, occupation and employment status*

In the univariable logistic regression analyses, self-report of rheumatoid arthritis status by a healthcare professional was only associated with unemployed adults (UOR= 3.14 [2.90-3.40]) relative to white-collar workers (Table 3.5). Self-report of gout status by a healthcare professional was associated with unemployed adults (UOR= 2.13 [1.69-2.69]) and blue-collar workers (UOR= 1.79 [1.26-2.55]) relative to white-collar workers. Self-report of lupus status by a healthcare professional was associated with unemployed adults (UOR= 1.90 [1.18-3.07]) and blue-collar workers (UOR= 0.34 [0.13-0.93]) relative to white-collar workers. Lastly, self report of fibromyalgia status by a healthcare professional was associated with unemployed adults (UOR= 2.81 [2.17-3.65]) and blue-collar workers (UOR= 0.25 [0.13-0.45]) relative to white-collar workers.

g. *Rheumatoid Arthritis*

In the multivariable model, self-report of rheumatoid arthritis status by a healthcare professional was not significantly associated with service (AOR = 1.12 [0.78-1.61]), farming (AOR = 0.72 [0.10-5.32]) and blue-collar (AOR = 1.18 [0.81-1.70]) occupations relative to white-collar workers. However, unemployed adults (AOR = 1.99 [1.90-2.09]), service workers (AOR = 1.11 [1.04-1.19]), and blue-collar workers (AOR = 1.13 [1.05-1.21]) were significantly more likely to report rheumatoid arthritis diagnosis by a healthcare professional relative to white-collar workers. In addition, individuals 45-65 years old vs. 18-45 years old (AOR = 2.47 [1.99-3.08]; women vs. men, (AOR= 1.96 [1.62-2.36]); those who reported being divorced, widowed, or separated (vs. married/living with a partner) AOR = 1.22 [1.00-1.49], obese vs. healthy weight (AOR= 1.55 [1.27-1.88]); and insured vs. no health insurance (AOR= 1.39 [1.01-1.92]) were significantly more likely to report a rheumatoid arthritis diagnosis by a healthcare professional.

h. *Gout*

In the multivariable model, self-report of gout status by a healthcare professional was not significantly associated with service (AOR = 1.19 [0.74-

1.90]), farming (AOR = 1.09 [0.16-7.47]) and blue-collar (AOR = 1.30 [0.89-1.90]) occupations yet significantly associated with unemployed adults (AOR = 1.40 [1.10-1.79]) relative to white-collar workers. Individuals 75 years and older vs. 18-45 years old (AOR = 4.92 [3.32-7.31]; other race/ethnicity versus white, non-Hispanic (AOR= 1.63 [1.08-2.48]); those who reported being divorced, widowed, or separated (vs. married/living with a partner) AOR = 1.30 [1.05-1.61], and obese vs. healthy weight (AOR= 3.51 [2.58-4.77]) were significantly more likely to report a gout diagnosis by a healthcare professional.

i. *Lupus*

In the multivariable model, self-report of lupus status by a healthcare professional was not significantly associated with service (AOR = 0.76 [0.31-1.97]), farming (AOR = 0.00 [0.00-0.00]) and blue-collar (AOR = 0.92 [0.31-2.75]) occupations yet significantly associated with unemployed adults (AOR = 2.00 [1.18-3.35]) relative to white-collar workers. Individuals 45-65 years old vs. 18-45 years old (AOR = 2.68 [1.65-4.36]) and women vs. men, (AOR= 7.39 [3.64-14.98]) were significantly more likely to report a lupus diagnosis by a healthcare professional.

j. *Fibromyalgia*

In the multivariable model, self-report of fibromyalgia status by a healthcare professional was not significantly associated with service (AOR = 0.99 [0.59-1.64]), farming (AOR = 0.00 [0.00-0.00]) and blue-collar (AOR = 0.80 [0.43-

1.49]) occupations yet significantly associated with unemployed adults (AOR = 3.16 [2.36-4.21]) relative to white-collar workers. Adults 45-65 years old vs. 18-45 years old (AOR = 2.01 [1.53-2.64]; women vs. men, (AOR= 10.03 [6.70-14.96]); some college or higher vs les than high school (AOR= 1.89 [1.23-2.88]); overweight and obese vs. healthy weight (AOR= 1.81 [1.30-2.50] and 2.77 [2.08-3.68] respectively); and insured vs. no health insurance (AOR= 1.65 [1.00-2.36]) were significantly more likely to report a rheumatoid arthritis diagnosis by a healthcare professional.

V. Discussion

The present study examined both the prevalence of rheumatic diseases and association between an individual's socio-demographic characteristics and specific arthritic condition by occupation. Previous studies have traditionally focused on one or two specific occupation types or industrial sectors when describing the prevalence rates of arthritis in the US (McMillan and Nichols 2005; Hansen and Reed 2006; Fontana, Neel et al. 2007). However, this study used a nationally representative sample of US workers and found considerable variation in the prevalence of arthritis in employed and unemployed adults as well as specific arthritis type conditions at the national population level. We also identified socio-demographic characteristics that were significantly associated with report of specific arthritis conditions.

Occupational and non-occupational factors have been suggested to be involved in the etiology of certain arthritis conditions (Aluoch and Wao 2009) therefore we sought to describe the prevalence of arthritis conditions according to job title and socio-demographic characteristics. We found arthritis was highest among healthcare support, protective service, and community and social support occupations and lowest among food preparation and serving related occupations as well as fishing and forestry occupations. These findings are consistent with reports from Dillon and colleagues describing musculoskeletal-related disorders of the hand-wrist being highest in similar occupations including technicians, machine operators, and assemblers (Dillon, Petersen et al. 2002).

We also found high prevalence rates of specific arthritis conditions among adults employed in protective service and building, grounds cleaning and maintenance occupations who reported on rheumatoid arthritis. The study by Eberhardt and colleagues suggests that the effect of heavy manual jobs exposures such as those found in grounds cleaning and maintenance occupations was greatest in the early years of rheumatic diseases (Eberhardt, Larsson et al. 2007; Eberhardt 2009). Adults employed in physically demanding and labor intensive occupations may benefit from behavioral and educational interventions designed on ergonomic practices specific to the job type and workplace needs (Parks and Cooper 2006; Allaire, Wolfe et al. 2009).

There is growing evidence of the influence of occupational exposures in the risk of developing lupus (Parks and Cooper 2006). Exogenous influences on the development of lupus may originate in the workplace. We found lupus was highest among those employed as building, grounds cleaning & maintenance workers as well as personal care and service occupations. It is possible that environmental or non-genetic workplace factors influence the development of lupus such as infectious agents, chemical compounds or other workplace factors that may directly or indirectly stimulate an adverse immune response (Parks and Cooper 2006; Merskey 2008). Solvents are used extensively as degreasers and cleansers in many settings (e.g., cleaning metal in a variety of industries, dry-cleaning establishments), but the specific type of solvent varies substantially across types of workplaces, has varied through time, and even varies among workplaces. Additional surveillance among workers employed as personal care and service occupations identified in this analysis with a high rate of lupus could be educated on workplace chemical safety.

Of note, fibromyalgia was highest among those adults employed as healthcare practitioners and technical healthcare support occupations and lowest in sales and related occupations. Fibromyalgia is a common non-articular rheumatic syndrome of unknown etiology characterized by myalgia and multiple points of focal muscle tenderness to palpation (Merskey 2008). It is possible that given the relative introduction of classification and diagnosis criteria of fibromyalgia, health care professional may tend to report this condition more frequently than other US occupations (Merskey 2008).

Most adults spend half of their waking hours at work making the workplace an excellent setting for promoting health (Menkens 2009). Health promotion at work has effectively reduced number of employee sick days, resulting in improved productivity and cost savings to employers (Noblet and Lamontagne 2006). In addition to improving employee health, there is a strong business case for promoting physical activity among working adults with arthritis (Rimmer, Riley et al. 2004). We found overweight and obese adults were significantly more likely to report a physician diagnosis of arthritis than adults of healthy weight. There are a significant number of employer benefits related to better health such as reduced absenteeism but less obvious benefits of physical activity have also been demonstrated such as decreased back pain, increased productivity, increased stress tolerance and improved decision-making (McEachan, Lawton et al. 2008).

Surveillance for specific arthritis type conditions within the workforce and monitoring the distribution of workers with these conditions could allow for the prioritization and development of arthritis specific worksite health promotions programs. Understanding the socio-demographic characteristics strongly associated with these deleterious conditions could support tailored health promotions interventions. For example, rheumatoid arthritis is recognized to be a leading cause of pain and disability and, more recently, as placing people at increased risk of work loss (Beaton, Bombardier et al. 2009). The impact of arthritis on those who are still working is less well characterized, described and is inconsistently measured. Given that arthritis is the most common form of inflammatory arthritis with a prevalence rate of 1% and an annual incidence of 3 per 10,000 adults (Silman and Pearson 2002), identifying specific job types that have high rates of arthritis could aid in developing educational and behavioral interventions to improve work life.

Adults with rheumatoid arthritis often decrease their routine work hours, are often absent from the workplace, or suffer from job loss, all of which culminate in occupational productivity losses (Burton, Morrison et al. 2006). We found that adults aged 46-65 years old were significantly more likely to report a diagnosis of rheumatoid arthritis than adults aged 18-45 years old. Studies have shown that the associated costs associated with the burned of this disease are substantial. Lundkvist et al found that productivity losses accounted for 32% of the total annual costs per adult with rheumatoid arthritis in Europe, taken together these productivity cost are greater than other medical components such as medical costs (21%), drug costs (14%), non-medical costs (14%) or informal care costs (19%) (Lundkvist, Kastang et al. 2008). Compounded with the growing aging populations these costs could be expected to increase.

We found several socio-demographic characteristics that were significantly associated with report of rheumatoid arthritis, gout, lupus and fibromyalgia. Unemployment was significantly associated with all arthritis type conditions relative to white-collar workers. This observation may be due to the healthy worker effect where only the healthiest workers survive within the trade (that is, young individuals with, for example, arthritis pain would be forced into another trade than white-collar work) (Holmberg, Stiernstrom et al. 2002; Pearce, Checkoway et al. 2007). This would lead to bias toward the null. It has been suggested that farmers are less willing to seek healthcare for musculoskeletal problems(Holmberg, Stiernstrom et al. 2002), which would also lead to a bias toward the null. Other socio-demographic characteristics such as body mass index were significantly associated with rheumatoid arthritis, gout, and fibromyalgia while some geographic regions were significantly associated with gout and fibromyalgia.

Comparing the prevalence of arthritis from one region with another often provides insights into disease etiology. For example, coronary heart disease rates increased as Japanese migrated from Japan to Hawaii to mainland United States, suggesting that diet and environment were major causes of coronary heart disease (Bae, Fraser et al. 1998). For systemic lupus, a prevalence gradient exists with low prevalence of lupus occurring in Africans, moderate rates along the slave trade route among African descendents living in the Caribbean, and high rates in the United States. Data from the present study can be used to make inferences about differences in arthritis prevalence that might provide clues regarding rheumatic disease etiology.

The National Institute for Occupational Health and Safety (NIOSH) has developed a research program portfolio organized into eight National Occupational Research Agenda (NORA) sector programs that represent industry (Rogers 1996). Significant variation in life-time prevalence and specific arthritis type prevalence rates were noted between the NORA Sectors and the detailed occupational groups. Of note, estimates for NORA sectors are useful for characterizing broad variations in disease burden across the US workforce, but are not appropriate for use in the identification of worker groups who may be at-risk for occupational-related outcomes or for the identification of worker groups with high disease burden due to other factors (e.g., socio-demographic composition of the workforce). For example in the

NORA industry classification scheme, a participant employed as a security guard may be classified under the mining industry if they were working as security guard at a coal mine. However, employing the 2000 Standard Occupational Classification System (SOC) (USDC 1980) scheme would yield that same participant be classified as a Protective Service worker. Classification by industry as opposed to occupation not surprisingly leads to less variation in the range of arthritis prevalence rates. For example the range of male workers reporting arthritis varied little across NORA sector (11.7%-15.7%; see Table 2), while comparing male workers across the more detailed occupational categories yielded nearly a three-fold variation in prevalence rates (5.5% in Food preparation and serving-related occupations versus 16.1% in the Protective Service Occupations).

a. Limitations

The major advantage of the NHIS is that it is a large, multistage probability sample of the U.S. working population, with a high participation rate and minimal selection bias (NCHS 2000). The cross sectional design, however, is an important theoretical limitation with respect to causal inference, especially to the extent that there is a long latency between workplace exposure and onset of certain arthritis conditions and the fact that certain occupations may be viewed as more viable persons with disabling arthritic conditions . Data for this study are from self reports of survey participants and may be subject to recall bias. Also, the presence of arthritis was not confirmed by a health care provider; however, this case-finding question appears valid for public health surveillance purposes (Bombard, Powell et al. 2005; Sacks, Harrold et al. 2005).

b. Conclusions

In conclusion, the present study is first to describe national estimates for the prevalence of specific arthritis conditions in the US workforce by occupation and industry sector. Considerable variation in the estimates was noted, which is not surprising given that many of these conditions are age-related, associated with obesity, experiencing population shifts and occurring amidst an aging population. This variation in arthritis compounded with the increase in obesity in US worker groups suggests that overall arthritis will have a growing impact on the health care system as well as on working adults with arthritis in the future (Caban, Lee et al. 2005); one that needs to be anticipated in order to provide the early diagnosis and interventions that could help reduce the impact in the workplace.

Variation in the prevalence of rheumatoid arthritis by occupational group is of interest given this finding is consistent with findings of other similar studies but has no clear explanation. Work place adaptations from employers that assist working adults with rheumatic conditions in the workplace is needed. Future research should aim at developing surveillance system measures workplace accommodations and interventions for workers with arthritis. Using data from this nationally representative sample of US workers can assist in the future identification and monitoring of occupational groups that would benefit from additional research into educational interventions that support adults with arthritis conditions in the workplace.

Table 3.1.a Age-Adjusted Prevalence of Self-Report on "Ever told had arthritis" by socio-demographic characteristics for all adults ≥ 18 years participating in the NHIS 2004-2008

		TOTAL	
Demographics	**Sample N***	**% Ever Arthritis ± Standard Error**	**Estimated Annual US Population with Arthritis**
Total	131,407	21.7 ± 0.2	47,461,536
Age‡			
18-45 years old	64,003	8.0 ± 0.1	8,981,345
46-65 years old	43,031	29.5 ± 0.3	21,735,231
66-75 years old	12,910	46.9 ± 0.5	8,714,314
> 75 years old	11463	53.2 ± 0.6	8,030,643
Gender			
Male	60,146	18.3 ± 0.2	19,996,471
Female	71,261	24.9 ± 0.2	27,465,064
Race/Ethnicity			
White, Non-Hispanic	82,183	24.6 ± 0.2	38,022,896
Black, Non-Hispanic	19,709	19.2 ± 0.4	4,851,897
Other, Non-Hispanic	4,447	13.3 ± 0.6	1,002,818
Hispanic	22,773	11.5 ± 0.3	3,233,776
Marital Status			
Married/Living with Partner	68,897	21.7 ± 0.2	30,343,409
Widowed, Divorced or Separated	34,636	35.4 ± 0.3	13,448,797
Single	27,155	8.8 ± 0.2	3,573,156
Education			
Less than High School	17,400	26.9 ± 0.5	5,503,671
High School Diploma	32,347	25.0 ± 0.3	12,828,882
Some College or Higher	80,661	19.8 ± 0.2	28,973,846
Body Mass Index			
Normal Weight	23,701	16.0 ± 0.3	7,373,687
Overweight	22,670	20.9 ± 0.4	9,111,983
Obese	83,043	24.1 ± 0.2	30,258,532
Health Insurance Status			
Insured	109,877	23.4 ± 0.2	43,566,575
Geographic Distribution			
Northeast	22377	22.6 ± 0.3	8,836,729
Midwest	29713	24.0 ± 0.4	12,661,378
South	48775	21.3 ± 0.3	17,057,647
West	30542	18.9 ± 0.3	8,905,779

* Differences in sub-total population sample due to item non-response or missing.
‡ Age category is not age-adjusted.

Table 3.1.b Age-Adjusted Prevalence of Self-Report on "Ever told had arthritis" by employed and socio-demographic characteristics among adults ≥ 18 years participating in the NHIS 2004-2008

		EMPLOYED	
Demographics	**Sample N***	**% Ever Arthritis ± Standard Error**	**Estimated Annual US Population with Arthritis**
Total	131,407	14.2 ± 0.2	18,946,545
Age‡			
18-45 years old	64,003	7.1 ± 0.1	5,852,378
46-65 years old	43,031	24.1 ± 0.3	1,146,004
66-75 years old	12,910	38.5 ± 1.3	1,325,963
> 75 years old	11463	38.6 ± 2.3	308,162
Gender			
Male	60,146	12.4 ± 0.2	9,155,462
Female	71,261	16.3 ± 0.2	9,791,083
Race/Ethnicity			
White, Non-Hispanic	82,183	16.5 ± 0.2	15,344,315
Black, Non-Hispanic	19,709	11.8 ± 0.4	1,784,171
Other, Non-Hispanic	4,447	9.2 ± 0.7	448,796
Hispanic	22,773	6.9 ± 0.3	1,256,124
Marital Status			
Married/Living with Partner	68,897	15.1 ± 0.2	13,311,001
Widowed, Divorced or Separated	34,636	21.6 ± 0.4	3,890,213
Single	27,155	6.4 ± 0.2	1,715,920
Education			
Less than High School	17,400	11.2 ± 0.5	944,573
High School Diploma	32,347	15.2 ± 0.3	4,234,617
Some College or Higher	80,661	14.2 ± 0.2	13,725,657
Body Mass Index			
Normal Weight	23,701	9.7 ± 0.3	2,704,623
Overweight	22,670	13.7 ± 0.4	12,199,720
Obese	83,043	16.1 ± 0.2	18,745,072
Health Insurance Status			
Insured	109,877	15.2 ± 0.2	17,116,398
Geographic Distribution			
Northeast	22377	15.1 ± 0.3	3,611,594
Midwest	29713	16.3 ± 0.3	5,378,514
South	48775	13.5 ± 0.3	6,519,572
West	30542	12.0 ± 0.3	3,436,865

* Differences in sub-total population sample due to item non-response or missing.
‡ Age category is not age-adjusted.

Table 3.1.c Age-Adjusted Prevalence of Self-Report on "Ever told had arthritis" by unemployed and socio-demographic status among adults ≥ 18 years participating in the NHIS 2004-2008

		UNEMPLOYED	
Demographics	**Sample N***	**% Ever Arthritis ± Standard Error**	**Estimated Annual US Population with Arthritis**
Total	131,407	33.5 ± 0.3	28,487,090
Age‡			
18-45 years old	64,003	10.5 ± 0.3	3,122,650
46-65 years old	43,031	39.5 ± 0.5	10,258,961
66-75 years old	12,910	48.8 ± 0.6	7,387,615
> 75 years old	11463	54.0 ± 0.6	7,717,863
Gender			
Male	60,146	30.7 ± 0.4	10,829,757
Female	71,261	35.4 ± 0.4	17,657,332
Race/Ethnicity			
White, Non-Hispanic	82,183	37.1 ± 0.4	22,656,024
Black, Non-Hispanic	19,709	30.5 ± 0.6	3,066,085
Other, Non-Hispanic	4,447	20.6 ± 1.1	552,234
Hispanic	22,773	20.1 ± 0.5	1,975,736
Marital Status			
Married/Living with Partner	68,897	33.2 ± 0.4	17,009,964
Widowed, Divorced or Separated	34,636	48.0 ± 0.5	9,554,921
Single	27,155	13.5 ± 0.4	1,855,902
Education			
Less than High School	17,400	37.8 ± 0.7	4,556,446
High School Diploma	32,347	36.8 ± 0.5	8,586,983
Some College or Higher	80,661	31.0 ± 0.4	15,233,030
Body Mass Index			
Normal Weight	23,701	25.7 ± 0.6	4,667,276
Overweight	22,670	33.6 ± 0.7	5,268,100
Obese	83,043	36.5 ± 0.3	18,035,853
Health Insurance Status			
Insured	109,877	36.0 ± 0.3	26,427,505
Geographic Distribution			
Northeast	22377	34.6 ± 0.6	5,219,747
Midwest	29713	36.9 ± 0.7	7,275,950
South	48775	33.2 ± 0.5	10,526,858
West	30542	29.4 ± 0.6	5,464,533

* Differences in sub-total population sample due to item non-response or missing.
‡ Age category is not age-adjusted.

Table 3.2.a Age-Adjusted Prevalence of "Ever told had arthritis" by Occupational Classification, NORA Sector for all adults 18 years and older: NHIS 2004-2008

		TOTAL	
Occupational Classification	**Sample N**	**% Ever Arthritis ± Standard Error**	**Estimated Annual US Population with Arthritis**
Total	73,519	14.5 ± 0.2	18,603,311
Management	6,512	15.0 ± 0.5	1,812,004
Business and Financial Operation	3,207	14.0 ± 0.7	767,561
Computer and Mathematical	1,881	11.2 ± 1.1	374,401
Architecture and Engineering	1,329	12.1 ± 1.0	308,428
Life, Physical, and Social Science	743	12.0 ± 1.4	155,819
Community and Social Services	1,313	16.7 ± 1.3	361,607
Legal	829	16.0 ± 1.6	240,187
Education, Training, and Library	4,403	15.6 ± 0.6	1,209,609
Arts, Design, Entertainment, Sports	1,398	13.1 ± 1.0	319,509
Healthcare Practitioners and Technical	3,811	15.3 ± 0.7	10,16,632
Healthcare Support	1,894	17.0 ± 1.0	484,096
Protective Service	1,500	16.7 ± 1.1	435,667
Food Preparation and Serving Related	3,716	10.5 ± 0.6	665,586
Building & Grounds Cleaning	3,359	13.5 ± 0.7	726,122
Personal Care and Service	2,399	16.5 ± 0.9	624,427
Sales and Related	7,714	13.6 ± 0.4	1,906,652
Office and Administrative Support	10,417	16.6 ± 0.4	2,931,036
Farming, Fishing, and Forestry	561	11.0 ± 2.0	100,418
Construction and Extraction	4,447	11.2 ± 0.6	917,810
Installation, Maintenance, and Repair	2,516	14.3 ± 0.8	691,236
Production	5,224	14.7 ± 0.6	1,338,076
Transportation and Material Moving	4,289	15.4 ± 0.7	1,194,455
Military Specific	57	20.2 ± 7.4†	21,964
NORA Industry Sector			
Agriculture, Forestry & Fishing	949	13.6 ± 1.3	225,195
Construction	5,506	11.9 ± 0.6	1,222,141
Healthcare & Social Assistance	9,855	16.5 ± 0.5	2,650,544
Manufacturing	8,152	15.3 ± 0.5	2,251,824
Mining	294	15.1 ± 2.4†	83,774
Services	35,167	14.2 ± 0.2	8,668,920
Transport, Warehousing & Utilities	3,738	16.1 ± 0.7	1,062,866
Wholesale and Retail Trade	9,805	13.4 ± 0.4	2,394,115
Krieger category			
White Collar Worker	42244	14.8 ± 0.2	11,041,841
Service Workers	14181	14.3 ± 0.3	3,297,507
Farming	561	11.0 ± 2.0	100,418
Blue Collar Worker	16476	13.9 ± 0.3	4,141,579

† = Estimates do not meet NCHS standards of reliability or precision, given the sample size fell below 45.

Table 3.2.b Age-Adjusted Prevalence of "Ever told had arthritis" by Occupational Classification, NORA Sector for all male among adults 18 years and older: NHIS 2004-2008

		MALES	
Occupational Classification	**Sample N**	**% Ever Arthritis ± Standard Error**	**Estimated Annual US Population with Arthritis**
Total	73,519	12.7 ± 0.2	8,977,570
Management	6,512	14.4 ± 0.7	1,097,361
Business and Financial Operation	3,207	12.7 ± 1.0	335,033
Computer and Mathematical	1,881	10.1 ± 1.3	248,972
Architecture and Engineering	1,329	13.3 ± 1.2	281,921
Life, Physical, and Social Science	743	11.1 ± 1.8	80,495
Community and Social Services	1,313	14.9 ± 1.8	135,972
Legal	829	14.5 ± 2.4	107,366
Education, Training, and Library	4,403	13.5 ± 1.1	326,538
Arts, Design, Entertainment, Sports	1,398	10.5 ± 1.3	146,418
Healthcare Practitioners and Technical	3,811	12.2 ± 1.3	241,708
Healthcare Support	1,894	14.2 ± 2.2†	77,646
Protective Service	1,500	16.1 ± 1.3	321,548
Food Preparation and Serving Related	3,716	5.5 ± 0.7	158,462
Building & Grounds Cleaning	3,359	12.1 ± 0.9	385,359
Personal Care and Service	2,399	10.1 ± 1.4	95,141
Sales and Related	7,714	12.2 ± 0.6	908,141
Office and Administrative Support	10,417	13.1 ± 0.7	731,401
Farming, Fishing, and Forestry	561	9.8 ± 1.9†	70,095
Construction and Extraction	4,447	11.3 ± 0.6	853,016
Installation, Maintenance, and Repair	2,516	14.5 ± 0.9	633,303
Production	5,224	13.6 ± 0.7	849,800
Transportation and Material Moving	4,289	14.2 ± 0.7	883,951
Military Specific	57	11.0 ± 5.1†	7,913
NORA Industry Sector			
Agriculture, Forestry & Fishing	949	12.4 ± 1.5	158,912
Construction	5,506	11.7 ± 0.6	1,055,255
Healthcare & Social Assistance	9,855	13.0 ± 0.8	550,208
Manufacturing	8,152	14.4 ± 0.5	1,483,160
Mining	294	15.7 ± 2.6†	73,812
Services	35,167	12.2 ± 0.3	3,733,195
Transport, Warehousing & Utilities	3,738	15.5 ± 0.9	74,4289
Wholesale and Retail Trade	9,805	11.7 ± 0.5	1,171,553
Krieger category			
White Collar Worker	42244	12.8 ±0.3	4,505,358
Service Workers	14181	11.2 ± 0.5	1,174,131
Farming	561	9.8 ± 1.9†	70,095
Blue Collar Worker	16476	13.2 ± 0.4	3,220,071

† = Estimates do not meet NCHS standards of reliability or precision, given the sample size fell below 45.

Table 3.2.c Age-Adjusted Prevalence of "Ever told had arthritis" by Occupational Classification, NORA Sector for all female among adults 18 years and older: NHIS 2004-2008

		FEMALES	
Occupational Classification	**Sample N**	**% Ever Arthritis ± Standard Error**	**Estimated Annual US Population with Arthritis**
Total	73,519	16.6 ± 0.2	9,625,741
Management	6,512	16.1 ± 0.8	714,643
Business and Financial Operation	3,207	15.2 ± 1.0	432,527
Computer and Mathematical	1,881	13.9 ± 1.8	125,428
Architecture and Engineering	1,329	6.4 ± 1.6†	26,507
Life, Physical, and Social Science	743	13.3 ± 2.1	75,323
Community and Social Services	1,313	18.1 ± 1.6	225,635
Legal	829	17.4 ± 2.1	132,821
Education, Training, and Library	4,403	16.6 ± 0.8	883,070
Arts, Design, Entertainment, Sports	1,398	16.4 ± 1.7	173,090
Healthcare Practitioners and Technical	3,811	16.6 ± 0.9	774,924
Healthcare Support	1,894	17.7 ± 1.1	406,449
Protective Service	1,500	18.8 ± 2.2	114,118
Food Preparation and Serving Related	3,716	14.6 ± 0.9	507,123
Building & Grounds Cleaning	3,359	15.6 ± 1.2	340,763
Personal Care and Service	2,399	18.6 ± 1.2	529,286
Sales and Related	7,714	15.3 ± 0.7	998,511
Office and Administrative Support	10,417	18.2 ± 0.5	2,199,634
Farming, Fishing, and Forestry	561	15.6 ± 6.0†	30,323
Construction and Extraction	4,447	10.6 ± 1.8†	64,794
Installation, Maintenance, and Repair	2,516	13.1 ± 2.1†	57,932
Production	5,224	17.2 ± 1.1	488,276
Transportation and Material Moving	4,289	20.2 ± 1.8	310,504
Military Specific	57	37.9 ± 0.5†	14,051
NORA Industry Sector			
Agriculture, Forestry & Fishing	949	17.5 ± 2.8†	66,283
Construction	5,506	13.2 ± 1.4	166,886
Healthcare & Social Assistance	9,855	17.8 ± 0.5	2,100,335
Manufacturing	8,152	17.4 ± 0.9	768,664
Mining	294	11.6 ± 4.6†	9,962
Services	35,167	16.3 ± 0.3	4,935,724
Transport, Warehousing & Utilities	3,738	17.6 ± 1.3	318,576
Wholesale and Retail Trade	9,805	15.7 ± 0.6	1,222,561
Krieger category			
White Collar Worker	42244	16.5 ± 0.3	6,536,482
Service Workers	14181	16.8 ± 0.5	2,123,376
Farming	561	15.6 ± 6.0†	303,232
Blue Collar Worker	16476	17.0 ± 0.8	921,507

† = Estimates do not meet NCHS standards of reliability or precision, given the sample size fell below 45.

Table 3.3.a. Age-Adjusted Prevalence of Self-Report on "Ever told had Arthritis," by socio-demographic, NORA Sector, Krieger category among adults with arthritis (n=10,306) participating in the NHIS 2007-2008

		Arthritis	
Demographics	**Sample N***	**% Arthritis ± Standard Error**	**Estimated Annual US Population with Arthritis**
Total	45,174	17.5 ± 0.3	15,738,627
Age‡			
18-45 years old	21,955	5.6 ± 0.2	2,580,984
46-65 years old	14,832	24.6 ± 0.5	7,364,884
66-75 years old	4,493	39.5 ± 0.9	2,948,571
> 75 years old	3,894	46.4 ± 1.1	2,844,187
Gender			
Male	19,889	14.5 ± 0.3	6,260,531
Female	25,285	20.4 ± 0.3	9,478,096
Race/Ethnicity			
White, Non-Hispanic	27,428	20.2 ± 0.3	12,561,418
Black, Non-Hispanic	7,048	15.2 ± 0.5	1,590,195
Other, Non-Hispanic	1,928	10.1 ± 0.9	342,437
Hispanic	7,773	9.5 ± 0.4	1,128,861
Marital Status			
Married/Living with Partner	23,079	18.1 ± 0.3	10,034,094
Widowed, Divorced or Separated	11,807	29.7 ± 0.6	4,577,223
Single	10,078	5.9 ± 0.3	1,093,400
Education			
Less than High School	5,666	22.2 ± 0.8	1,775,287
High School Diploma	10,827	21.4 ± 0.5	4,374,524
Some College or Higher	28,415	15.7 ± 0.3	9,553,099
Body Mass Index			
Normal Weight	15,254	12.9 ± 0.3	3,964,172
Overweight	14,782	16.9 ± 0.4	4,982,407
Obese	13,864	23.7 ± 0.5	6,431,173
Employment Status			
Employed	26,282	11.3 ± 0.2	6,198,841
Unemployed	18,849	27.3 ± 0.5	9,539,786
Health Insurance Status			
Insured	26,282	11.3 ± 0.2	6,198,841
Geographic Variation			
Northeast	7,483	18.5 ± 0.5	2,841,357
Midwest	10,146	19.6 ± 0.6	4,238,911
South	16,750	17.3 ± 0.4	5,634,127
West	10,795	15.0 ± 0.5	3,024,230
NORA Industry Sector			
Agriculture, Forestry & Fishing	333	10.1 ± 1.8†	71,629
Construction	1,826	10.2 ± 0.9	418,108
Healthcare & Social Assistance	3,557	13.0 ± 0.7	884,058
Manufacturing	2,672	12.6 ± 0.8	735,277
Mining	113	12.7 ± 4.1†	28,602
Services	12,310	11.1 ± 0.4	2,827,983
Transport, Warehousing & Utilities	1,284	11.7 ± 1.1	308,785
Wholesale and Retail Trade	3,259	11.0 ± 0.6	781,671
Krieger category			
White Collar Worker	14,479	11.6 ± 0.3	9,009,989
Service Workers	4,995	11.2 ± 0.5	2,722,187
Farming	199	6.3 ± 1.9†	59,161
Blue Collar Worker	5,394	11.4 ± 0.5	3,344,286

* Differences in sub-total population sample due to item non response or missing.
† = Estimates do not meet NCHS standards of reliability or precision, given the sample size fell below 45.
‡ = Age category is not age-adjusted.

Table 3.3.b. Age-Adjusted Prevalence of Self-Report on "Ever told had Rheumatoid Arthritis," by socio-demographic, NORA Sector, Krieger category among adults with arthritis participating in the NHIS 2007-2008

		Rheumatoid Arthritis	
Demographics	**Sample N***	**% Arthritis ± Standard Error**	**Estimated Annual US Population with Arthritis**
Total	45,174	2.1 ± 0.1	1,903,067
Age‡			
18-45 years old	21,955	0.9 ± 0.1	395,518
46-65 years old	14,832	3.0 ± 0.2	886,800
66-75 years old	4,493	4.4 ± 0.4	330,091
> 75 years old	3,894	4.7 ± 0.4	290,656
Gender			
Male	19,889	1.3 ± 0.1	564,385
Female	25,285	2.9 ± 0.1	1,338,682
Race/Ethnicity			
White, Non-Hispanic	27,428	2.3 ± 0.1	1,418,940
Black, Non-Hispanic	7,048	2.4 ± 0.2	244,242
Other, Non-Hispanic	1,928	1.3 ± 0.3†	44,575
Hispanic	7,773	1.5 ± 0.2	182,369
Marital Status			
Married/Living with Partner	23,079	2.0 ± 0.1	1,118,789
Widowed, Divorced or Separated	11,807	4.0 ± 0.2	620,672
Single	10,078	0.9 ± 0.1	158,455
Education			
Less than High School	5,666	3.4 ± 0.3	272,337
High School Diploma	10,827	2.5 ± 0.2	515,035
Some College or Higher	28,415	1.8 ± 0.1	1,114,949
Body Mass Index			
Normal Weight	15,254	1.6 ± 0.1	483,594
Overweight	14,782	2.1 ± 0.1	613,177
Obese	13,864	2.7 ± 0.2	735,807
Employment Status			
Employed	26,282	1.1 ± 0.1	617,758
Unemployed	18,849	3.7 ± 0.2	1,285,308
Health Insurance Status			
Insured	26,282	2.1 ± 0.1	1,733,873
Geographic Variation			
Northeast	7,483	2.0 ± 0.2	305,701
Midwest	10,146	2.4 ± 0.2	509,770
South	16,750	2.2 ± 0.1	726,743
West	10,795	1.8 ± 0.1	360,851
NORA Industry Sector			
Agriculture, Forestry & Fishing	333	0.3 ± 0.3†	2,084
Construction	1,826	0.8 ± 0.2†	32,840
Healthcare & Social Assistance	3,557	1.2 ± 0.2	83,824
Manufacturing	2,672	1.2 ± 0.3†	69,601
Mining	113	1.6 ± 1.1†	3,590
Services	12,310	1.3 ± 0.1	331,931
Transport, Warehousing & Utilities	1,284	0.6 ± 0.2†	15,554
Wholesale and Retail Trade	3,259	1.1 ± 0.2†	76,452
Krieger category			
White Collar Worker	14,479	1.2 ± 0.1	901730
Service Workers	4,995	1.3 ± 0.2	315676
Farming	199	0.6 ± 0.6†	5211
Blue Collar Worker	5,394	1.1 ± 0.2	315811

* Differences in sub-total population sample due to item non response or missing.
† = Estimates do not meet NCHS standards of reliability or precision, given the sample size fell below 45.
‡ = Age category is not age-adjusted.

Table 3.3.c. Age-Adjusted Prevalence of Self-Report on "Ever told had Gout," by socio-demographic, NORA Sector, Krieger category among adults with arthritis (n=10,306) participating in the NHIS 2007-2008

		Gout	
Demographics	**Sample N***	**% Arthritis ± Standard Error**	**Estimated Annual US Population with Arthritis**
Total	45,174	1.3 ± 0.1	1,169,754
Age‡			
18-45 years old	21,955	0.5 ± 0.1	225,623
46-65 years old	14,832	2.0 ± 0.1	588,165
66-75 years old	4,493	2.7 ± 0.1	205,122
> 75 years old	3,894	2.5 ± 0.3	150,843
Gender			
Male	19,889	2.0 ± 0.1	848,033
Female	25,285	0.7 ± 0.1	321,721
Race/Ethnicity			
White, Non-Hispanic	27,428	1.4 ± 0.1	894,975
Black, Non-Hispanic	7,048	1.3 ± 0.1	133,135
Other, Non-Hispanic	1,928	1.6 ± 0.3†	54,333
Hispanic	7,773	0.6 ± 0.1†	70,807
Marital Status			
Married/Living with Partner	23,079	1.4 ± 0.1	795,925
Widowed, Divorced or Separated	11,807	1.9 ± 0.1	286,259
Single	10,078	0.5 ± 0.1	86,939
Education			
Less than High School	5,666	1.2 ± 0.2	94,488
High School Diploma	10,827	1.5 ± 0.1	305,241
Some College or Higher	28,415	1.3 ± 0.1	768,581
Body Mass Index			
Normal Weight	15,254	0.6 ± 0.1	170,958
Overweight	14,782	1.3 ± 0.1	385,427
Obese	13,864	2.2 ± 0.2	597,689
Employment Status			
Employed	26,282	1.0 ± 0.1	571,336
Unemployed	18,849	1.7 ± 0.1	598,418
Health Insurance Status			
Insured	26,282	1.4 ± 0.1	1,048,881
Geographic Variation			
Northeast	7,483	0.9 ± 0.1	132,598
Midwest	10,146	1.2 ± 0.1	249,990
South	16,750	1.6 ± 0.1	506,197
West	10,795	1.4 ± 0.2	280,968
NORA Industry Sector			
Agriculture, Forestry & Fishing	333	1.2 ± 0.6†	8,312
Construction	1,826	1.6 ± 0.4†	66,868
Healthcare & Social Assistance	3,557	0.3 ± 0.1†	23,462
Manufacturing	2,672	1.2 ± 0.2†	68,889
Mining	113	2.2 ± 1.3†	5,004
Services	12,310	1.0 ± 0.1	246,500
Transport, Warehousing & Utilities	1,284	1.5 ± 0.4†	39,387
Wholesale and Retail Trade	3,259	1.4 ± 0.2	100,702
Krieger category			
White Collar Worker	14,479	0.9 ± 0.1	687,084
Service Workers	4,995	0.9 ± 0.2†	219,584
Farming	199	0.9 ± 0.9†	8,878
Blue Collar Worker	5,394	1.6 ± 0.2	471,782

* Differences in sub-total population sample due to item non response or missing.
† = Estimates do not meet NCHS standards of reliability or precision, given the sample size fell below 45.
‡ = Age category is not age-adjusted.

Table 3.3.d. Age-Adjusted Prevalence of Self-Report on "Ever told had Lupus," by socio-demographic, NORA Sector, Krieger category among adults with arthritis (n=10,306) participating in the NHIS 2007-2008

		Lupus	
Demographics	**Sample N***	**% Arthritis ± Standard Error**	**Estimated Annual US Population with Arthritis**
Total	45,174	0.3 ± 0.0	248,165
Age‡			
18-45 years old	21,955	0.2 ± 0.0†	74,116
46-65 years old	14,832	0.4 ± 0.1	133,333
66-75 years old	4,493	0.4 ± 0.1†	32,583
> 75 years old	3,894	0.1 ± 0.1†	8,129
Gender			
Male	19,889	0.1 ± 0.0†	28,561
Female	25,285	0.5 ± 0.1	219,604
Race/Ethnicity			
White, Non-Hispanic	27,428	0.3 ± 0.0	168,605
Black, Non-Hispanic	7,048	0.4 ± 0.1†	37,534
Other, Non-Hispanic	1,928	0.1 ± 0.1†	4,690
Hispanic	7,773	0.3 ± 0.1†	34,220
Marital Status			
Married/Living with Partner	23,079	0.3 ± 0.0	150,348
Widowed, Divorced or Separated	11,807	0.4 ± 0.1	60,266
Single	10,078	0.2 ± 0.0†	37,550
Education			
Less than High School	5,666	0.2 ± 0.1†	17,949
High School Diploma	10,827	0.2 ± 0.0†	46,872
Some College or Higher	28,415	0.3 ± 0.0	183,344
Body Mass Index			
Normal Weight	15,254	0.2 ± 0.0†	71,618
Overweight	14,782	0.3 ± 0.0†	77,514
Obese	13,864	0.4 ± 0.1	97,938
Employment Status			
Employed	26,282	0.2 ± 0.0	99,728
Unemployed	18,849	0.4 ± 0.1	148,437
Health Insurance Status			
Insured	26,282	0.3 ± 0.0	231,349
Geographic Variation			
Northeast	7,483	0.3 ± 0.1†	39,606
Midwest	10,146	0.3 ± 0.1†	62,197
South	16,750	0.2 ± 0.0	77,454
West	10,795	0.3 ± 0.1†	68,907
NORA Industry Sector			
Agriculture, Forestry & Fishing	333	0.0 ± 0.0†	0
Construction	1,826	0.1 ± 0.1†	4,404
Healthcare & Social Assistance	3,557	0.5 ± 0.2†	37,259
Manufacturing	2,672	0.1 ± 0.1†	3,679
Mining	113	0.0 ± 0.0†	0
Services	12,310	0.2 ± 0.0†	43,478
Transport, Warehousing & Utilities	1,284	0.1 ± 0.1†	1,732
Wholesale and Retail Trade	3,259	0.1 ± 0.1†	9,173
Krieger category			
White Collar Worker	14,479	0.2 ± 0.1†	185,091
Service Workers	4,995	0.2 ± 0.1†	40,091
Farming	199	0.0 ± 0.0†	0
Blue Collar Worker	5,394	0.1 ± 0.0†	24,137

* Differences in sub-total population sample due to item non response or missing.
† = Estimates do not meet NCHS standards of reliability or precision, given the sample size fell below 45.
‡ = Age category is not age-adjusted.

Table 3.3.e. Age-Adjusted Prevalence of Self-Report on "Ever told had Fibromyalgia," by socio-demographic, NORA Sector, Krieger category among adults with arthritis (n=10,306) participating in the NHIS 2007-2008

Demographics	Sample N*	Fibromyalgia: % Arthritis ± Standard Error	Fibromyalgia: Estimated Annual US Population with Arthritis
Total	45,174	1.2 ± 0.1	1,090,449
Age‡			
18-45 years old	21,955	0.7 ± 0.1	308,808
46-65 years old	14,832	2.1 ± 0.2	615,468
66-75 years old	4,493	1.5 ± 0.2	109,927
> 75 years old	3,894	0.9 ± 0.2†	56,246
Gender			
Male	19,889	0.2 ± 0.0†	86,700
Female	25,285	2.2 ± 0.1	1,003,749
Race/Ethnicity			
White, Non-Hispanic	27,428	1.5 ± 0.1	955,445
Black, Non-Hispanic	7,048	0.5 ± 0.1†	49,780
Other, Non-Hispanic	1,928	0.3 ± 0.1†	11,241
Hispanic	7,773	0.6 ± 0.1	71,910
Marital Status			
Married/Living with Partner	23,079	1.3 ± 0.1	722,810
Widowed, Divorced or Separated	11,807	1.8 ± 0.2	276,817
Single	10,078	0.5 ± 0.1	88,064
Education			
Less than High School	5,666	0.8 ± 0.1	65,164
High School Diploma	10,827	1.1 ± 0.1	228,845
Some College or Higher	28,415	1.3 ± 0.1	796,440
Body Mass Index			
Normal Weight	15,254	0.8 ± 0.1	234,061
Overweight	14,782	1.0 ± 0.1	296,437
Obese	13,864	1.9 ± 0.2	522,070
Employment Status			
Employed	26,282	0.7 ± 0.1	367,429
Unemployed	18,849	2.1 ± 0.1	723,019
Health Insurance Status			
Insured	26,282	1.3 ± 0.1	998,756
Geographic Variation			
Northeast	7,483	1.0 ± 0.1	147,881
Midwest	10,146	1.5 ± 0.2	317,453
South	16,750	1.2 ± 0.1	382,418
West	10,795	1.2 ± 0.2	242,696
NORA Industry Sector			
Agriculture, Forestry & Fishing	333	0.0 ± 0.0†	0
Construction	1,826	0.2 ± 0.1†	9,043
Healthcare & Social Assistance	3,557	1.2 ± 0.2	82,872
Manufacturing	2,672	0.3 ± 0.1†	15,534
Mining	113	0.0 ± 0.0†	0
Services	12,310	0.8 ± 0.1	192,147
Transport, Warehousing & Utilities	1,284	0.5 ± 0.2†	13,756
Wholesale and Retail Trade	3,259	0.6 ± 0.2†	40,676
Krieger category			
White Collar Worker	14,479	0.9 ± 0.1	671,947
Service Workers	4,995	0.6 ± 0.1†	152,615
Farming	199	0.0 ± 0.0†	0
Blue Collar Worker	5,394	0.2 ± 0.1†	62,579

* Differences in sub-total population sample due to item non response or missing.
† = Estimates do not meet NCHS standards of reliability or precision, given the sample size fell below 45.
‡ = Age category is not age-adjusted.

Table 3.4. Weighted logistic regression of socio-demographic correlates on self-report of healthcare provider diagnosis of arthritis among adult participants of the 2004-2008 National Health Interview Survey.

Demographics	UOR	95% CI	AOR	95% CI
Employment Status *(Ref = White-collar workers)*				
Unemployed	3.26	3.13-3.40	1.99	1.90-2.09
Service Workers	0.94	0.88-0.99	1.11	1.04-1.19
Farming	0.71	0.47-1.04	1.10	0.74-1.63
Blue-collar Worker	0.92	0.86-0.98	1.13	1.05-1.21
Age *(Ref = 18-45 years old)*				
46-65 years old			3.76	3.58-3.95
66-75 years old			5.61	5.25-6.00
> 75 years old			6.35	5.89-6.85
Gender *(Ref = Males)*				
Female			1.44	1.39-1.50
Race/Ethnicity *(Ref = White, Non-Hispanic)*				
Black, Non-Hispanic			0.85	0.81-0.90
Other, Non-Hispanic			0.65	0.58-0.73
Hispanic			0.58	0.54-0.62
Marital Status *(Ref = Married / Living with Partner)*				
Widowed, Divorced or Separated			1.16	1.11-1.21
Single			0.69	0.65-0.73
Education *(Ref = Less than High School)*				
High School Diploma			0.94	0.88-0.99
Some College or Higher			0.84	0.78-0.89
Body Mass Index (Ref = Normal Weight)				
Overweight			1.40	1.32-1.49
Obese			1.67	1.59-1.76
Health Insurance Status *(Ref = not insured)*				
Insured			1.31	1.22-1.40
Geographic Distribution *(Ref = West)*				
Northeast			1.05	1.00-1.15
Midwest			1.17	1.10-1.24
South			1.03	0.97-1.08

UOR = Unadjusted Odds Ratio; AOR = Adjusted Odds Ratio; 95% CI = 95% Confidence Interval

Table 3.5.a. Weighted logistic regression models of socio-demographic correlates on self-report of healthcare provider diagnosis of specific arthritis condition (Rheumatoid Arthritis) among adult participants of the 2007-2008 National Health Interview Survey.

	Rheumatoid Arthritis (n=1,057)	
Demographics	**UOR; 95%CI**	**AOR; 95%CI**
Employment Status *(Ref = White-collar worker)*		
Unemployed	3.35; 2.76-4.06	2.40; 1.92-3.01
Service Workers	1.04; 0.74-1.46	1.12; 0.78-1.61
Farming	0.46; 0.06-3.38	0.72; 0.10-5.32
Blue Collar Worker	0.90; 0.65-1.26	1.18; 0.81-1.70
Age *(Ref = 18-45 year olds)*		
46-65 years old		2.47; 1.99-3.08
66-75 years old		2.31; 1.71-3.12
> 75 years old		2.21; 1.60-3.05
Gender *(Ref = Males)*		
Female		1.96; 1.62-2.36
Race/Ethnicity *(Ref = White, Non-Hispanic)*		
Black, Non-Hispanic		1.02; 0.82-1.28
Other, Non-Hispanic		0.70; 0.41-1.21
Hispanic		0.87; 0.66-1.15
Marital Status *(Ref = Married/Living with Partner)*		
Widowed, Divorced or Separated		1.22; 1.00-1.49
Single		0.73; 0.53-0.99
Education *(Ref = Less than High School)*		
High School Diploma		0.77; 1.60-0.98
Some College or Higher		0.66; 0.52-0.85
Body Mass Index *(Ref = Normal Weight)*		
Overweight		1.35; 1.08-1.69
Obese		1.55; 1.27-1.88
Health Insurance Status *(Ref = Not Insured)*		
Insured		1.39; 1.01-1.92
Geographic Variation *(Ref = West)*		
Northeast		0.90; 0.66-1.22
Midwest		1.19; 0.94-1.51
South		1.04; 0.84-1.30

UOR = Unadjusted Odds Ratio; AOR = Adjusted Odds Ratio; 95% CI = 95% Confidence Interval
† = As per NCHS standards of reliability or precision, given the sample size fell below 45 observations, estimates are flagged as unstable or unreliable

Table 3.5.b. Weighted logistic regression models of socio-demographic correlates on self-report of healthcare provider diagnosis of specific arthritis condition (Gout) among adult participants of the 2007-2008 National Health Interview Survey.

	Gout (n=584)	
Demographics	**UOR; 95%CI**	**AOR; 95%CI**
Employment Status *(Ref = White-collar worker)*		
Unemployed	2.13; 1.69-2.69	1.40; 1.10-1.79
Service Workers	0.95; 0.59-1.53	1.19; 0.74-1.90
Farming	1.05; 0.15-7.32	1.09; 0.16-7.47
Blue Collar Worker	1.79; 1.26-2.55	1.30; 0.89-1.90
Age *(Ref = 18-45 year olds)*		
46-65 years old		2.90; 2.11-3.99
66-75 years old		4.28; 2.91-6.29
> 75 years old		4.92; 3.32-7.31
Gender *(Ref = Males)*		
Female		0.30; 0.24-0.38
Race/Ethnicity *(Ref = White, Non-Hispanic)*		
Black, Non-Hispanic		0.95; 0.71-1.26
Other, Non-Hispanic		1.63; 1.08-2.48
Hispanic		0.54; 0.36-0.81
Marital Status *(Ref = Married/Living with Partner)*		
Widowed, Divorced or Separated		1.30; 1.05-1.61
Single		0.66; 0.43-0.98
Education *(Ref = Less than High School)*		
High School Diploma		1.32; 0.93-1.88
Some College or Higher		1.38; 0.96-1.98
Body Mass Index *(Ref = Normal Weight)*		
Overweight		1.70; 1.22-2.35
Obese		3.51; 2.58-4.77
Health Insurance Status *(Ref = Not Insured)*		
Insured		0.99; 0.67-1.47
Geographic Variation *(Ref = West)*		
Northeast		0.56; 0.41-0.78
Midwest		0.82; 0.53-0.98
South		0.93; 0.68-1.25

UOR = Unadjusted Odds Ratio; AOR = Adjusted Odds Ratio; 95% CI = 95% Confidence Interval
† = As per NCHS standards of reliability or precision, given the sample size fell below 45 observations, estimates are flagged as unstable or unreliable

Table 3.5.c. Weighted logistic regression models of socio-demographic correlates on self-report of healthcare provider diagnosis of specific arthritis condition (Lupus) among adult participants of the 2007-2008 National Health Interview Survey.

	Lupus (n=135)	
Demographics	**UOR; 95%CI**	**AOR; 95%CI**
Employment Status *(Ref = White-collar worker)*		
Unemployed	1.90; 1.18-3.07	2.00; 1.18-3.35
Service Workers	0.66; 0.27-1.64	0.76; 0.31-1.97
Farming	†	†
Blue Collar Worker	0.34; 0.13-0.93	0.92; 0.31-2.75
Age *(Ref = 18-45 year olds)*		
46-65 years old		2.68; 1.65-4.36
66-75 years old		2.00; 1.01-4.13
> 75 years old		0.53; 0.21-1.27
Gender *(Ref = Males)*		
Female		7.39; 3.64-14.98
Race/Ethnicity *(Ref = White, Non-Hispanic)*		
Black, Non-Hispanic		1.57; 0.89-2.76
Other, Non-Hispanic		0.70; 0.21-2.36
Hispanic		1.38; 0.62-3.06
Marital Status *(Ref = Married/Living with Partner)*		
Widowed, Divorced or Separated		1.11; 0.61-2.03
Single		1.14; 0.65-2.00
Education *(Ref = Less than High School)*		
High School Diploma		1.00; 0.41-2.44
Some College or Higher		1.40; 0.57-3.46
Body Mass Index *(Ref = Normal Weight)*		
Overweight		1.45; 0.83-2.52
Obese		1.39; 0.79-2.42
Health Insurance Status *(Ref = Not Insured)*		
Insured		1.97; 0.84-4.68
Geographic Variation *(Ref = West)*		
Northeast		0.69; 0.32-1.48
Midwest		0.93; 0.46-1.90
South		0.74; 0.40-1.37

UOR = Unadjusted Odds Ratio; AOR = Adjusted Odds Ratio; 95% CI = 95% Confidence Interval
† = As per NCHS standards of reliability or precision, given the sample size fell below 45 observations, estimates are flagged as unstable or unreliable

Table 3.5.d. Weighted logistic regression models of socio-demographic correlates on self-report of healthcare provider diagnosis of specific arthritis condition (Fibromyalgia) among adult participants of the 2007-2008 National Health Interview Survey.

	Fibromyalgia (n=525)	
Demographics	**UOR; 95%CI**	**AOR; 95%CI**
Employment Status *(Ref = White-collar worker)*		
Unemployed	2.81; 2.17-3.65	3.16; 2.36-4.21
Service Workers	0.72; 0.44-1.18	0.99; 0.59-1.64
Farming	†	†
Blue Collar Worker	0.25; 0.13-0.45	0.80; 0.43-1.49
Age *(Ref = 18-45 year olds)*		
46-65 years old		2.01; 1.53-2.64
66-75 years old		0.95; 0.63-1.42
> 75 years old		0.48; 0.27-0.86
Gender *(Ref = Males)*		
Female		10.03; 6.70-14.96
Race/Ethnicity *(Ref = White, Non-Hispanic)*		
Black, Non-Hispanic		0.26; 0.16-0.42
Other, Non-Hispanic		0.15; 0.05-0.46
Hispanic		0.60; 0.39-0.93
Marital Status *(Ref = Married/Living with Partner)*		
Widowed, Divorced or Separated		1.22; 0.94-1.59
Single		0.72; 0.48-1.07
Education *(Ref = Less than High School)*		
High School Diploma		1.39; 0.87-2.20
Some College or Higher		1.89; 1.23-2.88
Body Mass Index *(Ref = Normal Weight)*		
Overweight		1.81; 1.30-2.50
Obese		2.77; 2.08-3.68
Health Insurance Status *(Ref = Not Insured)*		
Insured		1.65; 1.00-2.36
Geographic Variation *(Ref = West)*		
Northeast		0.68; 0.48-0.98
Midwest		0.96; 0.67-1.38
South		0.90; 0.65-1.25

UOR = Unadjusted Odds Ratio; AOR = Adjusted Odds Ratio; 95% CI = 95% Confidence Interval
† = As per NCHS standards of reliability or precision, given the sample size fell below 45 observations, estimates are flagged as unstable or unreliable

Chapter IV – Specific Aim / Paper #2

I. Summary

Occupational studies have found that adverse physical body demands and individual health behaviors (e.g. smoking, drinking and physical activity) are related to the health of workers, including increased risk of functional limitations. Relationships between occupation and functional limitations among workers with arthritis are examined along with associations mediated by important health behaviors. A structural equation model with latent variables was used to explore direct and mediated relationships for a sub-sample of 10,847 US working adults with self-reported arthritis using the 2004-2008 National Health Interview Survey. A two latent factor (gross and fine-motor functional limitations) model had good model fit. Occupation had direct effects on the functional limitation latent variables and health behaviors. Health behaviors mediated the relationship between occupation and both motor functional limitations. Workers with arthritis that were current smokers and did not engage in physical activity reported significantly greater levels of both types of motor functional limitations. The association between occupation type and functional limitations operate in part through the health behaviors of working adults with arthritis. The rapidly aging US worker population will require innovative and preventative approaches that improve workplace organization and accommodate the functional limitations of workers with arthritis.

II. Background

Arthritis affects an individual's capacity to live a full and active life (Scott and Garrood 2000). In 2005, an estimated 46 million American adults (22%) had some form of arthritis, and this total is expected to rise to 67 million (25%) by the year 2030 as the population ages (CDC 2006). The increasing burden of disease due to arthritis (CDC 2001) is also associated with an increasing cost of arthritis to society, which currently exceeds 65 billion dollars annually (Maetzel, Li et al. 2004).

Although some individuals with arthritis may be disabled prior to diagnosis (Fex, Larsson et al. 1998), the greatest increase in functional limitations occurs in the first 3 years of the natural disease process (Sokka 2003). For example, in the case of rheumatoid arthritis, one prospective longitudinal study reported that 22% of participants who were employed at enrollment had stopped working after 5 years because of their arthritis (Young, Dixey et al. 2002). At least one-third of individuals with arthritis will leave their employment prematurely, although this may vary depending on socioeconomic factors (Harris 2003; Backman, Kennedy et al. 2004).

The work environment has important direct effects on arthritis as exemplified by the strong association between exposure to whole body vibration (e.g. jack hammer operations) and osteoarthritis in men (Bernard 1997; Olsson, Skogh et al. 2004). Given the physical demands of many occupations and the susceptibility of inflamed joints to further damage from these stresses, work activities can worsen inflammation and functional limitations in workers with active arthritis (Stolov and Clowers 1981; Steultjens, Dekker et al. 2002). Occupations that require repeated bending, stretching, and twisting, or exposure to whole body vibration are associated with more functional limitations (Bernard 1997; Olsson, Skogh et al. 2004). These findings are analogous to the consequences of over-use of inflamed or susceptible peripheral joints that potentially affect worker duties and productivity as well as overall quality of life.

According to the World Health Organization's International Classification of Functioning, Disability and Health, limitations in physical functioning are viewed as a complex interaction of the whole person (e.g. genetic disposition, health behaviors) with societal and environmental influences and contextual factors such as occupation (Harris 2003). The degree of functional limitation is an important determinant of health-related quality of life that influences the likelihood of work disability, and is the major predictor of medical costs in adults with arthritis (Barlow, Wright et al. 2001; Boonen, de Vet et al. 2001; Ward and Kuzis 2001; Ward 2002). While some studies have looked at the association between specific occupations, work characteristics and arthritis (Semanik, Wilbur et al. 2004; Munir, Jones et al. 2005; Gignac, Cao et al. 2008; Macedo, Oakley et al. 2009), none have explored the association between occupation type, arthritis and functional limitations, particularly at the population level.

Lifestyle-related characteristics (such as smoking, drinking and physical activity) have been shown to account for functional limitations over time (Dekker, van Dijk et al. 2009; Peterson, Giuliani et al. 2009). For example, using longitudinal data, researchers found that among community residing adults, limited physical activity and current smoking was associated with an increased risk of reporting functional limitation or inability to complete activities of daily living (Song, Chang et al. 2007). It may be possible that the association between occupation and functional limitations operates partially through an individual's health behaviors.

In the present study, we used a structural equation modeling (SEM) framework to test the association of occupation on specific functional limitations, both directly and indirectly, through health behaviors in a nationally representative sample of employed US adults with arthritis. SEM allows for the estimation of multiple equations simultaneously, so that associations between multiple predictor and outcome variables can be assessed in the same model including indirect pathways (mediator effects) (Bollen 1989; MacKinnon, Lockwood et al. 2002; Skrondal and Rabe-Hesketh 2004). We considered health behaviors as a potential mediator that may explain part of the association of functional limitations and occupation type among workers with arthritis.

Given that each occupation type experiences different levels of stress, demands, and physical requirements, we expected the occupational context to condition the relationship between health behaviors and functional limitations. We hypothesized that workers with arthritis that engaged in negative health behaviors (e.g. drinking and smoking) would report greater functional limitations while workers with greater physical activity would report less functional limitations, but that these differences would also depend on the occupational environment.

III. Methods

a. *Study Population and Variables*

The National Health Interview Survey (NHIS) utilizes a complex sample survey design to obtain samples that represent the US civilian non-institutionalized population (Botman and Jack 1995). Work status was defined as being employed either part time or full time in the week prior to the NHIS interview date, and having an assigned occupational category. Occupation type was measured by 23 standardized occupation codes derived from more detailed US census occupation codes (USDC 1980). We collapsed occupation types into four occupational sectors: white collar, blue collar, service, and farm workers (Krieger, Williams et al. 1997; Krieger, Barbeau et al. 2005).

The health behaviors examined for these analyses included heavy drinking, smoking, and leisure-time physical activity (LTPA). "Heavy drinking" was defined as men who consume greater than two drinks per day and women who drank greater than one drink per day (Breslow and Smothers 2005). Participants who reported smoking at least 100 cigarettes in their lifetime were asked if they now smoked every day, some days, or not at all; those responding that they smoked every day or some days were considered "current smokers." Participants were considered to have met the Healthy People 2010 regular leisure-time physical activity guidelines if they reported engaging in: either "light-moderate activity" classified as ≥ 30 min ≥ 5 times per week, "vigorous activity" ≥ 20 min ≥ 3 times per week, or qualified for both activity categories, consistent with the methods and definitions used by the National Center for Health Statistics (Schoenborn and Adams 2010). We report participants that had unmet leisure-time physical activity objectives.

Functional limitation latent factors were measured by nine ordinal variables: walking, climbing, standing, sitting, stooping, carrying, pushing, grasping, and reaching. For each measure, participants were asked "By yourself, and without using any special equipment, how difficult is it for you to... [...Walk a quarter of a mile - about 3 city blocks?, ...Walk up 10 steps without resting?, ...Stand or be on your feet for about 2 hours?, etc]. Responses were measured on a 5-point ordinal scale: 1=Not at all difficult; 2=Only a little difficult; 3=Somewhat difficult; 4=Very difficult; or 5=Can't do at all. We employed confirmatory factor analysis to determine if these measures loaded on a single latent factor or two specific functional limitation latent factors: 1) fine-motor (i.e. grasp and reach), and 2) gross-motor functional limitations (i.e. remaining seven items).

b. *Analysis / Models*

Using a five pronged approach, we 1) Described the prevalence of functional limitations and health behaviors across occupation and control variables (Table 4.1); 2) Estimated latent variable models for the functional limitation items; 3) Estimated the effects of occupation, health behavior variables, and control variables on the functional limitations latent variables (Table 4.1, Model 1); 4) Estimated a moderation model for the effects of control variables and health behaviors on the functional limitations latent variables for each of the four occupation categories (Table 4.1, Models 2-5); and 5) Estimated a mediation model of the effects of occupation and control variables on health behaviors and functional limitations latent variables (Table 4.1, Model 6) (Baron and Kenny 1986). All models controlled for covariates with alpha= 0.05.

Our conceptual mediation path model (Figure 4.1) (including adjustments for covariates) specified that occupation had direct effects and indirect effects through health behavior mediators on gross- and fine-motor functional limitations. Our moderation model estimated the effects of these health behaviors and covariates on functional limitations for each occupation type separately.

We gauged model quality by overall and component fit indices: the single factor model had good fit: comparative fix index (CFI) = 0.972, Tucker-Lewis index (TLI) = 0.977, root mean square error of approximation (RMSEA) = 0.052, chi-square (χ^2) = 539.25 (df=19); $P<0.001$; however, the two factor model had a slightly better model fit: CFI = 0.977, TLI = 0.979, RMSEA = 0.049, χ^2 = 454.38 (df=18); $P<0.001$. The structural equation model estimating the direct and indirect effects of occupational category on functional limitations factors (Model 6, Figure 1) had good fit: CFI = 0.92, TLI = 0.90, RMSEA = 0.04. All moderation models for specific occupational sectors fit the data very well. Covariates included age in years, gender, race (white, black, other), marital status (married/living with partner, single, or divorced/widowed/separated) and obesity status (normal weight, overweight, or obese) (WHO 1995).

Descriptive and model-based analyses were performed with adjustments for sample weights and designed effects using SAS 9.2 and MPlus 5.21 statistical packages (SAS Institute. 2001; Muthen and Muthen 2009). Partially standardized coefficients were used for ease of interpreting the magnitude of association with latent variables. The protocol was approved by the Institutional Review Board of the University of Miami.

IV. **Results**

The 2004-2008 NHIS sample of 10,847 working adults with arthritis represented an estimated annual 18,946,545 adults in the non-institutionalized U.S. population (Table 4.1). Nearly two-thirds of the sample reported unmet leisure time physical activity objectives (63%); additionally, 22% reported smoking and 44% reported heavy drinking. Socio-demographic subgroups with the highest rates of these health behaviors/indicators included those with less than a high school education (78% reported unmet leisure time physical activity objectives) and those who reported not having health insurance (43% reported smoking and 59% reported heavy drinking).

In Model 1 examining associations among all workers with arthritis (Table 4.2), older workers were more likely to experience gross limitations than younger workers (0.01 standard deviation units per year ($p<0.001$) and fine motor 0.07 SD units per year ($p<0.001$), while female workers were significantly less likely to report fine (-

0.17 SD) and gross (-0.28 SD) motor functional limitations than their male counterparts. Obese workers were significantly more likely to report gross functional limitations (0.28 SD) compared to workers of healthy weight. Workers with arthritis who reported being a current smoker and not engaging in leisure-time physical activity reported significantly greater levels of both gross (0.14 SD and 0.20 SD) and fine (0.13 SD and 0.07 SD) motor functional limitations, respectively. Blue collar workers experienced significantly higher levels of fine motor (0.11 SD) and significantly lower levels of gross motor (-0.11 SD) functional limitations compared to white collar workers. Farm workers also experienced significantly lower levels of gross motor (-0.50 SD) functional limitations compared to white collar workers.

Among white collar workers (Table 4.2, Model 2), persons who were older, widowed, current smokers, and not engaging in leisure-time physical activity were more likely to experience fine motor functional limitations. Also among white collar workers, females (-0.24 SD) and heavy drinkers (-0.08 SD) were significantly less likely to report fine motor functional limitations. Lastly, greater levels of gross motor functional limitations occurred with increasing age (0.01 SD), being single (0.15 SD) or widowed (0.15 SD), obese (0.27 SD), being a current smoker (0.13 SD), and unmet leisure-time physical activity (0.20 SD), while lower levels of gross motor functional limitations occurred for females (-0.28 SD).

For blue collar workers with arthritis, increasing age (0.01 SD), being single (0.21 SD) or widowed (0.03 SD), being a current smoker (0.13 SD), and not engaging in leisure-time physical activity (0.21 SD) resulted in higher levels of gross functional limitations, while females (-0.23 SD) were less likely to experience gross motor functional limitations. Service workers with arthritis were significantly more likely to experience fine motor functional limitations with increasing age (0.01 SD), smoking (0.13 SD), and unmet leisure-time physical activity (0.14 SD), while less likely to experience gross motor functional limitations if female (-0.16 SD). For service workers, increased gross-motor limitations exist for older, widowed, obese or overweight, smoking, and inactive respondents, while gross-motor limitations were lower for females.

The mediation path model (Table 4.3), which provides the direct, indirect, and total effects of occupation sector type on functional limitations through the health behaviors, had very good model fit (CFI ≥0.979, TLI ≥0.989, and RMSEA = 0.048). Being a blue-collar worker results in more fine motor limitations overall (total effect = 0.18 SD) compared to a white-collar workers. This effect is mostly direct, although 43% of the effect operated through increased drinking and decreased LTPA. The total effect of blue-collar work on gross-motor limitations disappeared due to a significant negative direct effect, but significant positive indirect effects through smoking and inactivity. For service workers, increases in both fine- and gross-motor limitations were due primarily to the indirect effects through smoking and inactivity. For farmers, lower levels of smoking resulted in less functional limitations and other mechanisms accounted for lower levels in gross-motor limitations (direct effect -0.50 SD).

V. Discussion

In the present analysis functional limitations loaded as two separate factors, gross and fine-motor limitations. The scientific and clinical literature is sparse in guiding how to analyze or report research findings when varying assessments for functional limitations are used (Escalante, Haas et al. 2004). The need for data parsimony may sway investigators to report findings as a global measure of functional limitations when, perhaps separate loading factors may shed new insight to the classification of functional limitations among working adults who report arthritis. For example, for all workers, obesity was strongly associated with gross motor limitations, but was unrelated to fine motor limitations.

Markers of disease activity such as erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), severity of radiographic joint damage, disease duration, and socio-demographic variables traditionally used in arthritis research do not fully account for the variability in an adults' functional limitations, suggesting that additional factors, such as individual health behaviors, might play an important role (Dagfinrud, Kjeken et al. 2005). Few studies have investigated the contribution of behavioral factors (smoking, drinking, leisure-time physical activity) to functional impairment in working adults with arthritis, and none have weighed the relative impact of health behavior variables compared with these other factors (Dagfinrud, Kjeken et al. 2005).

This analysis demonstrated that the association between occupation type and functional limitations operate in part, through the health behaviors of working adults with arthritis. For example, among all workers with arthritis that reported being current smokers and not engaging in leisure-time physical activity, significantly greater levels of both gross and fine motor functional limitations were reported, respectively. Several studies have suggested that health behaviors may play an independent role in recovery from functional limitations and disability (Miller, Rejeski et al. 2000; Lee and Park 2006). Physical activity and maintenance of normal weight were significantly associated with recovery from functional limitations in older adults (Miller, Rejeski et al. 2000). Reductions in functional limitation levels have been reported among non-smokers, moderate drinkers, and those having regular health checkups (Dales, Friedman et al. 1979; Branch 1985; Wang, van Belle et al. 2002).

Our moderation models that estimated the effects of control variables and health behaviors on the functional limitations latent variables demonstrated variation by occupation type. For example the strongest association between obesity and gross functional limitations occurred among service workers making it one of the strongest risk factor correlates. This association was also significant among white collar workers although it was not as strong, raising the possibility that obesity among workers with arthritis may be more detrimental among those employed in select workforce sectors. These findings were are consistent with other studies where in older adults low level of physical activity and overweight, through its influence on changes in functional limitations, was associated with a slow progression of the individual's disability (Miller, Rejeski et al. 2000).

The mediation path model showed that being a blue-collar worker resulted in more fine motor limitations overall when compared to white-collar workers. This direct effect had a significant contribution that operated through increased drinking and decreased exercise. Given that Americans reporting arthritis and rheumatism have lower rates of participation in the labor force and reduced working life expectancy (Chung, Sokka et al. 2006), developing workplace programs that address negative health behaviors among working adults with arthritis is important. The aging of the US population, particularly the baby boomers, their expected delay in retirement, compounded with the estimated absolute number of persons reporting a disability, in 2005 increasing 7.7%, from 44.1 to 47.5 million remain an important public health concern (Scott and Garrood 2000; Sacks, Harrold et al. 2005; CDC 2006). These trends are particularly relevant since the most common cause of disability in the United States continues to be arthritis or rheumatism (affecting an estimated 8.6 million persons) (Scott and Garrood 2000).

a. *Limitations / Strengths*

The structural equation models tested were cross-sectional and restricted to a sample of working adults with arthritis; thus, causal direction cannot be determined. It could be argued that having functional limitations makes an individual select a particular occupation type, and that relationship in our model could be operating in the reverse direction. A social cognitive perspective would argue for reciprocally determining relationships among model constructs, and such relationships can be better tested with longitudinal data. The presence of arthritis was not confirmed by a healthcare provider; however, this case-finding question has been shown to be valid for public health surveillance purposes (Sacks, Harrold et al. 2005).

Another limitation was the exclusive use of self-report measures for functional limitations. Performance-based measures of physical functioning could circumvent the influence of arthritis on self-ratings of functional limitations and yield a more valid estimate of the effect of occupation on functional limitations. However, prospective analyses are needed to support claims of causality along the functional limitations trajectory. Notwithstanding, the NHIS has several notable strengths, including a large sample size representative of the US non-institutionalized household population and excellent household response rates (95%–98%).

b. ***Conclusions***

In this study, we have shown that health behaviors (such as smoking, drinking, and non-engagement in leisure-time physical activity) appeared to be implicated in the association between occupation type and functional limitation among a nationally representative sample of working adults with arthritis. Occupational type may be linked to functional limitations through one's sense of control of their health behaviors, as proposed by the psychological functioning perspective (Wickrama, Lorenz et al. 1997). Our findings suggest that, negative health behaviors mediate the relationship between occupation and functional limitations. This is heartening from a prevention perspective, given that these health behaviors are modifiable and would be amenable to workplace and other health promotion interventions (Holtermann, Jorgensen et al. 2010). Therefore, employers should consider taking additional steps can be taken to further promote, for example, increased physical activity participation for workers with arthritis and to create the provision of workplace environments that support smoking cessation resources to their employees with arthritis who smoke and report functional limitations.

Table 4.1. Age-Adjusted Prevalence (± standard error) of self-report on unmet leisure-time physical activity (LTPA) objectives, smoking and heavy drinking among working adults with arthritis 18 years of age and older by selected covariates: the National Health Interview Survey 2004-2008

Socio-demographic characteristics	Sample N*	Estimated Annual US Population	Overall Study Sample		
			% Unmet LTPA Objectives ± SE	**% Smoking ± SE**	**% Heavy Drinking ± SE**
Total	**10,847**	**18,946,545**	**63.4 ± 0.6**	**22.2 ± 0.5**	**43.8 ± 0.7**
NCHS Category					
White Collar	6,334	11,041,841	59.5 ± 0.8	17.9 ± 0.6	40.9 ± 0.8
Blue Collar	2,147	4,141,579	70.4 ± 1.2	31.2 ± 1.2	48.3 ± 1.7
Service	2,095	3,297,507	66.4 ± 1.4	26.6 ± 1.2	50.1 ± 1.9
Farming	52	100,418	68.7 ± 7.2	8.0 ± 3.4†	54.1 ± 14.4†
Age‡					
18-45 years old	3,287	5,852,378	60.1 ± 1.1	29.8 ± 1.0	57.1 ± 1.3
46-65 years old	6,474	11,460,041	64.3 ± 0.7	20.0 ± 0.6	38.6 ± 0.9
66-75 years old	860	1,325,963	68.3 ± 1.8	1.4 ± 1.2	23.4 ± 2.2
> 75 years old	226	308,161	64.5 ± 4.0	7.8 ± 1.9	21.7 ± 4.3
Gender					
Male	4,660	9,155,462	62.9 ± 0.9	23.4 ± 0.8	35.9 ± 1.1
Female	6,187	9,791,083	64.5 ± 0.7	21.2 ± 0.6	51.9 ± 0.9
Race/Ethnicity					
White, Non-Hispanic	8,046	15,344,315	61.4 ± 0.7	22.5 ± 0.6	43.0 ± 0.8
Black, Non-Hispanic	1,466	1,784,170	69.3 ± 3.3	21.9 ± 1.4	47.1 ± 2.4
Other, Non-Hispanic	258	448,796	71.6 ± 1.4	25.3 ± 3.4	41.3 ± 4.9
Hispanic	996	1,256,123	73.9 ± 1.7	18.8 ± 1.7	52.0 ± 2.9
Marital Status					
Married/Living with Partner	6,089	13,311,001	63.2 ± 0.7	20.3 ± 0.6	40.1 ± 0.9
Widowed, Divorced Separated	3,375	3,890,213	65.8 ± 1.0	27.7 ± 1.0	50.8 ± 1.3
Single	1,357	1,715,920	59.5 ± 1.7	24.5 ± 1.6	57.1 ± 2.2
Education					
Less than High School	756	944,572	78.0 ± 1.8	30.9 ± 2.1	56.5 ± 3.1
High School Diploma	2,542	4,234,616	72.2 ± 1.1	31.6 ± 1.1	52.5 ± 3.1
Some College or Higher	7,521	13,725,657	59.7 ± 0.7	18.7 ± 0.6	40.9 ± 0.9
Obesity Status (Body Mass Index)					
Healthy Weight	1,335	2,704,623	55.5 ± 1.7	27.9 ± 1.4	47.1 ± 2.0
Overweight	1,848	3,840,727	60.0 ± 1.4	22.1 ± 1.2	42.0 ± 1.6
Obese	7,562	12,199,720	66.3 ± 0.7	20.7 ± 0.6	43.5 ± 0.8
Health Insurance Status					
Yes Health Insurance	9,662	17,116,398	62.7 ± 0.6	20.0 ± 0.5	42.3 ± 0.7
No Health Insurance	1,173	1,805,150	71.1 ± 1.5	43.3 ± 1.8	59.1 ± 2.3
Region United States					
Northeast	1,948	3,611,594	60.9 ± 1.4	20.2 ± 1.0	42.5 ± 1.6
Midwest	2,978	5,378,514	63.6 ± 1.1	23.8 ± 1.0	46.3 ±1.3
South	3,825	6,519,571	67.7 ± 1.0	24.2 ± 0.9	45.3 ± 1.2
West	2,096	3,436,864	57.6 ± 1.5	18.2 ± 1.2	38.5 ± 1.9

* Differences in sub-total population sample due to item non-response or missing.
† = Estimates have a relative standard error ≥ 30% and should be used with caution, as they do not meet NCHS standards of reliability or precision (NCHS, 2008).
‡ = Age category is not age-adjusted.

Table 4.2. Functional limitation structural equation model results and select path model results among adult workers with arthritis: National Health Interview Survey 2004-2008

	All Workers (Model 1)		**White Collar** (Model 2)		**Blue Collar** (Model 3)		**Service** (Model 4)		**Farming** (Model 5)	
Variables	**Fine (SD)**	**Gross (SD)**	**Fine (SD)**	**Gross (SD)**	**Fine (SD)**	**Gross (SD)**	**Fine (SD)**	**Gross (SD)**	**Fine (SD)**	**Gross (SD)**
Control Variables										
Age	0.070**	0.011**	0.005*	0.012**	0.008	0.011**	0.010*	0.007*	†	†
Gender **(ref=male)**	-0.170**	-0.276**	-0.240**	-0.283**	0.057	-0.234*	-0.160*	-0.308**	†	†
Race/Ethnicity (ref=white)										
Hispanic	0.065	-0.007	0.055	-0.060	-0.071	0.066	0.112	0.027	†	†
Black	-0.054	0.003	-0.052	0.028	0.027	0.005	-0.048	-0.023	†	†
Other	-0.083	-0.042	0.042	-0.079	-0.366	-0.156	-0.183	0.246	†	†
Marital Status (ref=married)										
Single	0.013	0.125*	-0.025	0.151*	0.211	0.206*	-0.123	0.050	†	†
Widow	0.087*	0.114*	0.153*	0.145**	-0.060	0.032**	0.049	0.149*	†	†
Obesity (ref=normal weight)										
Obese	0.059	0.284**	0.078	0.268**	0.085	0.344	0.030	0.363**	†	†
Overweight	-0.045	0.064	0.000	0.020	-0.326	-0.035	0.135	0.228*	†	†
Health Behaviors										
Drinking	-0.019	0.001	-0.077*	0.007	0.020	-0.021	0.061	-0.077*	†	†
Smoking	0.125**	0.140**	0.118*	0.126**	0.095	0.129**	0.143*	0.156**	†	†
Unmet Leisure-Time Physical Activity	0.072**	0.197**	0.052*	0.195**	0.103	0.212**	0.103**	0.193**	†	†
NCHS Category (ref=white collar)										
Blue Collar	0.107*	-0.111*	–	–	–	–	–	–	–	–
Service	0.067	0.047	–	–	–	–	–	–	–	–
Farm	0.106	-0.498*	–	–	–	–	–	–	–	–
R^2	0.07	0.14	0.08	0.14	0.11	0.14	0.12	0.15	†	†

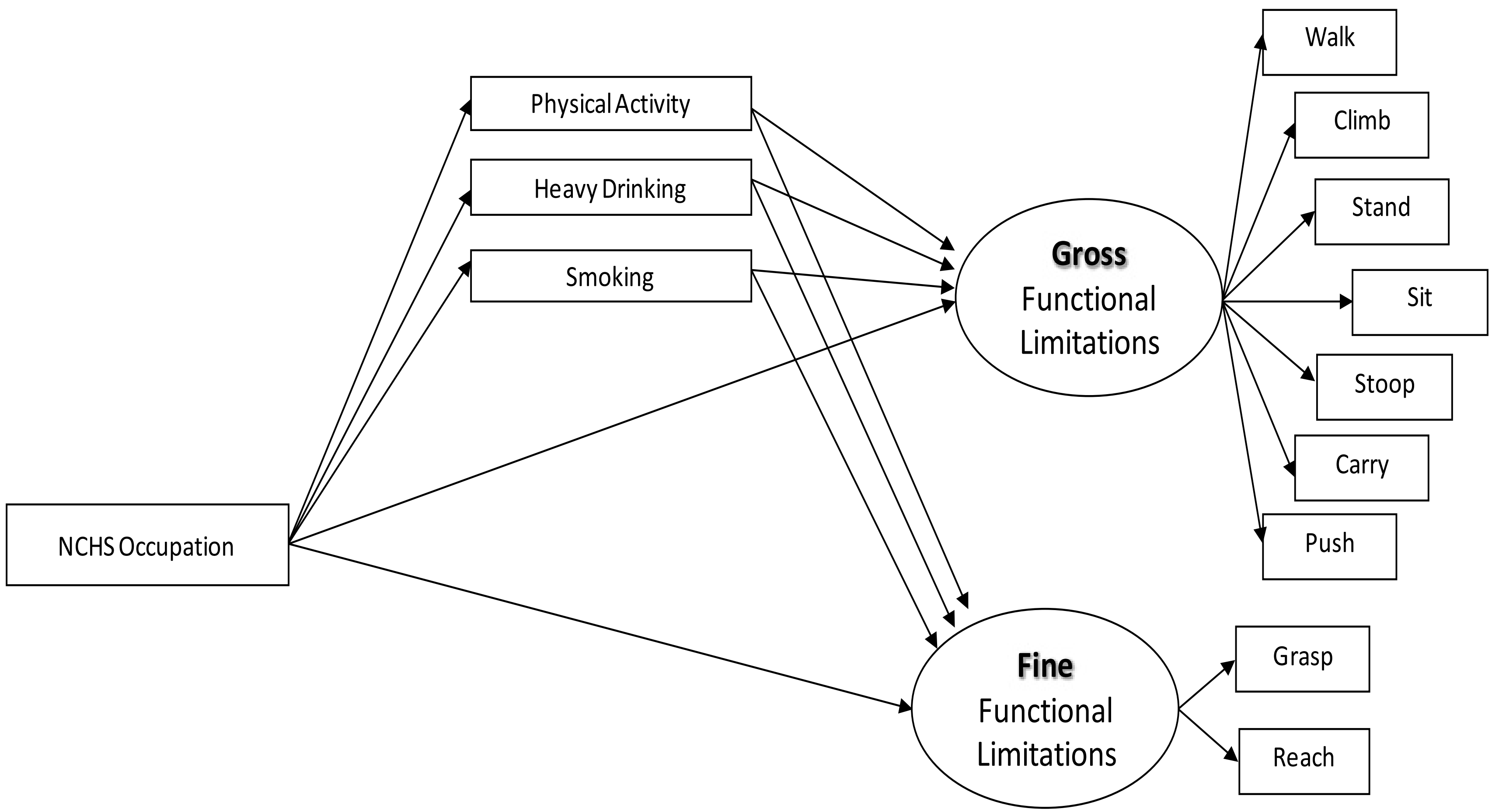
Notes: Partially standardized coefficients are presented (SD = Standard-Deviation units). Significance levels are based on un-standardized coefficients.
* p<0.01; ** p<0.001, two-tailed t-test.
† Model would not estimate given too few observations (n=52)

Table 4.3. Direct, indirect, and total effects of occupation type on fine and gross motor functional limitations among employed US adults with arthritis participating in the 2004-2008 National Health Interview Survey (Model 6)

Occupational Category†	**Fine Motor Limitations (SD)**	**Gross Motor Limitations (SD)**
Blue Collar Worker (n=2,147)		
Direct Effect	0.108*	-0.111**
Through smoking	0.052**	0.058**
Through drinking	-0.007	0.000
Through unmet LTPA	0.023**	0.063**
Total Effect	0.176**	0.010
Service Worker (n=2,095)		
Direct Effect	0.066	0.047
Through smoking	0.037**	0.041**
Through drinking	-0.003	0.000
Through unmet LTPA	0.010*	0.026**
Total Effect	0.110*	0.115**
Farm Worker (n=52)		
Direct Effect	0.106	-0.498*
Through smoking	-0.051*	-0.057*
Through drinking	-0.011	0.000
Through unmet LTPA	0.013	0.037
Total Effect	0.058	-0.518*

Notes: Partially standardized coefficients are presented (SD = Standard-Deviation units). Significance levels are based on un-standardized coefficients.
* $p<0.01$; ** $p<0.001$, two-tailed t-test.
† = White Collar workers are the comparison group.
LTPA = Leisure-time Physical Activity

Figure 4.1. Path model for the relationship between employment and functional limitations in the structural equation model. All paths are controlled for covariates with the exception of the paths from functional limitations to its indicators.



Chapter V – Specific Aim / Paper #3

I. Summary

The working poor are at higher risk of disease and disability, increasingly must delay retirement to make ends meet, and have fewer years remaining after the age of 65. We use the burden of disease due to arthritis to illustrate these converging phenomena. We merged data from the National Health Interview Survey, Medical Expenditure Panel Survey, and the National Death Index into a single database. We then calculated and compared age- and occupation-specific quality-adjusted life years (QALYs) between workers with and without arthritis using unabridged life tables. White-collar workers with arthritis are much less likely to remain in the workforce than those in service, farming, or blue-collar jobs. Nevertheless, white-collar workers have a higher overall health-related quality of life than other workers, and suffer significantly fewer QALYs lost to arthritis at all ages. For instance, while 65-year-old white-collar workers without arthritis look forward to 17 QALYs of future life, blue-collar workers with arthritis look forward only to 11. A stronger social contract is needed to reduce work time for lower-income elderly workers with disabling conditions.

II. Background

People over the age of 65 are the fastest growing demographic group in the US, with their numbers projected to increase 53.2% by 2020 (Census 2010). While many elderly persons continue to work past retirement because they prefer to, an increasingly large segment of this population continues to work out of financial necessity (Hareven 1985; Census 1997; Head, Baker et al. 2006; Ghilarducci and Turner 2007; USDHHS 2009). Both blue-collar and elderly people are much more likely than younger or more affluent people to suffer from disabling conditions (Census 1997; Gignac 2005; Ghilarducci and Turner 2007; Gignac, Sutton et al. 2007; Lacaille, White et al. 2007; Kaptein, Gignac et al. 2009). We might therefore expect to see an increasing burden of disease and disability among the American workforce, reducing both the quality of life and productivity of Americans.

The increasing age of the US workforce presents new challenges for government, employers, and working families (De Long 2004). Notably, as fewer younger workers are available to pay into retirement funds and Medicare, this places a policy emphasis on encouraging more Americans to delay retirement. In the US and other industrialized nations, improved older worker integration will be important factors in order for economies to adjust to the pressures of population aging (Burton, Morrison et al. 2006; Escorpizo, Bombardier et al. 2007; Beaton, Bombardier et al. 2009). However, even with seemingly neutral policies aimed at increasing the retirement age for everyone (Smith, Toder et al. 2003), the graying workforce will be disproportionately represented by people from lower social classes that also suffer from a range of chronic medical conditions (De Long 2004).

Arthritis provides one lens through which this social phenomenon can be viewed, as it is a common disabling condition that would normally force many workers to leave the workforce (CDC 2006; Hootman and Helmick 2006). In 2005, approximately 46 million US adults self-reported a doctor-diagnosis of arthritis, of whom 19 million suffered activity limitations as a result (CDC 2006). It is estimated that by the year 2030, approximately 67 million adults aged 18 years and older will have doctor-diagnosed arthritis (Hootman and Helmick 2006). Arthritis both contributes to and arises from poverty; blue-collar and elderly workers are at increased risk of arthritis, and arthritis is a major risk factor for losing one's job (Head, Baker et al. 2006; Ghilarducci and Turner 2007). Between 20-70% of people who were employed at the onset of their arthritis were work-disabled after 7–10 years (Gignac 2005). In this study, we take a snapshot of the burden of disease due to arthritis among US workers by age and social class.

III. Methods

a. *Overview of quality of life methodology*

We used the quality-adjusted life year (QALY) as an outcome measure (Khanna and Tsevat 2007). The QALY contains two dimensions: the time spent alive and one's health-related quality of life (HRQoL), which is scaled from 0 (death) to 1 (perfect health) and can be used to adjust the amount of time lived in good health to reflect relatively higher or lower morbidity (Khanna and Tsevat 2007). In this case, we use the EuroQol 5D (abbreviated EQ-5d), which is an HRQoL measure contained within the Medical Expenditure Panel Survey (MEPS). One QALY represents a year of life lived in perfect health.

We used a 4-step process to estimate quality-adjusted life expectancy (QALE) and to calculate incremental QALYs arising from arthritis among employed adults over age 18 relative to employed adults without arthritis. First, we estimated 1-year age interval and occupation type specific mean EQ-5D scores, representing our health-related quality of life measure. We then calculated 1-year age interval and occupation-specific probabilities of death using a nationally representative database of US adults. Third, we calculated 1-year age interval and occupation-specific QALE using the interval and occupation-specific point estimates developed in steps one and two. Fourth, we calculated the age- and occupation-specific differences in QALEs between workers with arthritis and workers without arthritis. The difference between QALE values yields the incremental QALYs.

b. *Study Databases*

Data were obtained from two publicly available nationally representative samples of the US adult population: the 1997–2004 National Health Interview Survey (NHIS) and the 2001–2003 MEPS. The NHIS is an annual population-based survey of the resident non-institutionalized US civilian population conducted by the National Center for Health Statistics (NCHS) (NCHS 2000). Interviews are conducted in-person by trained interviewers. In the Family Core component, information was collected on socio-demographic characteristics and health conditions for all members of the household. In the Sample Adult Core component, one adult household member was randomly selected to provide more detailed personal health information in the NHIS. The MEPS is a sub-sample of NHIS participants that also generates a nationally representative survey of the US civilian non-institutionalized population with oversampling of Hispanics and blacks, containing detailed information on demographic characteristics, health conditions, and medical expenditures (Cohen 2003). Data from the NHIS also were linked to mortality data from the National Death Index (NDI) (Sathiakumar, Delzell et al. 1998; NCHS 2010).

c. Data Sample and Measures

i. Occupational and Arthritis Classification

Employed respondents aged 18 years and older reported on their occupation for the week prior to NHIS interview. Employment status (i.e. employed versus non-employed) was specified as a dichotomous variable based on the question "What is your current working status?" Workers were then grouped using the 2000 Standard Occupational Codes (SOC) into four major occupational groups, white-collar, service, farm, and blue-collar worker (Krieger and Fee 1994; Krieger, Williams et al. 1997; Coons, Rao et al. 2000).

In the NHIS, arthritis status among adults 18 years and older was assessed by response to the question: "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 (fy-bro-my-

AL-jee-uh)?" Participants who responded in the affirmative to this question were coded as having arthritis.

ii. *Health Related Quality of Life Measure*

Health-related quality of life scores were derived from the EQ-5D measure. The EQ-5D consists of a 5-item descriptive system that measures 5 dimensions of health status (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) with 3 levels per dimension (no problem, some problems, and extreme problems) (Coons, Rao et al. 2000). The combination of all possible dimensions and levels resulted in 243 unique health states (McDowell and Newell 1996; Shaw, Johnson et al. 2005). A multi-attribute value function was used to map preferences for these health states. From this scoring function, an EQ-5D index score based on responses to the 5-item questionnaire are calculated and provided by MEPS in the publically available dataset (McDowell and Newell 1996). The construct validity, reliability, and responsiveness of the EQ-5D have been documented extensively in both general and specific disease populations. The scoring algorithm for the EQ-5D index descriptive system used in this research is based on US community preferences (Shaw, Johnson et al. 2005).

There were 17,967 individuals 18 years of age or greater with valid EQ-5D scores and occupation type included in this analysis. The sample design of the MEPS Household component survey includes stratification, clustering, multiple stages of selection, and oversampling of minority populations (Machlin, Yu et al. 2010). Using the MEPS sampling weights and robust standard error estimators, we adjusted for these factors and for survey non-response when estimating age and occupation specific mean EQ-5D scores.

iii. *Estimating Probability of Death*

Age and occupation-specific probabilities of death were calculated by arthritis status using the National Health Interview Survey linked with the National Death Index. We pooled the data from the 1997 to 2004 NHIS for the adults and linked it with pooled 1997 to 2004 (with follow up through 2006) mortality data from the NDI and provided by the NCHS (NCHS 2000). During this time period, there were 16,965 deaths among the 242,223 NHIS participating adults identified in the probabilistically-determined matching process. The probability of death based on selected matches determined by the NCHS to be likely correctly matched deaths (the outcome) was calculated for all adults from 18 to 88 years old by arthritis status using pooled logistic regression models, a type of discrete-time survival analysis model.

iv. *Quality-Adjusted Life Expectancy (QALE) Measure*

We constructed a total of eight life tables in 1-year age intervals using US mortality data for each of the worker groups (white-collar, service, farm, and blue-collar workers) by arthritis status (Anderson 2000). We let A_i^c be the number of the population members surviving to age *i* and c denote the worker group (white-collar, service, farm, and blue-collar workers); and B_i^c be the life years between age *i* and *i* + 1. Denoting the mortality rate at age, we estimated B using standard life table assumptions: $B_i^c = (1 - m_i/2)\, A_i^c$ (Anderson 2000). The life expectancy (LE) at age *i* is the total life years above age *i* divided by the population surviving to age *i* : $LE_i = \sum_{j \geq i} B_j^c / A_i^c$. Since the QALYs at age *i* is $B_i^c\, x_i$, the QALE at age *i* is $QALE_i = \sum_{j \geq i} B_i^c x_j / A_i^c$ (Attaran and Guseman 1988; Anderson 2000; Muennig, Franks et al. 2005). The QALE lost contributed by arthritis is

$$\sum_{j \geq i} B_j^c \left(\sum_k \left(x_j^0 - x_j^k\right) p_j^k \right) / A_i^c$$

Where x_j^o and x_j^k are the mean EQ-5D scores of the reference group (i.e. workers without arthritis) and for the k^{th} level of the risk factor, arthritis, respectively for age *i* and gender j; p_{ij}^k is the proportion of the population in the same one-year age interval and risk factor level *k*. Similar to the proportion of explainable QALYs lost, we calculated the proportion of explainable QALE lost contributed by arthritis by dividing the QALE lost by the potential QALEs that would be gained if the entire population had perfect health:

$$\frac{\sum_{j \geq i} B_j^c \left(\sum_k \left(x_j^0 - x_j^k\right) p_j^k\right) / A_i^c}{\sum_{j \geq i} B_j^c \left(\sum_k \left(1 - x_j^k\right) p_j^k\right) / A_i^c} \text{ x } 100\%$$

v. Incremental Quality-Adjusted Life Years (QALY) calculation

The difference between the QALE of workers without arthritis from the QALE of workers with arthritis for any given age and occupation-specific group yields the incremental QALYs. We calculated the incremental QALYs between and across worker group categories.

IV. RESULTS

There were 19,699 workers in the pooled study database, representing an estimated annual 187,090,449 U.S. workers that reported on occupation type and arthritis status for the 1997-2004 NHIS study period. Overall, white-collar workers were only slightly less likely to work beyond age 65 than other workers: 14% of all white-collar workers were over 65 relative to 16% of service and blue-collar workers, and 17% of farmers. But white-collar workers appear to be much more likely to retire if they develop arthritis. While approximately 35% of white-collar workers over the age of 65 had arthritis, 61% of service workers, 56% of farm workers, and 48% of blue-collar workers had arthritis (Table 5.1). Thus, it is possible that those white collar workers who do suffer from arthritis opt to leave the workforce rather than continue to work in pain.

a. *Health Related Quality of Life*

Next, we examine EQ-5D scores, which capture much of the morbidity among those suffering from arthritis. Overall, workers with arthritis reported EQ-5D scores that were lower 0.69 (95% confidence interval 0.67-0.70) than workers without arthritis 0.88 (0.87-0.89) (Table 5.2). White-collar workers reported higher mean EQ-5D scores than corresponding workers in other worker groups, reflecting lower overall morbidity. For instance, white-collar workers with and without arthritis had a mean EQ-5D score of 0.84 (0.76-0.92), and 0.92 (0.90-0.93), respectively while workers with and without arthritis in other worker categories had lower EQ-5D scores: service workers (0.74 [0.71-0.78] and 0.91 [0.90-0.91], respectively), farm workers (0.74 [0.72-0.75] and 0.88 [0.87-0.89], respectively), and blue-collar workers (0.72 [0.70-0.75] and 0.87 [0.85-0.88], respectively). In all cases, we see that white collar workers with arthritis suffer considerably less overall morbidity (relative to those without arthritis) than other workers. For instance, while white collar workers with arthritis realize a 10% drop in their EQ-5D score (from 0.92 to 0.84), service workers realize over a 20% drop in their EQ-5D score (0.91 to 0.74). This indicates that the overall suffering of white-collar workers with arthritis is significantly lower than that of other workers.

b. *Incremental Quality-Adjusted Life Years (QALYs)*

While morbidity provides much of the story, it is also informative to explore the remaining healthy life expectancy at age 65, or QALE. This is a measure of the quality time remaining for workers of different social classes. Figure 5.1 presents the QALE remaining among white collar, service, farm, and blue-collar workers with arthritis at 2 different ages, 25 and 65. At age 25, blue-collar workers can expect to live 44 years of perfect health over their remaining life, while white-collar workers can expect to live 50. Among those with arthritis, QALE is 33 and 39 respectively. Said another way, blue-collar workers with arthritis can look forward to 17 fewer years of perfect health. At age 65, white-collar workers with arthritis who remain in the workforce can expect to lose just 4 QALYs relative to those without arthritis, while blue-collar workers lose nearly 6 of their remaining years of perfect health measured in QALYs.

V. DISCUSSION

In the past, youth from lower income families could often garner blue-collar factory jobs with sizable pension plans and health insurance (Hareven 1996). As the U.S. population ages and increasingly shifts toward a service sector economy (Attaran and Guseman 1988), more lower income workers will need to work past retirement age because they lack retirement savings or other assets (Census 1997). This population is also more likely to suffer from disabling conditions earlier in life, and has less access to health care.[32] As a result, the lower-income US worker can easily fall into a downward financial spiral, in which productivity declines for health reasons, as the need to put in more hours to meet one's basic survival needs increases (Birkenmaier, Rowan et al. 2009).

Arthritis serves as a powerful lens for looking at these convergent phenomena (Gignac 2005; Gignac, Sutton et al. 2007; Kaptein, Gignac et al. 2009). Many people can work in pain with this condition if need be; while some white-collar workers continue to work beyond age 65, those with arthritis appear to leave the workforce. Only approximately 47% of blue-collar workers over 65 have arthritis. Lower-income workers of this age in the service and farming sectors—two job types that are unlikely to come with pension plans—are more likely to have arthritis than not, with an arthritis prevalence between 51-71%. Unfortunately, these workers also have many fewer years of healthy life to look forward to. By age 65, blue-collar workers with arthritis can only expect to enjoy 11 remaining QALYs, many of which will be spent on the job. White-collar workers without arthritis will enjoy 17 remaining years of perfect health, and may be more likely to opt whether to continue to work or to retire.

Our study is subject to a number of important limitations. First, the NHIS and MEPS are based upon population survey data that are subject to measurement error. We attempted to minimize this confounding and maximize the specificity of our estimates via Oaxaca decompositions (Bauer and Sinning 2010). In addition, arthritis prevalence was obtained by self-report rather than medical records; these responses are thus both subject to self-report bias as well as perceptual bias. However, this case-finding question has been shown valid for public health surveillance purposes (Bombard, Powell et al. 2005; Sacks, Harrold et al. 2005).

As manufacturing moves overseas, the Patient Protection and Affordable Care Act will play an important role in protecting the US worker (DHHS 2010). Foremost, it will help protect a family's assets in the event of illness of one of its members. However, additional federal programs, such as disability and unemployment insurance will be needed to maintain a higher quality of life for all workers, particularly those with arthritis limitations. Educational system enhancements (e.g. evidence-based arthritis health promotion interventions) hold hope for producing cost-savings, while making the US workforce more competitive (Belfield and Levin 2007). Still, as the native population ages, new funding for such programs will need to be sought in the face of expanding budget deficits. Politically difficult choices—such as reducing spending, increasing taxation, and developing new programs to attract young, skilled immigrants—will need to be made if the US is to maintain its standard of living.

Table 5.1. Occupation and age-stratified sample size, population size, percentage of workers over the age of 65, percentage in the workforce with arthritis, and percent older than 65 who are working with arthritis among US workers with arthritis in the combined National Health Interview Survey (1997-2004) and Medical Expenditure Panel Survey (2001-2003).

Occupational Groups	**Sample N**	**Estimated Annual US Worker Population**	**Percent of Workers > Age 65**	**Percent in Workforce with Arthritis**	**Percent Older than 65 in Workforce with Arthritis**
All Workers	19,699	187,090,449	15%	22%	44%
White-collar Worker	10,804	114,646,129	14%	19%	51%
18-24 years old	725	6,855,730		3%	
25-44 years old	4,813	52,221,217		8%	
45-64 years old	3,738	38,651,796		31%	
65-74 years old	828	8,734,044		45%	
≥ 75 years old	700	8,183,339		59%	
Service Workers	3,330	25,666,964	17%	26%	58%
18-24 years old	319	2,746,181		2%	
25-44 years old	1,433	11,173,886		13%	
45-64 years old	1,024	7,745,301		38%	
65-74 years old	296	2,004,775		52%	
≥ 75 years old	258	1,996,818		65%	
Farm Worker	548	3,602,846	17%	20%†	71%†
18-24 years old	51	384,279		4%†	
25-44 years old	231	1,372,693		7%†	
45-64 years old	174	1,278,450		25%†	
65-74 years old	43	219,389		50%†	
≥ 75 years old	49	348,033		55%†	
Blue-collar Worker	5,017	43,174,508	16%	22%	47%
18-24 years old	332	3,174,913		2%	
25-44 years old	2,215	18,839,984		10%	
45-64 years old	1,656	14,005,265		29%	
65-74 years old	468	3,861,040		42%	
≥ 75 years old	346	3,293,305		53%	

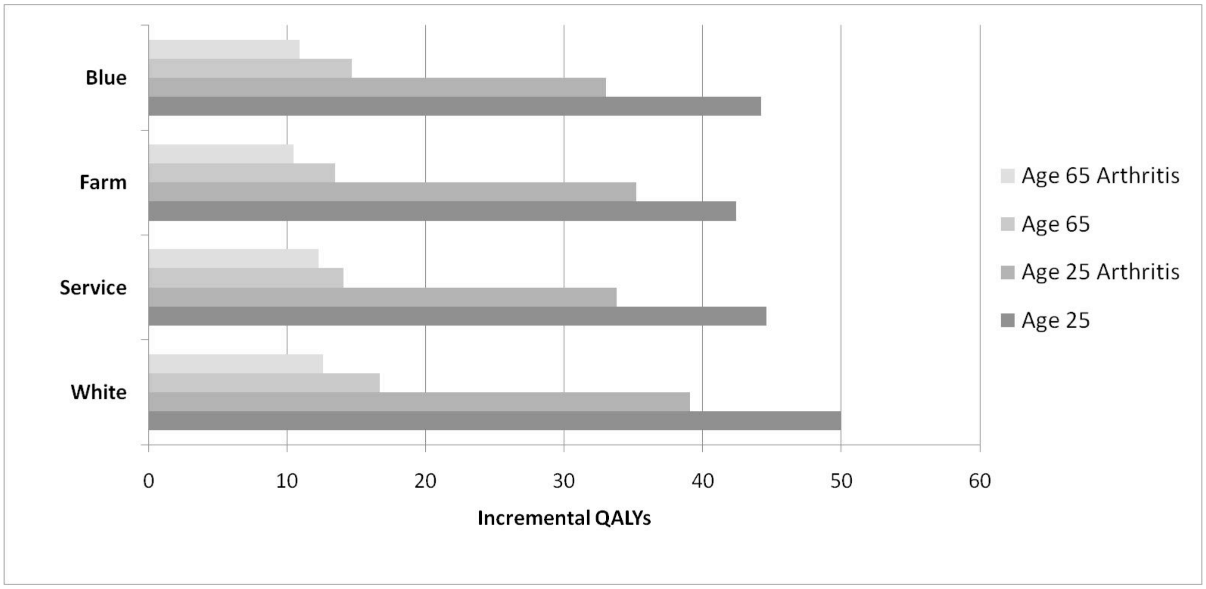
† = Estimates have a relative standard error ≥ 30% and should be used with caution, as they do not meet NCHS standards of reliability or precision (NCHS, 2008).

Table 5.2. Occupation and age-stratified mean and 95% Confidence Interval (CI) for the Euro-Qol (EQ-5D) score among US workers in the combined National Health Interview Survey (1997-2004) and Medical Expenditure Panel Survey (2001-2003).

	Mean EQ-5D [95%CI]	
	Respondents with Arthritis	**Respondents without Arthritis**
All Workers	0.69 [0.67-0.70]	0.88 [0.87-0.89]
White-collar Worker	0.72 [0.71-0.74]	0.90 [0.89-0.91]
18-24 years old	0.84 [0.77-0.92]	0.91 [0.90-0.93]
25-44 years old	0.74 [0.71-0.78]	0.91 [0.90-0.91]
45-64 years old	0.74 [0.72-0.75]	0.88 [0.87-0.89]
65-74 years old	0.72 [0.70-0.75]	0.87 [0.85-0.88]
≥ 75 years old	0.67 [0.64-0.71]	0.79 [0.76-0.82]
Service Workers	0.64 [0.61-0.66]	0.86 [0.85-0.87]
18-24 years old	0.88 [0.80-0.96]	0.90 [0.88-0.92]
25-44 years old	0.62 [0.56-0.68]	0.87 [0.86-0.89]
45-64 years old	0.63 [0.60-0.68]	0.82 [0.80-0.85]
65-74 years old	0.65 [0.60-0.70]	0.81 [0.77-0.85]
≥ 75 years old	0.64 [0.58-0.70]	0.77 [0.69-0.85]
Farm Worker†	0.68 [0.61-0.75]	0.84 [0.81-0.87]
18-24 years old†	0.73 [0.33-0.98]	0.88 [0.84-0.93]
25-44 years old†	0.96 [0.40-0.96]	0.87 [0.82-0.91]
45-64 years old†	0.76 [0.70-0.82]	0.81 [0.75-0.88]
65-74 years old†	0.71 [0.62-0.79]	0.84 [0.78-0.91]
≥ 75 years old†	0.53 [0.34-0.72]	0.60 [0.38-0.82]
Blue-collar Worker	0.63 [0.60-0.65]	0.86 [0.85-0.87]
18-24 years old	0.84 [0.71-0.97]	0.91 [0.89-0.94]
25-44 years old	0.69 [0.64-0.74]	0.87 [0.86-0.89]
45-64 years old	0.58 [0.54-0.62]	0.83 [0.82-0.55]
65-74 years old	0.64 [0.59-0.70]	0.81 [0.77-0.84]
≥ 75 years old	0.63 [0.57-0.70]	0.78 [0.75-0.83]

† = Estimates have a relative standard error ≥ 30% and should be used with caution, as they do not meet NCHS standards of reliability or precision (NCHS, 2008).

Figure 5.1. Quality-adjusted life expectancy remaining at age 25 and age 65 for white collar, service, farm, and blue collar workers with and without arthritis.



Chapter VI – Discussion & Conclusion

I. Overview of Major Findings

As an overall summary of the research findings of this dissertation, we found musculoskeletal disorders, specifically the arthritis conditions, to be prevalent and reported disproportionately by U.S. workers. A healthcare provider diagnosis of arthritis was significantly associated with unemployed adults as well as blue-collar relative to white-collar workers. These chronic conditions were found to modify an individual' report of activity limitations both directly and indirectly via their respective health behavior. In addition, the health-related quality of life of workers with arthritis was found to be worse than those without arthritis. In this chapter, a brief overview of the major study findings organized by specific aims and tested hypothesis are presented. This section is not meant to be a comprehensive discussion of all study findings as articulated in the discussion section of each chapter specific aim/paper, rather it is a succinct recapitulation of significant dissertation results in light of the current scientific literature.

II. Specific Aim #1: The Prevalence of Arthritis in the US Workforce

In our first specific aim, we sought to document and compare the prevalence, trends, and geographical variation of rheumatic diseases (e.g. "EVER" diagnosis of arthritis, as well as specific arthritic conditions such as rheumatoid arthritis, gout, lupus, or fibromyalgia with a subset of the 2007-2008 NHIS) as a surrogate marker for all musculoskeletal diseases for all US workers.

We found the prevalence of arthritis among the US worker population (14%) to be somewhat lower than the general US population (22%) and much lower than among unemployed adults (34%). These findings are consistent with the few existing peer-reviewed articles describing the prevalence of arthritis and associated musculoskeletal conditions in the general worker and unemployed adult populations. In 2003, Muchmore et al found that arthritis and joint disorders affected approximately 15% of the general US worker population (Muchmore, Lynch et al. 2003), consistent with our finding of arthritis prevalence estimates for employed adults based on the National Health Interview Survey (NHIS) data.

The prevalence of general arthritis was highest among healthcare support occupations and protective service occupations. A longitudinal study by de Zwart et al showed that the workers in more physically demanding occupations reported increasing musculoskeletal complaints across the four-year study period (de Zwart, Broersen et al. 1997). Healthcare support occupations that frequently shoulder the brunt of heavy patient lifting , equipment handling, and long standing hours (Celia Rde and Alexandre 2003), would likely benefit from arthritis educational and intervent programs that improve their specific arthritis.

Among the NIOSH NORA Industrial sectors, arthritis was highest among female workers employed in the healthcare and social assistance industry. Females generally report a larger burden of arthritis conditions than men (Anderson 1996; Sallfors, Hallberg et al. 2003). Perhaps woman employed in the healthcare and social assistance industries are more familiar than other employed females in recognizing arthritis symptoms, and are more likely to visit a healthcare professionals for diagnosis and treatment.

The geographical distribution of arthritis has been a longstanding research interest among the rheumatologic community given the potential exposure of environmental factors that can influence arthritis incidence (Lawrence, Behrend et al. 1966; Rosati, Granieri et al. 1978; Moss 1997; Wang, Elsbett-Koeppen et al. 2000; Ramos-Remus, Sierra-Jimenez et al. 2007; Pedersen, Kjaer et al. 2009). We found using the CDC surveillance definition of arthritis (i.e. Ever told by a healthcare professional you had: osteoarthritis, rheumatoid arthritis, gout, lupus, and fibromyalgia) that NHIS participants with arthritis were more likely to reside in the mid-west region of the United States. Women participating in the longitudinal Nurse's Health Study who resided in the same geographic location throughout the follow up period had the highest relative risk of developing rheumatoid arthritis, compared to women who resided in the western region of the US (Vieira, Hart et al. 2010). Particulate air pollution such as that arising from traffic at nearby transportation roads has been suggested as contributing factor to systemic inflammatory disease (Hart, Laden et al. 2009). Some recent environmental studies have shown much higher levels of airborne particulate matter in the Midwest US, when compared to the rest of the US, may be exacerbated by meteorologic patterns (Pope, Hansen et al. 2004). Our data may support a potential ecological association between working in a region with higher pollution and reporting of a doctor diagnosis of arthritis. Further studies connecting

U.S. environmental large and fine particulate data with doctor diagnosis of arthritis are need to substantiate such an association.

III. Specific Aim #2: Health Behaviors and Functional Limitations Among Workers with Arthritis

The second specific aim/paper utilized the 2004-2008 NHIS, to assess the differential health impacts of arthritis and functional limitations of US worker health behaviors (physical activity patterns, risky alcohol consumption, and cigarette use) by occupation and NORA Industry sector. We hypothesized: $H_{2\text{-}1}$: Within each major occupational group (i.e. white-collar, service, farm, and blue-collar workers) smoking and alcohol use will be higher in workers with arthritis who report higher functional limitation relative to workers with arthritis and lower functional limitation; and $H_{2\text{-}2}$: Self-report of musculoskeletal disorders (i.e. arthritis) will be lower among occupations that report higher levels of leisure-time physical activity.

Three major findings emerged from these analyses that examined the relationships between occupation and functional limitations among workers with arthritis, as well as associations mediated by important health behaviors.

First, among workers with arthritis, we observed that functional limitations could be expressed as two separate factors (i.e. gross and fine-motor limitations) using confirmatory factor analysis. Traditionally, studies examining activity limitations among individuals with arthritis have used a one global functional limitation variable (Escalante, Haas et al. 2004). We found that for workers with arthritis, functional limitations could be expressed best as two factors, gross limitations and fine-motor limitations. In our study, fine-motor limitations were defined as problems with grasping and reaching; and gross-motor functional limitations were defined as difficulties walking, climbing, standing, sitting, stooping, carrying, and pushing. Our findings are consistent with those of Chong et al who recently identified latent variables derived from functional limitation factors among healthy individuals (Chong 2008). This information provides an approach to functional limitations for future studies in arthritis research to better understand and further refine the common features of motor skills that are being tested in individuals with movement limitations and arthritis.

Report of both fine- and gross-motor functional limitations varied significantly by type of occupation. For example, among white collar workers, persons who were older, widowed, current smokers, and not engaging in leisure-time physical activity were more likely to experience fine motor functional limitations; while persons increasing age, being single or widowed, obese, being a current smoker, and unmet leisure-time physical activity were more likely to report greater levels of gross motor functional limitations. These findings support hypothesis H_{2-1} and are consistent with those of Ahacic et al who described similar patterns of mobility limitations by age, gender and social class in a national Swedish sample (Ahacic, Parker et al. 2003). Lastly, we found that negative health behaviors (such as risky drinking, cigarette smoking, and non-engagement in leisure-time physical activity) significantly correlated reporting of both fine- and gross-motor functional limitations by occupation type. Our path mediation model examining the direct, indirect, and total effects of occupation type on functional limitation, showed that blue-collar workers reported more fine motor limitations than white-collar workers. This effect was mostly direct, although 43% of the effect operated through increased drinking and decreased engagement in leisure-time physical activity. This finding was also consistent with our study hypothesis H_{2-2} and with Hammerman et al. who reported that blue-collar workers with arthritis were significantly more likely to report functional limitations if they engaged in higher levels of risky drinking than workers without arthritis (Hammerman, Maikowski et al. 1981).

IV. Specific Aim #3: Health-Related Quality of Life Among Workers with Arthritis

In our third specific aim, we estimated the health-related quality of life effects of having musculoskeletal disorders using Quality Adjusted Life Years (QALYS) by major US occupation (i.e. white-collar, service, farm, and blue-collar workers). We hypothesized in H_{3-1} that the QALYs among workers with arthritis who are employed in blue collar occupations will be significantly lower than workers with arthritis employed in other occupations.

Using three broad-based measures assessing the burden of disease, we first estimated the Health-Related Quality of Life (HRQoL), then the Quality-Adjusted Life Years (QALY), and finally calculated the Quality-Adjusted Life Expectancy (QALE) for workers with and without arthritis. Overall, workers with arthritis experienced a significant loss in quality of life due to arthritis burden when compared to workers without arthritis.

Overall, workers with arthritis reported lower mean EQ-5D scores than workers without arthritis. These findings are consistent with other national studies that have shown individuals afflicted with chronic conditions such as arthritis tended to report lower health-related quality of life than those individuals without chronic health conditions. For example, Sullivan et al found considerable variation in the EQ-5D scores among older US adults with arthritis; the older adults with arthritis reported lower health related quality of life than older adults without arthritis (Sullivan, Ghushchyan et al. 2010). We also observed mean EQ-5D scores among blue-collar workers with arthritis to be lower for all age categories when compared to the same age-categories for all other occupational groups (e.g. service, farm or white-collar). These findings are consistent with reports from Bardage and Isacson showing that blue-collar workers with hypertension reported worse health related quality of life than blue-collar workers without hypertension (Bardage, Isacson et al. 2003). In these studies, blue-collar workers tended to engage in more rigorous occupational activity than white-collar workers, requiring more physical demands and activities. They also tended to be lower on the socioeconomic index in terms of household income and educational attainment, likely influencing their health-related quality of life experience (Bardage, Isacson et al. 2003).

In our study, the quality-adjusted life expectancy for workers with arthritis was lower than for US workers without arthritis in this nationally representative sample.

Population level studies over the past few decades have demonstrated that mortality among individuals with rheumatoid arthritis, for example, has been higher than the general population (Sokka, Abelson et al. 2008; Myasoedova, Davis et al. 2010). Age and sex have been the most consistent predictors for mortality reported in rheumatoid arthritis; disease-specific features (such as severity of arthritis, inflammatory markers, functional disability and rheumatoid factor) have variable prognostic importance (Leigh and Fries 1991; Pincus, Keysor et al. 2004; Troelsen, Garred et al. 2010). This is an important area because employment and specific occupation type may hold the possibility of identifying and targeting worker groups at risk for poor health-related quality of life in terms of improving the productivity of the rapidly aging US workforce.

Among all four types of occupational groups reporting arthritis and in support of our study hypothesis $H_{3\text{-}1}$, we found that blue-collar workers experienced the lowest quality-adjusted life expectancy for all age categories. Employment as a blue-collar worker can be both physically and mentally taxing (Bamberger, Sonnenstuhl et al. 2006; Novak, Bullen et al. 2007; Schreuder, Roelen et al. 2008; Dagan, Wolf et al. 2009). They often hold non-office, hourly jobs, for which both work pace and workload may increase while paid hours remain low or constant (Ringen, Anderson et al. 2002; Elbel, Aldana et al. 2003; Bacharach, Bamberger et al. 2004; Szubert and Sobala 2005). In addition, blue-collar workers usually have restricted control over their tasks or work schedule; may be required to do repetitive, monotonous, and physically demanding activities; be exposed to loud noise or extreme temperatures;

and experience limited mobility and support within the organizational structure (Wilson, Sisk et al. 1997; Louhevaara, Penttinen et al. 1999; Bagwell and Bush 2000; Campbell, Tessaro et al. 2000; PHR 2001). Thus, these workers may face multiple sources of job stress that can significantly influence their quality of life in and out of the workplace (e.g. living in poor neighborhoods, and report lower educational attainment). Therefore, understanding the interplay between arthritis status, health-related quality of life and occupation type is critical to developing workplace arthritis management strategies that improve the quality of life for workers with arthritis.

We found significant variation in the incremental quality-adjusted life years between and across specific occupational groups, suggesting that the type of employment (in addition to already known predicators) may influence the years of perfect health lost to arthritis, particularly for those workers who are employed in blue-collar jobs. Regardless of occupational grouping, we found that all employed adults with arthritis experienced a loss of almost three years of perfect health due to their arthritis condition when compared to white collar workers without arthritis. Allaire et al recently reported that older adults may be particularly vulnerable to the effects of arthritis on employment, resulting in disability (Allaire, Wolfe et al. 2009). Improving the health-related quality of life of workers with arthritis may support improvement of worker productivity and/or delay serious illness due to an arthritis condition, particularly among the growing older worker population. Hence, employment maintenance among older workers will be an increasingly important goal, for individuals, employers and society.

Lastly, when comparing the incremental QALYs across occupations with arthritis, we found, 18-year-old blue-collar workers with arthritis will have an estimated 17 fewer years of perfect health (i.e. 17 fewer QALYs) when compared to white collar workers without arthritis. Additional research elucidating the elements behind these observed stark differences in health-related quality of life between worker groups is needed.

V. Limitations

This dissertation is not without important limitations. In this study, the definition for arthritis status was obtained from each database by participant self-report, and does not reflect confirmation from a medical record. The general arthritis definition is also not specific to any specific type of arthritis condition; rather, it is an affirmation to ever being told by a doctor or other health professional the participant had arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia. Notwithstanding, this case-finding question has been shown by Kvien et al to be valid for public health surveillance purposes (Kvien, Glennas et al. 1996).

Occupation and industry coding were also obtained by participant self-report, where they state their current occupation held at least the one-week prior to survey administration (Brackbill, Frazier et al. 1988). There is also a potential for misclassification bias of occupation and industry name by survey coders given the use of the 3-digit census occupations (Ljung and Hallqvist 2007). These census codes representing 500 occupational categories, are quite detailed, and subtle word changes can result in a different occupational classification.

Data obtained from both publicly available databases (NHIS and MEPS) were cross-sectional, therefore limiting our ability to determine causality; for example, we cannot determine in the case of health behaviors, functional limitations and occupation type, if workers with arthritis were employed in an occupation because of their arthritis limitation, or if their functional limitation forced them into an occupation. The unmeasured explanatory variables in our analysis could also affect our estimates; nonetheless, analytical techniques utilized such as structural equation modeling and mediation analysis aided in controlling for the effect of these unmeasured variables.

Most importantly in terms of accounting for differences in observed estimates between workers with and without arthritis (as well as any comparisons with the general population) is the healthy worker effect (Shah 2009). This effect plays a role when measuring health and exposure indicators for worker morbidity and mortality (Baillargeon 2001; Radon, Goldberg et al. 2002; Richardson, Wing et al. 2004). The arthritis estimates for employed adults in this dissertation results are generally lower than among unemployed adults or the general population since persons who have severe arthritis often drop out of the workforce (Li, Gignac et al. 2006). It is often most evident in cross sectional studies such as the present study that are influenced by biases such as selection bias when assessing the prevalence of musculoskeletal conditions in the working population.

The healthy worker effect is a likely explanation for the observed lower rate of arthritis among employed individuals. The healthy worker effect is observed when measures in morbidity and mortality among employed adult workers are lower than the general population. Arthritis is a progressively disabling condition where workers with arthritis could eventually limit the number of hours on the job, change occupation type to maintain productivity, or even experience severe disability eventually rendering them unemployed. This effect in observational, and particularly, cross sectional studies unfortunately results in selection bias when assessing the prevalence of certain health indicators in the working population. However, this finding identifies the actual burden of disease in the working population and also presents an opportunity to implement secondary prevention programs to slow the further progression of arthritis in identified high risk worker groups.

Lastly, using advanced, robust, flexible statistical techniques such as structural equation modeling, we were able to tease out study linkages between a participant's socio-demographic characteristics (e.g. education level, gender, occupation type, etc) with factors associated with functional limitations and negative health behaviors. Some of the measures in these models were directly observed, and some were latent variables (i.e. functional limitations) which are unobserved variables measured by observed indicators (i.e. grasping, pulling, reaching, etc). The latent variable (functional limitation) was added to certain models to measure unobserved heterogeneity, which may bias parameters if left uncorrected.

VI. Implications and Impact of the Dissertation Findings

The rapidly aging US population is likely to delay retirement in the upcoming years (Suthers, Kim et al. 2003). Older workers will seek to remain actively employed and highly productive members of the US workforce due to both improved population health compared to prior generations, but also increased economic pressures (Quinn 1980; Rix 1996; Schofield, Fletcher et al. 2008). At the same time, this baby boom generation will have greater chances to develop arthritis and subsequent functional limitations with increasing age (HN 2005; Leveille, Wee et al. 2005). We found in the 2004-2008 NHIS survey period an estimated annual 18,946,545 workers reported being told by their doctor they had arthritis. Therefore, classifying the prevalence of arthritis, and its possible association with occupation and health behaviors, as well as its impact on an individual's quality of life, is paramount since the number of US workers with arthritis will increase dramatically as this worker population rapidly ages. Further decline in the retirement of blue-collar and service workers with arthritis from the workforce will require organizational changes to sustain productivity in this older workforce.

Traditionally, population-level estimates of arthritis describe the incidence and prevalence of arthritis by major socio-economic indicators, however, specific aim / paper #1 in this study expanded on this work by including an important lens, occupation. Americans spend a significant proportion of their waking hours and overall lives working, sometimes more than one job or extra work shifts (Yamasaki, Schwartz et al. 1998; Collins 2007; Krueger and Friedman 2009). Increasingly, many lower income workers will need to work past retirement age because they lack retirement savings or other assets. This population is also more likely to suffer from disabling musculoskeletal conditions such as arthritis earlier in life and are likely to have fewer financial resources to access health care.

Specific aim / paper #1 provides a national perspective of occupational groups and industries experiencing a disproportionate burden of specific arthritis types. We also identified socio-demographic correlates that are strongly associated with report of arthritis diagnosis by a healthcare professional. In an era of limited financial support for health promotion activities, or improved surveillance capacity, identifying factors correlated with workers reporting arthritis is critical to targeted and tailored worker interventions. Public health professionals could target the specific occupational groups we identified with elevated estimates of arthritis for secondary prevention interventions to improve the workplace experience of working adults with arthritis and keep them active and productive in the US workforce well pass their retirement age.

Informative to musculoskeletal and activity limitation research, this dissertation's study findings on functional limitations among workers with arthritis, particularly as it pertains to potentially predicting worker productivity or even disability outcomes are useful. It is unclear however, how certain complex movements such as grasping, stooping, pulling, are evaluated in qualitative research to yield a functional limitations measure (Pincus 2008; Sokka and Pincus 2009). Researchers have traditionally employed global physical limitation scales to describe a degree of physical limitations in an individual (Escalante, Del Rincon et al. 2004; Escalante, Haas et al. 2004). In this study, we build further upon this work by examining functional limitations among workers with arthritis at the population-level. We found that workers with arthritis experienced functional limitations that could be expressed as two separate factors (fine and gross-motor limitations) using confirmatory factor analysis, suggesting that these limitations may influence occupation type and workplace organization as more refined measures. Researchers should consider modeling functional limitations as two separate factors among employed individuals with arthritis. This is critically important given that occupational demands vary by job type, therefore efforts to further investigate and develop interventions by occupation type among workers with arthritis will require directed and focused musculoskeletal interventions based on the type of functional limitation rather than one global measure.

Using structural equation modeling, we explored the direct and indirect effects of negative health behaviors on the relationship between occupation type and functional limitations. We found changes on the effects of control variables and health behaviors on the functional limitations reported by workers varying by occupation type. For example, among service workers, one of the strongest risk factor correlates was between the association of obesity and gross functional limitations. Population-based studies have consistently shown a link between overweight or obesity and knee osteoarthritis (Garcia-Poma, Segami et al. 2007; Magliano 2008; Reynolds and McIlvane 2009). Previous investigations by our occupational research group have shown that obesity is increasing among most US workers, suggesting an expectant increase in osteoarthritis in all worker groups (Caban, Lee et al. 2005). As U.S. society transitions from a blue collar to service oriented economy with frequent sedentary tasks, increased leisure-time physical activity is required to thwart rising obesity levels (Seo and Li 2010).

Similarly, findings from our third specific aim / paper further build on specific aim / paper #2 where we found that workers with arthritis report lower health-related quality of life than workers without arthritis. We explored the burden of disease among workers in different service sectors using arthritis as an example of a chronic condition that impedes one's ability to work. We found that service, farm, and blue-collar workers, are now finding themselves having to work beyond retirement age, and they must also do so with a much higher burden of disabling illness that might otherwise have led to retirement at age 65. As federal programs that expand on disability and unemployment in the US grow and change to accommodate the changing US population demographics, special attention on individuals with arthritis working past the retirement is warranted (Grimaldi 1998; Gold, Mittler et al. 2001; Kemper, Weaver et al. 2008). Workers with arthritis could be marginalized in the workplace, and forced out of their job, unnecessarily increasing rates of unemployment and disability claims (Reisine, Fifield et al. 2007; Allaire, Wolfe et al. 2009; Sokka, Kautiainen et al. 2010). Researchers and public health professional should target the specific worker groups identified in this research as having significant loss in years of perfect health due to arthritis in order to actively retain them engaged and productive in the workforce.

VII. Recommendations for surveillance of musculoskeletal disorders in US workers.

Not all musculoskeletal disorders are created equal. Researchers often use self-reported and non-specific measures of musculoskeletal disorders data from epidemiological surveys to address questions about a specific disease and even develop interventions. This raises two important issues as experienced in this dissertation study in the collection and analysis of arthritis measures in general population survey that truly warrants further discussion.

First, not all nationally population-based surveys ask respondents to report their specific type of arthritis. This is often challenging, daunting and problematic because arthritis subtypes have a distinct etiology, pathogenesis, and functional, health and economic impacts. For example, individuals with rheumatoid arthritis have been shown to have higher risks of major vascular events, to experience more daily pain, and to be more likely to suffer from depression than those individuals with osteoarthritis. When survey measures combine all arthritis types into one condition by asking participants "Have you EVER been told you by a health care professional that you have arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia", a significant amount of information is lost. This type of measurement approach for arthritis is unfortunately common to large US population-level studies such as the NHIS and the NHANES; however, recent efforts by national professional groups and governmental agencies such as the US Arthritis Foundation, and the Centers for Disease Control and Prevention are developing alternate case-finding definitions. These definitions could include biomarkers strongly associated with disease type and severity to further classify and characterize disease type.

In some recent investigations using the NHIS, participants have been asked to self-report the specific type of arthritis condition they were diagnosed with by their healthcare provider. In these types of studies, misclassification is likely to exist. Osteoarthritis and rheumatoid arthritis are often considered by lay people to be synonymous with each other and with other types of joint diseases. Previous research has highlighted the low positive predictive value of self-reported rheumatoid arthritis and osteoarthritis. Because relying on subjects to identify their type of arthritis may lead to inaccuracies, finding ways to corroborate responses with other collected data may be a strategy to increase their predictive validity in nationally representative databases that utilize participant self-report. Combing healthcare expenditure with self report data maybe a viable way at the population level, to improve sensitivity and specificity of the disease case. For example, merging MEPS and NHIS data allows researchers to verify if a MEPS respondent was diagnosed by their healthcare professional with arthritis. The respondents self-report can be correlated with the doctor-diagnosis to as congruence of each measure.

Longitudinal studies collecting biological data among worker populations with disproportionately high levels of arthritis are needed to address the second important issue, self-report bias (Ting, Schneeweiss et al. 2005; Cohen, Cohen et al. 2008;

Sokka, Abelson et al. 2008; Zhao, Liu et al. 2010). Survey participants can often confuse the type of arthritis they were told by their health care provider (MacGregor, Bamber et al. 1994; Bellamy, Duffy et al. 1998; Lassere, van der Heijde et al. 2001). Using strict diagnostic criteria as recommend by the American College of Rheumatology paired with relevant biological markers and imaging (e.g. C-reactive protein, rheumatoid factor, bilateral x-rays of articulations) could support a more precise definition of the type and even severity of arthritis in large population-level databases of US workers (Hochberg, Chang et al. 1992; Lunt, Symmons et al. 2005; Zhao, Liu et al. 2010).

Further collection of workplace and non-occupational exposures such as environmental factors, chemicals agents, and physical work demands have been suggested as was to improve surveillance measures and reduce incident musculoskeletal disorders. For example, organic solvents used in household cleaners and also found in paints, varnish, lacquers, thinners, paint and varnish removers, waxes (floor and shoe polish), inks, adhesives, antifreeze mixtures, motor fuel, pharmaceutical products and preservatives have been implicated in immunologic flaring (Cocco, Palli et al. 1994; Cocco, Ward et al. 1998; Burgel, White et al. 2010). Worker groups exposed to high levels of cleaning chemicals such as housekeepers could be followed over time to assess for the incidence of rheumatoid arthritis or lupus. Long-term observational studies are needed to effectively capture both self-report and biological measures in the workplace setting. For example, exposure to chronic workplace physical demands has been associated with knee osteoarthritis

(Anderson and Felson 1988; Felson, Hannan et al. 1991). Collecting knee x-ray or MRI imaging periodically across different worker groups will allow for improved classification of physical demands on knee osteoarthritis severity.

Developing data collection methods that validate self reported data on musculoskeletal disorders and type paired with biological measures from non-workplace and occupational exposure are needed (Mastin, Henningsen et al. 1992). Improved case-finding definitions embedded in national population-level surveys such NHIS that use both stringent classification measures (as suggested by the America College of Rheumatology), and validated with biomarkers would likely improve estimates of musculoskeletal conditions such as arthritis in US worker populations (Sacks, Harrold et al. 2005; van der Helm-van Mil, Breedveld et al. 2006; Zakkak, Wilson et al. 2009). Currently models such as tobacco exposure data that utilize a combination of self-report and biomarkers (i.e. urinary, saliva and hair samples cotinine or nicotine) to validate smoking status and tobacco exposure can be incorporated in the field of musculoskeletal epidemiology (Bernert, Turner et al. 1997; Vartiainen, Seppala et al. 2002; Gilligan, Sanson-Fisher et al. 2010). For example, in the case of arthritis, in order to diagnosis a case of rheumatoid arthritis, survey participants can self-report the following information that will have lasted a minimum of six continuous weeks: morning stiffness lasting at least 1 hour, arthritic pain in three or more body joints, arthritic pain that appears symmetric to both joints, nodules over body prominences or extensor surfaces of the body (Liu, Harker et al. 2004; Soubrier and Dougados 2005). This self-reported information could be correlated with laboratory data on serum rheumatoid factor or radiographic changes (i.e. erosion or bony decalcification of involved joints) to positively identify a case of rheumatoid factor (Liu, Harker et al. 2004; Soubrier and Dougados 2005). The National Health and Nutrition Examination Survey already collects some limited biological data on rheumatic factors, and would favorably lend itself to serve as a good national population-level based survey to examine specific arthritic conditions among US workers.

Even if robust and vast amounts of musculoskeletal health data were available for working adults, the question of how best to utilize this information in terms of developing primary and secondary prevention efforts remains. Whether it be the worker, employer or healthcare-provider, who is responsible for identifying the musculoskeletal condition and its attribution as work-related will be challenging. Considerable evidence has been published over the last six decades documenting the prevalence of musculoskeletal disorders in working age adults, and that some proportion of the burden of these conditions is attributable to factors other than the workplace (Leigh and Fries 1991; Dillon, Petersen et al. 2002). A broader research question remains in that when is a musculoskeletal disorder such as arthritis or carpal tunnel attributable to work?

Occupational health researchers have accepted the association between some physical and psychosocial factors (e.g. physical activity, alcohol consumption, and cigarette smoking) and musculoskeletal disorders in the workplace (Li, Gignac et al. 2006; Zyrianova, Kelly et al. 2006; Bengtsson, Theorell et al. 2009). While a considerable proportion of the musculoskeletal disease burden would still occur, independent of occupational exposures, what surveillance methods could be implemented to attribute those musculoskeletal conditions that are truly work-related and how do we ensure that it is done accurately and uniformly across industry, occupational groups and various worker characteristics? Accurate comprehensive surveillance data are needed by public health professionals responsible for preventing occupational illness and injury (Koh and Aw 2003; Greife 2004; Bonneterre, Bicout et al. 2008; Souza, Steege et al. 2010). Such data allow for targeting of industries for additional prevention and regulatory actions and also provide a basis for observing changes in illness and injury rates over time.

As described in the specific aims / papers of this dissertation, many approaches to occupational musculoskeletal disorder surveillance can be conceptualized however, most have critically important limitations. In this dissertation, advantages and potential limitations in occupational illness surveillance obtained with the NHIS, MEPS and NDI have been documented. Based on published scientific evidence and in light of findings obtained from this dissertation, it appears that state-based surveillance systems would be most useful in characterizing the prevalence, severity and trends of musculoskeletal disorders (Welch 1989; Thomsen, McClain et al. 2007). Similar to sampling techniques used in state-based surveys such as the Behavioral Risk Factor Surveillance System (BRFSS), future research into state-based monitoring that could target specific and regional occupational groups with specific case-finding and biological assessment markers may be useful to enhancing estimate precision (Thomsen, McClain et al. 2007). Future research in musculoskeletal epidemiology will need to decipher and develop more precise measures of musculoskeletal disease burden to further refine and elucidate its association with health behaviors among US workers.

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APPENDIX

A.1. Calculate trends in arthritis status by occupational group

```
/*
Alberto Caban-Martinez
Dissertation SAS Code
Function: Calculate trends in arthritis status by occupation
Compiled: 11/30/2009
*/


libname lib 'G:\';

data a;
 set lib.nhis0408;
run;

/*
proc contents data=a position;
run;

    1760   Race              Num    8
    1761   HispanicOrigin    Num    8
    1762   WTFA_FAM          Num    8
    1763   PSU               Num    8
    1764   Stratum           Num    8
    1765   FinalWeight       Num    8
    1766   OccDetail         Num    8
    1767   OccSimple         Num    8
    1768   Age               Num    8
    1769   Age4Levels        Num    8
    1770   Gender            Num    8
    1771   RaceEthnicity     Num    8
    1772   MaritalStatus     Num    8
    1773   Education         Num    8
    1774   BMI3Levels        Num    8
    1775   Region            Num    8
    1776   EverArthritis48_2 Num    8
    1777   EverArthritis78_2 Num    8
    1778   EverRA78_2        Num    8
    1779   EverGout78_2      Num    8
    1780   EverLupus78_2     Num    8
    1781   EverFibro78_2     Num    8
    1782   EverArthritis48   Num    8
    1783   EverArthritis78   Num    8
    1784   EverRA78          Num    8
    1785   EverGout78        Num    8
    1786   EverLupus78       Num    8
    1787   EverFibro78       Num    8
    1788   ArthritisLimit    Num    8
    1789   NeckPain3m        Num    8
    1790   LowBackPn3m       Num    8
    1791   PainDownLegs      Num    8
    1792   JobStatus         Num    8
    1793   HispanicType      Num    8
    1794   NORAgroup         Num    8
    1795   YoungOlderWorkers Num    8
*/

%macro t1(var);
ods output crosstabs=x1;
proc surveyfreq data=a;
 cluster psu;
 stratum stratum;
 weight FinalWeight;
 tables srvy_yr*&var/row;
run;
```

```
ods output close;

data xx1;
 set x1;
 keep year pct se wt;
 i=mod(_n_,3);
 if i=1 & srvy_yr^=. then do;
  year=srvy_yr;
  pct=rowpercent;
  se=rowstderr;
  wt=1/(se*se);
  output;
 end;
run;

proc glm;
 model pct=year/ss1 solution;
 weight wt;
run;
quit;
%mend;

%t1(EverArthritis48_2);
%t1(EverGout78_2);

%macro t1(group,var);
ods output crosstabs=x1;
proc surveyfreq data=a;
 cluster psu;
 stratum stratum;
 weight FinalWeight;
 tables &group*srvy_yr*&var/row;
run;
ods output close;

data xx1(index=(grp));
 set x1;
 keep grp year pct se wt;
 i=mod(_n_,3);
 if i=1 & srvy_yr^=. then do;
  grp=&group;
  year=srvy_yr;
  pct=rowpercent;
  se=rowstderr;
  wt=1/(se*se);
  output;
 end;
run;

data xx2;
 set xx1;
 keep grp pct1-pct5 se1-se5;
 retain pct1-pct5 se1-se5;
 array p pct1-pct5;
 array s se1-se5;
 i=mod(_n_,5);
 if i=0 then i=5;
 p[i]=pct;
 s[i]=se;
 if i=5 then output;
run;

proc print noobs data=xx2;
 var grp pct1 se1 pct2 se2 pct3 se3 pct4 se4 pct5 se5;
 format pct1-pct5 se1-se5 6.2;
run;
```

```
proc glm data=xx1;
 class grp;
 model pct=grp year(grp)/ss1 solution noint;
 weight wt;
run;
quit;
%mend;

%t1(occsimple,EverArthritis48_2);

proc print data=x1;
run;

proc surveylogist data=a;
 cluster psu;
 stratum stratum;
 weight FinalWeight;
 class occsimple;
 model  EverArthritis48_2=occsimple srvy_yr(occsimple)/noint;
run;
```

A.2. Program to create tab delimited file for MPlus

```
/*
Alberto Caban-Martinez
Dissertation SAS Code
Function: Create a tab delimted data source file for MPlus
Compiled: 1/29/2010
*/


libname Out "C:\Users\Alberto\Desktop\Alberto project";


proc contents data=out.attempt; run;

proc freq data=out.attempt;
table walk;
run;

proc sort data=out.attempt;
by stratum newpsu;
run;

data out;
set out.attempt;
file "C:\Users\Alberto\Desktop\Alberto project\evelyn.dat" delimiter=",";
put  ActLim3 Ag Age AgeCat4 Arth48 Arth78 BMI BMICat3 Binge Black BlueK
Carry Climb Cnstrct Coll Drinker DrinkerF DrinkerM Educ FMX FPX FarmK Fibro78
Gender Gout78 Grasp HHX HSch Hispanic Hlthcr Ins JobStat JobType Krieger LTPA
LessHS Limits Lupus78 Marital Marry Mine Mnf ModPA NmlWt Nora Obese OccLong OccShort
Other OvrWt PSU Push RA78 RECTYPE RaceE Reach Region SRVY_YR ServiceK Services Single
Sit Sleep SmkCat2 SmkCat3 Stand Stoop Stratum TransP VigPA Walk White WhiteK Whole
Widow Wt2 Wt5 YngOld newpsu;
run;
```

A.3. Risky Drinking Model

```
TITLE: Arthritis, Functional Limitations, & Drinking (Behaviors)

DATA: file is evelyn.dat;

VARIABLE: names are ActLim3 Ag Age AgeCat4 Arth48 Arth78
BMI BMICat3 Binge Black BlueK Carry Climb Cnstrct Coll
Drinker DrinkerF DrinkerM Educ FMX FPX FarmK Fibro78 Gender
Gout78 Grasp HHX HSch Hispanic Hlthcr Ins JobStat JobType
Krieger LTPA LessHS Limits Lupus78 Marital Marry Mine Mnf
ModPA NmlWt Nora Obese OccLong OccShort Other OvrWt PSU Push
RA78 RECTYPE RaceE Reach Region SRVY_YR ServiceK Services
Single Sit Sleep SmkCat2 SmkCat3 Stand Stoop Stratum TransP
VigPA Walk White WhiteK Whole Widow Wt2 Wt5 YngOld newpsu;

usevariables are Age Gender Drinker BlueK ServiceK FarmK
Stratum newPSU Wt5 Walk Climb Stand Sit Stoop carry push grasp
reach Hispanic Black Other Coll HSch Single Widow Obese OvrWt;

categorical Walk Climb Stand Sit Stoop Carry Push grasp reach
        Drinker;

stratification is Stratum;
cluster is newpsu;
weight is Wt5;

missing are .;

ANALYSIS: type complex missing;
Processor = 4;
estimator is MLR;
integration = montecarlo(500);

MODEL:
Gross by Walk Climb Stand Sit Stoop Carry Push;
Fine by grasp reach;

Gross Fine ON Age Gender Hispanic Black Other
Coll HSch Single Widow Obese OvrWt Drinker
BlueK ServiceK FarmK;

Drinker ON Age Gender Hispanic Black Other
```

```
Coll HSch Single Widow Obese OvrWt
BlueK ServiceK FarmK;


!Leave out one of the Krieger categories as the reference.
!Model has Gross and Fine factors as final outcome and Drinking variable as the
mediator.
!MODel indIRECT:
!Gross IND BlueK;
!Gross IND ServiceK;
!Gross IND FarmK;
!Fine IND BlueK;
!Fine IND ServiceK;
!Fine IND FarmK;


OUTPUT: standardized cinterval;
```

A.4.Leisure-Time Physical Activity Model

```
TITLE: Arthritis, Functional Limitations, & LTPA (Behaviors)

DATA: file is evelyn.dat;

VARIABLE: names are ActLim3 Ag Age AgeCat4 Arth48 Arth78
BMI BMICat3 Binge Black BlueK Carry Climb Cnstrct Coll
Drinker DrinkerF DrinkerM Educ FMX FPX FarmK Fibro78 Gender
Gout78 Grasp HHX HSch Hispanic Hlthcr Ins JobStat JobType
Krieger LTPA LessHS Limits Lupus78 Marital Marry Mine Mnf
ModPA NmlWt Nora Obese OccLong OccShort Other OvrWt PSU Push
RA78 RECTYPE RaceE Reach Region SRVY_YR ServiceK Services
Single Sit Sleep SmkCat2 SmkCat3 Stand Stoop Stratum TransP
VigPA Walk White WhiteK Whole Widow Wt2 Wt5 YngOld newpsu;

usevariables are Age Gender LTPA BlueK ServiceK FarmK
Stratum newPSU Wt5 Walk Climb Stand Sit Stoop carry push grasp
reach Hispanic Black Other Coll HSch Single Widow Obese OvrWt;

categorical Walk Climb Stand Sit Stoop Carry Push grasp reach
        LTPA;

stratification is Stratum;
cluster is newpsu;
weight is Wt5;

missing are .;

ANALYSIS: type complex missing;
Processor = 4;
estimator is MLR;
integration = montecarlo(500);

MODEL:
Gross by Walk Climb Stand Sit Stoop Carry Push;
Fine by grasp reach;

Gross Fine ON Age Gender Hispanic Black Other
Coll HSch Single Widow Obese OvrWt LTPA
BlueK ServiceK FarmK;

LTPA ON Age Gender Hispanic Black Other
Coll HSch Single Widow Obese OvrWt
```

BlueK ServiceK FarmK;

!Leave out one of the Krieger categories as the reference.
!Model has Gross and Fine factors as final outcome and Drinking variable as the mediator.
!MODel indIRECT:
!Gross IND BlueK;
!Gross IND ServiceK;
!Gross IND FarmK;
!Fine IND BlueK;
!Fine IND ServiceK;
!Fine IND FarmK;

OUTPUT: standardized cinterval;

A.5.Smoking Model

```
TITLE: Arthritis, Functional Limitations, & Smoking (Behaviors)

DATA: file is evelyn.dat;

VARIABLE: names are ActLim3 Ag Age AgeCat4 Arth48 Arth78
BMI BMICat3 Binge Black BlueK Carry Climb Cnstrct Coll
Drinker DrinkerF DrinkerM Educ FMX FPX FarmK Fibro78 Gender
Gout78 Grasp HHX HSch Hispanic Hlthcr Ins JobStat JobType
Krieger LTPA LessHS Limits Lupus78 Marital Marry Mine Mnf
ModPA NmlWt Nora Obese OccLong OccShort Other OvrWt PSU Push
RA78 RECTYPE RaceE Reach Region SRVY_YR ServiceK Services
Single Sit Sleep SmkCat2 SmkCat3 Stand Stoop Stratum TransP
VigPA Walk White WhiteK Whole Widow Wt2 Wt5 YngOld newpsu;

usevariables are Age Gender SmkCat2 BlueK ServiceK FarmK
Stratum newPSU Wt5 Walk Climb Stand Sit Stoop carry push grasp
reach Hispanic Black Other Coll HSch Single Widow Obese OvrWt;

categorical Walk Climb Stand Sit Stoop Carry Push grasp reach
        SmkCat2;

stratification is Stratum;
cluster is newpsu;
weight is Wt5;

missing are .;

ANALYSIS: type complex missing;
processor = 4;
estimator is MLR;
integration = montecarlo(500);

MODEL:
Gross by Walk Climb Stand Sit Stoop Carry Push;
Fine by grasp reach;

Gross Fine ON Age Gender Hispanic Black Other
Coll HSch Single Widow Obese OvrWt SmkCat2
BlueK ServiceK FarmK;

SmkCat2 ON Age Gender Hispanic Black Other
Coll HSch Single Widow Obese OvrWt
```

BlueK ServiceK FarmK;

!Leave out one of the Krieger categories as the reference.
!Model has Gross and Fine factors as final outcome and Drinking variable as the mediator.
!MODel indIRECT:
!Gross IND BlueK;
!Gross IND ServiceK;
!Gross IND FarmK;
!Fine IND BlueK;
!Fine IND ServiceK;
!Fine IND FarmK;

OUTPUT: standardized cinterval;

A.6.Simultaneous (all health behaviors) Models

```
TITLE: Arthritis, Functional Limitations, & Health Behaviors

DATA: file is evelyn.dat;

VARIABLE: names are ActLim3 Ag Age AgeCat4 Arth48 Arth78
BMI BMICat3 Binge Black BlueK Carry Climb Cnstrct Coll
Drinker DrinkerF DrinkerM Educ FMX FPX FarmK Fibro78 Gender
Gout78 Grasp HHX HSch Hispanic Hlthcr Ins JobStat JobType
Krieger LTPA LessHS Limits Lupus78 Marital Marry Mine Mnf
ModPA NmlWt Nora Obese OccLong OccShort Other OvrWt PSU Push
RA78 RECTYPE RaceE Reach Region SRVY_YR ServiceK Services
Single Sit Sleep SmkCat2 SmkCat3 Stand Stoop Stratum TransP
VigPA Walk White WhiteK Whole Widow Wt2 Wt5 YngOld newpsu;

usevariables are Age Gender Drinker SmkCat2 LTPA BlueK ServiceK
FarmK WhiteK Stratum newPSU Wt5 Walk Climb Stand Sit Stoop carry
push grasp reach Hispanic Black Other Coll HSch Single Widow Obese
OvrWt;

categorical Walk Climb Stand Sit Stoop Carry Push grasp reach
        Drinker SmkCat2 LTPA;

stratification is Stratum;
cluster is newpsu;
weight is Wt5;

missing are .;

ANALYSIS: type complex missing;
Processor = 4;
estimator is MLR;
integration = montecarlo(100);

MODEL:
Gross by Walk Climb Stand Sit Stoop Carry Push;
Fine by grasp reach;

Gross ON Age Gender Hispanic Black Other
Coll HSch Single Widow Obese OvrWt Drinker
SmkCat2 LTPA BlueK ServiceK FarmK;

Fine ON Age Gender Hispanic Black Other
```

```
Coll HSch Single Widow Obese OvrWt Drinker
SmkCat2 LTPA BlueK ServiceK FarmK;

WhiteK ON Age Gender Hispanic Black Other
Coll HSch Single Widow Obese OvrWt Drinker
SmkCat2 LTPA BlueK ServiceK FarmK;

Drinker SmkCat2 LTPA ON Age Gender Hispanic Black Other
Coll HSch Single Widow Obese OvrWt
BlueK ServiceK FarmK;


!Leave out one of the Krieger categories as the reference.
!Model has Gross and Fine factors as final outcome and Drinking variable as the
mediator.
!MODel indIRECT:
!Gross IND BlueK;
!Gross IND ServiceK;
!Gross IND FarmK;
!Fine IND BlueK;
!Fine IND ServiceK;
!Fine IND FarmK;


OUTPUT: standardized cinterval;
```

A.7.1. One Factor – Functional Limitations

```
TITLE: Alberto One Factor Model Example

DATA: file is mplus.dat;
Listwise = on;

VARIABLE: names are stratum psu wt5 OccShort
Krieger Nora AgeCat4 Gender Marital Educ Ins
Region Arth48 BMICat3 LTPA SmkCat2 Drinker Walk
Climb Stand Sit Stoop Reach Grasp Carry Push
ActLim3 white black other hispanic;

usevariables are Walk Climb Stand Sit Stoop
Reach Grasp Carry Push ;

categorical Walk Climb Stand Sit Stoop
Reach Grasp Carry Push;

! this is where we specify the sample design

stratification is stratum;
!cluster is psu_fina;
weight is wt5;

missing are .;

ANALYSIS: type complex;
!estimator is MLR;
!integration = montecarlo(100);

MODEL:
limits BY Walk Climb Stand Sit Stoop
Reach Grasp Carry Push;

!gross by grasp reach;

OUTPUT: standardized cinterval;
```

A.7.2.Two Factor – Functional Limitations

```
TITLE: Alberto Model Example

DATA: file is mplus.dat;
Listwise = on;

VARIABLE: names are stratum psu wt5 OccShort
Krieger Nora AgeCat4 Gender Marital Educ Ins
Region Arth48 BMICat3 LTPA SmkCat2 Drinker Walk
Climb Stand Sit Stoop Reach Grasp Carry Push
ActLim3 white black other hispanic;

usevariables are Walk Climb Stand Sit Stoop
Reach Grasp Carry Push ;

categorical Walk Climb Stand Sit Stoop
Reach Grasp Carry Push;

! this is where we specify the sample design

stratification is stratum;
!cluster is psu_fina;
weight is wt5;

missing are .;

ANALYSIS: type complex;
!estimator is MLR;
!integration = montecarlo(100);

MODEL:
gross BY Walk Climb Stand Sit Stoop
Carry Push;
fine BY Reach Grasp;

!gross by grasp reach;

OUTPUT: standardized cinterval;
```

VITA

Alberto Juan Cabán-Martinez was born in Caguas, Puerto Rico, on October 25, 1979. His parents are Elma Rosa Martinez de Caban and Alberto Juan Cabán-Alemany. He has two younger brothers, Carlos Andres Cabán and Arnaldo Andres Cabán. In August of 1997 he matriculated at the University of Miami, College of Arts and Sciences from which he graduated with a B.Sc. in computer science and minors in chemistry, biology and mathematics in May 2001. He went on to attend Nova Southeastern University, College of Osteopathic Medicine, and received his Masters of Public Health degree in May 2004.

In August 2004, he entered the Doctor of Osteopathic Medicine program at Nova Southeastern University, College of Osteopathic Medicine, where he completed a one year pre-doctoral fellowship in neuromuscular medicine between his second and third year of medical school. During his fellowship year in medical school, he initially matriculated in the Doctor of Philosophy in Public Health program at the Florida International University (F.I.U.) Robert Stempel College of Public Health while dually engaged in his medical school training. In 2008 after completing his third year of clinical rotations, he transferred from F.I.U. into the Doctor of Philosophy in Epidemiology program at the University of Miami, Miller School of Medicine and accepted a 2-year research leave of absence from Nova Southeastern University to pursue full time research activities related to his dissertation. He will be granted the degree of Doctor of Osteopathic Medicine (D.O.) and Doctor of Philosophy (Ph.D.) in May 2011 upon completion of his osteopathic medical and graduate school training.