THE COST OF INACTIVITY:

DIFFERENCES IN TOTAL HEALTHCARE EXPENDITURES AND HEALTHCARE SERVICE UTILIZATION BETWEEN SEDENTARY AND ACTIVE ADULTS WITH ARTHRITIS

by

ERICA LYNN ODOM

(Under the Direction of Joel Lee)

ABSTRACT

Despite the known benefits of physical activity (PA) adults with arthritis (AWA) are less active than adults without arthritis. A two-part study was undertaken to determine whether routine PA among U.S. AWA was associated with lower healthcare utilization or predicted lower medical expenditures. Subjects included AWA in the 2010 Medical Expenditure Panel Survey (MEPS) dataset (n=5,600).

Part 1: MEPS data were analyzed to generate descriptive characteristics and explore differences in healthcare utilization by physical activity status. Measures of interest included the length of time elapsed since last check-up, whether appointments for care were made, number of visits for care, number of times tests, care or treatment were thought necessary, and number of times a specialist was needed. Descriptive statistics were calculated for inactive and active AWA. Chi-Square tests were used to identify differences in frequency of service utilization. *Part 2:* A retrospective case-control study was conducted to assess the impact of PA on medical expenditures. PA was the primary

independent variable and total medical expenditures served as the dependent variable. Potential confounders such as age, race, gender, BMI, insurance, heart disease, high blood pressure, stroke, diabetes, and obesity were included in the model. Logistic regressions, via SAS 9.3, were used to predict savings in total healthcare expenditures based on PA status and compute odds ratios.

Healthcare utilization differed between active and inactive AWA. Generally, active AWA utilized fewer services than inactive AWA. Active and inactive AWA differed significantly (Chi-square) in time since last checkup ($p<.0001$), needing a specialist ($p<.0001$), number of appointments for care ($p=.0004$), and number of healthcare visits ($p<.0001$), but not in need for test(s) or treatment ($p=.4197$). Active AWA also had significantly lower medical expenditures than inactive ones. Regressions showed PA predicted cost savings up to $3,000 among AWA even after adjusting for confounders (OR = 0.762, CI: 0.703, 0.825).

These findings suggest there are simple ways to improve arthritis management and reduce healthcare expenditures through PA. Promoting arthritis-appropriate PA programs or systematizing incentives for participation in them may be a cost-effective strategy for improving quality of life and reducing health-related costs for adults with arthritis.

INDEX WORDS: *Arthritis, Osteoarthritis, Physical Activity, Intervention, Healthcare Expenditures, and Healthcare Costs*

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CHAPTER 1: INTRODUCTION

The Cost of Inactivity: Differences in Total Healthcare Expenditures and Healthcare Service Utilization Between Sedentary and Active Adults With Arthritis

Organizational Structure of Dissertation

This dissertation is organized into eight discrete chapters and addresses two overarching research questions. It follows a traditional format in chapters one through six, but includes two manuscript chapters at the end for potential submission to a health promotion journal. Specifically, the dissertation is organized beginning with an introductory chapter (chapter one) that outlines the research questions, purpose, and gaps. The introductory chapter is followed by a background and literature review chapter (chapter two) which provides information about relevant past studies, and current statistics and public health recommendations that provide context for the research proposed in this dissertation. The background and literature review chapter is followed by a methods chapter (chapter three) that describes the methods and analysis plans that were implemented to examine the research questions proposed in this dissertation. The results of the dissertation research are presented in chapter four, following the methods chapter. The results chapter includes a discussion of descriptive characteristics of the study population in addition to presenting the results of the analyses for each of the research questions. A discussion chapter (chapter five) is included after the results chapter. The

discussion chapter addresses the meaning of the results within the context of current public health practice, related past findings, implications of findings and limitations of the research, analysis, and findings. A conclusion chapter (chapter six) follows the discussion chapter and ties together the overarching findings and implications of the results and analyses associated with both research questions. Two manuscript chapters follow the conclusion chapter. Chapter seven presents a complete manuscript including references, formatted in the style required by the *American Journal of Health Promotion* (2015), and addresses the first research question presented in the introduction chapter. Chapter eight also presents a complete manuscript including references, formatted in the style required by the *American Journal of Health Promotion* (2015), but addresses the methods, analysis, results, and conclusion associated with the second research question presented in the introduction chapter. References for citations in the dissertation chapters (i.e., chapters one through six) are included after the manuscript chapters. All tables and figures referenced throughout the dissertation and manuscript chapters are included in appendices that follow the references. A table of contents is included at the start of this dissertation that outlines the structure and page numbers associated with the chapters and sections described herein.

Introduction

Physical activity is one of four public health interventions proven effective for the management of arthritis (Centers for Disease Control and Prevention [CDC] & Arthritis Foundation [AF], 2010). It contributes to improved mood, increased physical functioning, reduced arthritis pain and disability, and delayed progression of the disease (American

College of Rheumatology [ACR], 2012; CDC & AF, 2010; Physical Activity Guidelines Advisory Committee, 2008). Several community-based physical activity (PA) and self-management education (SME) programs exist that have been proven to be safe and effective for arthritis management (Brady, Jernick, Hootman & Sniezek, 2009; Brady, Kruger, Helmick, Callahan & Boutaugh, 2003). CDC recommends and actively promotes these programs through multi-year funding opportunities with state health departments. However, despite CDC's efforts at increasing the availability of and participation in these programs, the programs have limited geographic availability, are underused (Brady et al., 2009) and are largely unfinanced. Unlike the widespread financing and reimbursement support available through Medicare for diabetes self-management training and education programs (Department of Health and Human Services [DHHS], 2001), and through Medicare supplement plans for the SilverSneakers® Fitness program for seniors (Nguyen et al., 2008), health insurance reimbursement and incentives are generally not offered for participation in the proven, arthritis-appropriate physical activity and self-management education (SME) programs recommended by CDC. This is likely due to a lack of information about whether many of these programs have any cost-saving benefits for individuals with arthritis. Despite the lack of support and commitment for reimbursement or other financing, data do exist that suggest that at least one of the CDC recommended, arthritis-appropriate physical activity programs, EnhanceFitness®, has significantly reduced healthcare costs among older adult participants (Ackermann et al., 2008) in addition to providing general health and arthritis-specific health benefits. Information is not available, however, about any arthritis-specific cost-savings associated with the program EnhanceFitness®. Further, statements regarding cost-savings cannot be made

about the remaining programs (i.e., the Arthritis Foundation Exercise Program, Aquatics Program and Walk With Ease Program, and Fit & Strong and Active Living Every Day) which were evaluated for health-related outcomes including arthritis-specific outcomes such as pain reduction, improvements in functional status, and/or increases in physical activity (Brady et al., 2009) but not cost-savings.

Cost-savings are often used as a marker to determine whether financing or reimbursement for healthcare or related services is worthwhile. A study was therefore proposed to examine cost issues among adults with arthritis relative to personal physical activity behaviors. Two research questions were of primary interest. First, a descriptive analysis was conducted to characterize the study population study and describe healthcare service utilization among adults with arthritis by physical activity status. Additionally, an examination of whether adults with arthritis who are routinely active use fewer or a different distribution of healthcare and provider services was undertaken. The following research question was used to guide the first portion of this study: "Is participation in routine physical activity among adults with arthritis associated with reduced or varying patterns of healthcare services utilization (e.g., fewer doctor office or clinic visits, fewer diagnostic tests or treatments, and fewer specialist appointments)?" It was hypothesized that healthcare service utilization would be less for adults with arthritis who were physically active than those with arthritis who were sedentary. Data from the Medical Expenditure Panel (MEPS) for 2010 were used for the analysis (MEPS, 2012). The second portion of the study sought to determine whether physical activity predicted lower healthcare expenditures or savings for routinely active adults with arthritis. Specifically, the second research question asked; "Are total medical expenditures lower among adults

with arthritis who are physically active than adults with arthritis who are sedentary?" It was hypothesized that healthcare costs would be less for adults with arthritis who were physically active than those who were sedentary. MEPS data from 2010 were also used to address the second research question.

Although limited published research is available that documents cost-savings and related findings associated with specific branded, packaged or structured physical activity interventions, the proposed research is unique in that it is the only study examining national data on general physical activity behaviors, as a predictor of medical expenditure savings among adults with arthritis in well over a decade. A 2001 study (Wang, Helmick, Macera, Zhang & Pratt, 2001) looked at 1987 MEPS data for similar outcomes and found higher medical costs associated with inactivity in adults with arthritis. The study is also unique in that it is the only study using 2010 MEPS data to describe healthcare patterns and services utilization among adults with arthritis and by physical activity status. Both research questions are also timely in that they are being investigated close upon the heels of the August 2015 publication of the U.S. Surgeon General report on the benefits of walking. Walking, in particular, remains an economical and recommended form of unstructured physical activity that is appropriate for many people with arthritis and can help more people meet the activity recommendations for adults with arthritis included in the national Physical Activity Guidelines for Americans (DHHS, 2015; Every Body Walk Collaborative, 2015). Findings from these studies can be used to bolster support for evidence-based physical activity programs, such as the Arthritis Foundation's Walk With Ease program, that are recommended by the CDC for adults with arthritis (Brady et al.,

2009), and that can help adults with arthritis who desire to walk for fitness or arthritis-related health benefits do so more safely.

CHAPTER 2: BACKGROUND & LITERATURE REVIEW

Public Health Impact and Prevalence of Arthritis

According to the Centers for Disease Control and Prevention (2013a), more than 52.5 million U.S. adults report having doctor-diagnosed arthritis. This figure is projected to increase to 67 million by 2030 (CDC, 2009 & 2011) as the U.S. population ages and prevalence of obesity increases. The term "arthritis" is used to describe more than 100 rheumatic diseases and conditions that affect joints and the surrounding tissues, and includes conditions ranging from osteoarthritis (OA) and rheumatoid arthritis (RA) to fibromyalgia and lupus. The disease is characterized by pain, stiffness, and physical disability and can be progressive if left unmanaged (CDC, 2005; CDC, 2009; CDC & AF, 2010). Though arthritis is the nation's most common cause of disability (CDC, 2005; CDC, 2009; CDC & AF, 2010), it remains an under-addressed, leading contributor to chronic disease morbidity and reduced quality of life. Modifiable and non-modifiable risk factors exist for arthritis. Modifiable risk factors include joint injury, overweight and obesity, certain occupations (i.e., manual labor involving repetitive motions), and infection (CDC, 2013b). Non-modifiable risk factors include age, gender, and genetic predisposition (CDC, 2013b). Lower education and lower socio-economic status are also associated with arthritis (CDC, 2013b). Arthritis affects more women than men (with gout as the only exception) at every age (Helmick et al., 2008).

Arthritis is recognized as the most common cause of disability. Disability due to arthritis is reportedly greater than disability associated with other serious, high-cost and burdensome chronic conditions such as heart disease, stroke, and diabetes (CDC, 2005; CDC, 2009; CDC & AF, 2010). Arthritis limits the activities of nearly 22.7 million U.S. adults with the condition (CDC, 2013a) and, in turn, these limitations impact work function, social engagement, the ability to perform daily life activities, and overall quality of life (CDC & AF, 2010). Arthritis places a significant burden on the U.S. population in terms of medical expenditures, lost work productivity, disability, and pain (CDC & AF, 2010), the majority of which is due to OA, the most common type of arthritis. Because of its growing burden, arthritis is becoming an increasingly important public health concern, particularly as the population ages, obesity rates rise, and the likelihood increases for people to remain in the workforce past the traditional retirement age (McIlvane, 2009).

Arthritis Costs and Burden

Estimates place the total cost of arthritis at $128 billion, which includes $81 billion in medical expenditures and $47 billion in lost earnings (CDC, 2007b). The $81 billion in medical expenditures include the sum of payments from public and private insurers and other sources for medical costs that were related to arthritis. Lost earnings were calculated based on projections for wages that would have been earned had adults with arthritis remained in the workforce. The data-source researchers used to produce these estimates was the Medical Expenditure Panel Survey. Beyond financial costs, arthritis puts additional stress on the healthcare system, and results in approximately 992,100 hospitalizations (Helmick et al., 2008) and 44 million outpatient visits (U.S.

Bone and Joint Decade, 2008) each year. Osteoarthritis is responsible for between $3.4 and $13.2 billion annually in job-related costs alone (Buckwalter, Saltzman & Brown, 2004; CDC & AF, 2010). Though arthritis is more common in older adults, two-thirds of adults with arthritis are working-aged (CDC, 2010a), which in turn, has significant implications for the viability of the U.S. workforce. Throughout the lifespan, arthritis remains a significant contributor to leisure (CDC, 2010b) and work (CDC, 2007a) limitations. Currently, more than 8.3 million working-age adults report work-related limitations; these limitations influence the type and amount of work people do and whether adults with arthritis are able to work at all (CDC & AF, 2010). Depending on the severity of the condition, arthritis-associated disability may result in early retirement for some individuals or being shut out of the workforce in early or middle adulthood, far before retirement is even an option.

Arthritis Burden and Inactivity

Published literature confirms the significant burden, in terms of both costs and increasing prevalence, of arthritis. The literature also confirms the high rate of physical inactivity among adults with arthritis and provides a variety of risk factors and possible reasons for the observed inactivity. The burdensome and costly public health implications of inactivity or insufficient activity among adults with arthritis are of great concern and worthy of action, not only because arthritis affects more than 52.5 million people in the U.S. (CDC, 2013a), but also because people with arthritis commonly have other serious co-occurring conditions such as heart disease (Bolen et al., 2009), diabetes (Bolen et al., 2008), and high blood pressure (Murphy et al., 2009), which are costly and generally

require routine physical activity for successful management (Shi et al., 2006) or prevention (ACR, 2015; Physical Activity Guidelines Committee, 2008). Fifty-three percent of adults with arthritis have high blood pressure whereas 24 percent have heart disease and 16 percent of adults with arthritis have diabetes (Murphy, Bolen, Helmick & Brady, 2009). High cholesterol (47%), chronic respiratory conditions (19%), and obesity (36%) are also common among adults with arthritis (Murphy et al., 2009). No recent published data are available describing the fiscal costs of inactivity specifically among adults with arthritis, particularly with regard to an analysis of current, nationally representative data. The proposed studies, were therefore undertaken to learn more information about the influence of physical activity on medical costs and healthcare utilization among American adults with arthritis.

Physical Activity Interventions Appropriate for Many Adults With Arthritis

CDC recommends at least six evidence-based physical activity programs for adults with arthritis (Brady et al., 2009). This list of evidence-based programs is dynamic. In order to provide greater choice and increase the likelihood of widespread availability, the CDC Arthritis Program maintains an ongoing practice of identifying and assessing new programs for potential inclusion on the list of recommended arthritis-appropriate programs. Similarly, in efforts to maintain a list of effective, quality recommendations, programs that are unable to maintain infrastructure or that have incorporated new program elements or changes that might impact program fidelity or otherwise invalidate the accepted evidence base, may be removed from the list. The current list of recommended programs includes the Arthritis Foundation's (AF) Exercise Program,

Walk with Ease (WWE) program, and Aquatics program. They also include other branded programs such as Fit & Strong, Active Living Every Day, and EnhanceFitness® (Brady et al., 2009). Each of these programs is community-based and has been evaluated for safety, effectiveness, and appropriateness for adults with arthritis. Additionally each has been tested for effectiveness and resulted in relieving arthritis pain, improving physical, mental, social, or work functioning, and/ or increasing physical activity in individuals with arthritis (Brady et al., 2009). The list of programs designated by CDC as evidence-based and appropriate for adults with arthritis is dynamic in that programs may be added or removed from the list as the evidence-base changes; but each of the programs, when included on the list, is recommended for widespread dissemination and is deemed to have broad public health benefit (Brady et al., 2009). In addition to the functional and quality of life types of health benefits previously described that are associated with the CDC-recommended programs, one of these programs, EnhanceFitness®, has been shown to reduce healthcare costs and utilization (Ackerman et al., 2008) in research that focused on older adults and included some older adults with arthritis. Despite these economic findings, systemic support is not yet available to promote or sustain financing or healthcare reimbursement for this or any of the other CDC-recommended programs for people with arthritis. More data is needed that demonstrates the cost saving benefits of physical activity, specific to adults with arthritis. Demonstrating cost-savings for more arthritis-appropriate programs or for physical activity in general, may help position these programs for future reimbursement. Medicare is currently evaluating some of these programs.

Ackermann et al., (2008), in a study that was not nationally representative, conducted a retrospective cohort study to determine whether participation in the EnhanceFitness® (EF) physical activity intervention for older adults and adults with arthritis as a covered Medicare managed care benefit, resulted in lower healthcare utilization and costs for older adults. Older adult enrollees (n=1,188) who participated in the EF program were entered into the study and matched by age and sex against 5,027 benefit plan enrollees who had not participated in the EF program. Adjusted total medical costs were significantly lower ($1,186 lower; p=.005) among EF participants compared to non-EF participants, partly due to lower inpatient costs ($3,384; P=.02). EnhanceFitness® participants who attended EF classes at least once a week had lower adjusted total healthcare costs in Year 1 ($1,929; P<.001) and Year 2 ($1,784; P<.001) than non-EF participants (Ackerman et al., 2008). Further, a dose-response relationship was observed between EF participation and healthcare service utilization and costs. Specifically, EF participants who attended fewer EF class sessions had more primary and specialty care visits than those who attended more EF class sessions and those who attended the fewest sessions had similar healthcare costs as non-EF participants. Higher EF users also had significantly fewer hospitalizations, lower adjusted specialty care costs, and lower adjusted total healthcare costs ($1,929 lower; P<.001) compared to non EF-users (Ackerman et al., 2008). Many of these differences persisted for at least 2 years. Although the study was not specific to adults with arthritis, it did include older adults, which by default included some adults with arthritis (19.9% of the EnhanceFitness® users had arthritis and 16.6% of controls had arthritis) and/or other health conditions. Researchers accounted for potential selection bias between those who may have elected

to enroll in EnhanceFitness® versus those who did not through statistical and methodological controls such as including adults with similar healthcare costs and matching participants and controls by sex and age. The researchers also noted that subjects in both groups were similar in terms of comorbidities and prescriptions. No information, beyond a risk score based on comorbidities and prescription use, was included to assess the impact of disease severity on EnhanceFitness® use. However, the authors concluded that the study results provide considerable evidence that insurer coverage of a voluntary participation, group-based physical activity program can be cost-effective, with quickly achieved returns (Ackerman et al., 2008).

National Physical Activity Guidelines and Adults with Arthritis

The 2008 *Physical Activity Guidelines for Americans* were developed by the United States Department of Health and Human Services and based on scientific evidence about the long-term benefits of routine physical activity for individuals age six and older (Physical Activity Guidelines Advisory Committee, 2008). The Guide was developed for policy makers and health professionals to provide information about the amounts and types of activity that are safe and appropriate for various subpopulations of the American general public. *The Physical Activity Guidelines for Americans* include recommendations for adults with arthritis (Physical Activity Guidelines Advisory Committee, 2008). The guidance is divided under two recommendations that take into account age and health status. Adults with arthritis are encouraged to work towards the recommendations for either Active Adults or Active Older Adults based on personal health goals and individual abilities. The Guidelines also recommend that people with

arthritis include daily flexibility exercises as a part of their fitness routine to help maintain proper joint range of motion. The Guidelines highlight both the primary and tertiary prevention benefits of physical activity for people with arthritis (ACR, 2015; Physical Activity Guidelines Advisory Committee, 2008), and use OA as an example of a special condition for which special considerations are merited, but exercise is still recommended:

> Strong scientific evidence indicates that both aerobic activity and muscle-strengthening activity provide therapeutic benefits for persons with osteoarthritis. When done safely, physical activity does not make the disease or the pain worse. Studies show that adults with osteoarthritis can expect improvements in pain, physical function, quality of life, and mental health with regular physical activity. People with osteoarthritis should match the type and amount of physical activity to their abilities and the severity of their condition. (Physical Activity Guidelines Advisory Committee, 2008)

Low-impact activities that do not cause or increase pain and that are unlikely to result in joint injury are recommended for most adults with arthritis (e.g., gardening, swimming, and walking) (Physical Activity Guidelines Advisory Committee, 2008). Sandstad et al., (2015) in a pilot study of a ten-week high intensity physical activity training intervention among adults with arthritis, found both reduced joint inflammation and reduced risk factors for cardiovascular disease (i.e., improvements in maximal oxygen uptake, heart rate recovery, blood pressure, BMI, percent body fat, and waistlines) for adults with arthritis. Further, Sandstad (2015) determined that the study participants experienced no adverse outcomes and improvements in overall

cardiovascular health. CDC, on the arthritis section of its website, recommends that adults under age 65, with normal function and no limitations in typical daily activities, and without a co-occurring condition like diabetes, heart disease, or cancer follow the Active Adult physical activity recommendations (CDC, 2014) from the 2008 *Physical Activity Guidelines for Americans*. The Guidelines recommend:

- 150 minutes of moderate intensity aerobic activity per week; or
- 75 minutes of vigorous intensity aerobic activity per week; or
- A mix of moderate and vigorous intensity activity per week equaling the above (where every two minutes of moderate activity is equivalent to one minute of vigorous activity).

Additionally, muscle strengthening exercises are encouraged and are recommended two or more days per week. Balance exercises are recommended for adults who are at risk for falls (three days per week). Aerobic activity can be divided into shorter increments of activity (at least ten-minutes each) throughout the week in order to make it more manageable (CDC, 2014; Physical Activity Guidelines Advisory Committee, 2008).

Adults with arthritis who are over age 65 or have poor function and limitations in typical daily activities, or other chronic conditions in addition to arthritis are recommended to follow the Guidelines for Older Adult Americans (CDC, 2014; Physical Activity Guidelines Advisory Committee, 2008). The Older Adult recommendations, in terms of amounts and blend of activities, are the same as the recommendations for Active Adults. For even greater health benefits, the Guidelines recommend increasing aerobic activity to as much as 300 minutes per week (CDC, 2014; Physical Activity Guidelines Advisory Committee, 2008).

Unstructured Physical Activities Appropriate for Arthritis

Beginning work towards or maintaining the recommended amounts of physical activity can be difficult for adults with physical limitations and disability including and beyond those attributable to arthritis. Though being physically active is not without risk, the American College of Rheumatology, CDC, and others agree that the benefits of physical activity for people with arthritis outweigh the risks (ACR, 2015; CDC, 2014; Physical Activity Guidelines Advisory Committee, 2008). CDC recommends that adults with arthritis initiating or increasing physical activity levels incorporate changes or increases in activity level slowly (both in terms of time increments, duration, and intensity); modify activity as needed (any activity is better than none but there may be times when symptoms or disease status will make exercising unrealistic or prohibitive); engage in joint friendly activities; be aware of the evidence-based programs that CDC recommends for adults with arthritis; and discuss activity and exercise goals with healthcare providers to ensure that personal activity choices align with medical therapies and treatment goals (CDC, 2014).

Regarding unstructured physical activity, CDC specifically recommends the following types for adults with arthritis on their website:

- Low-impact aerobic activities including brisk walking, cycling, swimming, water aerobics, gardening, group exercise classes, and dancing.
- Muscle-strengthening exercises including calisthenics, weight training, and working with resistance bands. These can be done at home, in an exercise class, or at a fitness center.

- Balance exercises including walking backwards, standing on one foot, and tai chi. If you are at risk of falling, balance exercises are included in many group exercise programs. (CDC, 2014)

Balance exercises are recommended to help adults improve balance and coordination and thereby help reduce risk of future falls.

American College of Rheumatology's Exercise Guidance

Although CDC does not differentiate physical activity guidance for adults by arthritis type, the American College of Rheumatology (ACR) (2015) does provide a statement recommending physical activity for adults with rheumatoid arthritis and OA:

> Research shows that people with many forms of arthritis can participate safely in appropriate, regular exercise. Long-term studies have shown that even people with inflammatory arthritis such as rheumatoid arthritis (RA) can benefit from moderate intensity, weight-bearing activity. Other benefits include less bone loss and small-joint damage associated with RA and no increase in pain or disease activity. (ACR, 2015)

ACR's exercise recommendations for people with OA are consistent with those of the Physical Activity Guidelines. Although ACR does not specify any weekly goals for duration or intensity of physical activity, they do encourage a mix of strengthening and aerobic exercise as appropriate for people with OA (ACR, 2015). The ACR statement on exercise also highlights the benefits of routine exercise for people with OA, including reduced arthritis symptoms, improvements in physical function and range of joint motion,

improved coordination and balance, reduced or delayed disability, and maintenance of an appropriate body weight as benefits (ACR, 2015).

Physical Inactivity Among Adults With Arthritis

Despite the physical activity recommendations, adults with arthritis are less active than adults without arthritis. Researchers who looked at 2002 National Health Interview Survey data found that 44 percent of adults with arthritis were inactive compared with 36 percent of adults without arthritis (Shih, Hootman, Kruger & Helmick, 2006). Dunlop, Manheim, Yelin, Song and Chang in a 2003 review article, determined that 71 percent of adults with arthritis did not exercise vigorously on a regular basis (defined as at least three times per week) and that lack of vigorous exercise was associated with subsequent functional deterioration (adjusted OR = 1.6, 95% CI 1.3–1.9) among adults with arthritis. Although vigorous activity was not defined in the Dunlop et al., (2003) review study, the Physical Activity Guidelines Advisory Committee in Appendix 1 (2008) defined relative-vigorous physical activity for older adults as a level of effort of 7 or 8 "on a scale of 0 to 10, where 0 is the level of effort of sitting, and 10 is maximal effort" for aerobic activity.

Factors Associated With Inactivity Among Adults With Arthritis

Known factors associated with inactivity in adults with arthritis include functional limitations, advanced age, and lower education (Shih et al., 2006). Lack of access to facilities where exercise may occur was also associated with inactivity (Shih et al., 2006). Specifically among men with arthritis, inactivity was also determined to be associated with severe joint pain. However, inactivity among women with arthritis was also

associated with frequent mental or social limitations, perceived need for special equipment, lack of PA counseling, and being Black or Hispanic (Shih et al., 2006). Having chronic disease comorbidities, such as diabetes, heart disease or obesity in addition to arthritis, was also associated with reduced physical activity behaviors (Shi et al., 2006); directional relationships are unclear but some researchers suggest that arthritis may serve as the main barrier to physical activity in each of these cases (Bolen et al., 2008 & 2009; Hootman, Murphy, Helmick & Barbour, 2011).

Kaplan, Huguet, Newsom and McFarland (2003) explored characteristics and risk factors of inactive older Canadian adults with arthritis. Among the study population, approximately 39 percent of older adults with arthritis were identified as inactive. Inactive adults with arthritis in the Kaplan et al., (2003) study were more likely to be female, aged 75 or older, less educated, underweight (BMI < 20.0), overweight (BMI > 25.0), or experiencing psychological distress, comorbidities, or severe pain. Inactive adults were also more likely to report poorer self-rated health, and lacked prescription drug insurance. Gender effects were observed as well, with functional limitations, severity of pain, and lack of prescription drug insurance acting as stronger predictors of physical inactivity in men than in women (Kaplan et al., 2003).

Kaplan et al., (2003) concluded that inactivity is associated with significant medical costs among adults with arthritis and suggested that increased activity among this population may provide economic benefits. Dunlop also stressed that modifiable risk factors, such as inactivity, contributing to the cost of arthritis are important to address from a public health perspective because many of these risk factors can be corrected or improved through intervention (Dunlop et al., 2003)

Reducing Inactivity Among Adults With Arthritis

According to Conn, Hafdahl, Minor and Nielsen (2008), in 2001 60 percent of adults with arthritis did not meet the minimum recommended levels of physical activity, prompting a need for increased health promotion and intervention in this population. Exploring this phenomenon further, Conn et al., (2008) conducted a meta-analysis examining published and unpublished results of primary research on physical activity interventions among adults with arthritis. The meta-analysis, which was a subset of a larger study on all chronic diseases and physical activity, revealed that on average these interventions increased physical activity among adults with arthritis. The interventions also reduced arthritis pain moderately. The authors indicated that this study was the first meta-analysis to examine physical activity behaviors among people with arthritis and concluded that additional research, particularly longitudinal studies on the dose-response effects of physical activity interventions, research on adherence to physical activity recommendations, as well as studies on physical activity promotion and variations in intervention components and delivery are needed (Conn et al., 2008).

Previous Findings on the Impact of Physical Activity on Costs and on Healthcare Utilization Among Adults With Arthritis

Over a decade ago Wang et al., (2001) examined 1987 MEPS data and published results that concluded that inactive adults with arthritis were observed to have significantly higher medical costs than physically active adults with arthritis, a trend which remained consistent across different demographic characteristics, such as sex, age, race, geographic region of residence, and weight, smoking, SES, and functional limitation

status, that were examined via multivariate regression. The adjusted costs of inactivity were estimated to average "12.4% ($1,250 in 2000 dollars) and ranged from 7.8% to 14.3%" across the different demographic groups examined (Wang et al., 2001, p. 439). The authors concluded that in addition to the known health benefits of physical activity among adults, increasing physical activity among adults with arthritis could also provide considerable economic benefits (Wang et al., 2001).

Dunlop et al., (2003), in a review study, estimated that the average annual number of physician visits for a person with any type of arthritis ranged from 7.8 to 11.5 in the U.S., totaling approximately 39 million visits per year. The average hospital-stay for a person with arthritis ranged between 7.3 and 8.2 days per year for a total of 2.6-3.8 million days (Dunlop et al., 2003). The possible influence of comorbidities on the observed high healthcare utilization was not discussed in the report that resulted from the Dunlop study nor were the specific reasons for a given visit, meaning that a visit could have been for arthritis or for reasons related to other comorbidities or health events. The present studies compared patterns of healthcare services utilization between active and sedentary adults with arthritis and examined current, national medical cost data, while accounting for the possible influence of common arthritis-associated comorbidities, to determine whether medical costs were lower among active adults with arthritis.

Social Determinants of Health and Arthritis and Inactivity

A complex mix of factors come into play and influence physical activity behaviors. These factors include individual, social, environmental, economic and other factors that determine the likelihood that a person will be active and have access to the

resources, environments, and opportunities needed to maintain an active lifestyle. These factors and the interplay between them are commonly called the social determinants of health and addressed in health promotion efforts. Attention to the social determinants of health is merited for the research questions proposed in this manuscript because many of these factors (such as lack of access to facilities and special equipment, or lack of knowledge and guidance about what is safe) drive inactivity among adults with arthritis. The Habitat Corporation's (2015) version of the socio-ecological model addressing the social determinants of health was therefore adapted in Figure 1 to include points of potential influence whereby public health action can be undertaken to facilitate increased access and availability of physical activity opportunities and programs appropriate for adults with arthritis, such as the evidence-based programs recommended by CDC for this population.

The present studies, should their respective hypothesis not be disproved, are well positioned to help create an economic argument for encouraging financing and/or support for reimbursement for the evidence-based physical activity interventions that CDC recommends for adults with arthritis. Specifically, a determination that total healthcare costs or services utilization are reduced for adults with arthritis who are physically active, when combined with the functional, mental, social and preventive health benefits of safe exercise for people with arthritis, might prompt wider distribution, and increased awareness of, access to, and participation in the CDC recommended arthritis programs. Participation in these evidence-based programs may, in turn, help more adults with arthritis increase their physical activity levels and reap activity-related health benefits. Reimbursement or financing, however, is crucial for mass uptake of the CDC-

recommended programs. If reimbursement or financing for the CDC-recommended arthritis programs becomes a reality, there will be greater incentives for more community organizations to begin offering the programs and for more providers to recommend (Tompkins, Belza & Brown, 2009) that patients with arthritis participate in them, two outcomes that are well aligned with national public health goals for arthritis outlined in HealthyPeople 2020 and a CDC and Arthritis Foundation document entitled, A National Public Health Agenda for Osteoarthritis (CDC & AF, 2010).

Maintaining independence and remaining in communities is of increasing importance as the U.S. population ages and debilitating, aging-associated chronic diseases such as arthritis increase in prevalence and negatively impact quality of life and increase cost-related burdens on the medical system, state budgets, and the workforce, potentially resulting in early retirement and increased burden on the public welfare and benefits system. Maintaining independence and curbing disability are also important from an economic standpoint in that aging and functional as well as mental disability, such as the disability resulting from arthritis, increases both the likelihood of nursing home placement (Andel, Hyer & Slack, 2013; Wolinsky, Callahan, Fitgerald & Johnson, 1993) and limit participation in the work force (CDC, 2007a). Arthritis is recognized as one of the most common causes of disability (CDC & AF, 2010) and may be a contributing factor to functional disability associated with nursing home placement (Andel et al., 2013; Wolinsky et al., 1993). Physical activity can improve the quality of life for people with arthritis, restore function, and delay disease progression and disability (CDC & AF, 2010), which may have significant societal cost-savings implications for medical expenditures and service utilization. Routine physical activity can also improve overall

quality of life for people with arthritis, and possibly help them remain active, productive, and engaged in community life and the workforce longer and well into old age. The literature examined on medical costs, physical activity, and arthritis were limited to the U.S. population. The fact that the literature is limited and dated further emphasizes the lack of recent studies on the effects of unstructured, routine physical activity, outside of a packaged intervention, on medical expenditures among adults with arthritis.

Dataset Selection: Advantages of MEPS Data

The Medical Expenditure Panel Survey (MEPS) was identified as the data source that would be used to examine both research questions of interest for the present two-part study. MEPS contains a wealth of information on healthcare service utilization and medical expenditures for Americans and provides variables that allow for the segmentation of this information by physical activity status and disease status. Additionally, it provides a source of nationally representative data for American adults of all ages (ages 18 and older) and is not limited to older, working, or previously employed adults. MEPS is an ongoing, national, United States government administered, survey that is representative of the American population and that is conducted by the Department of Health and Human Services, Agency for Healthcare Research and Quality. The population for MEPS is a subset sampled entirely from a larger study population of participants in the National Health Interview Survey, also administered by the U.S. Department of Health and Human Services. A new MEPS sample is drawn each year from the previous year's pool of National Health Interview Survey participants for inclusion into MEPS.

MEPS is recognized as the most complete source of U.S. healthcare cost and service utilization data (MEPS, 2012). "MEPS collects data on the specific health services that Americans use, how frequently they use them, the cost of these services, and how they are paid for, as well as data on the cost, scope, and breadth of health insurance held by and available to U.S. workers" (MEPS, 2012). MEPS survey data is derived from information reported by individuals and families, their healthcare providers and institutions, and employers (MEPS, 2012). Data are collected through five rounds of data collection conducted over a two-year period. The survey is comprised of three components: the Household, Insurance/Employer, and Medical Provider Components. Data from the Household Component, which includes hundreds of variables, is available via the Internet for public download. Data are excluded from MEPS full-year files for participants not responding (non-respondents) to one or more rounds of data collection which helps eliminate issues that might be associated with survey drop-outs over time and respondents for which baseline data would be missing (MEPS, 2012). Statistical survey weights are also applied to full-year respondents to compensate for full and partial-year non-response (MEPS, 2012). A major advantage of MEPS data is that it includes measures for healthcare costs, services utilization, disease status, and physical activity within a single data source, the consolidated Household Component. Further there is a historical precedent of using MEPS to estimate the cost of inactivity among people with arthritis (Wang et. al., 2001). As such, it was deemed to be a particularly appropriate data source for determining whether reduced total healthcare costs and services utilization might be observed among adults with arthritis who are routinely active as proposed for the current studies. MEPS also allows for the inclusion and

assessment of pertinent economic, health, and demographic factors that may influence medical costs and services utilization among adults with arthritis and allows for comparisons of economic outcomes that may differ between active and sedentary adults with arthritis.

Summary of Background

Despite the known benefits of physical activity, adults with arthritis are far less active than adults without arthritis and little or no recent literature is available that documents the cost of physical inactivity in terms of healthcare service utilization and total medical expenditures among adults with arthritis. Most of the existing literature is either dated, not specific to adults with arthritis, or lacking specifics about costs for adults with arthritis. Given the dearth of current or relevant findings and the potential policy and public health programming implications of knowing more about the cost of arthritis as it relates to physical activity practices, a two-part study was undertaken to determine whether routine, physical activity (at least three times per week for at least 30 minutes per episode) among U.S. adults with arthritis was associated with lower healthcare services utilization or lower medical expenditures. Subjects included adults with arthritis in the 2010 MEPS dataset. Methods undertaken to examine the research question as well as the analyses, results, discussion, and conclusion follow in the subsequent chapters.

CHAPTER 3: METHODS

Within the undertaking of this study, a proposal was submitted describing activities related to this research to The University of Georgia (UGA) Institutional Review Board for human subjects review and determination. The UGA Human Subjects Office reviewed the submission and assigned a determination of "not human research" to the proposal in August 2015. A copy of the notification is included under Appendix A.

Methods for Addressing Research Question I: Health Services Utilization

Study Design

The first half of the proposed two-part study addressed research question I, was descriptive in nature, and examined the relationship between physical activity and healthcare service utilization, specifically taking a look at the frequency of health service utilization among adults with arthritis by physical activity status. Descriptive statistics were calculated and presented both for inactive adults with arthritis and for active adults with arthritis. Chi-Square tests were used to determine significant differences in the frequency of service utilization across the various healthcare service categories. The study sought to determine if people with arthritis who were routinely physically active used fewer or a different distribution of healthcare and provider services. Basic descriptive statistics describing population characteristics and frequency distributions related to healthcare service utilization were also calculated.

Variables of Interest

A number of preventive, specialty, and general healthcare services were assessed for frequency of use including variables measuring: length of time since general health check-up, number of doctor office or clinic appointments and visits made in the last 12 months, number of times diagnostic tests or healthcare treatment is needed, and number of times a patient reports needing to see a specialist. Additional variables about health and demographic characteristics associated with adults with arthritis were also examined to provide richer context to the findings and to explore variation of these factors (e.g., age, sex, race, presence of other chronic comorbidities, etc.) by physical activity status (i.e., inactive versus active). Central tendency patterns, as evidenced by frequency distributions and the modes, were calculated for each service type and presented by patient physical activity status. Themes were also examined in relation to potential gaps and opportunities for improvements in policy, and promotion of health behaviors and practices of benefit for adults with arthritis. Chi-Square results and implications were calculated and are discussed as well. SAS version 9.3 (SAS, 2012) was used to compute frequency distributions and Chi-Square test statistics. Table 1 includes a more detailed description of the variable selections including their names, coding schema, and definitions.

Methods for Addressing Research Question II: Total Medical Expenditures

Study Design and Analysis Methods

The second half of the present study, addressing research question II, was predictive in nature. A retrospective case-control study was conducted using 2010 MEPS

data to assess the impact of physical activity on total healthcare expenditures among adults with arthritis (MEPS, 2012). Cases were defined as adults with arthritis (having a report of either OA or RA diagnosis) who were physically active for one-half hour or more at least three times a week. Controls were inactive adults with arthritis. Because the public health guidance regarding physical activity recommendations does not differ for patients based on diagnosis of osteoarthritis or rheumatoid arthritis, adults with both types of arthritis were included as part of the study sample.

SAS version 9.3 (SAS, 2012) was used to analyze data from the full-year consolidated data file for 2010 (MEPS, 2012). The "proc logistic" procedure was used to predict total healthcare expenditures among people with arthritis. Physical activity status was identified as the primary independent variable of interest. Potential confounders that might affect the relationship between arthritis, physical activity, and medical expenditures, such as age, race, gender, body mass index (BMI), insurance coverage, and common arthritis comorbidities such as heart disease, high blood pressure, stroke, diabetes, and obesity were also included in the model. The full logistic regression model assessed the impact of physical activity on total medical expenditures while controlling both for these potential confounders independently, as well as for potential interactions between physical activity and each of these variables. Backwards stepwise elimination was used to construct the final, reduced model by eliminating insignificant results at each step to gradually improve and obtain the final reduced model. A decision was made at the outset to retain physical activity, the main predictor (independent variable) of interest, in the model at each step, regardless of significance. Decisions about whether to stratify by certain covariates or present adjusted findings were based on interaction significance

results. Figure 2 depicts the full model, including interaction terms, that was used at the outset of the study. The final reduced model only included significant variables and interaction terms. Covariates and interaction terms that were not a significant predictor of healthcare expenditures were eliminated. Odds ratios were also calculated using SAS.

Preliminary Decisions About Variable Selections

Variables of interest and relevance were identified from the MEPS 2010 dataset and recoded in a binary format, as described in Table 2. Survey item responses categorized as "inapplicable," "not ascertained," "refused" or where a respondent answered "don't know" were excluded from the analysis. The study population for the regression analysis was narrowed to include only adults (over age 17) who reported being diagnosed with arthritis. The variable, ARTHDX, was modified to convert responses about status of arthritis diagnoses to a binary format for the logistic regression procedure used for this study. Descriptive characteristics yielded from the first portion of the study assessing healthcare services utilization among adults with arthritis using MEPS 2010 data were used to provide greater context about the characteristics of active and inactive adults with arthritis for the current, second half of the study. Physical activity status was analyzed using the PHYACT53 variable. The PHYACT53 variable was recoded as dichotomous and used to distinguish people who were moderately active three or more times per week and therefore defined as "active" from those who were not and therefore classified as "inactive." Total healthcare expenditures were analyzed using the TOTEXP10 variable which included total healthcare payments from all sources for the year including self-pay. Age (AGE10X), gender (SEX), race (RACEX), heart disease,

high blood pressure, diabetes, stroke, smoking, chronic bronchitis, emphysema, asthma, obesity (as measured by BMI), and insurance coverage (INSCOV10) were also modified to render these variables in a binary format and include them in the model. Presence of a behavior or condition (e.g., active, smoker, overweight or obese, or diagnosis of stroke, heart disease, diabetes, asthma, emphysema, chronic bronchitis or arthritis) was categorized as "1" whereas the absence of either was coded as "0". Except for race and sex, the binary variable option aligned with the low risk category was coded as "1" and high risk category was coded as "0".

Because SAS models the dependent variable on "0", for ease of interpretation, savings in medical expenditures (TOTEXP10) was coded as "0" whereas little or no savings were coded as '1'. "Savings," for the purposes of this study, was defined as total medical expenditures that were less than or equal to $1,000 (or $3,000 in the second-level analysis) below average expenditures for the study population. Respectively, total expenditures above each of these amounts were described as "no savings" or "close to average or higher total medical expenditures" and were recoded as "1". Average total medical expenditures were calculated for adults with arthritis in the 2010 MEPS dataset and used as the basis for the total medical expenditures recoding decisions. A complete listing of the variable descriptions and recoding decisions is described in Table 2.

Collinearity

Collinearity is a methodological concern that can occur and cause problems in multiple regression models. Collinearity occurs when one or more predictor variables are highly correlated with each other. For example, heart disease and high blood pressure

often occur together and have some shared characteristics. Because of this, heart disease and high blood pressure could be collinear and inclusion of both in a regression model might prevent a researcher from obtaining valid results about the predictive capacity of either variable on an outcome variable. Given that both heart disease and high blood pressure were included as covariates in this study, there was some concern that collinearity might be present and invalidate or compromise the results of these predictors in the logistic regression model. However, after consulting the literature on similar studies, it was expected that collinearity would not be a methodological concern for the present study. A previous study by Aljadhey (2013) on the effects of physical activity and high blood pressure (HBP) on medical and pharmaceutical expenditures using 2002 MEPS data included each of the covariates proposed for inclusion in this study (i.e., gender, age, race, heart disease, insurance coverage, heart disease, diabetes, stroke, BMI, smoking, arthritis etc.) as well as others pertinent to hypertension. Prior to conducting the regression analysis, Aljadhey (2013) examined potential for multi-collinearity via pairwise correlations between covariates and an examination of variance inflation factors (VIF). The researchers determined that collinearity was not a problem for any of the covariates (Aljadhey, 2013). All were correlated at <.3 except heart disease and heart attack which were correlated at .48. Further, no VIFs were higher than ten (VIFs ranged between 1.59 and 1.21) (Aljadhey, 2013). These previous findings suggest that collinearity will not be a problem for the current study. In efforts to confirm these findings, a diagnostic check was performed in SAS on all of the MEPS 2010 predictor variables included in the logistic regression model for the current study. These predictors included physical activity, heart disease, high blood pressure, stroke, diabetes,

emphysema, asthma, overweight/ obesity, chronic bronchitis, smoking, age, race, insurance and gender. The diagnostic check revealed that collinearity was not present. Correlations between heart disease, high blood pressure and stroke were low and ranged between 0.20 and 0.24. Further, the VIFs that were generated via the diagnostic check for all predictors ranged between 1.045 (gender) and 1.27 (chronic bronchitis). The study proceeded accordingly with all of the planned predictor variables included in the regression model.

Regression Models

Several multiple logistic regression models were run to examine the impact of physical activity among adults with arthritis on annual medical expenditures at different levels of savings (i.e., 1 at a savings of $1,000 or more; 2) at a savings of $3,000 or more compared to average expenditures; 3) at a savings of $5,000 or more; and 4) at a savings of $4,000 or more). Regarding the regression model, at each level of savings ($1,000, $3,000, $4,000, and $5,000), the full model included physical activity as the main predictor, as well as insurance status, age, race, sex, smoking status, BMI, diabetes, stroke, high blood pressure, heart disease, asthma, chronic bronchitis, and emphysema as covariates. Interaction terms were also included for physical activity and each of the covariates in the full model (e.g., physical activity and age; physical activity and sex; physical activity and race, etc.). Stepwise, backwards elimination was performed for each regression model within SAS to eliminate insignificant results and identify the reduced model.

As previously described, the full model was assessed at four different levels of potential "savings." "Savings" were based on a variety of amounts that were at least $1,000 less than the average total medical expenditures for adults with arthritis in the MEPS 2010 dataset; and regressions were run at each level of savings. The average total medical expenditure for adults with arthritis was calculated at $8,382 from the MEPS 2010 sample. The four "savings" levels were therefore based on savings equivalent to $1,000, $3,000, $4,000, or $5,000 or more below the average, $8,382. Logistic regressions were therefore run in the following four cycles, consistent with the four levels of savings. Cycle one identified factors predicting total medical expenditures that were at least $1,000 below average. Specifically, in cycle one savings were predicted based on costs that were less than or equal to $7,382 (i.e., $1,000 or more less than average total medical expenditures). Whereas in cycle two, savings were calculated based on expenditures that were at least $3,000 less than average (i.e., total medical expenditures less than or equal to $5,382). These same tests were repeated at savings of $5,000 and then $4,000.

CHAPTER 4: RESULTS

Results for Research Question I: Patterns in Healthcare Utilization

Analytic Sample Overview

One purpose of the current research was to identify characteristics of adults with arthritis and explore healthcare utilization patterns among adults with arthritis by physical activity status. A second purpose was to learn whether physical activity predicted savings in medical expenditures for adults with arthritis who were routinely active. The MEPS dataset used to explore these questions contains data for adults with arthritis as well as individuals without arthritis. As such, in order to examine the research questions at hand, the larger dataset was narrowed from N=32,846 to include only adults with arthritis (n=5,600). Individuals without arthritis were excluded from the subsequent analysis. Table 3 in Appendix C and the discussion chapter, provide some information about the characteristics of these individuals for context and comparison with those of adults with arthritis. Approximately seventeen percent (17.1%) (n=5,600) of the study population (N=32,846) reported diagnosed arthritis compared to 54.87 percent (n=18,022) reporting no arthritis. For the descriptive and regression analysis, the analytic sample was also limited to Black and White adults with arthritis. All other races were excluded from the sample that was assessed.

Descriptive Characteristics of All Adults with Arthritis

The following characteristics were observed among adults with arthritis included in the analytic sample. Of all adults with arthritis, 63.41 percent were female and 76.87 percent were White. Thirty-seven percent of adults with arthritis were male. Among adults with arthritis, the average age was 59.4 years old. Further, among all adults with arthritis 38 percent were retirement-age or older (>64) whereas 62 percent were working-aged (>17 but <65). The average total healthcare expenditures for adults with arthritis was $8,382. Of all adults with arthritis, ten percent were uninsured. Twenty percent (20.32%) of all adults with arthritis were current smokers and nearly seventy-two percent (71.54%) of all adults with arthritis were overweight, whereas 28 percent were normal or under-weight. Further, among all adults with arthritis, 21.02 percent had diabetes, 10.07 percent had a history of stroke or transient ischemic attack, 62.36 percent had been diagnosed with high blood pressure, and fourteen percent (13.90%) had been diagnosed with coronary heart disease. Regarding chronic respiratory conditions, fifteen percent (15.25%) of all adults with arthritis had asthma. Approximately six percent of all adults with arthritis had chronic bronchitis and approximately six percent of all adults with arthritis had emphysema. Among all adults with arthritis, the average number of medical office visits in 2010 was 3.2. Table 4 describes these characteristics in greater detail.

Regarding adults with arthritis and at least two comorbidities, the most common combination was arthritis, diabetes, and high blood pressure. Eighteen percent of adults with arthritis also had diabetes and high blood pressure. Heart disease and high blood pressure was the second most common multi-comorbidity combination among adults with arthritis. Twelve percent of adults with arthritis reported also having heart disease

and high blood pressure. Additional information about multiple comorbidities among adults with arthritis may be found in Table 5.

Only 48 percent (47.53%) of all adults with arthritis were physically active at least three or more times per week compared to 52.47 percent who were not. Table 6 describes physical activity levels among adults with arthritis by demographic characteristics such as age, gender and race, as well as by smoking status and co-occurring chronic conditions. Of the 5,600 adults with arthritis included in the dataset, physical activity status was reported for 5,441. Among the 5,441 for which physical activity data was reported, 2,855 were inactive as defined by *not* engaging in at least moderate activity three or more times per week. Conversely, 2,586 adults with arthritis reported being routinely physically active. The average age for *active* adults with arthritis was 58 years and the total medical expenditure for this group was $6,538.22. Whereas the average age for *inactive* adults with arthritis was 62 (61.79) years and the average total medical expenditure for inactive adults with arthritis was $9,710.25.

Healthcare Services Utilization

Physical activity status was significantly associated with the length of time, in years, that had elapsed since a reported last checkup (X^2=31.3986, p<.0001), needing to see a specialist in the last year (X^2=21.0374, p<.0001), whether an appointment was made in the last year for routine medical care (X^2=12.3676, p=.0004), as well as the number of visits in the last year to a medical office for care (X^2=52.0020, p<.0001) among adults with arthritis (Table 7). However, routine physical activity was not

associated with any perceived need (by physicians or patients) for any test, care, or treatment during the past 12 months (X^2=0.6511, p=.4197).

Overall healthcare service utilization patterns differed significantly between active and inactive adults with arthritis (Table 7). Inactive adults with arthritis were more likely to have been seen for a routine checkup within the last year (42.87%) than active adults with arthritis (38.37%). Inactive adults with arthritis were also more likely to have been seen for a routine checkup within the past two years than active adults with arthritis. The opposite was true for adults without arthritis. Adults without arthritis who were physically active were more likely to have been seen by a physician for a routine checkup assessing overall health than inactive adults without arthritis at every time increment (ranging from less than a year to more than five years since last routine check-up). Most adults without arthritis (57.55%) had received a checkup within the last year regardless of physical activity status. However, the overwhelming majority of adults with arthritis (81.24%) were likely to have had a routine checkup within the past year, regardless of physical activity status. Fifty-five percent (54.80%) of adults with arthritis reported needing to see a specialist for care in the past 12 months. Adults with arthritis who needed to see a specialist for care were more likely to be inactive (55.01%) than active (44.99%).

Active adults with arthritis were slightly less likely to have visited a doctor's office or clinic for care in the last 12 months (8.22% reported no visits) than inactive adults with arthritis (6.92% reported no visits), as depicted in Figure 3. Further, active adults with arthritis who did seek care reported fewer visits in the last 12 months than inactive adults with arthritis. Specifically, active adults with arthritis were more likely to

report one or two visits for care in the last 12 months whereas inactive adults with arthritis were more likely to report three or more visits for care in the last 12 months. The likelihood that the patient with arthritis seeking care was inactive increased progressively with the number of visits reported, meaning that the gap in differences between active and inactive adults with arthritis increased in parallel with the number of visits for care. For example, of adults who reported three visits to a doctor's office for care in the last 12 months, 52 percent (52.13%) were inactive and 48 percent (47.87%) were active, meaning there was an absolute difference of four between inactive and active adults with arthritis (or eight percent difference between the two groups). Of adults who reported four visits to a doctor's office for care in the last 12 months, 56 percent (55.93%) were inactive and 44 percent (44.07%) were active, meaning at four visits, there was an absolute difference of 12 between the two groups (or 24 percent difference). But of adults who reported ten or more visits to a doctor's office for care in the last 12 months, 60 percent (59.86) were inactive and only 40 percent (40.14) were active, meaning the gap between the two groups had widened to an absolute difference of 20 (or 40 percent difference). These differences were significant (X^2= 52, p<.0001).

Similarly, there were also significant differences in the likelihood to have made an appointment in the last 12 months for routine care (X^2=12.37, p=.0004), though the majority of adults with arthritis made an appointment for care in the last 12 months (80.04%) regardless of their physical activity status. Active adults with arthritis were less likely to have made an appointment for care than inactive adults with arthritis. Of adults with arthritis who reported making an appointment for routine care in the last year, 53 percent (53.41%) were inactive and 47 percent (46.59%) were active.

Of the five measures of healthcare service utilization examined, all showed significantly different utilization patterns by physical activity status with only one exception. Reports about whether "you or a doctor believed you needed any care, tests, or treatment" did not differ significantly between active and inactive adults with arthritis.

Results for Research Question II: Differences in Medical Expenditures

Regression Models

Several logistic regression models were run to examine the impact of physical activity among adults with arthritis on annual medical expenditures at different levels of savings (i.e., savings of $1,000, $3,000, $4,000 and $5,000 or more compared to average expenditures). The average total medical expenditures for adults with arthritis were determined to be $8,382. The first model identified factors predicting total medical expenditures that were at least $1,000 below average. The second model identified factors predicting medical expenditures that were at least $3,000 below average. Specifically, in model one, savings were calculated based on costs that were $1,000 or more less than average (i.e., total medical expenditures less than or equal to $7,382). Whereas in model two, savings were calculated based on expenditures that were at least $3,000 less than average (i.e., total medical expenditures less than or equal to $5,382). These same tests were repeated at savings of $4,000 and $5,000. Stepwise backwards elimination was performed within SAS to eliminate insignificant results and identify the reduced models for each savings level.

Achieving the Reduced Model

When predicting savings of at least $1,000, the reduced model was achieved after fifteen steps (as depicted in Table 8) during which BMI, smoking, and all but one interaction term, physical activity and heart disease, were removed. When predicting savings of at least $3,000, the reduced model was achieved after fourteen steps (as depicted in Table 9) during which BMI, smoking, and all but two interaction terms, physical activity and heart disease, and physical activity and gender, were removed.

Descriptive Characteristics

Approximately seventeen percent (17.1%) (n=5,600) of the study population reported having arthritis compared to 54.87 percent (n=18,022) reporting no arthritis. Results were either inapplicable (n=9,157), not ascertained or respondents refused to answer or answered "don't know" for the remaining proportion of the total study population (N=32,846). Thirty-seven percent (36.59%) of adults with arthritis were male and 63 percent (63.41%) were female. Among adults with arthritis, the average age was 59.4 years old. Thirty-eight percent (38.34) were age 65 or older and 61.66 percent were working-aged. Twenty percent (20.32%) of adults with arthritis were current smokers. Seventy-two percent (71.54%) of adults with arthritis were overweight, whereas 28 percent were normal or underweight. Further, among adults with arthritis, 21.02 percent had diabetes, 10.07 percent had a history of stroke or transient ischemic attack, 62.36 percent had been diagnosed with high blood pressure, and fourteen percent (13.90%) had been diagnosed with coronary heart disease. Regarding chronic respiratory conditions, fifteen percent (15.25%) of adults with arthritis had asthma. Approximately six percent of

adults with arthritis had chronic bronchitis and approximately six percent of adults with arthritis had emphysema. Forty-eight percent (47.53 %) of adults with arthritis were physically active whereas 52.47 percent were not. The average total healthcare expenditures for adults with arthritis was $8,382. Ninety percent of adults with arthritis were insured; ten percent were not. Table 4 summarizes the characteristics of all adults with arthritis from the MEPS 2010 dataset.

Table 6 describes characteristics of adults with arthritis by physical activity status. Of the 5,600 adults with arthritis included in the dataset, physical activity status was reported for 5,441. Among the 5,441 for which physical activity data was reported, 2,855 were inactive as defined by engaging in at least moderate activity three or more times per week. Conversely, 2,586 adults with arthritis reported being routinely physically active. The average age for *active* adults with arthritis was 58 years and the total medical expenditure for this group was $6,538.22. Whereas the average age for *inactive* adults with arthritis was 62 (61.79) years and the average total medical expenditure for inactive adults with arthritis was $9,710.25.

Crude and Adjusted Analysis Results Summary

Adults with arthritis who were moderately active at least thirty minutes at a time, at least three times per week had significantly lower total medical expenditures than inactive adults with arthritis. Further being physically active was significantly associated with below-average medical expenditures. Being physically active was associated with savings in medical expenditures that were as much as $3,000 below average for adults with arthritis. However, being physical active was not associated with savings of $5,000

or $4,000. Table 10 depicts the crude results of the regression analysis for $1,000 in savings among active adults with arthritis.

Physical Activity Predicts $1,000 or More in Savings

Analysis of the crude relationship between physical activity and total medical expenditures, which did not account for confounding, showed that adults with arthritis who were physically active were significantly likely to have at least $1,000 in savings over the average annual medical costs for adults with arthritis (OR = .537, X^2= 251.2842, p<.0001). Specifically, the odds of having at least $1,000 in savings were 46 percent greater for active adults with arthritis than inactive adults with arthritis. Consistent with the results of the crude analysis, even after potential confounders were introduced into the model, physical activity remained a significant predictor of medical cost-savings among adults with arthritis. After controlling for the effects of insurance status, age, race, sex, smoking status, BMI, diabetes, stroke, high blood pressure, heart disease, asthma, chronic bronchitis, emphysema and interactions between each of these covariates and physical activity, physical activity remained a significant predictor of savings among adults with arthritis. Specifically, after insignificant covariates were removed through backwards elimination and the model was reduced, the adjusted results showed that physical activity was still significantly associated with a cost-savings of at least $1,000 (below average medical expenditures) for adults with arthritis (OR = .716, CI: 0.716, 0.656 and X^2=54.8890, p<.0001). Stated another way, the adjusted results showed that the odds of having $1,000 or more in savings were 28 percent greater among active adults with arthritis than inactive ones. The reduced model adjusted for the effects of health

insurance, age, gender, race, diabetes, stroke, high blood pressure, heart disease, asthma, bronchitis, and emphysema.

In addition to physical activity, several covariates also predicted savings among adults with arthritis. Lack of a chronic disease (i.e., heart disease, diabetes, high blood pressure, stroke, emphysema, chronic bronchitis, or asthma) predicted savings as did being under age 65, uninsured, Black, or male. Being uninsured predicted the greatest odds of savings among adults with arthritis after controlling for the other covariates in the model. After controlling for the other covariates, the absence of heart disease predicted the second greatest odds of savings (OR = 0.400, CI: 0.346, 0.436; X^2 =152.4233, p<.0001). Further, a significant interaction was identified between physical activity and heart disease in predicting cost-savings among adults with arthritis. Tables 10 and 11 summarize the results of the regression analysis predicting $1,000 or more in savings.

Physical Activity Predicts $3,000 or More in Savings

Analysis of the crude relationship between physical activity and total medical expenditures showed that adults with arthritis who were physically active were also significantly likely to have at least $3,000 in savings compared to average annual medical expenditures for adults with arthritis (OR = 0.582, CI: 0.544, 0.623; X^2= 241.4186, p<.0001). Specifically, the odds of having savings that were at least $3,000 were 42 percent greater for active adults with arthritis than inactive ones. Table 12 depicts the crude results.

Consistent with the results of the crude analysis, even after potential confounders were introduced into the model, physical activity remained a predictor of significant

medical cost-savings ($3,000 or more) among adults with arthritis. After eliminating insignificant covariates and interactions and controlling for the effects of insurance status, age, race, sex, diabetes, stroke, high blood pressure, heart disease, asthma, chronic bronchitis, and emphysema physical activity remained a significant predictor of savings among adults with arthritis. The adjusted results (Table 12) showed that physical activity was significantly associated with a cost-savings of at least $3,000 compared to average medical expenditures for adults with arthritis (OR = 0.762, CI: 0.703, 0.825; X^2=44.7189, p<.0001). Specifically, the odds of having $3,000 or more in savings were 24 percent greater for active adults with arthritis than inactive adults with arthritis, after adjusting for the covariates.

In addition to physical activity, several covariates continued to predict savings among adults with arthritis at the higher savings level of $3,000 or more. Lack of a chronic disease (i.e., heart disease, diabetes, high blood pressure, stroke, emphysema, chronic bronchitis, or asthma) continued to predict savings as did being under age 65, uninsured, Black, or male. Being uninsured continued to predict the greatest odds of savings among adults with arthritis after controlling for the other covariates in the model. Significant interactions were identified again between physical activity and heart disease and for the first time between physical activity and gender in predicting savings of $3,000 or more among adults with arthritis. Notably, after controlling for the effects of physical activity, insurance, age, race, sex, diabetes, stroke, high blood pressure, asthma, bronchitis, and emphysema, adults with arthritis and *no* heart disease were significantly likely to have had savings of $3,000 or more in medical expenditures (i.e., expenditures that were less than or equal to $5,382) (OR = 0.409, CI: 0.354, 0.472 and X^2=149.9284,

p<.0001). Being male, also predicted savings whereas being female did not. After controlling for the effects of physical activity, insurance, age, race, diabetes, stroke, high blood pressure, heart disease, asthma, bronchitis, and emphysema, male adults with arthritis were significantly likely to have had "savings" (i.e., medical expenditures that were at least $3,000 below average expenditures for adults with arthritis) (OR = 0.627, CI: 0.578, 0.681; X^2=124.7181, p<.0001). However, the opposite was true for females with arthritis; being female and having arthritis was not associated with these extreme savings. Tables 12 and 13 summarize the results of the regression analysis predicting at least $3,000 in savings.

Summary of Results

Forty-eight percent (47.53%) of adults with arthritis were physically active at least three or more times per week compared to 52.47 percent who were not. The average total healthcare expenditures for adults with arthritis was $8,382. Of the five measures of healthcare service utilization examined, all showed significantly different utilization patterns by physical activity status with only one exception. Reports about whether "you or a doctor believed you needed any care, tests, or treatment" did not differ significantly between active and inactive adults with arthritis. Generally, active adults with arthritis used fewer services than inactive adults with arthritis. Physical activity status was significantly associated with the length of time, in years, that had elapsed since a reported last checkup (X^2=31.3986, p<.0001), needing to see a specialist in the last year (X^2=21.0374, p<.0001), whether an appointment was made in the last year for routine medical care (X^2=12.3676, p=.0004), and the number of visits in the last year to a

medical office for care (X^2=52.0020, p<.0001) among adults with arthritis (Table 7). However, physical activity was not associated with perceived need (by physician or patient) for any test, care, or treatment in the past 12 months (X^2=0.6511, p=.4197).

Physical activity was also a predictor of lower total annual medical expenditures among adults with arthritis. Even after controlling for the effects of insurance status, age, race, sex, smoking status, BMI, diabetes, stroke, high blood pressure, heart disease, asthma, chronic bronchitis, emphysema and interactions between each of these covariates and physical activity, physical activity remained a significant predictor of savings among adults with arthritis. Being physically active was associated with savings in medical expenditures up to $3,000 below the average annual expenditure for adults with arthritis (OR=0.762, CI: 0.703, 0.825). However, being physical active was not associated with savings of $5000 or $4,000 among adults with arthritis.

CHAPTER 5: DISCUSSION

A two-part study was conducted to better understand the impact of physical activity on healthcare service utilization and medical costs. The following two research questions were subsequently examined and hypothesis tested for statistical significance:

I. Is participation in routine physical activity among adults with arthritis associated with reduced or varying patterns of healthcare services utilization (e.g., fewer doctor office or clinic visits, fewer diagnostic tests or treatments, and fewer specialist appointments)?

II. Are total medical expenditures lower among adults with arthritis who are physically active than adults with arthritis who are sedentary?

It was hypothesized that healthcare service utilization would be less for adults with arthritis who were physically active than those with arthritis who were sedentary and that healthcare costs would be less for adults with arthritis who were physically active than those who were sedentary. These hypotheses were not disproved. A discussion of the observed results follows herein.

Discussion Addressing Results from Research Question I: Healthcare Utilization

Healthcare service utilization patterns differed significantly between active and inactive adults with arthritis and, on average, healthcare expenditure were higher among inactive adults with arthritis ($9,710.25) than active adults with arthritis ($6,538.22).

Additionally, active adults with arthritis were generally half as likely to have a chronic disease comorbidity (i.e., heart disease, diabetes, stroke, emphysema, or bronchitis) than inactive adults with arthritis (see Table 6). While the overall patterns of healthcare service utilization were similar based on a comparison of the modes for active and inactive adults with arthritis, inactive adults with arthritis utilized more healthcare services than active adults with arthritis. Although the statistical test, Chi-Square, used to assess differences in healthcare service utilization by physical activity status cannot be used to imply predictive or causal relationships, significant differences and patterns of association were revealed that suggest that those who were active may have been healthier or able to better manage their disease because active adults with arthritis used fewer healthcare services. These results also suggest that reduced healthcare service utilization is likely a contributing factor for the observation that physically active adults with arthritis had lower total medical expenditures than inactive adults with arthritis. It is, however, important to note that compared to adults without arthritis, adults with arthritis were generally higher consumers of healthcare services.

Rates of comorbidities in the study population were relatively similar to national estimates reported from other data sources in the literature. Murphy et al., (2009), using data from the 2007 National Health Interview Survey, estimated that 16 percent of adults with arthritis had diabetes whereas the current study estimated a slightly higher percentage (21.02) with arthritis and diabetes. Murphy et al., (2009), also reported that stroke affected seven percent of adults with arthritis whereas the current study estimated that 10.07 percent had a history of stroke or transient ischemic attack. Murphy et al., (2009) reported that among adults with arthritis, 53 percent had high blood pressure and

24 percent had heart disease. The current study, however, showed a somewhat higher estimate for adults with arthritis and high blood pressure (62.36%) and lower estimate for those with heart disease and arthritis (13.90%). Reasons for these differences may be due to differences between the two study populations or minor differences across surveys between the disease categories or descriptions assessed (e.g., stroke in Murphy (2009) study versus stroke *or* transient ischemic attack assessed via the current study using MEPS). It is also likely that clusters of chronic conditions were present among adults with arthritis, meaning that it is possible that adults with arthritis were affected by multiple, co-occurring chronic conditions.

More research is needed to determine how or if these results are unique to adults with arthritis and whether they have more to do with the influence of physical activity status in general, aside from any disease condition. Additional research is also needed to determine more specifics about how care is used by adults with arthritis and relates to arthritis-related health outcomes. Despite the need for additional information, it was interesting to see that physical activity appears to have potential implications for helping relieve the burden on the healthcare system and resultant costs, simply by reducing healthcare service utilization. However, it is important to note that reduced healthcare services could potentially be viewed negatively from a non-economic standpoint in that there may be health benefits that may be obtained from care that is sought or received for preventative or disease management reasons. Unfortunately, the greater likelihood is that care, when it is actively sought, is generally for the purpose of addressing or remedying a health concern or injury or reducing disease symptoms rather than preventing new disease or the progression of existing disease. Results from the current study suggest that

there may be indirect and direct economic benefits associated with promoting and encouraging increased physical activity among adults with arthritis. Packaged interventions that are evidence-based have been identified by the CDC as appropriate for adults with arthritis. Promotion of these programs by healthcare providers and others could lead to increased physical activity among adults with arthritis and subsequent improvements in health outcomes, arthritis management, and reductions in healthcare services utilizations and associated costs.

MEPS 2010 Dataset and Adults Without Arthritis

The full dataset for MEPS 2010 (N=32,846) was divided into two groups, adults with arthritis and individuals without arthritis. The majority of the analysis were carried out on adults with arthritis. The following paragraph presents a brief description of the characteristics of individuals without arthritis for context and comparison. Additional details about the characteristics of individuals without arthritis are presented in Table 3. Individuals without arthritis were younger, more active and had less chronic disease and lower total annual medical expenditures on average. Specifically, the average age of individuals without arthritis was 40 years. Seventy-five percent of these individuals were insured and 60% were active. Twenty-three percent had high blood pressure and less than eight percent had either asthma, diabetes, heart disease, stroke, emphysema, or bronchitis. The average total annual medical expenditures for these individuals was $2,825.

Discussion Addressing Results from Research Question II: Medical Expenditures

Physical activity was a significant predictor of savings in total annual healthcare expenditures among adults with arthritis in the crude, full, and reduced models. As expected, being male or not having heart disease was protective, particularly in the model that assessed for more extreme savings (i.e., savings of at least $3,000). Being inactive and having arthritis, even after adjusting for possible confounders, was consistently, significantly associated with "no savings" in total annual medical expenditures. Specifically, the odds of "no savings" among *inactive* adults with arthritis were approximately 30-40 percent greater than the odds of "no savings" for *active* adults with arthritis. The economic value of physical activity for adults with arthritis seems clear and is consistent with the hypothesis proposed at the outset of the study– adults with arthritis who were routinely active had lower medical costs on average and experienced cost-savings up to $3,000 or more. Savings associated with physical activity for adults with arthritis did not persist, however, at levels of $5,000 or $4,000.

Interactions

Significant interactions were observed between physical activity and heart disease at both the $1,000 or more and $3,000 or more levels of savings. Whereas a significant interaction was observed at only the higher level of savings between physical activity and gender. The interaction between physical activity and heart disease was not surprising. Being physically active did not result in any cost-savings if a person with arthritis also had heart disease. Heart disease is among the most costly chronic diseases in the U.S. Some estimates place the collective cost of heart disease at nearly $300 billion annually

(Roger et al., 2012). More than 80 million Americans suffer from some form of heart disease and the individual costs of heart disease can be quite high for those who suffer from more severe or advanced forms of the disease (Roger et al., 2012). It is likely that the observed interaction reflects the synergistic relationship between heart disease and higher-than-average medical costs, a relationship that is far less likely for someone with arthritis and no heart disease. Further, the literature shows that heart disease is also a leading cause of disability, and adults with heart disease and arthritis are less active than adults with arthritis alone (Bolen et al., 2009; Hawker et al., 2014). The combination of these factors is likely responsible for the observed interaction between physical activity and heart disease related to medical expenditures among adults with arthritis. The literature also documents that arthritis is a barrier for physical activity among adults with arthritis and diabetes (Bolen et al., 2008), another disease that is a high medical cost driver, so it was somewhat surprising to see that a similar interaction was not observed between physical activity and diabetes within the study population.

Possible reasons for the relationship between physical activity and gender among adults with arthritis are less clear but may have to do with the fact that there were far fewer men (37%; n=2,049) in the study population than women (64%; n= 3,551) and because men (53%) were more likely to be physically active than women (45%) and may have had lower costs overall. According to Miles (2012), before the initiation of the 2010 Affordable Care Act insurers and other payers routinely charged higher premiums to women and older adults. This practice suggested that it costed more to insure these individuals, likely because they used more health care or had higher medical expenditures than men and younger adults. Other researchers have noted less use of healthcare and

lower medical costs and charges among men, particularly compared to women aged-45 to 64 and older (Bertakis & Azari, 2010; Owens, 2008). It is also possible that men had a different mix of comorbidities that influenced their costs and likelihood to be active compared to women with arthritis in the MEPS 2010 study population.

Other Findings

It was not surprising to find that, after adjusting for possible confounders affecting the relationship between arthritis, physical activity and medical expenditures, the absence of chronic diseases such as heart disease, high blood pressure, diabetes, asthma, emphysema, stroke and chronic bronchitis predicted savings in medical expenditures. This finding is consistent with prevailing wisdom and theory that the absence of major chronic disease reflects a healthier state of being and would therefore be associated with lower medical expenditures. This was shown to be true, despite the fact that cancer, which can be a major driver of costs, was not included in the model because of its lack of relevance to the primary relationships of interest between arthritis, physical activity and cost. Further, the exclusion of cancer may have resulted in higher than average costs, and shown even greater savings, than would have been seen if cancer had been included in the model.

Although the results related to the absence of disease in predicting lower medical expenditures were expected, another result was not. It was unexpected to find that being Black did *not* predict *higher* medical expenditures but instead predicted savings up to $3,000 in annual medical expenditures. This finding was surprising because the literature indicates that, although arthritis affects the same or greater numbers of Blacks as Whites,

Blacks suffer more severely from the disease (McIlvane, 2009). The literature also identifies arthritis as one of the top three chronic conditions affecting Blacks and the leading cause of activity limitations in this group (CDC, 1996). Studies have looked at physiological evidence and shown radiographic evidence of increased arthritis in Blacks compared to Whites, notably with older Blacks (who reported similar pain) showing more severe x-ray evidence of arthritis and performing more poorly on activity tasks than Whites (Burns, Graney, Lummus, Nichols, & Martindale-Adams, 2007; McIlvane, 2009). Studies have also shown marginally significant findings indicating that low SES Black women with arthritis tend to have more pain and functional impairment than Whites (McIlvane, 2009). Risk factors and prevalence data clearly emphasize the disproportionate burden of arthritis on Black and because of this, the initial expectation was that Blacks would have higher medical costs and be less likely to be active or show savings.

However, a closer look at the literature revealed disparities in care and access to treatment among Blacks, not just generally, but also specific to care for arthritis, which may in turn have contributed to the results observed in the present study. According to the literature, although Blacks with arthritis experience more severe pain and disability related to arthritis (Abraído-Lanza, White, Armbrister, & Link, 2006; CDC, 2005; Hootman, Sniezek, & Helmick, 2002) they also experience delayed treatment, and are less likely to have joint replacement surgery (CDC, 2009; Dunlop et al., 2003) than Whites (McIlvane, 2009). Even with presumed equal access to care in terms of having some type of health insurance, data show that Blacks still have lower rates of knee replacement surgery than Whites (Blake et al., 2002; McIlvane, 2009) indicating that

factors other than insurance are also in play in reducing access to care. There is also evidence that Blacks experience delayed onset of receiving arthritis medications such as anti-inflammatory treatments or pain prescriptions (McIlvane, 2009; Suarez-Almazor et al., 2007). Further, Blacks experience reduced access to specialists for arthritis despite the severity of their symptoms. At least one study demonstrated that Blacks were more likely to end up at clinics and emergency rooms for arthritis care whereas Whites were more likely to be seen by an orthopedic surgeon for arthritis pain (Blake et al., 2002; McIlvane, 2009). Literature on healthcare in general shows financial strain, poorer quality health facilities in minority communities, discrimination, and lack of health insurance all impact care and access to services for Blacks (Kershaw et al., 2009; McIlvane, 2009; Rooks & Whitfield, 2004; Williams & Braboy, 2005). The observed results are likely due to a combination of these factors and resulted in lower healthcare expenditures, simply because there was likely less healthcare use and reduced treatment access for the Blacks in the study population.

Given that MEPS (2012) derives the "total medical expenditures" variable (TOTEXP10) from the sum of all payments for medical services from all sources ranging from self (out-of-pocket) to public and private insurers and other sources such as workers' compensation, it is far less surprising that being Black and having arthritis was associated with significant medical cost-savings after adjusting for the effects of age, sex, insurance, and other chronic diseases (i.e., heart disease, high blood pressure, diabetes, asthma, emphysema, stroke and chronic bronchitis). The savings that were achieved for this group most likely reflect the disparities in healthcare for Blacks, and were most

likely influenced by the issues that traditionally impact health inequities and limit access to health services and care, such as race and socio-economic status.

The literature shows that 22.7 million adults with arthritis experience arthritis-attributable activity limitations (CDC, 2013a). These limitations may range from difficulties in the ability to perform activities that affect daily living (e.g., grasping small objects, combing hair, bathing, etc.) to those that are less severe but still diminish functioning and independence (e.g., pushing heavy items, walking a quarter of a mile, etc.). It is conceivable that adults with arthritis with lower physical functioning status experienced fewer or greater benefits of routine physical activity and that a measure for this should be included in any future model assessing these relationships, including or independent of physical activity status. It is suspected, however, that functional status in adults with arthritis may be highly correlated with physical activity status. Despite this it would be useful to learn the impact of a variety of specific forms of functional limitations among adults with arthritis on medical expenditures and prescription costs and usage. It was, also interesting to observe, and consistent with expectations, that sedentary adults with arthritis were more likely to be a bit older and have higher medical expenditures (average age of 62 and expenditures of $6,538.22) than active adults with arthritis (average age of 58 and expenditures of $9,710.25). This is likely due to the effects of age on illness (i.e., the increased likelihood for multiple comorbidities and greater disease severity resulting in increased healthcare usage and ensuing costs) and greater disability and potentially reduced opportunities for physical activity at older ages. Despite this, the adjusted model (which controlled for age, various comorbidities, and several other

covariates) suggested that age did not play a strong role in tempering the relationship between physical activity and medical expenditures among adults with arthritis.

Future studies might also examine the role of multiple comorbidities in influencing physical activity status. The current study determined that adults with arthritis and at least one other comorbidity (heart disease, diabetes, high blood pressure, stroke, asthma, chronic bronchitis, or emphysema) were nearly twice as likely to be inactive (Table 6). After controlling for comorbidities, however, physical activity remained significantly associated with medical expenditure savings. However, having greater knowledge about the role of multiple comorbidities in influencing physical activity may be useful for clinicians and others in making physical activity recommendations that might be more specific and meet the unique needs of adults with multiple random or distinct mixes of comorbidities. Future studies might examine the role of multiple comorbidities beyond two, on physical activity and cost outcomes among adults with arthritis. As previously noted in the literature review, Sandstad et al., (2015) concluded that adults with arthritis who participated in a pilot study of a ten-week high intensity physical activity training intervention showed both reduced joint inflammation and reduced risk factors for CVD (i.e., improvements in maximal oxygen uptake, heart rate recovery, blood pressure, BMI, percent body fat, and waistlines) as well as no adverse outcomes and improvements in overall cardiovascular health. Quin et al., (2015) determined that adults with arthritis and at least one other chronic comorbidity reported significantly more social participation restriction, (e.g., ability to go shopping or to sporting events, attend parties or meetings, visit friends, etc.), serious psychological distress, and work limitations (e.g., work related disability or missed days due to illness

or injury) than those with multiple chronic conditions but no arthritis. Further, Quin et al., (2015) concluded that having arthritis alone negatively impacted social participation restriction and work disability more than having any other chronic condition. These results suggest that arthritis alone and in the presence of one or more chronic comorbidities may drive physical and social limitations, but that exercise is an important intervention for arthritis alone and within the context of preventing future chronic disease comorbidities like heart disease. Future study of the role of specific combinations of comorbidities and their combined impact on arthritis outcomes, care and costs is merited.

Implications

This study was undertaken primarily for the purpose of identifying an evidence base illustrating cost-savings associated with physical activity among adults with arthritis as a way to bolster support for reimbursement or financing for evidence-based physical activity interventions recommended by CDC for adults with arthritis. Adults with arthritis have unique physical and mental barriers to being physically active, but stand to gain significant health and arthritis-symptom management benefits by engaging in routine physical activity. As such, adults with arthritis can increase physical activity levels and maintain a more active lifestyle by having greater access to safe, affordable, and arthritis-appropriate forms of physical activity. The CDC recommended programs, if disseminated more widely and sustained, can help meet these needs and close this gap.
Reimbursement can propel increased dissemination of the CDC-recommended programs, increase access, and increase the likelihood that adults with arthritis become more aware of and likely to participate in them.

Findings from this study provide evidence lending support for the case for systematized financing of evidence-based, arthritis-appropriate interventions. The findings can also be used to provide policy makers with a greater understanding about the relationship between physical activity and healthcare expenditures among adults with arthritis and make meaningful recommendations about cost-efficient ways to reduce healthcare expenses and improve health and quality of life through physical activity. The findings, which determined that engaging in moderate physical activity three or more times per week predicted medical cost-savings up to and beyond $3,000 among adults with arthritis, suggest that encouraging, promoting, and putting incentives or reimbursements into place for arthritis-appropriate physical activity programs could be a cost-effective strategy for improving health and reducing health-related costs in this group.

The benefits of physical activity extend far beyond those that are specific to arthritis. It is important to recognize that physical activity has proven health and quality of life-related benefits for people with arthritis as well as for people with multiple chronic conditions (CDC & AF, 2010; Sandstad et al., 2015). For these reasons it is important to continue to promote physical activity among people with arthritis and continue research into cost-savings that may be associated with it. Because people with arthritis are faced with unique challenges (pain, fear, lack of function) that make it difficult for them to become and maintain a physically active lifestyle, evidence-based physical activity interventions that are appropriate for adults with arthritis and that have arthritis-specific health outcomes (i.e., improved physical function, etc.) are particularly critical for increasing physical activity safely in this population. Programs such as those that are

evidence-based and recommended by the CDC for adults with arthritis can play an important role in helping adults with arthritis become physically active on a continuing basis. Programs such as EnhanceFitness®, that are arthritis appropriate, can be ongoing in recurrence, and that have promising health- and cost-savings evidence associated with participation in them may be well-positioned for widespread dissemination and financing. However, more support is needed to increase availability of and participation in these community-based programs. Reimbursement is one way to achieve increases in program referrals and participation, increase availability of programs, and sustain these community offerings. The findings from this study suggest that reimbursement of these programs, which are low-cost community-based offerings, could be easily offset with the cost-savings that is likely to result in total medical expenditures from participation in them. In addition to supports needed to increase the availability and participation in these programs, more support is needed for researchers to identify more evidence-based physical activity programs and broaden the menu of choices and program availability for adults with arthritis. Future studies might also look at different forms of unstructured physical activity to determine whether there are specific cost-savings benefits associated with any specific forms of activity for adults with arthritis (e.g., swimming, walking, etc.).

Limitations in Assessing Differences in Healthcare Utilization, Research Question 1

The current study focused on the analysis of secondary, self-reported (in most cases) data collected as part of a larger medical panel survey with its own distinct purposes and as such may be limited by a number of factors. It is therefore expected that

the study results are subject, at minimum, to the typical biases that threaten survey data such as subject recall bias, and under or over reporting, and survey questions that may not be perfectly aligned to the present research gaps and policy questions. Despite these limitations, reliance on secondary, self-reported data was necessary for the present study because the alternatives (e.g., new data collection via a prospective natural experiment with a baseline of inactive adults with arthritis or focused original survey) would not be cost or time efficient and might be subject to some of the same biases.

A final potential limitation is that the present study, which utilized 2010 data exclusively, does not account for any potential historical artifacts that may have occurred that one year. Essentially, this study makes the assumption that 2010 data adequately represent a typical year without any unique events or circumstances that may have biased the results or limited its generalizability. The introduction of the Patient Protection and Affordable Care Act (ACA) in the spring of 2010 was a unique event in the history of healthcare (Government Publishing Office, 2010). Further the ACA was introduced during a period in which the U.S. was steeped in economic recession and high rates of unemployment. The occurrence of both of these events may have influenced healthcare usage and patterns during 2010 in unusual ways and may have resulted in patterns that are atypical of healthcare use before the recession and after full implementation of the ACA. Given that the average participant from the study population was working aged, the influence of the ACA on healthcare coverage and service utilization may have uniquely impacted the results during this transitional year. Future studies should incorporate a trend analysis to determine whether any observed differences in costs or health services utilization persist across time, how they may have differed pre- and post-

ACA implementation, and how ACA initiation and public versus private insurance, including Medicare may have influenced healthcare usage. Future studies may also be useful in uncovering more specific information about the initiation and cessation of physical behaviors and temporal influences on the resulting gains and losses of health benefits for adults with arthritis.

Limitations in Predicting Medical Savings Among Active Adults With Arthritis, Research Question II

It is acknowledged that this study did not address the unique needs of subpopulations of older adults with arthritis who may be sicker and affected by multiple, co-occurring chronic conditions and who may therefore be physically unable to exercise or for whom physical activity may be prohibitive or even harmful. It did however address the recommendations and needs of the majority of adults with arthritis and is consistent with the national public health guidelines for physical activity among people with arthritis which recommends a minimum of 150 minutes of moderate to vigorous physical activity per week for adults with arthritis (Physical Activity Guidelines Advisory Committee, 2008).

Several measures are included within the MEPS 2010 Household Component data set assessing functional limitations ranging from work, housework, and social participation limitations to more specific physical limitations such as inability to reach overhead, lift ten pounds, walk a mile, stand for 20 minutes, walk three blocks, climb ten steps, or reach overhead, etc. However, these limitations are not necessarily specific to arthritis and, taken independently, it is not possible to determine the specific health

condition or disease attributed as the reason for a given limitation. Given that 47 percent of adults with arthritis have at least one other comorbid condition, it is possible that common comorbidities, such as heart disease, stroke, diabetes heart disease, or high blood pressure or even age may be partly or even fully responsible in some cases for activity related functional limitations faced by adults with arthritis. It is possible to compute correlations and frequency distributions to characterize how joint pain and specific limitations affect adults with arthritis within the MEPS dataset. It is also possible to assess the impact of these factors in predicting physical activity behaviors or medical expenditures among adults with arthritis. It is suspected that physical activity status mirrored functional limitations to some extent among this population of adults with arthritis and as such it was not necessary to expand the model any larger to include functional limitations because the impact of these limitations would be borne out in the inactive population and the population with the greatest number of comorbidities (who are also likely to have the greatest limitations). Full exploration of this topic area was deemed to be beyond the scope of this paper but is recommended as an important area of future study.

Validity and Reliability Considerations

It should also be noted that although extensive examination has gone into determining the validity and reliability associated with the national MEPS survey, a 2008 study (Olin et al., 2008) noted significant under-reporting (12%) of hospital and physician expenditures reported for Medicare beneficiaries in the MEPS 2001-2003 datasets. The researchers noted that the under-reporting varied by event type. This finding

is somewhat important because it suggests that any absolute cost estimates generated as part of the study may be underestimated if, which is unlikely, a significant portion of the study sample are Medicare beneficiaries. However, given that the main purpose of the study design is to detect *relative* differences rather than report or use absolute numbers on costs, and given that the study population includes adults with arthritis ages 18 and older, most of which will not be eligible for Medicare, the proposed methodological approach was expected to yield valid and reliable results. Any descriptive characteristics about absolute medical costs that were reported as a part of these studies should be interpreted with caution since they may be slightly underestimated.

Other Potential Study Limitations

In addition to limits in external validity, it is also acknowledged that other factors may limit the comprehensiveness of the results. The definition and threshold used to define healthcare savings may have limited the analysis and subsequent results. Healthcare savings were defined as amounts less than the average annual total healthcare expenditures for the corresponding data year, rather than reduced healthcare expenditures, for a given subject who was inactive and then became active during different panel sessions within the 2010 data year.

Another limitation of this work is that it did not address mortality, due to any or all causes, that may have occurred in 2010. MEPS annual estimates reflect data for individuals who were considered in the target population (i.e. in-scope) at any time during a given survey year (MEPS, 2015). MEPS does not exclude in-scope participants from the survey during the year that death occurred. Instead, MEPS applies a statistical

person-weight that is post-stratified to corresponding estimates from the Medicare Current Beneficiary Survey and National Center for Health Statistics vital statistics data (MEPS, 2015). It is therefore important to note that adults with arthritis in their last year of life are likely to have had higher expenditures and be less active than those who survived the entire year and could have therefore overestimated the impact of physical activity on total medical expenditures for the year. However, given that this study examined adults of all ages with arthritis on medical expenditures and given the fact that older age did not have any significant influence on the relationship between physical activity and arthritis, this suggests that the proportion of older adults or non-survivors was either too small to have a significant impact on the results or perhaps that the impact of mortality was otherwise insignificant. The present study may also be limited by the fact that the total healthcare expenditure variable examined represents pooled costs from within the MEPS dataset, and can therefore include costs associated with multiple chronic and other conditions. Future studies might break out cost contributors within MEPS (e.g., include and examine variables that represent estimates of prescription and other costs) to better elucidate the different cost drivers that yield total medical costs for adults with arthritis. Exploration of how the cost drivers differ by age among adults with arthritis may also yield useful results that might be important in future public health policy.

A final potential limitation, consistent with a limitation in addressing research question I, is that the second half of the study, which addressed research question II and also used 2010 data exclusively, did not account for any potential historical artifacts that may have occurred that one year. Essentially, this study makes the assumption that 2010

data adequately represent a typical year without any unique events or circumstances that may have biased the results or limited its generalizability. It is important to note that the U.S. economy and job market were in the midst of a recession in 2010 which likely impacted access to healthcare and health insurance in ways that are less typical during a healthy and robust economy (Collins, Doty, Robertson & Garber, 2011). The impact of job loss and loss of employer subsidized insurance likely resulted in increased numbers of working aged patients being seen for free by healthcare providers. Further the signing of the Patient Protection and ACA into law, on March 23, 2010 (Government Publishing Office, 2010) signified a unique turning point in politics and healthcare that may have impacted the healthcare market and insurance access that year in ways that were then and are now atypical and that may have inadvertently influenced healthcare costs and outcomes without influencing individual physical activity behaviors. However, because of the newness of the ACA and the extended timeline that was in place for full adoption it is less likely that the introduction of the ACA had much impact on the study and results which utilized 2010 data. The present study aimed to uncover and adjust for the influence of some of these factors by including age and insurance coverage (of all types, both public, including Medicare, and private) in the regression model as covariates that might influence costs. Future studies should incorporate a trend analysis to determine whether any observed differences in costs or health services utilization persist across time.

CHAPTER 6: CONCLUSION

A review of the literature confirms the significant burden, in terms of both cost and prevalence, of arthritis. The present analyses confirm the high rate of physical inactivity among adults with arthritis and that physical activity is a significant, predictor of total healthcare expenditures. The burdensome and costly implications of inactivity or insufficient physical activity among adults with arthritis is of great concern and worthy of action, not only because arthritis affects 52.5 million people in the U.S. (CDC, 2013a), but because people with arthritis commonly have other serious co-occurring conditions such as heart disease, diabetes, and high blood pressure, which are also costly and require routine physical activity for successful management (ACR, 2012; CDC & AF, 2010; Physical Activity Guidelines Advisory Committee, 2008; Shi et al., 2006). A gap exists in the literature related to the fiscal costs of inactivity among adults with arthritis, particularly with regard to analysis of current, national population-based data. It is the author's hope that this study has helped uncover additional information about the scope and nature of the relationship between inactivity among adults with arthritis and healthcare expenditures and raised important questions worthy of future scientific inquiry.

People with arthritis need information about, and access to, affordable, effective, and convenient programs that can help them become physically active in a safe way (CDC & AF, 2010). CDC recommends several evidence-based, community program that

are effective for people with arthritis (Brady et al., 2009; CDC & AF, 2010). Unfortunately these programs are underutilized reaching few of those who can benefit from them (CDC, 2010a; CDC & AF, 2010). Better linking adults with arthritis to evidence-based, arthritis-appropriate physical activity programs can be accomplished by partnering with healthcare providers, worksites, and community organizations to reduce or offset the cost of the programs and offer them in settings and ways that are convenient, affordable, and responsive to the unique needs, barriers, and challenges facing adults with arthritis.

As society ages, new challenges will arise in helping older adults age in a way that helps them restore or maintain physical function and health, and remain independent and engaged in daily life and work-related activities as long as possible. Public health will increasingly be required to focus more on health related quality of life in addition to preventing mortality. Managing arthritis will be an important strategy for success in this endeavor.

CHAPTER 7: MANUSCRIPT I

PHYSICAL ACTIVITY MAKES A DIFFERENCE: VARIATION IN HEALTHCARE SERVICE UTILIZATION BETWEEN ACTIVE AND SEDENTARY ADULTS WITH ARTHRITIS[1]

[1] E.L. Odom, T. Miles, J. Lee, B. Rasulnia, and P. Reeves. To be submitted to the *American Journal of Health Promotion*.

Abstract

Purpose

Despite the benefits of physical activity (PA), adults with arthritis are less active than adults without arthritis. This study investigated whether participation in routine PA among adults with arthritis was associated with reduced or varying patterns of healthcare utilization.

Design

Medical Expenditure Panel Survey (MEPS) 2010 data (53.5% response rate) were analyzed to generate descriptive characteristics and explore differences (x^2) in service utilization by PA status.

Setting

U.S. adults with arthritis included in MEPS.

Subjects

Study subjects included adults (> age 17) with arthritis (n=5,600).

Measures

Measures of interest included the length of time since last check-up, whether appointments for care were made, number of visits for care, number of times tests, care or treatment were thought necessary, and number of times a specialist was needed.

Analysis

Descriptive statistics were calculated for inactive and active adults with arthritis. Chi-Square tests were used to identify differences in frequency of service utilization across the various categories.

Results

Generally, inactive adults with arthritis utilized more services than active adults with arthritis. PA was significantly associated with time since last checkup ($p<.0001$), needing a specialist ($p<.0001$), appointments for care ($p=.0004$), and number of visits ($p<.0001$), but not with need for test(s) or treatment ($p=.4197$).

Conclusion

Economic benefits may be associated with PA. Promotion of evidence-based, PA interventions may improve disease management and reduce healthcare utilization and costs among adults with arthritis.

Key Words: *arthritis, osteoarthritis, physical activity, intervention, and healthcare*

Note: The following manuscript is proposed for submission to the *American Journal of Health Promotion* (2015) and conforms to the Journal's style guidelines for quantitative research manuscripts.

Title

Physical activity makes a difference: Variation in healthcare service utilization between active and sedentary adults with arthritis

Outline

Abstract (220 words excluding subheadings)

Key Words

Indexing Key Words

Purpose

Methods

- Design
- Sample
- Measures
- Analysis

Results

- Descriptive Characteristics
- Healthcare Services Utilization

Discussion

Summary

Limitations

Significance

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References

Tables

Indexing Key Words

1. Manuscript format: research

2. Research purpose: descriptive

3. Study design: non-experimental

4. Outcome measure: morbidity, other financial/economic

5. Setting: clinical/healthcare, national

6. Health focus: fitness/physical activity

7. Strategy: incentives, policy

8. Target population age: adults, seniors

9. Target population circumstances (specify all that apply): geographic location limited to the U.S.

Purpose

Physical activity is one of four generic public health interventions proven effective and recommended by the Centers for Disease Control and Prevention (CDC) for

tertiary prevention and active management of arthritis.[1] Injury prevention, weight management, and self-management education are the remaining three recommended interventions. Research shows that physical activity contributes to improved mood, increased function, reduced pain and disability, and delayed progression of arthritis.[1-3] Several structured physical activity programs exist that have been proven to be safe and effective for adults with arthritis. These programs are recognized and promoted by the CDC in published materials and through funded state and national dissemination initiatives, yet research suggests that these programs are far underutilized.[4] Additionally, health insurance reimbursement and incentives are generally not offered for participation in them. Studies also show that, despite the known benefits of physical activity and the existence of these programs, adults with arthritis are far less active than adults without arthritis.[5] Reasons cited by adults with arthritis for not being physically active are pain, fear of worsening arthritis symptoms, and lack of knowledge about how to exercise safely.[5] The existing, evidence-based physical activity interventions recommended by CDC can help people with arthritis become more active and exercise safely. However, there is a need to have these programs disseminated more widely, increase participation in them, and sustain their delivery[4] (e.g., through reimbursement or other financing).

The current study used the national Medical Expenditure Panel Survey[6] (MEPS) 2010 data set to explore patterns of healthcare service utilization associated with physical activity and physical inactivity among adults with arthritis. Specifically, the following research question was of interest "Is participation in routine physical activity among adults with arthritis associated with reduced or varying patterns of healthcare services utilization?" It was hypothesized that healthcare services utilization would be different

and likely less for people with arthritis who were physically active compared with those who were sedentary. Healthcare services of interest included the length of time since a general health check-up, whether one or more doctor office or clinic appointments for care were made in the last 12 months, number of doctor office or clinic visits for care that were made in the last 12 months, number of times diagnostic tests, care or treatment was thought to be needed, and number of times a patient reported needing to see a specialist.

Methods

Design

The proposed study was descriptive in nature and examined the relationship between physical activity and healthcare service utilization, specifically taking a look at the frequency of health service utilization among adults with arthritis by physical activity status. Descriptive statistics were calculated and presented both for inactive adults with arthritis and for active adults with arthritis. Chi-Square tests were used to determine significant differences in frequency of service utilization across the various healthcare service categories. The study sought to determine if people with arthritis who are routinely physically active use fewer or a different distribution of healthcare and provider services. Basic descriptive statistics describing population characteristics and frequency distributions related to healthcare service utilization were also calculated.

Sample

The study sample was drawn entirely from the publicly available, consolidated household component files of the MEPS[6] 2010 dataset. MEPS[6] is a national, government

administered, survey that is representative of the American population. The overall response rate for the full-year consolidated household file for 2010 was 53.5 percent.[6] MEPS is recognized as the most complete source of U.S. healthcare cost and service utilization data. The survey includes data on the specific health services that Americans use and the frequency with which they use them in addition to other information.[6] The study sample was inclusive of the entire population of U.S. adults with arthritis included in the 2010 MEPS dataset. The sample, n=5,600, included adults, aged 18 and older, diagnosed with any form of arthritis (defined as having a report of either osteoarthritis or rheumatoid arthritis diagnosis). The sample was subsequently divided into two groups of interest. The primary group of interest included adults with arthritis who reported being physically active for ½ hour or more at least three times a week during 2010. Inactive adults with arthritis served as the comparison group. A description of the study sample and study methods and design were submitted for ethical review. The University of Georgia Institutional Review Board reviewed a proposal describing the sample and planned approach for this project and assigned a determination of "not human research" to the research proposal. The study proceeded accordingly without further need for review.

Measures

A number of preventive, specialty and general healthcare services were assessed for frequency of use including variables measuring: length of time since general health check-up, number of doctor office or clinic appointments and visits made in the last 12 months, number of times diagnostic tests or healthcare treatment is needed, and number

of times a patient reports needing to see a specialist (Table 1). Additional variables about health and demographic characteristics associated with adults with arthritis were also examined to provide richer context to the findings and to explore variation of these factors (e.g., age, sex, race, presence of other chronic comorbidities, etc.) by physical activity status (i.e., inactive versus active).

Analysis

Central tendency patterns, as evidenced by frequency distributions and modes, were calculated for each service type and presented by patient physical activity status. Themes were also examined in relation to potential gaps and opportunities for improvements in policy, and promotion of health behaviors and practices of benefit for adults with arthritis. Chi-Square results and implications were calculated and are discussed as well. SAS[7] version 9.3 was used to compute frequency distributions and Chi-Square test statistics.

Results

Descriptive Characteristics

Approximately seventeen percent (17.1%) (n=5,600) of the study population reported diagnosed arthritis compared to 54.87 percent (n=18,022) reporting no arthritis. Results were either inapplicable (n=9,157), not ascertained or respondents refused to answer or answered ‘don’t know’ for the remaining proportion of the total study population (N=32,846). Adults with arthritis were primarily female (63.41%) and White (76.87%). Among adults with arthritis, the average age was 59.4 years old, but 38 percent

(38.34) were retirement-age or older (>64) whereas 61.66 percent where working-aged (>17 but <65). The average total annual healthcare expenditures for adults with arthritis was $8,382. Ten percent of adults with arthritis were uninsured. Twenty percent (20.32%) of adults with arthritis were current smokers and nearly seventy-two percent (71.54%) of adults with arthritis were overweight, whereas 28 percent were normal or under-weight. Further, among adults with arthritis, 21.02 percent had diabetes, 10.07 percent had a history of stroke or transient ischemic attack, 62.36 percent had been diagnosed with high blood pressure, and fourteen percent (13.90%) had been diagnosed with coronary heart disease. Regarding chronic respiratory conditions, fifteen percent (15.25%) of adults with arthritis had asthma. Approximately six percent of adults with arthritis had chronic bronchitis and approximately six percent of adults with arthritis had emphysema. Adults with arthritis also had an average of 3.2 medical office visits in 2010.

Only 48 percent (47.53%) of adults with arthritis were physically active at least three or more times per week compared to 52.47 percent who were not. Table 6 describes physical activity levels among adults with arthritis by demographic characteristics such as age, gender and race, as well as by smoking status and co-occurring chronic conditions. Of the 5,600 adults with arthritis included in the dataset, physical activity status was reported for 5,441. Among the 5,441 for which physical activity data was reported, 2,855 were inactive as defined by *not* engaging in at least moderate activity three or more times per week. Conversely, 2,586 adults with arthritis reported being routinely physically active. The average age for *active* adults with arthritis was 58 years and the total medical expenditure for this group was $6,538.22. Whereas the average age for *inactive* adults with arthritis was 62 (61.79) years and the average total medical

expenditure for inactive adults with arthritis was $9,710.25. Descriptive statistics are summarized in Table 6.

Healthcare Services Utilization

Physical activity status was significantly associated with the length of time, in years, that had elapsed since a reported last checkup (X^2=31.3986, p<.0001), needing to see a specialist in the last year (X^2=21.0374, p<.0001), whether an appointment was made in the last year for routine medical care (X^2=12.3676, p=.0004), as well as the number of visits in the last year to a medical office for care (X^2=52.0020, p<.0001) among adults with arthritis (Table 7). However, physical activity was not associated with perceived need (by physician or patient) for any test, care, or treatment in the past 12 months (X^2=0.6511, p=.4197).

Overall healthcare service utilization patterns differed significantly between active and inactive adults with arthritis (Table 7). Inactive adults with arthritis were more likely to have been seen for a routine checkup within the last year (42.87%) than active adults with arthritis (38.37%). Inactive adults with arthritis were also more likely to have been seen for a routine checkup within the past two years than active adults with arthritis. The opposite was true for adults without arthritis. Adults without arthritis who were physically active were more likely to have been seen by a physician for a routine checkup assessing overall health than inactive adults without arthritis at every time increment (ranging from less than a year to more than 5 years since last routine check-up). Most adults without arthritis (57.55%) had received a checkup with the last year regardless of physical activity status. However, the overwhelming majority of adults with arthritis

(81.24%) were likely to have had a routine checkup within the past year, regardless of physical activity status. Fifty-five percent (54.80%) of adults with arthritis reported needing to see a specialist for care in the past 12 months. Adults with arthritis who needed to see a specialist for care were more likely to be inactive (55.01%) than active (44.99%).

Active adults with arthritis were slightly less likely to have visited a doctor's office or clinic for care in the last 12 months (8.22% reported no visits) than inactive adults with arthritis (6.92% reported no visits). Further, active adults with arthritis who did seek care reported fewer visits in the last 12 months than inactive adults with arthritis. Specifically, active adults with arthritis were more likely to report one or two visits for care in the last 12 months whereas inactive adults with arthritis were more likely to report three or more visits for care in the last 12 months. The likelihood that the patient with arthritis seeking care was inactive increased progressively with the number of visits reported, meaning that the gap in differences between active and inactive adults with arthritis increased along with the number of visits for care. For example, of adults who reported three visits to a doctor's office for care in the last 12 months, 52 percent (52.13%) were inactive and 48 percent (47.87%) were active, meaning there was an absolute difference of four between inactive and active adults with arthritis (or eight percent difference). Of adults who reported four visits to a doctor's office for care in the last 12 months, 56 percent (55.93%) were inactive and 44 percent (44.07%) were active, meaning at four visits, there was an absolute difference of 12 between the two groups (or 24 percent difference). But of adults who reported ten or more visits to a doctor's office for care in the last 12 months, 60 percent (59.86) were inactive and only 40 percent

(40.14) were active, meaning the gap between the two groups had widened to an absolute difference of 20 (or 40 percent difference). These differences were significant (X^2= 52, p<.0001).

Similarly, there were also significant differences in the likelihood to have made an appointment in the last 12 months for routine care (X^2=12.37, p=.0004), though the majority of adults with arthritis made an appointment for care in the last 12 months (80.04%) regardless of their physical activity status. Active adults with arthritis were less likely to have made an appointment for care than inactive adults with arthritis. Of adults with arthritis who reported making an appointment for routine care in the last year, 53 percent (53.41) were inactive and 47 percent (46.59) were active.

Of the five measures of healthcare service utilization examined, all showed significantly different utilization patterns by physical activity status with only one exception. Reports about whether "you or a doctor believed you needed any care, tests, or treatment" did not differ significantly between active and inactive adults with arthritis.

Discussion

Summary

Healthcare service utilization patterns differed significantly between active and inactive adults with arthritis and, on average, healthcare expenditures were higher among inactive adults with arthritis ($9,710.25) than active adults with arthritis ($6,538.22). Further, active adults with arthritis were about half as likely to have a chronic-disease comorbidity than inactive adults with arthritis (i.e., stroke, diabetes, heart disease, or emphysema). While the overall patterns of healthcare service utilization were similar

based on a comparison of the modes for active and inactive adults with arthritis, inactive adults with arthritis utilized more healthcare services than active adults with arthritis. Although the statistical test, Chi-Square, used to assess differences in healthcare service utilization by physical activity status cannot be used to imply predictive or causal relationships, significant differences and patterns of association were revealed that suggest that those who were active may have been healthier or able to better manage their disease because active adults with arthritis used fewer healthcare services. These results also suggest that reduced healthcare service utilization is likely a contributing factor for the observation that physically active adults with arthritis had lower total medical expenditures than inactive adults with arthritis. It is, however, important to note that compared to adults without arthritis, adults with arthritis were generally higher consumers of healthcare services.

Rates of comorbidities in the study population were relatively similar to national estimates reported from other data sources in the literature. The 2009 literature[8] estimates that 16 percent of adults with arthritis had diabetes whereas the current study estimated a slightly higher percentage, 21.02 percent with arthritis and diabetes. Murphy et al.,[8] also reported that stroke affected approximately seven percent of adults with arthritis whereas the current study estimated that 10.07 percent had a history of stroke or transient ischemic attack. Murphy et al.,[8] also reported that 53 percent and 24 percent of adults with arthritis respectively were affected by high blood pressure and heart disease. The current study, however, showed a somewhat higher estimate for adults with arthritis and high blood pressure (62.36%) and lower estimate for the percentage (13.90%) diagnosed with both coronary heart disease and arthritis. Reasons for these differences

may be due to differences between the two study populations or minor differences across surveys between the disease categories or descriptions assessed (e.g., stroke in Murphy study[8] versus stroke *or* transient ischemic attack assessed via the current study using MEPS[6]). It is also likely that clusters of chronic conditions were present among adults with arthritis.

More research is needed to determine how or if these results are unique to adults with arthritis and whether they have more to do with the influence of physical activity status in general, aside from any disease condition. Additional research is also needed to determine more specifics about how care is used by adults with arthritis and relates to arthritis-related health outcomes. Despite the need for additional information, it is interesting to see that physical activity appears to have potential implications for helping relieve the burden on the healthcare system and resultant costs, simply by reducing healthcare service utilization. However, it is important to note that reduced healthcare services could potentially be viewed negatively from a non-economic standpoint in that there may be health benefits that may be obtained from care that is sought or received for preventative or disease management reasons. Unfortunately the greater likelihood is that care, when it is actively sought, is generally for the purpose of addressing or remedying a health concern or injury or reducing disease symptoms rather than preventing new disease or the progression of existing disease.

Limitations

The current study focused on the analysis of secondary, self-reported (in most cases) data collected as part of a larger medical panel survey with its own distinct

purposes and as such may be limited by a number of factors. It is therefore expected that the study results are subject, at minimum, to the typical biases that threaten survey data such as subject recall bias, and under or over-reporting, and survey questions that may not be perfectly aligned to the present research gaps and policy questions. Despite these limitations, reliance on secondary, self-reported data was necessary for the present study because the alternatives (e.g., new data collection via a prospective natural experiment with a baseline of inactive adults with arthritis or focused original survey) would not be cost or time efficient and might be subject to some of the same biases.

A final potential limitation is that the present study, which utilized 2010 data exclusively, does not account for any potential historical artifacts that may have occurred that one year. Essentially, this study makes the assumption that 2010 data adequately represent a typical year without any unique events or circumstances that may have biased the results or limited its generalizability. The introduction of the Patient Protection and Affordable Care Act (ACA) in the spring of 2010 was a unique event in the history of healthcare.[9] Further the ACA was introduced during a period in which the U.S. was steeped in economic recession and high rates of unemployment. The occurrence of both of these events may have influenced healthcare usage and patterns during 2010 in unusual ways and may have resulted in patterns that are atypical of healthcare use before the recession and after full implementation of the ACA. Given that the average participant from the study population was working aged, the influence of the ACA on healthcare coverage and service utilization may have uniquely impacted the results during this transitional year. Future studies should incorporate a trend analysis to determine whether any observed differences in costs or health services utilization persist

across time, how they may have differed pre and post ACA implementation, and how ACA initiation and public versus private insurance, including Medicare may have influenced healthcare usage.

Significance

Results from the current study suggest that there may be indirect and direct economic benefits associated with promoting and encouraging increased physical activity among adults with arthritis. Packaged interventions, that are evidence-based, have been identified by the CDC as appropriate for adults with arthritis. Promotion of these programs by healthcare providers and others could lead to increased physical activity among adults with arthritis and subsequent improvements in health outcomes, arthritis management, and reductions in healthcare services utilization and associated costs.

So What? Implications for Health Promotion Practitioners and Researchers

What is already known on this topic?

Physical activity is widely recognized as an effective way to manage symptoms, reduce limitations and restore physical function in adults with arthritis.[1-3] Despite the known benefits of physical activity, adults with arthritis are far less active than adults without arthritis, largely due to pain, fear of exacerbating symptoms and lack of knowledge about how to exercise safely.[10] Adults with arthritis need information about, and access to, affordable, effective, and convenient programs that can help them become physically active in a safe way.[1]

What does this article add?

This study determined that, in general, inactive adults with arthritis utilized more healthcare services than active adults with arthritis. Significant differences and patterns of association were revealed that suggest that active adults with arthritis may have been healthier or able to better manage their disease because active adults with arthritis used fewer healthcare services. Maintaining functional independence, preventing or limiting disability and remaining viable and in communities longer will become of increasing economic importance as the U.S. population ages and debilitating, aging-related chronic diseases such as arthritis increase in prevalence and influence on quality of life. Removing barriers and facilitating access to safe and effective forms of physical activity, such as the structured PA interventions recommended by CDC for adults with arthritis, may help increase initiation of new physical activity behaviors or maintenance of continued physical activity among adults with arthritis. Increasing physical activity can in turn, improve arthritis management and limit progression of the disease and arthritis-associated disability[1-3] allowing affected adults of all ages to maintain independence and remain actively engaged in valued work and life activities longer.

What are the implications for health promotion practice or research?

CDC recommends several evidence-based, community program that are effective for people with arthritis.[4] Unfortunately these programs are underutilized reaching few of those who can benefit from them.[1,11] Better linking adults with arthritis to evidence-based, arthritis-appropriate physical activity programs is merited and can be accomplished by partnering with healthcare providers, worksites, and community

organizations to reduce or offset the cost of the programs and offer them in settings and ways that are convenient, affordable, and responsive to the unique needs, barriers, and challenges facing adults with arthritis. In addition to the practice-based recommendations, more research is needed. In particular, research is needed to more fully assess and understand the relationship between physical activity and healthcare-related costs among adults with arthritis; and to identify specific policy implications that may be relevant for health promotion practice.

As society ages, new challenges will arise in helping older adults age in a way that helps them restore or maintain physical function and health, and remain independent and engaged in daily life and work-related activities as long as possible. Health promotion and public health practitioners, and clinical providers will increasingly be required to focus more on health related quality of life in addition to preventing mortality. Managing arthritis will be an important strategy for success in this endeavor.

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CHAPTER 8: MANUSCRIPT II

PHYSICAL ACTIVITY MAKES A DIFFERENCE: DIFFERENCES IN TOTAL HEALTHCARE EXPENDITURES BETWEEN ACTIVE AND SEDENTARY ADULTS WITH ARTHRITIS[2]

[2] E.L. Odom, T. Miles, J. Lee, B. Rasulnia, and P. Reeves. To be submitted to the *American Journal of Health Promotion*.

Abstract

Purpose

The present study sought to determine whether physical activity among adults with arthritis was associated with reduced healthcare expenditures.

Design

A retrospective case-control study was conducted using Medial Expenditure Panel Survey (MEPS) data (53.5% response rate) to assess the impact of physical activity on total healthcare expenditures among adults with arthritis.

Setting

The study setting was limited to 2010 MEPS data on U.S. adults with arthritis.

Subjects

Subjects included adults, 18 or older, with arthritis (n=5,600).

Measures

Physical activity was the primary independent variable of interest and total medical expenditures served as the dependent variable. Potential confounders such as age, race, gender, BMI, insurance, heart disease, high blood pressure, stroke, diabetes, and obesity were included in the model.

Analysis

Logistic regressions, via SAS 9.3, were used to predict savings in total healthcare expenditures based on physical activity status and compute odds ratios.

Results

Active adults with arthritis had significantly lower expenditures than inactive ones. Adjusted results showed physical activity was associated with cost-savings up to $3,000 compared to average (OR = 0.762, CI: 0.703, 0.825).

Conclusion

These findings suggest there may be simple ways to reduce healthcare expenses and improve quality of life through physical activity. Promoting arthritis-appropriate physical activity programs or systematizing incentives for participation in them could be a cost-effective strategy for improving health and reducing health-related costs among adults with arthritis.

Key Words: *arthritis, osteoarthritis, costs, expenditures, physical activity, interventions, medical, and healthcare*

Note: The following manuscript is proposed for submission to the *American Journal of Health Promotion* (2015) and conforms to the Journal's style guidelines for quantitative research manuscripts.

Title

Physical activity makes a difference: Differences in total healthcare expenditures between active and sedentary adults with arthritis

Outline

Abstract (220 words excluding subheadings)

Key Words

Indexing Key Words

Purpose

- Purpose overview
- Background

Methods

- Design
- Sample
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    1. Collinearity

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References

Tables

Indexing Key words

1. Manuscript format: research

2. Research purpose: relationship testing

3. Study design: non-experimental

4. Outcome measure: financial/economic

5. Setting: clinical/healthcare, national

6. Health focus: fitness/physical activity

7. Strategy: incentives, policy

8. Target population age: adults and senior adults

9. Target population circumstances (specify all that apply): geographic location limited to the U.S.

Purpose

Physical activity is widely recognized as an effective way to manage symptoms and limitations and restore physical function in adults with arthritis.[1] Yet adults with arthritis are far less active than adults without arthritis, despite the fact that several physical activity programs exist that have been proven to be safe and effective for this population.[2] Unlike the widespread financing and reimbursement available for diabetes management programs,[3] health insurance reimbursement and incentives are generally not offered for participation in evidence-based arthritis-appropriate programs. The present study, therefore, sought to determine whether physical activity among adults with arthritis might be associated with reduced healthcare expenditures. Specifically, the following research question was of interest; "Are total medical expenditures lower among

adults with arthritis who are physically active than adults with arthritis who are sedentary?" It was hypothesized that healthcare costs would be less for adults with arthritis who were physically active compared with those who were sedentary and that healthcare savings associated with physical activity might position evidence-based, arthritis-appropriate physical activity programs as candidates for financing or reimbursement. Data from the Medical Expenditure Panel Survey (MEPS), Consolidated Household File from 2010 were used for the analysis.[4]

Background

Physical activity is generally recommended by health promotion practitioners, public health professionals and clinical provides for adults with arthritis.[1,5,6] Yet adults with arthritis are far less active than adults without arthritis; and having chronic comorbidities in addition to arthritis can further complicate the ability to be active.[7-9] Physical activity has arthritis-specific, tertiary prevention benefits and can also help prevent the development of other chronic diseases such as heart disease, diabetes, and obesity that are leading causes and contributors to U.S. mortality.[1,5,6] Physical activity can help adults with arthritis restore function, maintain independence, better manage arthritis-attributable pain and limitations and limit or delay arthritis progression.[1,5,6] However, opportunities and need exists for healthcare providers to monitor activity levels and counsel patients with arthritis about the importance of physical activity and adopting health enhancing behaviors.[10] Further, adults with arthritis need choices and access to a variety of safe, and evidence-based forms of physical activity that are appropriate for adults with arthritis.[2] Establishing evidence for cost-saving benefits of physical activity

among adults with arthritis may help position the proven physical activity programs that CDC recommends for adults with arthritis as programs that should be more actively promoted, financed and widely available to increase physical activity among adults with arthritis. Maintaining independence and remaining viable and in communities longer will become of increasing economic importance as the U.S. population ages and debilitating, aging-associated chronic diseases such as arthritis increase in prevalence and influence on quality of life.

Methods

Design

A retrospective case-control study was conducted using secondary data from MEPS for the year 2010 to assess the impact of physical activity on total healthcare expenditures among adults with arthritis.[4] Cases included adults with arthritis who reported being physically active for one-half hour or more at least three times a week during 2010. Inactive adults with arthritis served as controls. Potential confounders that might affect the relationship between arthritis, physical activity, and medical expenditures were included as covariates. The full logistic regression model (Figure 1) assessed the impact of physical activity on total medical expenditures while controlling both for potential confounders independently, as well as for potential interactions between physical activity and each of these variables.

Sample

The study sample, n=5,600, was drawn entirely from the publicly available, household component files of the MEPS[4] 2010 dataset and included only adults, aged 18 and older, reporting a diagnosis of either osteoarthritis or rheumatoid arthritis. MEPS[4] is a national representative survey that utilizes participants drawn from the National Health Interview Survey.[4] The Survey is recognized as the most complete source of U.S. healthcare cost and service utilization data and achieved a 53.5 percent overall response rate for the full-year consolidated household file for 2010.[4] Because the public health guidance regarding physical activity recommendations does not differ for patients based on diagnosis of osteoarthritis or rheumatoid arthritis, adults with both types of arthritis were included as part of the study sample. A proposal was submitted describing the sample and activities related to this research to the University of Georgia (UGA) Institutional Review Board for human subjects review and determination. The study was assigned a determination of "not human research" upon completion of the review.

Measures

Physical activity status was identified as the primary independent variable of interest. Potential confounders that might affect the relationship between arthritis, physical activity, and medical expenditures, such as age, race, gender, body mass index (BMI), insurance coverage, and common arthritis comorbidities such as heart disease, high blood pressure, stroke, diabetes, and obesity were also included in the model as covariates.

Collinearity

A previous, unconnected study of the effects of physical activity and high blood pressure (HBP) on medical and pharmaceutical expenditures using 2002 MEPS data included the same covariates proposed for inclusion in this study as well as others pertinent to hypertension.[11] These researchers determined that collinearity was not a problem for any of the covariates[11] suggesting that collinearity would not be a problem for the current study. A subsequent diagnostic check for collinearity was performed in SAS. The results of the diagnostic check also confirmed that collinearity was not present.

Analysis

SAS version 9.3[12] was used to analyze data from the full-year consolidated data file for 2010.[4] The "proc logistic" procedure was used to predict savings in total healthcare expenditures among adults with arthritis by physical activity status. The full logistic regression model, shown in Figure 1, assessed the impact of physical activity on total medical expenditures while controlling both for these potential confounders independently, as well as for potential interactions between physical activity and each of these variables. Backwards stepwise elimination was used to construct the final, reduced model by eliminating insignificant results at each step to gradually improve and obtain the final reduced model. A decision was made at the outset to retain physical activity, the main predictor (independent variable) of interest, in the model at each step, regardless of significance. Decisions about whether to stratify by certain covariates or present adjusted findings were based on interaction significance results. The final reduced model only included significant variables and interaction terms. Covariates and interaction terms that

were not a significant predictor of healthcare expenditures were eliminated. Odds ratios were also calculated using SAS.[12]

"Savings", for the purposes of this study, was defined as total medical expenditures that were less than or equal to $1,000 (or $3,000 in the second level analysis) below average expenditures for the study population. Respectively, total expenditures above each of these amounts were described as "no savings" or "close to average or higher total medical expenditures". Average total medical expenditures were calculated for adults with arthritis in the 2010 MEPS[4] dataset and used as the basis for the total medical expenditures recoding decisions. Descriptive characteristics yielded from a related analysis assessing healthcare services utilization among adults with arthritis using MEPS[4] 2010 data were used to provide greater context about the characteristics of active and inactive adults with arthritis for the current study.

Regression Models

The full logistic model was assessed at multiple levels of potential savings. The average total, annual medical expenditures for adults with arthritis from the 2010 MEPS[4] dataset were calculated at $8,382. Thresholds for four different levels of potential savings were identified based on this average and logistic regressions were run in cycles accordingly. The first cycle identified factors predicting total annual medical expenditures that were at least $1,000 below average total expenditures for adults with arthritis (i.e., total medical expenditures less than or equal to $7,382). The second cycle identified factors predicting annual medical expenditures that were at least $3,000 below

average (i.e., total medical expenditures less than or equal to $5,382). These same tests were repeated in subsequent cycles at savings of $4,000 and $5,000.

Results

Descriptive Characteristics

Approximately seventeen percent (17.1%) (n=5,600) of the study population reported having arthritis compared to 54.87 percent (n=18,022) reporting no arthritis. Results were either inapplicable (n=9,157), not ascertained or respondents refused to answer or answered 'don't know' for the remaining proportion of the total study population (N=32,846). Thirty-seven percent (36.59%) of adults with arthritis were male and 63 percent (63.41%) were female. Among adults with arthritis, the average age was 59.4 years old. Thirty-eight percent (38.34%) were age 65 or older and 61.66 percent were of working age. Twenty percent (20.32%) of adults with arthritis were current smokers. Seventy-two percent (71.54%) of adults with arthritis were overweight, whereas 28 percent were normal or underweight. Further, among adults with arthritis, 21.02 percent had diabetes, 10.07 percent had a history of stroke or transient ischemic attack, 62.36 percent had been diagnosed with high blood pressure, and fourteen percent (13.90%) had been diagnosed with coronary heart disease. Regarding chronic respiratory conditions, fifteen percent (15.25%) of adults with arthritis had asthma. Approximately six percent of adults with arthritis had chronic bronchitis and approximately 6% of adults with arthritis had emphysema. Forty-eight percent (47.53 %) of adults with arthritis were physically active whereas 52.47 percent were not. The average total healthcare expenditures for adults with arthritis was $8,382. Ninety percent of adults with arthritis

were insured; ten percent were not. Table 4 describes the characteristics of adults with arthritis in greater detail.

Table 6 describes characteristics of adults with arthritis by physical activity status. Of the 5,600 adults with arthritis included in the dataset, physical activity status was reported for 5,441. Among the 5,441 for which physical activity data was reported, 2,855 were inactive as defined by engaging in at least moderate activity three or more times per week. Conversely, 2,586 adults with arthritis reported being routinely physically active. The average age for *active* adults with arthritis was 58 years and the total medical expenditure for this group was $6,538.22. Whereas the average age for *inactive* adults with arthritis was 62 (61.79) years and the average total medical expenditure for inactive adults with arthritis was $9,710.25.

Crude and Adjusted Analysis Summary Results

Adults with arthritis who were moderately active at least three times per week had significantly lower total medical expenditures than inactive adults with arthritis. Further, being physically active was significantly associated with below average medical expenditures. Being physically active was associated with savings in medical expenditures that were as much as $3,000 below average for adults with arthritis. However, being physical active was not associated with savings of $4,000 or more.

Physical Activity Predicts $1,000 or More in Savings

Analysis of the crude relationship between physical activity and total medical expenditures, showed that adults with arthritis who were physically active were

significantly likely to have at least $1,000 in savings below average annual medical costs for adults with arthritis (OR = .537, X^2= 251.2842, p<.0001). Consistent with the results of the crude analysis, even after potential confounders were introduced into the model, physical activity remained a significant predictor of medical cost-savings among adults with arthritis. After controlling for the effects of insurance status, age, race, sex, diabetes, stroke, high blood pressure, heart disease, asthma, chronic bronchitis, and emphysema, physical activity remained a significant predictor of savings among adults with arthritis. Specifically, after insignificant covariates were removed through backwards elimination and the model was reduced, the adjusted results showed that physical activity was still significantly associated with a cost-savings of at least $1,000 compared to average medical expenditures for adults with arthritis (OR = .716, CI: 0.716, 0.656 and X^2=54.8890, p<.0001). Tables 10 and 11 summarize the results of the regression analysis predicting $1,000 or more in savings.

Physical Activity Predicts $3,000 or More in Savings

Analysis of the crude relationship between physical activity and total medical expenditures showed that adults with arthritis who were physically active were also significantly likely to have at least $3,000 in savings compared to average medical expenditures for adults with arthritis (OR = 0.582, CI: 0.544, 0.623; X^2= 241.4186, p<.0001). Consistent with the results of the crude analysis, even after potential confounders were introduced into the model, physical activity remained a predictor of significant medical cost-savings ($3,000 or more) among adults with arthritis. The adjusted results, which controlled for the effects of insurance status, age, race, sex,

diabetes, stroke, high blood pressure, heart disease, asthma, chronic bronchitis, and emphysema, showed that physical activity remained a significant predictor of cost-savings of at least $3,000 below average medical expenditures for adults with arthritis (OR = 0.762, CI: 0.703, 0.825; p<.0001). Specifically, the odds of having at least $3,000 in savings was nearly 25 percent greater for active adults with arthritis than inactive adults with arthritis. Tables 12 and 13 summarize the results for predicting $3,000 or more in savings. No savings were observed at either the $5,000 or $4,000 levels.

Discussion

Summary

Physical activity was a significant predictor of total healthcare expenditures among adults with arthritis in the crude, full, and both reduced models. Being male, uninsured, younger or not having chronic disease also predicted savings, The odds of savings $1000 or more was 28% greater for active adults with arthritis compared to inactive ones, after adjusting for confounders; and the odds of savings $3000 or more was 24% greater for active adults with arthritis compared to inactive ones, after adjusting for confounders. The economic value of physical activity for adults with arthritis seems clear and is consistent with the hypothesis proposed at the outset of the study– adults with arthritis who were routinely active had lower medical costs on average and experienced cost-savings up to $3,000 or more. Savings associated with physical activity for adults with arthritis did not persist, however, at levels of $4,000 or higher.

Interactions

Significant interactions were observed between physical activity and heart disease at both the $1,000 or more and $3,000 or more levels of savings. Whereas a significant interaction was observed at only the higher level of savings between physical activity and gender. The interaction between physical activity and heart disease was unsurprising. Being physically active did not result in any cost-savings if a person with arthritis also had heart disease. Heart disease is among the most costly chronic diseases in the U.S. Some estimates place the collective cost of heart disease at nearly $300 billion annually.[13] More than 80 million Americans suffer from some form of heart disease and the individual costs of heart disease can be quite high for those who suffer from more severe or advanced forms of the disease.[13] It is likely that the observed interaction reflects the synergistic relationship between heart disease and higher-than-average medical costs, a relationship that is far less likely for someone with arthritis and no heart disease. Further, the literature shows that heart disease is also a leading cause of disability and adults with heart disease and arthritis are less active than adults with arthritis alone.[9] Each of these factors combined, are likely responsible for the observed interaction between physical activity and heart disease related to medical expenditures among adults with arthritis. The literature also documents that arthritis is a barrier for physical activity among adults with arthritis and diabetes,[8] another disease that is a high medical cost driver, so it was somewhat surprising to see that a similar interaction was not observed between physical activity and diabetes within the study population.

Possible reasons for the relationship between physical activity and gender among adults with arthritis are less clear but may have to do with the fact that there were far

fewer men (37%; n=2,049) in the study population then women (64%; n= 3,551) and because men (53%) were more likely to be physically active than women (45%) and may have had lower costs overall. It is also possible that men had a different mix of comorbidities that influenced their costs and likelihood to be active compared to women with arthritis in the MEPS[4] 2010 study population.

Other Findings

After adjusting for possible confounders, the absence of chronic diseases such as heart disease, high blood pressure, diabetes, asthma, emphysema, stroke or chronic bronchitis predicted savings in expenditures. This finding is consistent with prevailing wisdom and theory that the absence of major chronic disease reflects a healthier state of being and would therefore be associated with lower medical expenditures.

Although the results related to the absence of disease in predicting lower medical expenditures were expected, another result was not. It was unexpected to find that being Black did *not* predict *higher* medical expenditures but instead predicted savings up to $3,000 in annual medical expenditures. This finding was surprising because the literature indicates that, although arthritis affects the same or greater numbers of Blacks as Whites, Blacks suffer more severely from the disease.[14] The literature also identifies arthritis as one of the top 3 chronic conditions affecting Blacks and the leading cause of activity limitations in this group.[15] Studies have looked at physiological evidence and shown radiographic evidence of increased arthritis in Blacks compared to Whites, notably with older Blacks (who reported similar pain) showing more severe x-ray evidence of arthritis and performing more poorly on activity tasks than Whites.[14,16] Studies have also shown

marginally significant findings indicating that low SES Black women with arthritis tend to have more pain and functional impairment than Whites.[14] Risk factors and prevalence data clearly emphasize the disproportionate burden of arthritis on Black and because of this, the initial expectation was that Blacks would have higher medical costs and be less likely to be active or show savings.

However, a closer look at the literature revealed disparities in care and access to treatment among Blacks, not just generally, but also specific to care for arthritis, which may in turn have contributed to the results observed in the present study. According to the literature, although Blacks with arthritis experience more severe pain and disability related to arthritis[17-19] they also experience delayed treatment, and are less likely to have joint replacement surgery[20,21] than Whites.[14] Even with presumed equal access to care in terms of having some type of health insurance, data show that Blacks still have lower rates of knee replacement surgery than Whites[14,22] indicating that factors other than insurance are also in play in reducing access to care. There is also evidence that Blacks experience delayed onset of receiving arthritis medications such as anti-inflammatory treatments or pain prescriptions.[14,23] Further, Blacks experience reduced access to specialists for arthritis despite the severity of their symptoms. At least one study demonstrated that Blacks were more likely to end up at clinics and emergency rooms for arthritis care whereas Whites were more likely to be seen by an orthopedic surgeon for arthritis pain.[14,22] Literature on healthcare in general shows that financial strain, poorer quality health facilities in minority communities, discrimination, and lack of insurance all impact care and access to services.[14,24-26]

Given that MEPS[4] derives the 'total medical expenditures' variable (TOTEXP10) from the sum of all payments for medical services from all sources ranging from self (out-of-pocket) to public and private insurers and other sources such as workers' compensation, it is far less surprising that being Black and having arthritis, was associated with significant medical cost-savings after adjusting for the effects of older age, sex, un-insurance, and other chronic diseases (i.e., heart disease, high blood pressure, diabetes, asthma, emphysema, stroke and chronic bronchitis). The savings that were achieved for this group most likely reflect reduced costs overall due to the disparities in healthcare services and treatments for Blacks.

The literature shows that 22.7 million adults with arthritis experience arthritis-attributable activity limitations.[27] These limitations may range from difficulties in the ability to perform activities that affect daily living (e.g., grasping small objects, combing hair, bathing, etc.) to those that are less severe but still diminish functioning and independence (e.g., pushing heavy items, walking a quarter of a mile, etc.).[27] It is conceivable that adults with arthritis with lower physical functioning status experienced fewer or greater benefits of routine physical activity and that a measure for this should be included in any future model assessing these relationships, including or independent of physical activity status. It is suspected, however, that functional status in adults with arthritis may be highly correlated with physical activity status. Despite this it would be useful to learn the impact of a variety of specific forms of functional limitations among adults with arthritis on medical expenditures and prescription costs and usage.

Future studies might also examine the role of multiple comorbidities in influencing physical activity status. The current study determined that adults with arthritis

and at least one other comorbidity (heart disease, diabetes, stroke, asthma, chronic bronchitis, or emphysema) were nearly twice as likely to be inactive (Table 6). After controlling for comorbidities, however, physical activity remained significantly associated with medical expenditure savings. However, having greater knowledge about the role of multiple comorbidities in influencing physical activity may be useful for clinicians and others in making physical activity recommendations that might be more specific and meet the unique needs of adults with multiple random or distinct mixes of comorbidities. Future studies might examine the role of multiple comorbidities beyond two, on physical activity and cost outcomes among adults with arthritis. There may be other factors as well that could not be accounted for or where not explored within the scope of the current study that are important to consider.

Limitations

It is acknowledged that this study does not address the unique needs of subpopulations of older adults with arthritis who may be sicker and affected by multiple, co-occurring chronic conditions and who may therefore be physically unable to exercise or for whom physical activity may be prohibitive or even harmful. It does however address the recommendations and needs of the majority of adults with arthritis and is consistent with the national public health guidelines for physical activity among people with arthritis which recommends a minimum of 150 minutes of moderate to vigorous physical activity per week for adults with arthritis.[5]

Several measures are included within the MEPS[4] 2010 Household Component data set assessing functional limitations ranging from work, housework, and social

participation limitations to more specific physical limitations such as inability to reach overhead, lift ten pounds, walk a mile, stand for 20 minutes, walk three blocks, climb ten steps, or reach overhead, etc. However, these limitations are not necessarily specific to arthritis and, taken independently, it is not possible to determine the specific health condition or disease attributed as the reason for a given limitation. Given that 47 percent of adults with arthritis have at least one other comorbid condition,[28] it is possible that common comorbidities, such as heart disease, stroke, diabetes heart disease, or high blood pressure or even age may be partly or even fully responsible in some cases for activity related functional limitations faced by adults with arthritis. It is possible to compute correlations and frequency distributions to characterize how joint pain and specific limitations affect adults with arthritis within the MEPS[4] dataset. It is also possible to assess the impact of these factors in predicting physical activity behaviors or medical expenditures among adults with arthritis. It is suspected that physical activity status mirrored functional limitations to some extent among this population of adults with arthritis and as such it was not necessary to expand the model any larger to include functional limitations because the impact of these limitations would be borne out in the inactive population and the population with the greatest number of comorbidities (who are also likely to have the greatest limitations). Full exploration of this topic area was deemed to be beyond the scope of this paper but is recommended as an important area of future study.

Other Potential Study Limitations

A limitation of this work is that it did not address mortality, due to all or any causes, that may have occurred in 2010. Adults with arthritis in their last year of life are likely to have had higher expenditures and be less active than those who survived the entire year and could have therefore overestimated the impact of physical activity on total medical expenditures for the year. However, given that this study examined adults of all ages with arthritis on medical expenditures and given the fact that older age did not have any significant influence on the relationship between physical activity and arthritis, this suggests that the proportion of older adults or non-survivors was either too small to have a significant impact on the results or perhaps that the impact of mortality was otherwise insignificant. The present study may also be limited by the fact that the total healthcare expenditure variable examined represents pooled costs from within the MEPS[4] dataset, and can therefore include costs associated with multiple chronic and other conditions. Future studies might break out cost contributors within MEPS[4] (e.g., include and examine variables that represent estimates of prescription and other costs) to better elucidate the different cost drivers that yield total medical costs for adults with arthritis. Exploration of how the cost drivers differ by age among adults with arthritis may also yield useful results that might be important in future public health policy.

A final potential limitation is that the present study, which used 2010 data exclusively, did not account for any potential historical artifacts that may have occurred that one year. Essentially, this study makes the assumption that 2010 data adequately represent a typical year without any unique events or circumstances that may have biased the results or limited its generalizability. It is important to note that the U.S. economy and

job market were in the midst of a recession in 2010 which likely impacted access to healthcare and health insurance in ways that are less typical during a healthy and robust economy.[29] The impact of job loss and loss of employer subsidized insurance likely resulted in increased numbers of working aged patients being seen for free by healthcare providers. Further the signing of the Patient Protection and Affordable Care Act (ACA) into law, on March 23, 2010[30] signified a unique turning point in politics and healthcare that may have impacted the healthcare market and insurance access that year in ways that were then and are now atypical and that may have inadvertently influenced healthcare costs and outcomes without influencing individual physical activity behaviors. However, because of the newness of the ACA and the extended timeline that was in place for full adoption it is less likely that the introduction of the ACA had much impact on the study and results which utilized 2010 data. The present study aimed to uncover and adjust for the influence of some of these factors by including age and insurance coverage (of all types, both public, including Medicare, and private) in the regression model as covariates that might influence costs. Future studies should incorporate a trend analysis to determine whether any observed differences in costs or health services utilization persist across time.

Significance

A review of the literature confirms the significant burden, in terms of both cost and prevalence, of arthritis. The present analysis confirms the high rate of physical inactivity among adults with arthritis and that physical activity is a significant, predictor of total healthcare expenditures. The burdensome and costly implications of inactivity among

adults with arthritis is of great concern and worthy of action, not only because arthritis affects more than 52.5 million people in the U.S.,[31] but because people with arthritis commonly have other serious co-occurring conditions (i.e., heart disease, diabetes, or high blood pressure) that are costly and require physical activity for proper management.[7] A gap exists in the literature related to the fiscal costs of inactivity among adults with arthritis, particularly with regard to current, national population-based data. It is the author's hope that this study has helped uncover additional information about the scope and nature of the relationship between inactivity, arthritis, and healthcare expenditures and raised important questions worthy of future scientific inquiry.

So What? Implications for Health Promotion Practitioners and Researchers

What is Already Known on This Topic?

The benefits of physical activity are well documented in the literature and extend far beyond those that are specific to arthritis. It is important to recognize that physical activity has proven health and quality of life-related benefits for adults with arthritis as well as for those with multiple chronic conditions.[1] For these reasons it is important to continue to promote physical activity among adults with arthritis and continue research into cost-savings that may be associated with it. Because people with arthritis are faced with unique challenges (pain, fear, lack of function)[32] that make it difficult for them to become and maintain a physically active lifestyle, evidence-based physical activity interventions that are appropriate for adults with arthritis and that have arthritis-specific health outcomes (i.e., improved physical function, etc.) are particularly critical for increasing physical activity safely in this population. Programs such as those that are

evidence-based and recommended by the CDC for adults with arthritis[2] can play an important role in helping adults with arthritis become physically active on a continuing basis.

Programs exist, such as EnhanceFitness®, which are arthritis appropriate, are ongoing in recurrence, and have promising health and cost-savings evidence associated with participation in them.[33] More support is needed to increase participation in these community based programs. Reimbursement is one way to achieve increases in program referrals and participation, increase availability of programs, sustain these community offerings, and increase physical activity among adults with arthritis.

What Does This Article Add?

This study was undertaken primarily for the purpose of determining whether there was a way to create an evidence-base illustrating cost-savings associated with physical activity among adults with arthritis in order to bolster support for reimbursement (or other financing or policy) of evidence-based physical activity interventions recommended by CDC for adults with arthritis.[2] Adults with arthritis have unique physical and mental barriers to being physically active,[32] but stand to gain significant health and arthritis-symptom management benefits by engaging in routine physical activity.[1,5,6] As such, adults with arthritis can benefit and may increase physical activity levels by having greater access to safe, affordable forms of physical activity. The CDC recommend programs, if disseminated more widely and sustained, can help met these needs and close this gap. Reimbursement can propel increased dissemination of the CDC-recommended

programs, increase access, and increase the likelihood that adults with arthritis become more aware of and likely to participate in them.

What are the Implications for Health Promotion Practice or Research?

Findings from this study provide evidence lending support for systematized financing of arthritis-appropriate physical activity interventions. The findings can also be used to guide future policy decisions about cost-efficient ways to reduce healthcare expenses and improve health and quality of life through physical activity. The findings, which determined that engaging in moderate physical activity three or more times per week predicted medical cost-savings up to and beyond $3,000 among adults with arthritis, suggest that encouraging, promoting, and putting incentives or reimbursements into place for arthritis-appropriate physical activity programs could be a cost-effective strategy for improving health and reducing health-related costs in this group.

The findings from this study also suggest that reimbursement of these programs, which are low-cost community-based offerings, could be easily offset with the cost-savings that is likely to result in total medical expenditures from participation in them. In addition to supports needed to increase the availability and participation in these programs, more support is needed for researchers to identify more evidence-based physical activity programs and broaden the menu of choices and program availability for adults with arthritis. Future studies might also look at different forms of unstructured physical activity to determine whether there are specific cost-savings benefits associated with any specific forms of activity for adults with arthritis (e.g., swimming, walking, etc.).

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APPENDIX A: UGA IRB DETERMINATION

A proposal was submitted describing activities related to this dissertation research to the University of Georgia (UGA) Institutional Review Board for human subjects review and determination. The UGA Human Subjects Office reviewed the submission and assigned a determination of "not human research" to the proposal in August 2015. A copy of the notification is included herein.

Notification of Not Human Research Determination

To:	Erica Odom
Link:	STUDY00002431
P.I.:	Joel Lee
Primary Contact/Student Investigator:	Joel Lee
Title:	The Cost of Inactivity among Adults with Arthritis
Description:	The Human Subjects Office has reviewed this submission and assigned a determination of Not Human Research. For additional details, click on the link above to access the project workspace. The determination letter can be found in the History under "Letter Sent".

APPENDIX B: MEPS VARIABLES AND CODING SCHEMA

Table 1: Description of Variable Names and Coding Scheme Addressing Research Question I, Based on MEPS 2010 Consolidated Household File

MEPS Coding Scheme	Variable Title	MEPS Variable Name	MEPS Variable Definition	MEPS Source
Categorical: Not ascertained = -9 N/A= -1 Yes = 1 No = 2	Appointments for office or clinic care	**ADRTCR42**	Any appointment was made with a doctor or clinic for healthcare	These variables refer to events experienced in the last 12 months and were asked of adults age >=18 as part of the self-administered Consumer Assessment of Healthcare Providers and Systems.
Categorical and Numerical: Not ascertained = -9 DK= -8 N/A= -1 0 = 0 1 = 1 2 = 2 3 = 3 4 = 4 5 = 5 to 9 6 = 10 or more	Visits for care to an office or clinic	**ADAPPT42**	Number of times went to doctor's office or clinic to get care	
Categorical: Not ascertained = -9 DK= -8 N/A= -1 Yes = 1 No = 2	Frequency of need for care, tests, or treatment	**ADNDCR42** (only included if ADAPPT42 > 0)	Whether you or a doctor believed you needed any care, tests, or treatment	
Categorical: Not ascertained = -9 N/A= -1	Frequency of need to see a specialist	**ADSPEC42**	Needed to see a specialist	

Yes = 1 No = 2				
Categorical and Numerical: Not ascertained = -9 DK= -8 Refused = -7 N/A= -1 1 = w/in past year 2 = w/in past 2 years 3 = w/in past 3 years 4 = w/in past 5 years 5 = more than 5 years 6 = never	Length of time elapsed since last routine health check-up (assessing overall health)	**CHECK53**	How long since last routine check-up by doctor or other health professional for assessing overall health Age >17; both genders	This variable is based on provider data.

Table 2: Description of Study Variables and Recoding Decisions Associated With Research Question II				
Variable Name	**Variable Type**	**Description**	**Proposed Categorization**	**Original Format**
ARTHDX	Used to stratify and select sub-sample of interest	**S**tatus of arthritis diagnosis ARTHDX asked if the person (age 18 or older) had ever been diagnosed with arthritis. Persons aged 17 or younger were coded as "Inapplicable" (-1).	Binary: Arthritis = 1 No arthritis = 0	Categorical: Not ascertained = -9 DK= -8 Refused =-7 N/A = -1 Yes = 1 No = 2
TOTEXP10	Outcome/ Dependent Variable	Total healthcare expenditures Average total expenditures for adults with arthritis within the dataset were $8,382, therefore: Saving were code as “0” No savings was coded as “1” Level 1: Savings of $1,000 or more: if totexp10 <= '7382' then totexp10 = '0'; if totexp10 > '7382' then totexp10 = '1'; Level 2: Savings of $3,000 or more:	Binary, based on the average expenditures of people with arthritis (calculated from this data set as $8,382). Lower than average costs = 0 Average or higher than average costs = 1	Continuous: in U.S. dollars

		if totexp10 <= '5382' then totexp10 = '0'; if totexp10 > '5382' then totexp10 = '1';		
PHYACT53	Main Predictor/ Independent Variable	Physical activity status (Yes= currently spends half hour or more in moderate to vigorous physical activity at least three times a week)	Binary: Active = 1 Inactive = 0	Categorical: N/A = -9 DK= -8 Refused =-7 Inapplicable = -1 Yes = 1 No = 2
INSCOV10	Potential Confounder	Health insurance coverage status in 2010	Binary: Insured = 1 Uninsured = 0	Categorical: Any private [including TRICARE/CHAMPVA] any time during 2010 = 1 Public only during 2010 = 2 Uninsured all of 2010 = 3
SEX	Potential Confounder/ Descriptive	Gender	Binary: Male =1 Female = 0	Binary: Male = 1 Female =2
RACEX	Potential Confounder	Race/ethnicity	Binary; White = 1 Black = 0 All others excluded	Categorical: White N/O= 1 Black N/O = 2 AI/AN N/O= 3 Asian N/O = 4 N Hawaiian/ PI NO= 5 Multi-racial = 6
AGE10	Potential Confounder	Age as of 12/31/10	Binary: <65 = 0 >=65 = 1	Continuous
CHDDX	Potential Confounder	Ever diagnosed with coronary heart disease (ages >/= 18)	Binary: No condition = 0 Condition = 1	Categorical: Not ascertained =-9 DK= -8 Refused =-7

				N/A = -1 Yes = 1 No = 2
HIBPDX	Potential Confounder	Ever diagnosed with high blood pressure (ages >/= 18)	Binary: No condition = 0 Condition = 1	Categorical: Not ascertained =-9 DK= -8 Refused =-7 N/A = -1 Yes = 1 No = 2
STRKDX	Potential Confounder	Ever diagnosed as having had a stroke or transient ischemic attack (TIA or mini-stroke).	Binary: No condition = 0 Condition = 1	Categorical: Not ascertained =-9 DK= -8 Refused =-7 N/A = -1 Yes = 1 No = 2
DIABDX	Potential Confounder	Ever diagnosed with diabetes (ages >/= 18)	Binary: No condition = 0 Condition = 1	Categorical: Not ascertained =-9 DK= -8 Refused =-7 N/A = -1 Yes = 1 No = 2
BMINDX53	Potential Confounder	BMI </= 24.9 = normal or underweight BMI >/= 25.0 = overweight or obese BMINDX53 – Adult Body Mass Index (BMI) as based on reported height and weight Age > 17; both genders; "Inapplicable" (-1) was assigned if the person was deceased or if the person did not	Binary: Normal or underweight = 0 Overweight or obese = 1	Categorical and continuous: Not ascertained =-9 N/A = -1 8.9 - 97.6 BODY MASS INDEX

		belong to the applicable subgroups.		
ASTHDX	Potential Confounder	Ever diagnosed with asthma	Binary: No condition = 0 Condition = 1	Categorical: Not ascertained = -9 DK= -8 Refused =-7 N/A = -1 Yes = 1 No = 2
ADSMOK42	Potential Confounder	Currently smoke	Binary: Non-smoker = 0 smoker = 1	Categorical: Not ascertained = -9 N/A = -1 Yes = 1 No = 2
CHBRON31 and CHBRON53	Potential Confounder	CHBRON31 and CHBRON53 asked if the person (aged 18 or older) has had chronic bronchitis in the last 12 months. Note: emphysema, chronic bronchitis, and chronic obstructive bronchitis and combinations thereof include conditions that comprise COPD (Miller et al.., 2005) and, along with asthma, will be used as proxies for common respiratory comorbidities	Binary: No condition = 0 Condition = 1	Categorical: Not ascertained = -9 DK= -8 Refused =-7 N/A = -1 Yes = 1 No = 2

		among adults with arthritis.		
EMPHDX		Ever been diagnosed with emphysema (ages >/= 18)	Binary: No condition = 0 Condition = 1	Categorical: Not ascertained = -9 DK= -8 Refused =-7 N/A = -1 Yes = 1 No = 2

APPENDIX C: REGRESSION MODEL TABLES

Table 8. Summary of Backwards Elimination to Yield the Reduced Model Predicting Medical Cost-savings of at Least $1,000 Among Active Adults With Arthritis.

Step	Removed Covariate or Interaction Term*	df	Wald Chi-Square	p-value
1	Asthma * PA	1	.0001	.9915
2	Race * PA	1	.0935	.7598
3	BMI * PA	1	.4317	.5112
4	BMI	1	.6219	.4304
5	Emphysema * PA	1	.8030	.3702
6	Insurance * PA	1	1.1130	.2914
7	Stroke * PA	1	1.4966	.2212
8	Diabetes * PA	1	2.0718	.1500
9	Age * PA	1	2.0669	.1505
10	Chronic Bronchitis 1 * PA	1	2.0783	.1494
11	Chronic Bronchitis 2 * PA	1	1.8191	.1774
12	Gender * PA	1	2.2512	.1335
13	Smoking * PA	1	3.2907	.0697
14	Smoking	1	2.0402	.1532
15	High Blood Pressure * PA	1	3.2690	.0706

*Interaction is denoted with an asterisk (*) and physical activity is abbreviated as PA

Table 9. Summary of Backwards Elimination to Yield the Reduced Model Predicting Medical Cost-savings of at Least $3,000 Among Active Adults With Arthritis.

Step	Removed Covariate or Interaction Term*	df	Wald Chi-Square	p-value
1	BMI* PA	1	.0102	.9194
2	Asthma * PA	1	.0226	.8805
3	Diabetes * PA	1	.1520	.6966
4	Emphysema * PA	1	.1600	.6892
5	Race * PA	1	.5568	.4556
6	Stroke * PA	1	.7770	.3780
7	Smoking * PA	1	1.3636	.2429
8	Chronic Bronchitis 2 * PA	1	1.5564	.2122
9	Chronic Bronchitis 1 * PA	1	1.8698	.1715
10	BMI	1	2.0040	.1569
11	Smoking	1	3.3913	.0655
12	Insurance * PA	1	3.2651	.0708
13	Age * PA	1	2.8322	.0924
14	High Blood Pressure * PA	1	2.3988	.1214

*Interaction is denoted with an asterisk (*) and physical activity is abbreviated as PA

APPENDIX D: RESULTS TABLES

Table 3. Characteristics of Individuals *Without* Arthritis (n=27,246), 2010 MEPS Consolidated Household Dataset.

Characteristics	ALL
Age	
<65 (%)	92%
>/= 65 (%)	8%
Average (years)	40
Race	
White	79%
Black	21%
Sex	
Male	50%
Female	50%
Insurance Status	
Insured	75%
Uninsured	25%
Health Behaviors	
Physically Active	60%
Physically Inactive	40%
Overweight or Obese	60%
Smoker	18%
Comorbidities	
Heart disease	3%
Diabetes	6%
High blood pressure	23%
Stroke	2%
Asthma	7%
Chronic bronchitis*	1%
Emphysema	1%
Costs	
Average ($)	2,825

*Based on the average of two chronic bronchitis variables (CHBRON31 and CHBRON53), measuring chronic bronchitis diagnosis in different panel periods during 2010.

Table 4. Characteristics of Adults With Arthritis (n=5,600), Based on the 2010 MEPS Consolidated Household Dataset.

Characteristics	All Adults with Arthritis (n=5,600)
Age	
Average (years)	59.4
<65 (%)	62%
>/= 65 (%)	38%
Race	
White	77%
Black	23%
Sex	
Male	37%
Female	63%
Insurance Status	
Insured	90%
Not Insured	10%
Health Behaviors	
Physically Active	48%
Physically Inactive	52%
Overweight or Obese	72%
Smoker	20%
Comorbidities	
Heart disease	14%
Diabetes	21%
High blood pressure	62%
Stroke	10%
Asthma	15%
Chronic bronchitis*	6%
Emphysema	6%
Costs	
Average ($) for Arthritis	$8,382

*Based on the average of two chronic bronchitis variables (CHBRON31 and CHBRON53), measuring chronic bronchitis diagnosis in different panel periods during 2010.

Table 5. Characteristics of Adults With Arthritis (n=5,600) With at Least Two Other Comorbidities, Based on the 2010 MEPS Consolidated Household Dataset.

Characteristics	All Adults with Arthritis (n=5,600)
Multiple Comorbidities	
Heart disease & High blood pressure	12% (n=669)
Heart disease & Stroke	4% (n=199)
Heart disease & Asthma	2% (n=136)
Heart disease & Chronic bronchitis*	2% (n=85)
Heart disease & Emphysema	2% (n=118)
Heart disease & Diabetes	5% (n=297)
Diabetes & High blood pressure	18% (n=989)
Diabetes & Stroke	4% (n=213)
Diabetes & Asthma	4% (n=223)
Diabetes & Chronic bronchitis*	2% (n=93)
Diabetes & Emphysema	2% (n=100)

*Based on the average of two chronic bronchitis variables (CHBRON31 and CHBRON53), measuring chronic bronchitis diagnosis in different panel periods during 2010.

Table 6: Characteristics of Adults With Arthritis (n=5,600) by Physical Activity Status, Based on the 2010 MEPS Consolidated Household Dataset

Characteristics	Active	Inactive
Age		
Average (years)	58	62
<65 (%)	51.00	49.00
>/= 65 (%)	41.97	58.03
Race (%)		
White	48.49	51.51
Black	41.93	58.07
Sex (%)		
Male	52.73	47.27
Female	44.56	55.44
Insurance Status (%)		
Insured	46.97	53.03
Health Behaviors (%)		
Overweight or Obese	45.60	54.40
Smoker	46.59	53.41
Comorbidities (%)		
Heart disease	32.74	67.26
Diabetes	36.41	63.59
High blood pressure	42.34	57.66
Stroke	32.58	67.42
Asthma	41.68	58.32
Chronic bronchitis*	36.45	63.55
Emphysema	33.13	66.87
Costs		
Average ($) for Arthritis	$6,538	$9,710
< $8,382 (%)	51.73	48.27
>=$8,382 (%)	35.9	64.10

*Based on the average of two chronic bronchitis variables (CHBRON31 and CHBRON53), measuring chronic bronchitis diagnosis in different panel periods during 2010.

Table 7. Differences in Healthcare Service Utilization Including a Comparison of Modes by Physical Activity Status Among Adults With Arthritis (n=5,600), Based on 2010 MEPS Consolidated Household Dataset.
*Indicates significance

Healthcare Service	Inactive Adults with Arthritis, Mode (raw number and total %)	Active Adults with Arthritis, Mode (raw number and total %)	Total respondents for all possible response options	Chi-Square	p-value
Whether an appointment was made for care (in last 12 months)	2,104 (42.76%) reported 'yes'	1,835 (37.29%) reported 'yes'	4,921	12.3676	0.0004*
Number of visits for care (in last 12 months)	577 (11.78%) reported '5 to 9' visits	465 (9.49%) reported '5 to 9' visits	4,900	52.0020	<0.0001*
Whether any care, tests, or treatment were needed (in last 12 months)	1,836 (44.31%) reported 'yes'	1,593 (38.44%) reported 'yes'	4,144	0.6511	0.4917
Whether any type of specialist was needed (in last 12 months)	1,489 (30.14%) reported 'yes' to needing to see a specialist	1,218 (24.66%) reported 'yes' to needing to see a specialist	4,940	21.0374	<0.0001*
Length of time since last check-up (ranging from 'never' to 'more than 5 years')	2,295 (42.87%) received a checkup within the past year	2,054 (38.37%) received a checkup within the past year	5,353	31.3986	<0.0001*

Table 10. Crude and Adjusted Odds of Saving $1,000 or More in Total Annual Healthcare Expenditures Among Adults With Arthritis (n=5,600) Due to Routine Physical Activity, Controlling for Other Characteristics, Based on 2010 MEPS Consolidated Household Data.

Characteristics	Odds Ratio	95% C.I.	p-value
Physically Active~ (crude)	0.54	0.498, 0.580	<0.0001
Physically Active~ (adj.*)	0.72	0.654, 0.786	<0.0001

~reference group is inactive adults with arthritis
*adjusted for insurance status, age, gender, race, diabetes, stroke, high blood pressure, heart disease, asthma, chronic bronchitis, and emphysema

Table 11. Reduced Model - Odds of Saving $1,000 or More in Total Annual Healthcare Expenditures Among Adults With Arthritis (n=5,600) Due to Routine Physical Activity, Controlling for Other Characteristics, Based on 2010 MEPS Consolidated Household Data.

Characteristics	Odds Ratio	95% C.I.	p-value
Physically Active~ (adj.*)	0.716	0.656, 0.782	<0.0001
Uninsured**	0.226	0.188, 0.271	<0.0001
Age (under 65)***	0.690	0.620, 0.768	<0.0001
Sex (Female)****	1.502	1.372, 1.645	<0.0001
Race (Black)+	0.820	0.736, 0.913	0.0003
No Diabetes++	0.503	0.447, 0.567	<0.0001
No High Blood Pressure+++	0.521	0.473, 0.574	<0.0001
No Stroke++++	0.462	0.389, 0.548	<0.0001
No Asthma^	0.669	0.584, 0.766	<0.0001
No Chronic Bronchitis^^	0.742	0.577, 0.952	0.0196
No Emphysema^^^	0.468	0.372, 0.590	<0.0001
No Heart Disease^^^^^	0.400	0.346, 0.463	<0.0001

~reference group is inactive adults with arthritis
*adjusted for insurance, age, gender, race, and the seven chronic conditions listed above
**reference group is insured with arthritis
***reference group is adults with arthritis who were age 65 or older
****reference group is men with arthritis
+reference group is White adults with arthritis
++ reference group is adults with arthritis and diabetes
+++ reference group is adults with arthritis and high blood pressure
++++ reference group is adults with arthritis and stroke
^ reference group is adults with arthritis and asthma
^^reference group is adults with arthritis and chronic bronchitis; based on an average of two chronic bronchitis variables
^^^ reference group is adults with arthritis and emphysema
^^^^^ reference group is adults with arthritis and heart disease

Table 12. Crude and Adjusted Odds of Saving $3,000 or More in Total Annual Healthcare Expenditures Among Adults With Arthritis (n=5,600) Due to Routine Physical Activity, Controlling for Other Characteristics, Based on 2010 MEPS Consolidated Household Data.

Characteristics	Odds Ratio	95% C.I.	p-value
Physically Active~ (crude)	0.582	0.544, 0.623	<0.0001
Physically Active~ (adj.*)	0.762	0.703, 0.825	<0.0001

~reference group is inactive adults with arthritis
*adjusted for insurance status, age, gender, race, diabetes, stroke, high blood pressure, heart disease, asthma, chronic bronchitis, and emphysema

Table 13. Reduced Model - Odds of Saving $3,000 or More in Total Annual Healthcare Expenditures Among Adults With Arthritis (n=5,600) Due to Routine Physical Activity, Controlling for Other Characteristics, Based on 2010 MEPS Consolidated Household Data.

Characteristics	Odds Ratio	95% C.I.	p-value
Physically Active~ (adj.*)	0.762	0.703, 0.825	<0.0001
Uninsured**	0.229	0.196, 0.268	<0.0001
Age (under 65)***	0.663	0.601, 0.732	<0.0001
Sex (Female)****	1.594	1.469, 1.730	<0.0001
Race (Black)+	0.773	0.700, 0.853	<0.0001
No Diabetes++	0.451	0.403, 0.506	<0.0001
No High Blood Pressure+++	0.513	0.470, 0.560	<0.0001
No Stroke++++	0.478	0.403, 0.568	<0.0001
No Asthma^	0.665	0.586, 0.755	<0.0001
No Chronic Bronchitis^^	0.7285	0.573, 0.928	0.0103
No Emphysema^^^	0.461	0.366, 0.580	<0.0001
No Heart Disease^^^^^	0.409	0.354, 0.472	<0.0001

~reference group is inactive adults with arthritis
*adjusted for insurance, age, gender, race and the seven chronic conditions listed above
**reference group is insured with arthritis
***reference group is adults with arthritis who were age 65 or older
****reference group is men with arthritis
+reference group is White adults with arthritis
++ reference group is adults with arthritis and diabetes
+++ reference group is adults with arthritis and high blood pressure
++++ reference group is adults with arthritis and stroke
^ reference group is adults with arthritis and asthma
^^reference group is adults with arthritis and chronic bronchitis; based on an average of two chronic bronchitis variables
^^^ reference group is adults with arthritis and emphysema
^^^^^ reference group is adults with arthritis and heart disease

APPENDIX E: FIGURES

Figure 1. Adapted Social Determinants of Health

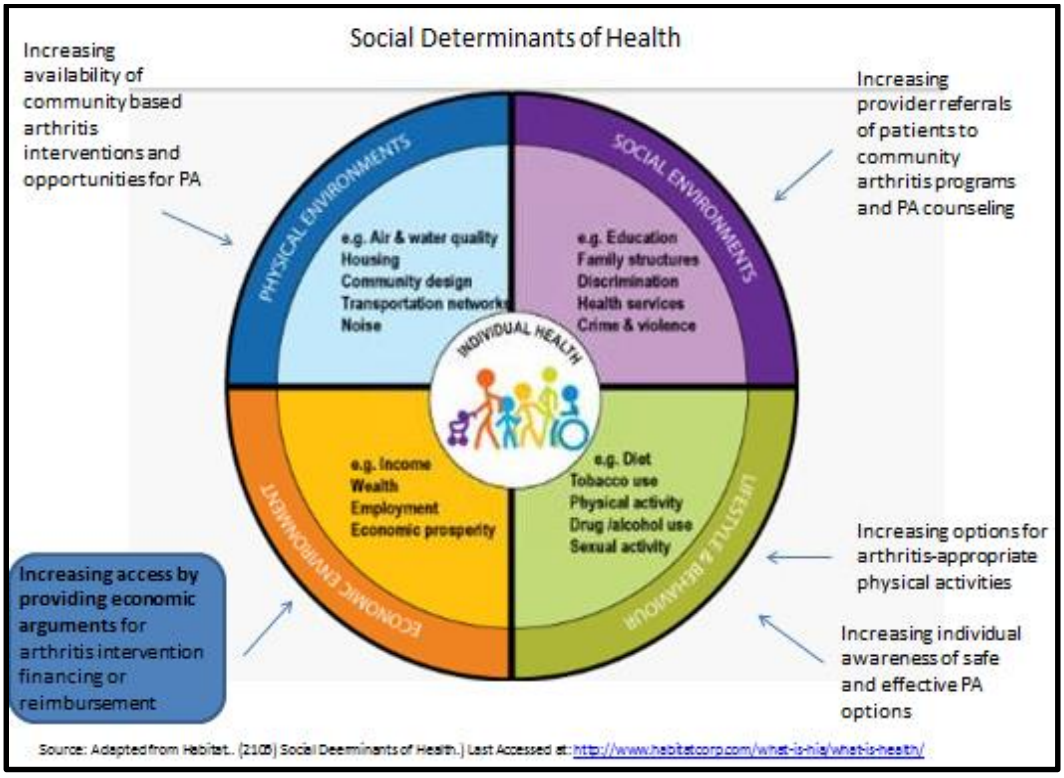

Figure 2. Full Model for Logistic Regression, Addressing Research Question II

Based on n = 5,600 adults with arthritis within the MEPS 2010 dataset

$$\log(Odds\ total\ medical\ expenditures) = \beta 0 + \beta 1 * PA + \beta 2 * gender + \beta 3 * insurance + \beta 4 * age + \beta 5 * race + \beta 6 * smoking + \beta 7 * HBP + \beta 8 * stroke + \beta 9 * CHD + \beta 10 * diabetes + \beta 11 * overweight + \beta 12 * asthma + \beta 13 * chronic\ bronchitis + \beta 14 * emphysema + \beta 15 * PA * gender + \beta 16 * PA * insurance + \beta 17 * PA * age + \beta 18 * PA * race + \beta 19 * PA * smoking + \beta 20 * PA * HBP + \beta 21 * PA * stroke + \beta 22 * PA * CHD + \beta 23 * PA * diabetes + \beta 24 * PA * overweight + \beta 25 * PA * asthma + \beta 26 * PA * chronic\ bronchitis + \beta 27 * PA * emphysema$$

Note: PA = physical activity; HBP= high blood pressure; CHD= coronary heart disease & Overweight = overweight or obese

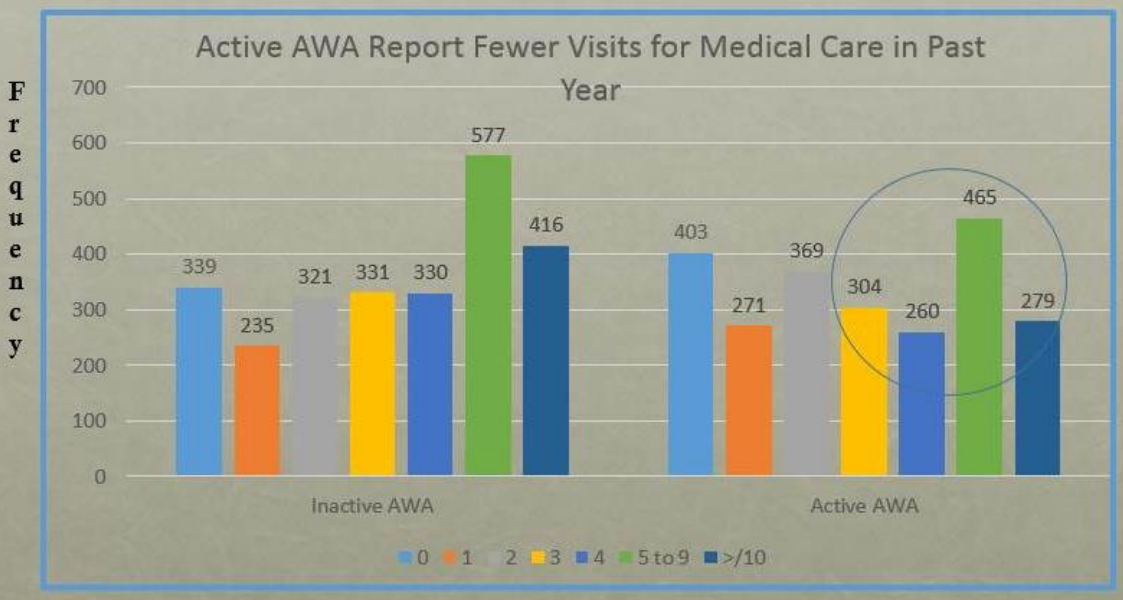

Figure 3. Number of Visits to a Medical Office for Care in Last 12 Months

$X^2 = 52.00$, $p < .0001$