Arthritis Activity and Work Limitation in Behavioral Risk Factor Surveillance System 2011-2013 Data

BY

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THESIS

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BRFSS	Behavioral Risk Factor Surveillance System
BMI	Body Mass Index
CDC	Centers for Disease Control
CT	Computed Tomography
ICF	International Classification of Functioning Disability and Health
MRI	Magnetic Resonance Imaging
NHANES I	National Health and Nutrition Examination Survey
NHANES-III	Third National Health and Nutrition Examination Survey
NSAIDS	Non-Steroidal Anti-Inflammatory Drugs
OA	Osteoarthritis
PACE	Pennsylvania's Pharmaceutical Assistance Contract for the Elderly
QWB	Quality of Well-Being Index
SAS	Statistical Analysis System
SF-36	Medical Outcomes Study Questionnaire Short Form 36 Health Survey
WHO	World Health Organization

SUMMARY

This study used 2011-2013 Behavioral Risk Factor Surveillance System data to provide a cross-sectional evaluation of the relationship between the exposure arthritis attributable joint pain and two outcomes: arthritis attributable activity limitation and arthritis attributable work limitation. Co-variates representing the domains: sociodemographic factors, health status factors and health behaviors were included in the analysis to assess how their inclusion affected the relationship between main exposure and each of the outcomes.

Arthritis attributable joint pain was evaluated as both a dichotomous variable (yes/no joint pain) and a categorical variable (no joint pain, mild-moderate joint pain, and severe joint pain). For each relationship evaluated, arthritis attributable joint pain was a significant risk factor for arthritis attributable activity limitation and arthritis attributable work limitation in both the crude and fully adjusted models. Fully adjusted odds ratios for the relationship between arthritis attributable joint pain and arthritis attributable activity limitation were, for dichotomous joint pain: 9.2 (8.3, 10.1), for categorical joint pain: mild-moderate 6.1 (5.5, 6.7), severe 24.9 (22.4, 27.6). Fully adjusted odds ratios for the relationship between arthritis attributable joint pain and arthritis attributable work limitation were, for dichotomous joint pain: 7.0 (5.9, 8.4), for categorical joint pain: mild-moderate 4.3 (3.6, 5.1), severe 17.1 (14.4, 20.4). Other statistically significant modifiable risk factors identified were self-reported health status and physical activity, though their odds ratios were smaller, ranging from 2.5-3.7 and 1.1-1.4 respectively. Future work in this area could focus on the relative contribution of co-variates with regard to the relationship between the main exposure and the outcomes, as well as identifying other factors which may affect these relationships.

I. INTRODUCTION

A. Arthritis background and significance

1. Arthritis definition and types

The term "arthritis" refers to over 100 various rheumatologic conditions affecting the joints and surrounding tissues, which over human history have been differentiated into different clinical entities (1-2). These conditions can vary in presentation, prognosis, treatment, and other features. In general these illnesses can increase joint pain and may affect joint function (1). Data from the National Health Interview Surveys from 2010-2012 found that, out of individuals aged 18 or older in the United States, 52.5 million or 22.7%, answered yes to having doctor diagnosed arthritis, with arthritis including "arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia" (3).

The most common conditions falling under the public health definition of arthritis are childhood arthritis, fibromyalgia, gout, rheumatoid arthritis, systemic lupus erythematosus, and osteoarthritis (4), with the most common form being osteoarthritis (5). The general term used to encompass chronic arthritis conditions in children is juvenile idiopathic arthritis. Due to the different conditions contained in this grouping and differing case definitions, estimates of cases vary, with approximately 70,000 to 100,000 cases in individuals under 16 being considered a commonly accepted estimate (6). Fibromyalgia prevalence is about 2% in the United States, with about 5 million adults with the condition in 2005 (7). Gout prevalence amongst U.S. adults was estimated at 3.9%, or 8.3 million people, from nationally representative 2007-2008 data from the National Health and Nutrition Examination Survey (8). Rheumatoid arthritis prevalence was estimated as affecting 0.6% of the United States population age 18 or older in 2005 (1.5 million persons) (9). United States population estimates from 2005 of systemic

lupus erythematosus found up to 322,000 cases, including probable cases (and 161,000 for definite cases only) (9).

In contrast, the prevalence of osteoarthritis in the United States as determined in 2005 was thought to be 34% of those aged 65 or older (7, 10), with some studies suggesting about 50% of those over 65 years old are affected (11), and 14% of those aged 25 and older are affected (7, 10). In 2005, osteoarthritis was thought to affect about 27 million persons in the United States (7, 12). Therefore of the over 100 various forms of arthritic conditions, osteoarthritis can be considered to account for over 51% of all forms of arthritis (3, 7, 12). Although there are many different arthritic conditions, the most common type, osteoarthritis, was of special interest in this study.

The exact mechanism of the development of osteoarthritis is still being elucidated, but the condition is believed to result from a series of mechanical and molecular interactions and traditionally can be considered as being due to progressive repetitive traumas such as that associated with constant use over time, e.g. with aging (10, 13-14). Over time a process of changes to the joint can occur in which the amount of joint "lubrication" (synovial fluid) is reduced and the structural integrity of the cartilage deteriorates (15). Osteophytes, which are bone growths associated with joint cartilage deterioration, can form, and the joint space may narrow (16).

The condition of osteoarthritis can be defined or diagnosed in different ways: symptoms or pathology. Pathology refers to changes in normal joint structure. Symptoms refer to issues such as pain in the area of the joint, muscle weakness and joint instability such as knee buckling (5, 14). Individuals may have joint changes including radiographic changes indicative of osteoarthritis without symptoms, discussed in further detail in section I A 5 "arthritis joint pain". In general, the medical diagnosis of osteoarthritis is a clinical decision/label by a medical provider such as a physician, based on a patient's history, physical examination and potentially additional information such as radiographic (xray) findings.

Magnetic resonance imaging (MRI), computed tomography (CT), or other advanced imaging, is rarely needed to make a medical diagnosis of osteoarthritis. Likewise, laboratory testing, such as bloodwork on markers of inflammation is generally rarely needed to make a diagnosis of osteoarthritis. The classic and most common clinical history in osteoarthritis is joint pain, especially joint pain that is worse with activity and has initial increased pain or stiffness after a period of rest (e.g. "morning stiffness") (17).

2. Natural history of and risk factors for osteoarthritis

Various sociodemographic factors, health status factors and health behavior factors affect the occurrence and course of osteoarthritis.

As one means of development of osteoarthritis is joint deterioration it has been found that the prevalence of osteoarthritis increases with age (5, 18). Osteoarthritis may be a progressive condition. The Framingham Osteoarthritis Study re-examined subjects who had knee xrays and who had answered questions regarding knee symptoms from 1983 to 1985 on average 8 years later. There were 1438 subjects in the initial study, 1051 were alive at the time of follow up and 869 (83%) participated in the follow up study. In women, 4% experienced disease progression per year as measured by radiographic findings compared to 2.8% in men (this sex difference was not statistically significant with a relative risk of 1.4, 95% confidence interval (0.8-2.5)), and the study indicated women had a 1.7 times higher rate of incident disease than men (95% confidence interval 1.0-2.7) (19). In this sample of elderly subjects (mean age 71, standard deviation 5 years) neither disease incidence nor rate of disease progression was affected by age.

Sex differences have also been observed in osteoarthritis (5). Women may be more likely to present with osteoarthritis in specific joints than men, e.g. hand, foot and knee (15, 20). Post menopause, the prevalence of osteoarthritis is thought to increase significantly in women, suggesting hormonal involvement (15, 21-23).

Non-white persons may be more likely to have osteoarthritis than white persons. A 2009 study by Jordan et al. evaluating information from the Johnston County Osteoarthritis Project found that overall African-Americans had a higher prevalence of both radiographic and symptomatic hip osteoarthritis than Caucasians (24). A 2007 study by the same author also looking at information from the Johnston County Osteoarthritis Project found that compared to Caucasians, African-Americans had slightly increased prevalence of both radiographic and symptomatic knee osteoarthritis, as well as markedly increased prevalence of severe radiographic findings of the condition (25).

Increased education may be associated with reduced occurrence or severity of osteoarthritis. A 2015 study by Murphy et al., of annual incidence of knee symptoms (defined as "on most days, do you have pain, aching, stiffness in your (right, left) knee?"), and four knee osteoarthritis categorizations: radiographic, symptomatic (defined as radiographic plus symptoms in the same knee), severe radiographic and severe symptomatic in the Johnson County Osteoarthritis Project, which is a longitudinal study of knee and hip osteoarthritis, found that incidence rates for both radiographic and severe radiographic osteoarthritis declined as education level increased, though the findings were only significant for severe radiographic osteoarthritis. In this study education was categorized as less than high school, some high school/completed high school, and more than high school (26).

Low income is associated with the occurrence and severity of osteoarthritis. The same 2015 study by Murphy et al., using Johnson County Osteoarthritis Project information, found that of those participants whose income was known, incidence rates decreased as household incomes increased, but this finding was statistically significant only for knee symptoms (26).

A 1993 study by Fryback et al. based on the Beaver Dam Health Outcomes study, that assessed the relationship between self-reported health status and arthritis found that self-reported health status as measured by SF-36, the Quality of Well-Being Index (QWB) and also by simply asking participants to

rate their health overall as excellent, very good, good, fair or poor comparing those with versus without arthritis showed that those with arthritis had significantly worse self-reported health status by all measures utilized as compared to those without arthritis ($p<0.05$) (27). A 2004 study by Dominick provided information specific to self-reported health status and osteoarthritis, involving subjects enrolled in Pennsylvania's Pharmaceutical Assistance Contract for the Elderly (PACE) program. Health status was determined by subjects reporting their health was excellent, very good, good, fair or poor. Those with osteoarthritis versus no arthritis were significantly more likely to report fair or poor health (odds ratio 1.12, 95% confidence interval 1.07-1.78) (28).

A 2015 systematic review and meta-analysis by Silverwood et al. noted that when co-morbidities are investigated in association with knee osteoarthritis they are linked with higher likelihood of the condition (29). Osteoarthritis and diabetes mellitus are common co-morbid conditions. A 2015 study by Adriaanse et al. of 1676 patients with type 2 diabetes mellitus found that osteoarthritis was one of the most common co-morbid conditions identified, in addition to high blood pressure and "neck, shoulder disorders" (30). A 2015 systemic literature review and meta-analysis by Louati et al. noted that "[t]he risk of [osteoarthritis] was greater in the [diabetes mellitus] than non [diabetes mellitus] population (OR=1.46 (1.08-1.96), p=0.01, as was [diabetes mellitus] in the [osteoarthritis] than non[osteoarthritis] population (OR=1.41 (1.21 to 1.65), p<0.00001)," (31). Osteoarthritis commonly co-occurs with hypertension; a 2013 study of 352 patients with osteoarthritis found 73.3% of individuals had hypertension (32). Obesity/overweight are also associated with increased frequency of osteoarthritis, especially with regard to knee osteoarthritis (33-34); a 2010 meta-analysis on risk factors for the development of knee osteoarthritis in the elderly by Blagojevic found the random-effects pooled odds ratio for overweight vs. normal weight was 2.18 (95% CI 1.86, 2.55), for obese vs. normal weight 2.63 (2.28, 3.05), and for overweight/obese vs. normal weight 2.96 (2.56, 3.43) (35). The relationship is

thought to be related both to issues involving joint loading forces as well as inflammatory and other physiological responses (36-38).

There is an unclear relationship between physical activity and risk for osteoarthritis. Participation in sports that involve direct impact on the joint at high intensity may increase the risk of osteoarthritis (5). Silverwood et al.'s 2015 systematic review and meta-analysis of risk factors for knee osteoarthritis found, with inclusion criteria of general population (e.g. not athletes), 16 studies evaluated high level physical activity, with 11 not finding significant results, three finding a statistically significant relationship between intense or high levels of physical activity and increased risk of knee osteoarthritis, one study implying that varied activity was less likely to be associated with development of knee osteoarthritis versus repetitive activity, and one study finding an increased risk only in persons running 20 miles or greater every week (29). A 2014 study by Barbour et al. found no increased risk of development of radiographic knee osteoarthritis for participants meeting Department of Health and Human Services physical activity guidelines of ≥150 minutes of physical activity per week (39).

Regarding the relationship between smoking and osteoarthritis, some studies have suggested that individuals who smoke may have lower prevalence of osteoarthritis than those that do not smoke. Review of the literature implies that those who smoke may have a slightly decreased risk of developing radiographic evidence of knee and hip osteoarthritis. However smoking negatively affects the intervertebral discs and contributes to spinal osteoarthritis (40). Silverwood et al.'s 2015 systematic review and meta-analysis of risk factors for knee osteoarthritis found that of 13 studies evaluated, "the pooled OR of 0.92 (95% CI 0.83-1.01)…suggests that overall smoking is not associated with knee [osteoarthritis]," (29).

There are few longitudinal studies that provide information on alcohol use as a risk factor for the development of osteoarthritis, therefore the association between alcohol use and osteoarthritis is unclear (41).

Structural, functional, psychological, and other factors may play a role in the progression of the disease, though these issues are still being investigated (42). Some studies are investigating the role of various biomarkers (e.g. biomarkers related to collagen metabolism and deterioration) in the presence and progression of osteoarthritis (43).

3. Osteoarthritis treatment

Treatment for osteoarthritis, depending on anatomic location and other factors, includes activity modification, weight loss/maintaining healthy weight, medication management including steroid, plasma-rich protein and hyaluronic acid injections, bracing including use of foot orthotics, use of heat or cold or other standard treatment modalities (e.g. ultrasound, iontophoresis), physical therapy including massage and supervised exercise, and surgical intervention (44-46). Treatment guidelines and results vary by anatomical location, severity of condition and various patient factors. A 2015 Cochrane Database Systematic Review of the use of land-based therapeutic exercise in individuals with knee osteoarthritis, examining the effect of this treatment on reduction of joint pain, improvement in physical function or improvement in quality of life, found high quality evidence that this treatment provides short term benefit for reduction of knee pain. This effect lasted at least two to six months after the end of formal treatment. The study also found moderate quality evidence of improvement in physical function in persons with knee osteoarthritis. The effect size is moderate to small and comparable to the effect of treatment with non-steroidal anti-inflammatory drugs (NSAIDS) (47).

4. Osteoarthritis cost and public health burden

A 2015 study by Losina et al. estimated United States lifetime costs attributable to knee osteoarthritis as $12,400 per person, taking into account factors such as average cost of treatments, and cost of lost work productivity (48). In 2009, 904,900 hip and knee replacements were performed in the United States, with an associated cost of about $42 billion, with osteoarthritis presumed to be the reason for the vast majority of these procedures (49-50). Costs associated with joint replacement represent some of the highest costs related to care for osteoarthritis, though they are effective (48).

Data from the 2010-2012 National Health Interview Surveys found that 22.7 million U.S. adults 18 or older, or 43.2% of those with arthritis, had arthritis attributable activity limitation (3). Osteoarthritis can impact work including contributing to early retirement (5). Information from the 2002 National Health Interview Survey found that about 33% of Americans aged 18 to 64 reported that arthritis limited their ability to work, and affected the type and amount of work they could perform (49, 51).

5. Arthritis joint pain

As mentioned with regard to the definition/diagnosis of arthritis, joint pain in an individual with osteoarthritis is an aspect of symptomatic disease. It can be characterized as aching or stiffness at the joint at first, worse with load bearing activity, which may, over time, progress to chronic joint pain. The prevalence of osteoarthritis with joint pain would generally be less than radiographic evidence of osteoarthritis, as large epidemiologic studies may define the presence of osteoarthritis based on radiographic findings, in other words, there are differing definition criteria. Therefore in those studies, symptomatic osteoarthritis would be defined as those subjects that met both radiographic criteria for the identification of osteoarthritis and also had pain/aching/stiffness at the joint. For example, one study whose goal was to survey the prevalence of osteoarthritis of the hip in the

Framingham Study Community Cohort, randomly recruited individuals 50 or older, and regardless of the presence of known arthritis or joint pain, obtained hip xrays which were read by physicians, with confirmation of radiographic evidence of osteoarthritis made by a radiologist with advanced musculoskeletal training. Participants were also asked about the presence of hip pain. Symptomatic hip osteoarthritis was defined as radiographic hip osteoarthritis plus the presence of hip pain on the same side as the radiographic evidence of hip osteoarthritis (52). A 2013 article by Neogi notes: "For example, the prevalence of *radiographic* knee OA was 19% and 28% among adults age ≥45 years in the Framingham study and Johnston County Osteoarthritis Project, respectively, while the prevalence of *symptomatic* knee OA was 7% in Framingham and 17% in the Johnston County Osteoarthritis Project." (25, 53-54).

The presence of joint symptoms may affect activity levels and participation in society (53, 55). Pain in osteoarthritis is of multi-factorial etiology and can be considered within the biopsychosocial framework, described in further detail in section I B, 1 of this document: "General conceptual background regarding arthritis as a disability". In this condition, biological factors such as genetics and joint structure, psychological factors such as pain perception, and social factors such as whether the individual works/type of work, interplay to affect an individual's function and the extent of osteoarthritis burden (53). Potentially modifiable risk factors for painful (e.g. symptomatic) osteoarthritis include overweight/obesity and psychological factors. Cognitive behavioral therapy may help reduce the negative effects of maladaptive thought patterns such as catastrophizing and improve positive mental strategies for coping and self-efficacy (53, 56-58). Programs such as the Arthritis Self Management Program incorporate several strategies including exercise and cognitive techniques to reduce arthritis symptoms (59). Structural modifications other than actual joint replacement may not effectively control symptomatic osteoarthritis (48), and pain is one of the primary reasons that individuals pursue joint

replacement (53). Increased severity of osteoarthritis symptoms are related to increased levels of functional restriction (53, 60-61).

B. Disability definitions: disability, activity limitation, work limitation

Disability may be viewed within the traditional medical model or the social model. The medical model sees disability as a trait of the individual requiring medical intervention to correct the condition. The social model of disability finds disability to be not intrinsic to the person, but a condition created by features of the environment such as physical barriers (62).

Activity limitation refers to difficulty in performing an activity, meaning any task or action (62). Work limitation would refer to limitation in the arena of work (comprising both specific physical activities as well as the social role of the worker), which can be considered an aspect of participation in society (62-63).

1. General conceptual background regarding arthritis as a disability

This study is generally informed by the concepts of the biopsychosocial model and the World Health Organization (WHO) International Classification of Functioning Disability and Health (ICF), both of which are more complex ways of viewing conditions than that of either the medical or the social model. They emphasize that wellness versus illness results from the interplay of multiple variables, as opposed to a strict dichotomy. The biopsychosocial model theory is generally attributed to psychiatrist George L. Engel and was introduced in the 1970s. It posits that illness arises from complex interactions that incorporate biological, social, and psychological factors, and conversely, that one cannot fully account for the onset or progression of an illness by considering only medical (biologic) factors, but must also somehow account for the importance of social and psychological aspects of an issue (64-65).

The World Health Organization International Classification of Function, Disability and Health

conceptual model has a basis in the biopsychosocial model, and also seeks to integrate medical and social factors to describe the relationship between a disease, human function at structural to societal level , and contextual (environmental or personal) factors (62). Within the WHO ICF, human function at the body structure level can include tissue, organ and body system functioning; at the activity level it can refer to ability to perform tasks such as climbing a flight of stairs; and work (employment) can be considered as a part of the societal participation level. Environmental factors include aspects of life external to the individual such as the physical world and even cultural attitudes; and personal factors can include sociodemographic information, habits and behaviors (66).

2. Cost and public health burden of "disability"

As described above, the concept of disability is fluid. The implications of disability depend of the definition of disability being used, the activity investigated, and the impact on societal participation (62). Therefore, it is unlikely that a generic evaluation of the costs or public health burden of "disability" would be helpful for any particular inquiry. Rather, disability must be defined based on the research question. In this study, the condition of interest is arthritis, specifically osteoarthritis, the most common arthritic condition. Information on the cost and public health burden of osteoarthritis has been provided in section 1 A, 4.

C. Arthritis as a disability

With regard to social limitations in the context of the biopsychosocial model or the WHO ICF, arthritis can contribute to restriction in participation in life activities such as involvement in the community and social events in general (67-68). A Centers for Disease Control and US Census Bureau analysis of Survey of Income and Program Participation data found in 2005 that arthritis was the most common cause of reported disability, with the most commonly reported cause of functional limitation

being difficulty with using lower extremities or difficulty with activities involving the lower extremities (53, 69).

II. RELATED LITERATURE AND RESEARCH AIMS

A. Known associations between arthritis related activity limitation and arthritis related work limitation and sociodemographic factors (age, sex, race, education, income), health status factors (self -reported health status, co-morbidities such as diabetes, hypertension, obesity/overweight), and health behaviors (smoking, alcohol use, physical activity)

1. Sociodemographic factors (age, sex, race, education, income)

As noted previously in section I A, 2, "Natural history and risk factors for osteoarthritis", the prevalence of osteoarthritis increases with increased age; women may be more predisposed to osteoarthritis in certain joints than men, and may be more predisposed to develop osteoarthritis overall compared to men after menopause; osteoarthritis may be more prevalent in individuals who are not white compared to white individuals; increased education is associated with decreased incidence and severity of osteoarthritis; and lower income is associated with increased incidence and severity of osteoarthritis.

Individuals with arthritis related activity limitation and those with arthritis related work limitation tend to be older. A 2008 prospective study by Gignac et al., which followed individuals with arthritis (at baseline consisting of 56.7% osteoarthritis only, and 10% osteoarthritis and inflammatory arthritis) over eighteen months found older adults were more likely to have reduced work hours ($p<0.05$) and to leave the work force ($p<0.001$) (70).

Those with arthritis-related activity limitation and arthritis related work limitation are more likely to be female than male (71). A study investigating pain and functional outcomes in men versus women following total knee replacement for osteoarthritis found univariate analysis of six month pain score for men vs women, and six month functional score for men versus women, were both statistically

significant with pain score 72.2 female 76.1 male p value 0.04, and function score 75.2 female 80.5 male p value 0.007, with pain and function measured by the Knee Injury and Osteoarthritis Outcome Score subscales. The relationship remained significant with the addition of age greater than 65, but lost statistical significance when pre-surgery pain was adjusted for in the pain predicting model, and when pre-surgery function was adjusted for in the function predicting model. Further regression models also adjusting for the presence of low back pain, depression, body mass index greater than 30, high school versus higher than high school education, osteoarthritis joint count greater than or equal to four, and co-morbidity count, found that pre-surgery pain or function score, low back pain and depression were statistically significant in six and 12 month pain and function predicting models. Co-morbidity count was statistically significant in all models as well, except p value was 0.09 in the six month pain score model (71).

Non-white persons may be more likely to experience arthritis related activity and work limitation than white persons. Data from the 2002 National Health Interview Survey found that a higher proportion of black individuals had severe joint pain, arthritis attributable activity limitations, and arthritis attributable work limitations compared to white persons. Compared to white persons, a higher proportion of Hispanic persons had severe joint pain and arthritis attributable work limitations (72).

The relationship between education and arthritis related activity limitation and arthritis related work limitation appears variable. Gignac et al.'s 2008 study of participants with primarily osteoarthritis type arthritis discussed above with regard to age, found that those with higher education (post-graduate level) were significantly more likely to change jobs ($p<0.01$). Leaving the work force was associated with lower education level ($p<0.05$) (70).

Low income is associated with arthritis attributable activity limitation and arthritis related work limitation. A 2013 study by Theis et al. found that income to poverty ratio <2.0 was associated with

social participation restriction, with prevalence ratio and 95% confidence interval 2.9 (2.5-3.4) for the univariate association, 2.5 (2.1-3.0) for the multivariate ICF domain specific model, and 1.4 (1.2-1.6) for the multivariate model containing all ICF domains (68).

2. Health status factors (self-reported health status, co-morbidities such as diabetes, hypertension, obesity/overweight)

As previously noted, those with osteoarthritis are more likely to have worse self-reported health status; those with osteoarthritis are also more likely to have medical co-morbidities including diabetes mellitus, hypertension, and obesity/overweight.

The relationship between self-reported health status and arthritis related activity limitation and arthritis related work limitation appears to vary. A 2009 study by Reichmann et al. using information from the Third National Health and Nutrition Examination Survey (NHANES-III) on participants with radiographic knee osteoarthritis in which self-reported health status was defined by having participants rate their health as poor, fair, good, very good, or excellent found that worse self-reported health status was associated with increased functional limitation (73). A 2014 study of 20 women on perceived health status found that more severe perceived impact of the condition of knee osteoarthritis as measured by the Arthritis Impact Measurement Scale was significantly associated with slower self-paced walking speed, r= -0.60 p=0.008, and also appeared associated with fast walking speed, r= -0.48, p=0.050 (74). A 2013 study by Bieleman et al. found that there was no significant difference in self-reported health status between individuals with early hip and/or knee osteoarthritis who continued to work two years after a baseline assessment and those who did not, as measured by the Dutch versions of the Western Ontario and McMasters University Arthritis Index and the Short Form-36 Health Survey (75).

Greater number of co-morbid conditions is associated with increased likelihood of arthritis related activity limitation and arthritis related work limitation. A study of 2002 National Health

Interview Survey data found that in those persons with arthritis as a co-morbidity to another chronic condition, the prevalence of community participation restriction increased with increasing number of co-morbid chronic conditions (67).

Diabetes appears to be associated with increased likelihood of arthritis related activity limitation and arthritis related work limitation in those with osteoarthritis. Appropriate quantity, intensity and duration of physical activity is often lacking in individuals with diabetes with functional limitation related to osteoarthritis. Physical activity is a primary intervention in the treatment of pain and functional limitation in osteoarthritis and is also important in the management of type 2 diabetes mellitus (76). A 2013 study of 2010-2012 National Health Interview Survey data by Barbour et al. found that, of those persons with diabetes, the prevalence of arthritis was 47.3%, and the prevalence of arthritis attributable activity limitation in those with diabetes and arthritis was 25.7% (3).

Those with hypertension are more likely to have arthritis related activity limitation and arthritis related work limitation. A 1994 study by Ettinger et al. using data from the National Health and Nutrition Examination Survey (NHANES I) found there was a significantly increased likelihood of difficulty with ambulation in persons with knee osteoarthritis and hypertension, with odds ratio 2.46 (1.21, 5.11) for ambulation (77).

Individuals who are obese/overweight are more likely to have arthritis related activity limitation and arthritis related work limitation. A 2011 study of Behavioral Risk Factor Surveillance System 2007 and 2009 data which estimated state specific and overall prevalence of arthritis in adults with obesity and prevalence of physical inactivity in obese adults with and without arthritis found that the median arthritis prevalence by state was 35.6% and obese adults with arthritis were 44% more likely to be physically inactive versus those without arthritis after adjusting for age, sex, race/ethnicity and education (78).

3. Health behaviors (smoking, alcohol use, physical activity)

As discussed previously, there is an unclear relationship between physical activity and the development of osteoarthritis, as well as the relationship between smoking and occurrence of osteoarthritis and alcohol use and osteoarthritis development.

Physical activity can have a differing effect on osteoarthritis related functional limitations depending on the features of the activity such as joint loading forces. An observational study of daily walking published in 2014 found that regular walking decreased the likelihood of functional limitation onset over the next two years in in the 1788 persons with knee osteoarthritis who participated in the study (79).

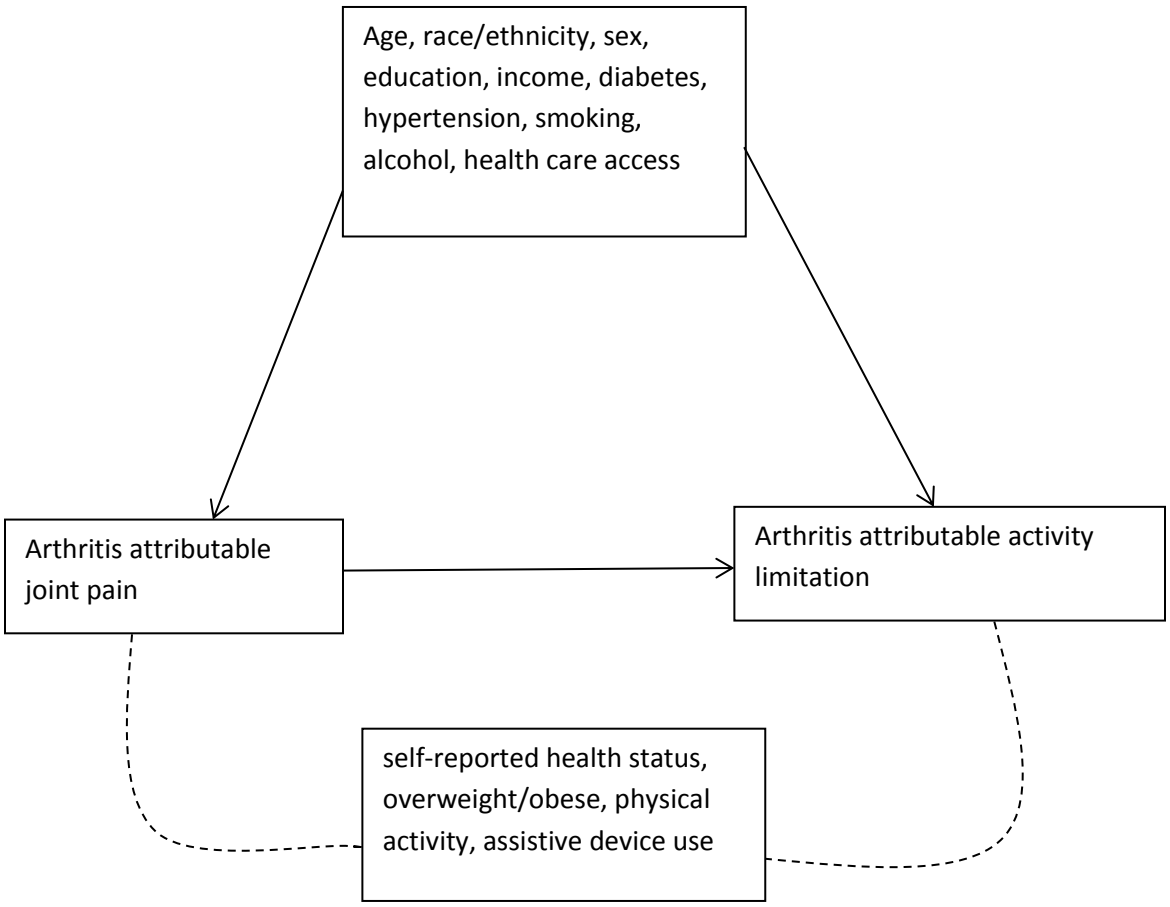
The association between smoking and arthritis activity and work limitation is not clear due to scant information. Some evidence suggests that smokers are at slightly increased risk of symptomatic (e.g. painful) osteoarthritis (40).

The relationship between alcohol and arthritis activity limitation and arthritis work limitation is not well defined due to low levels of information. A 2014 study by Fransen et al. notes that there is little evidence that regular consumption of alcohol is a significant factor in the development of symptomatic osteoarthritis (41).

4. Possible causal diagrams

Figure 1, below, is a possible causal diagram for the relationship between arthritis attributable joint pain and arthritis attributable activity limitation and co-variates: age, race/ethnicity, sex, education, income, self-reported health status, presence of diabetes, presence of hypertension, presence of overweight/obesity, physical activity, smoking status, alcohol use, as well as the additional co-variates: use of assistive devices and health care access. Another causal diagram, Figure 2, has also

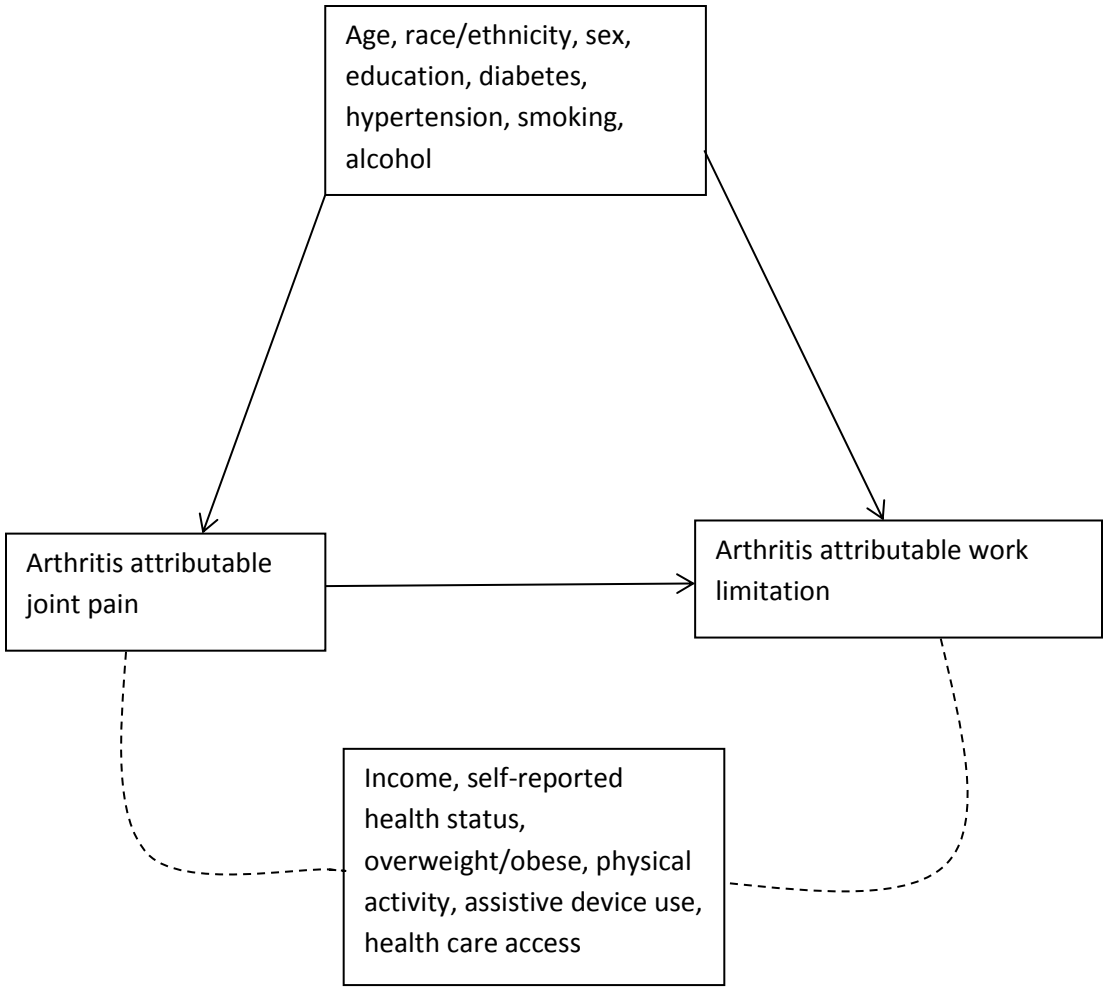
Figure 1. Possible causal diagram: arthritis attributable joint pain and arthritis attributable activity limitation



been created providing information on the relationship between arthritis attributable joint pain and arthritis attributable work limitation and co-variates: age, race/ethnicity, sex, education, income, self-reported health status, presence of diabetes, presence of hypertension, presence of overweight/obesity, physical activity, smoking status, alcohol use, as well as the additional co-variates: use of assistive devices and health care access.

Figures 1 and 2 are conceptually informed by the biopsychosocial and WHO ICF models described above in Section I, B, 1 General conceptual background regarding arthritis as a disability, in

Figure 2. Possible causal diagram: arthritis attributable joint pain and arthritis attributable work limitation



that they take into account that biological, psychological and social areas of life affect the health outcomes under consideration, and incorporate different structural levels of functioning in society in production of the outcomes investigated, for example the main exposure, self-reported arthritis attributable joint pain could broadly be considered a personal factor given that it involves the personal perception of pain, whereas the outcomes investigated can be considered aspects of societal participation, with work limitation being a more specific form of this concept and general activity

limitation as queried in the study being a less specific form of this concept. The basis of the creation of the causal diagrams, with arrows indicating possible causation, and dotted lines indicating an association are as per the 1999 Greenland article: Causal diagrams for epidemiologic research (80).

For both Figures 1 and 2, the relationship between the exposure and the outcome in question has been informed by the literature review provided in Section I A, 5 Arthritis joint pain, as well as that in Sections II Related literature and research aims, A, B, C (which provide information on the relationship between each co-variate and the two outcomes). It is noted that most published literature does not provide direct information on causal relationships as information on relationships may come from review type articles discussing general relationships, or from cross-sectional type studies. In addition to the co-variates included in this study, co-variates which may be of interest in future work, though not considered further in this analysis, are also included in the causal diagrams: assistive devices and health care access. In general, the relationship between assistive device use and arthritis joint pain and arthritis attributable activity and arthritis attributable work limitation are that the device may be provided for various reasons including to improve balance/stability and decrease pain. In knee osteoarthritis, the provision of assistive devices is done to help decrease pain and decrease functional limitations such as those in general activity limitation and more specific work limitation (81-82). As far as the relationships between exposure and outcomes and health care access, a 2014 study by Dobson et al. notes that osteoarthritis related knee pain can be decreased by interventions such as specific exercise and coping skills training, but that access to these interventions may not be available (83). A 2010 study by Badley and Ansari using information from the 2002-2003 Joint Canada/US Health Survey found that of those adults reporting having seen their regular physician in the last 12 months, considered a sign of access to health care, there was somewhat increased risk of reporting arthritis attributable activity limitation with prevalence rate and 95% confidence interval of 1.48 (1.02, 2.14) after adjusting for country (US or Canada), age, sex, education, income, body mass index, and physical

activity (84). With regard to the relationship between health care access and arthritis work limitation, the association is unclear, a 2006 review article by Mahalik et al., of studies focused on rheumatoid and osteoarthritis, found that work place health interventions and health education programs' effectiveness was limited as far as improving work outcomes including continuing work. Other factors related to health care access including income and having disability insurance indicate a variable association with work limitation (85).

Within Figures 1 and 2, the conceptualized possible relationships are generally similar, as work limitation can be considered a specific form of activity limitation. In Figure 1, age, race/ethnicity, sex, education, income, diabetes, hypertension, smoking, alcohol and health care access are placed in the "causal box", indicating that it is thought that presence/absence/or level of these factors affects the presence/absence/or level of arthritis attributable joint pain and arthritis attributable activity limitation, as opposed to joint pain and arthritis attributable activity level being able to affect the factors in question. For some co-variates, this is obvious; as for example, having joint pain does not affect one's age or race/ethnicity. Income and health care access were placed in the "causal box" here because income can be considered as similar to health care access in that having increased income and having adequate health care access should decrease reported arthritis attributable joint pain and arthritis attributable activity limitation due to provision of appropriate treatments (e.g. medication, physical therapy, assistive devices, home modifications, etc.) Self-reported health status, overweight/obesity, physical activity and assistive device use are placed in the "association box" in Figure 1 as it can be considered that the presence/absence/level of joint pain and arthritis attributable activity limitation could affect each of these factors, but conversely each of these factors could also affect joint pain and/or arthritis attributable activity limitation. For example, having joint pain and/or arthritis attributable activity limitation could affect one's self-reported health status, however, if one has a particular self-reported health status that could conceivably affect one's perception of pain and

therefore one's reported joint pain, as well as one's perception of functional abilities/limitations, and therefore one's reported arthritis attributable activity limitation. In Figure 2, the relationship between the exposure and outcome are more complicated for income and health care access, as income and access to health care via insurance and having income itself can be a byproduct of working, and one might be less likely to work if one had joint pain/severe joint pain, and conversely if one already has sufficient income and access to health care one may not work and therefore would be less likely to report work limitation, and one may be less likely to report joint pain due to adequate treatment. Therefore, income and health care access are placed in the "association box" within Figure 2 as opposed to the "causal box," to indicate a different type of relationship than that shown in Figure 1.

5. Relevant previous Behavioral Risk Factor Surveillance System studies on arthritis

The BRFSS does not separate out osteoarthritis from arthritis as a whole, though as noted in this document, osteoarthritis is the most common form of arthritis, comprising over 51% of all arthritic conditions (3, 7, 12). Studies generally relevant to this one which have focused on arthritis using recent BRFSS data include issues of the Center for Disease Control's Morbidity and Mortality Weekly Report, or Morbidity and Mortality Surveillance Summaries, publications which cover a wide range of topics. Issues specific to arthritis include a study on state specific prevalence of walking among persons with arthritis using 2011 BRFSS data (86), state specific prevalence of no leisure time physical activity with and without arthritis using 2009 BRFSS data (87), and a study on arthritis as a potential barrier to physical activity among adults with obesity using 2007 and 2009 BRFSS data which is detailed further in section II A, 2: "health status factors" (78).

Other studies with relevance to this one using BRFSS data include a study using 2005 BRFSS data to examine the relationship between obesity and arthritis, taking into account the 2002 change by the CDC of the initial arthritis case definition in surveillance studies to one that is less inclusive of only self-

reported arthritis diagnosed by a medical professional, which found that body mass index is an independent risk factor for self -reported arthritis (88). Also a study using 2005 BRFSS data to project the estimated percent of US adults with medical provider diagnosed arthritis and arthritis attributable activity limitation for 2030, which is projected to increase by a median percentage of 16 across 48 states (89), and a study using 2003 BRFSS data estimating state-specific arthritis attributable work limitation prevalence to range from 3.4 to 15% and median percent employment of those working age adults with arthritis attributable work limitation at 73.2% (90).

The purpose of this study is use 2011 and 2013 BRFSS data to investigate the relationship between arthritis attributable joint pain and arthritis attributable activity limitation, and arthritis attributable joint pain and arthritis attributable work limitation, taking into account co-variates including age, sex, race/ethnicity, education, income, self-reported health status, co-morbidities (diabetes, hypertension, underweight/overweight/obesity), smoking, alcohol use and physical activity. As noted above, although there has been considerable relevant published work in the area, previously published studies have not used 2011 and 2013 BRFSS data to examine these particular relationships while considering these sociodemographic, health status and health behavior characteristics. Thus this work will allow for more factors of conceptual importance to be considered with regard to more recent data in this area of study than previously published works, allowing for more precise estimates. Consideration of these co-variates in addition to the primary dependent and independent variables of interest will provide information on which characteristics remain important with other factors considered, potentially providing input on risk factors amenable for public health intervention in a more holistic context.

B. Research questions, aims and hypotheses

1. Research questions

What is the prevalence of a.) arthritis attributable joint pain; and b.) arthritis attributable severe joint pain in U.S. adults ≥18 years old, and how are these characteristics associated with arthritis attributable-activity limitation and arthritis attributable work limitation, taking into account the effects of sociodemographic characteristics, health status and health behaviors? 1.) Among U.S. adults with arthritis, what is the association between a.) arthritis attributable joint pain and b.) severe arthritis attributable joint pain, and arthritis attributable activity limitation? How do sociodemographic characteristics, health status characteristics and health behavior characteristics affect this relationship? 2.) Among U.S. adults with arthritis, what is the association between a.) arthritis attributable joint pain and b.) severe arthritis attributable joint pain, and arthritis attributable work limitation? How do sociodemographic characteristics, health status characteristics and health behavior characteristics affect this relationship?

2. Aims/hypotheses:

Aim 1: To determine, among U.S. adults with arthritis, what is the association between arthritis attributable joint pain and arthritis attributable activity limitation? How do sociodemographic characteristics, health status characteristics and health behavior characteristics affect this relationship?

Hypothesis 1: Those with arthritis attributable joint pain will report greater arthritis attributable activity limitation as indicated by statistically significant odds ratio greater than one when compared against those without arthritis attributable joint pain. This will be true even after controlling for sociodemographic, health status and health behavior characteristics.

Hypothesis 2: Those with greater severity arthritis attributable joint pain will report greater arthritis attributable activity limitation as indicated by statistically significant odds ratio greater than one when compared to those without arthritis attributable joint pain, with the magnitude of association being larger for the comparison of severe arthritis attributable joint pain to no arthritis attributable joint pain versus mild-moderate arthritis attributable joint pain to no arthritis attributable joint pain . This will be true even after controlling for sociodemographic, health status and health behavior characteristics.

Aim 2: To determine, among U.S. adults with arthritis, what is the association between arthritis attributable joint pain and arthritis attributable work limitation? How do sociodemographic characteristics, health status characteristics and health behavior characteristics affect this relationship?

Hypothesis 3: Those with arthritis attributable joint pain will have greater arthritis attributable work limitation as indicated by statistically significant odds ratio greater than one when compared against those without arthritis attributable joint pain. This will be true even after controlling for sociodemographic, health status and health behavior characteristics.

Hypothesis 4: Those with greater severity arthritis attributable joint pain will have greater arthritis attributable work limitation as indicated by statistically significant odds ratio greater than one when compared to those without arthritis attributable joint pain, with the magnitude of association being larger for the comparison of severe arthritis attributable joint pain to no arthritis attributable joint pain versus mild-moderate arthritis attributable joint pain to no arthritis attributable joint pain. This will be true even after controlling for sociodemographic, health status and health behavior characteristics.

III. METHODS

A. Data source/measurement/setting

1. Behavioral Risk Factor Surveillance System database background

The Behavioral Risk Factor Surveillance System (BRFSS) is a state-based program of data collection designed to measure behavioral risk factors in individuals 18 and older. It is the result of a partnership between the Centers for Disease Control and Prevention and the states and territories of the United States. Fifteen states initially participated in the original 1984 version, which has since expanded to include, in the 2011 and 2013 data, landline and cell phone information from all 50 states, the District of Columbia, Guam, and Puerto Rico (91-93).

2. Behavioral Risk Factor Surveillance System database methodology

The BRFSS collects data via telephone survey, including cell phone data since 2011. Also since 2011, BRFSS data is weighted with a method called raking or iterative proportional fitting (94). Iterative proportional fitting refers to a process by which the individual cell values in a data table are iteratively adjusted to add up to pre-selected column and row values (95). Per the "2011 BRFSS Overview" document, the purpose of iterative proportional fitting in the BRFSS data is: "[r]aking adjusts the data so that groups which are underrepresented in the sample can be more accurately represented in the final dataset. Raking allows for the incorporation of cell phone survey data, permits the introduction of additional demographic characteristics and more accurately matches sample distributions to known demographic characteristics of populations. The use of raking reduces nonresponse bias and has been shown to reduce error within estimates," (96).

BRFSS data are currently weighted for: “age, sex, categories of ethnicity, geographic regions within states, marital status, education level, home ownership and type of phone ownership,” (94).

3. Behavioral Risk Factor Surveillance System database benefits and limitations

Benefits and limitations of use of BRFSS data include that it is designed to be representative of the adult non-military, non-institutionalized population of each state, the District of Columbia, Guam and Puerto Rico. The large sample size allows for more refined analysis of subgroups. The dataset provides information on many variables of interest for describing the relationship between arthritis joint pain and arthritis activity and work limitation (93-94).

B. Study design, sample, study size

This is a cross sectional study using 2011 and 2013 Behavioral Risk Factor Surveillance System data, with the sample consisting of individuals aged ≥18 with arthritis. The analytic sample (described in detail in the Results chapter) further specified that participants have no missing data for the variables: joint pain, arthritis attributable activity limitation and arthritis attributable work limitation.

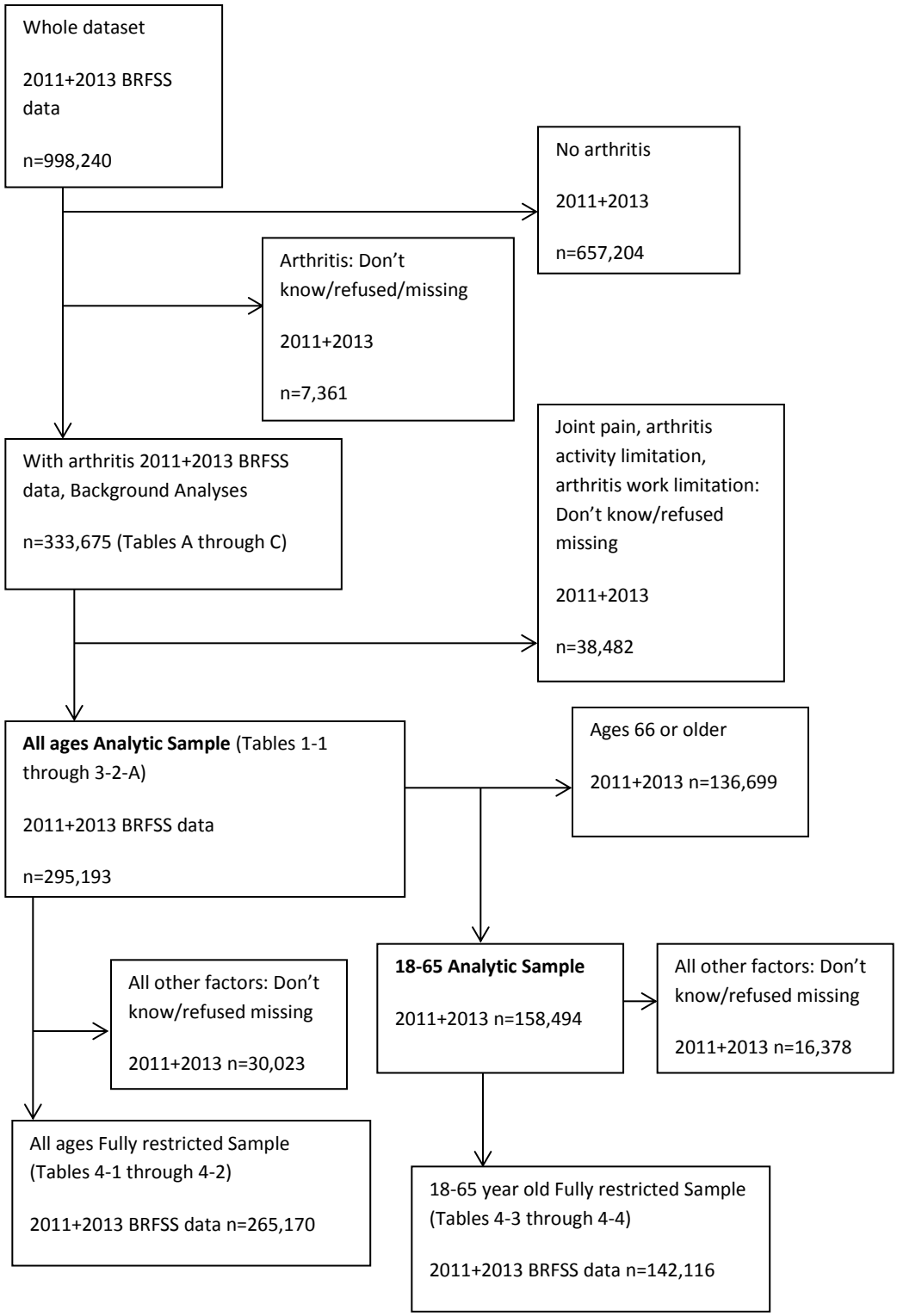
Figure 3 provides information on the analytic sample of BRFSS 2011 and 2013 data with unweighted frequencies and percents.

C. Variables

1. Main exposure variable

The main exposure variable of interest was arthritis attributable joint pain. If participants answered “yes” to the question: “Has a doctor, nurse, or other health professional EVER told you that you have some form of arthritis, rheumatoid arthritis, gout, lupus or fibromyalgia?”, participants were then asked questions regarding arthritis burden, including the question of interest: “Please think about the past 30 days, keeping in mind all of your joint pain or aching and whether or not

Figure 3. Analytic samples, BRFSS 2011 and 2013 data flow chart, unweighted frequencies



you have taken medication. DURING THE PAST 30 DAYS, how bad was your joint pain ON AVERAGE? Please answer on a scale of 0 to 10 where 0 is no pain or aching and 10 is pain or aching as bad as it can be." (97-100). The case definition of self-reported "doctor-diagnosed" arthritis has been shown to be valid for surveillance data by Sacks et al. using BRFSS data, with weighted sensitivity 77.4% for 45-64 year olds, and 83.6% for those ≥65, and weighted specificity 58.8% for 45-64 year olds, and 70.6% for those ≥65 (101). A study by Szoeke et al. in 2008 using information from the Melbourne Women's Mid-life Health Project further found that self-reported physician diagnosed arthritis indicated by the question: "Have you ever been told by a doctor that you have arthritis," was most predictive of radiologically assessed osteoarthritis as compared to asking: "[d]o you have arthritis or rheumatism" or [h]ave you experienced aches or stiff joints" (102).

In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 29653 (8.9%) were in the "don't know/missing/refused" category for arthritis joint pain.

In this study, analyses were conducted examining those with joint pain (numeric pain scale values 1 through 10) and without joint pain (numeric pain scale value 0) among those with arthritis, as well as by categorizing arthritis joint pain as none (numeric pain scale value 0), mild to moderate (numeric pain scale values 1-6) and severe (numeric pain scale values 7-10) (68, 103-104). For all analyses, no joint pain was the referent category.

2. <u>Outcome measures</u>

The outcome variables in this study, examined separately, were: arthritis attributable activity limitation and arthritis attributable work limitation.

If participants answered "yes" to having arthritis, they were asked: "Arthritis can cause symptoms like pain, aching, or stiffness around a joint. Are you now limited in any way in any of your

usual activities because of arthritis or joint symptoms?" In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 21416 (6.4%) were in the "don't know/missing/refused" category for arthritis attributable activity limitation. For all analyses, no arthritis attributable activity limitation was the referent category.

If participants answered "yes" to having arthritis, they were asked: "In this next question we are referring to work for pay. Do arthritis or joint symptoms now affect whether you work, the type of work you do or the amount of work you do?" In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 26799 (8.0%) were in the "don't know/missing/refused" category for arthritis attributable work limitation. For all analyses, no arthritis attributable work limitation was the referent category.

3. Co-variates

a. Sociodemographic factors (age, sex, race/ethnicity, education, income)

Age was divided differently for the two different outcomes. For the work limitation outcome, the age groups were: 18-35, 36-50, 51-65. For the activity limitation outcome, the age groups were: 18-35, 36-50, 51-65, ≥66. The cut off at 65 was used for the work limitation outcome because the traditional retirement age in the United States has been 65 for many years (though age for retirement is slowly increasing) (105). The intermediate cut points were informed by studies indicating a progression in prevalence of osteoarthritis over time, such as a 2013 study by Losina et al. using US population data from the 2007-2008 NHANES, which found the median age of diagnosis of knee osteoarthritis was 55 years old: "Median age represented the age at which 50% of those ultimately diagnosed with symptomatic knee OA had been diagnosed (i.e. the 50% mark of the cumulative distribution function of incident cases)," (18). In addition to the age categories described here, additional analyses were performed with standard CDC age groupings in the multivariable models (18-

44, 45-64 for the work limitation models and 18-44, 45-64, ≥65 in the activity limitation models) and results are described in the "Additional analyses" section of the Results. In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 1415 (0.4%) were in the "don't know/missing/refused" category for age. For all analyses for both outcomes, the 18-34 year old age grouping was the referent category.

Sex was categorized as male or female. In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 0 (0.0%) were in the "don't know/missing/refused" category for sex. For all analyses, male was the referent category.

Race was categorized into five race/ethnicity groups: white non-Hispanic; black non-Hispanic; Asian non-Hispanic, Hispanic, other non-Hispanic. In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 5018 (1.5%) were in the "don't know/missing/refused" category for race. For all analyses, white race was the referent category.

Education was categorized as less than high school, high school graduate/GED, some college or technical school, college graduate. In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 1215 (0.4%) were in the "don't know/missing/refused" category for education. For all analyses, college graduate was the referent category.

Income was initially categorized as <$15000, $15,000-$24,999, $25,000-$49,999, ≥$50,000. In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 52478 (15.7%) were in the "don't know/missing/refused" category for education. For all analyses, ≥$50,000 was the referent category, as has been done in other studies using BRFSS data (106). Income was only included for the outcome activity limitation. It was not used in analyses involving work limitation due in part to concerns about information on this factor being difficult to interpret with regard to this outcome (e.g. as the data is cross-sectional, how would an association between low income and presence of work

limitation be interpreted?) However, additional analyses were performed later to confirm that income did not meet criteria for inclusion in arthritis attributable work limitation multivariable models, discussed in Results section. In the analytic sample, which consisted of those participants with arthritis and without missing for joint pain, arthritis activity limitation and arthritis work limitation, income was the only variable with greater than 5% weighted missing , having 12.9% weighted missing (see section IV Results, B Descriptive Data, Table IV). Therefore the income variable was used with an additional level specifying missing data for analyses involving arthritis activity limitation.

b. <u>Health status factors (self-reported health status, co-morbidities such as diabetes, hypertension, underweight/obesity/overweight)</u>

With regard to self-reported health status, participants were asked: "Would you say that in general your health is excellent, very good, good, fair, or poor,"(97-100). In this study self-reported health status was divided into two categories: good or better (comprised of excellent, very good, good) and fair or worse (comprised of fair or poor). In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 1672 (0.5%) were in the "don't know/missing/refused" category for self-reported health status. For all analyses, good or better self-reported health status was the referent category.

Diabetes diagnosis was categorized as yes or no with yes including only those who reported being told by a health provider that they had diabetes (not including females who stated they were told they had diabetes only during pregnancy, and not including those who said they did not have a diagnosis of diabetes but had borderline or pre-diabetes). In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 555 (0.2%) were in the "don't know/missing/refused" category for diagnosed diabetes. For all analyses, no diabetes was the referent category.

Hypertension was categorized as yes or no with yes including only those who reported being

told by a health provider that they had hypertension (not including females who stated they were told they had hypertension only during pregnancy, and not including those who said they did not have a diagnosis of hypertension but had borderline high blood pressure or were pre-hypertensive). In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted values, 862 (0.3%) were in the "don't know/missing/refused" category for diagnosed hypertension. For all analyses, no hypertension was the referent category.

Weight was a four level variable, created from the "computed body mass index categories" calculated variable found within each of the2011 and 2013 BRFSS data, with level 0, the referent category, identifying those with BMI associated with normal weight (18.5 to <25.0), and the other levels in this nominal variable being BMI below 18.5 "underweight", BMI 25.0 to < 30.0 "overweight", and BMI ≥30.0 "obese". BMI cutoffs corresponded to CDC designations for BMI ranges and associated weight categories for adults (107). In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted data, 16293 (4.9%) were in the "don't know/missing/refused" category for obesity/overweight. For all analyses, normal weight was the referent category.

c. Health behaviors (smoking, alcohol use, physical activity)

To evaluate smoking, adults were categorized as yes or no with regard to current smoking status. In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted data, 5266 (1.6%) were in the "don't know/missing/refused" category for smoking status. For all analyses, not a current smoker was the referent category.

Alcohol use was categorized as any alcohol use in the last 30 days, yes or no. In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted data, 16212 (4.9%) were in the "don't know/missing/refused" category for alcohol use in the past 30 days. For all analyses, no alcohol use was the referent category.

The United States Department of Health and Human Services issues physical activity guidelines; the 2008 Physical Activity Guidelines for Americans states, in their Key Guidelines for Adults: "[f]or substantial health benefits, adults should do at least 150 minutes …a week of moderate-intensity, or 75 minutes…a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate-and vigorous-intensity aerobic activity," (108). Physical activity was evaluated in this study by a variable that categorized "Adults that participated in 150 minutes (or vigorous equivalent minutes) of physical activity per week", with levels being: 0 minutes (or vigorous equivalent minutes) of physical activity per week, 1-149 minutes (or vigorous equivalent minutes) of physical activity per week, and ≥150 minutes (or vigorous equivalent minutes) of physical activity per week. In the combined 2011 and 2013 BRFSS data, of those with arthritis, for unweighted data, 28512 (8.5%) were in the "don't know/missing/refused" category for "Adults that participated in 150 minutes (or vigorous equivalent minutes) of physical activity per week". For all analyses, ≥150 minutes (or vigorous equivalent minutes) of physical activity was the referent category.

D. <u>Statistical methods</u>

BRFSS data is weighted in two ways: design weighting and "raking" or iterative proportional fitting. Design weighting accounts for the number of phones and adults per household, as well as the number of records available and selected in each geographic and density strata. "Since 2011, BRFSS's new weighting protocols have ensured that data are representative of the population on a number of demographic characteristics including sex, age, race, education, marital status, home ownership, phone ownership (landline telephone, cellular telephone or both) and sub-state region…Raking weighting incorporates the known characteristics of the population into the sample. If the sample is disproportionately female, raking will adjust the responses of females in the sample to accurately represent the proportion of females in the population. This is done in an iterative process, with each

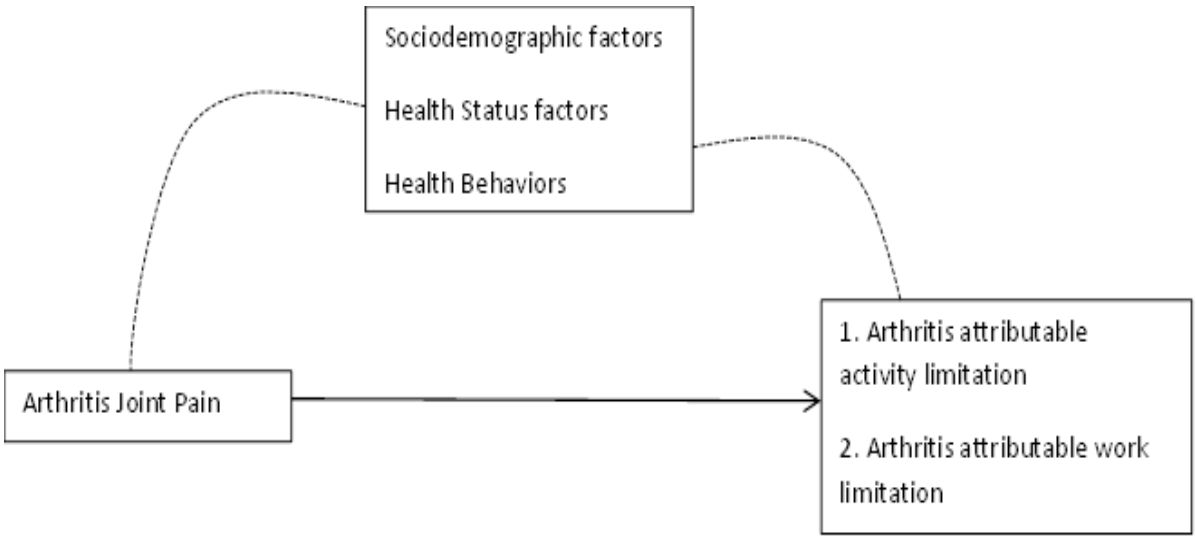
demographic factor introduced in a sequence." (109). As this analysis uses two years of BRFSS data, 2011 and 2013, the sample weight was adjusted appropriately to produce correct unweighted frequencies, and weighted percents and weighted measures of association.

Descriptive analyses of exposure, co-variates and outcomes of interest: arthritis attributable activity limitation and arthritis attributable work limitation, were performed including unweighted frequencies (e.g. sample size) and weighted percents. Crude relationships between main exposure to outcomes, main exposure to co-variates and co-variates to outcomes was assessed with SAS proc surveyfreq produced Rao-Scott chi square p value, which provides a more conservative estimate than Wald chi square for complex survey data (110). Although prevalence rate ratio would have been the preferred measure of association, there is currently no procedure available to obtain this information easily using SAS survey procedures. Therefore, crude relationships between the main exposure (arthritis attributable joint pain) and the outcomes (arthritis attributable activity limitation, arthritis attributable work limitation) were also assessed via logistic regression, and odds ratio and 95% confidence interval obtained. Stratified analysis was performed for each co-variate and arthritis joint pain against each outcome to assess for confounding and effect modification, with the co-variate considered a confounder at this point if there was a ≥10% change in the value of the odds ratio between the crude and adjusted value. Because SAS surveyfreq procedures do not provide a specific statistical test for interaction, logistic regression models for each outcome were constructed including joint pain and each co-variate, with the co-variate considered a possible effect modifier of interest if the p value for the interaction term was ≤0.2. Interaction terms with p value ≤0.2 were evaluated further with stratum specific odds ratios and 95% confidence intervals. In initial full multivariable models predicting each outcome, each of which were iteratively refined to reach a final model using the method of manual backward elimination, variables that had previously been identified as possible confounders or effect modifiers as described above were included, though the variables: age, sex, race/ethnicity, self-reported health

status, and physical activity were included regardless of statistical significance as these variables are commonly reported in the literature, and represent important factors in the domains: sociodemographic factors, health status factors, and health behaviors, which are theorized to potentially affect the relationship between arthritis attributable joint pain and each outcome of interest (see Figure 4 below), with consideration of the general conceptual background provided by the WHO ICF and the biopsychosocial model discussed in the Introduction. In initial full multivariable models, each included interaction term was evaluated for p value ≤0.2 and removed if p value was greater than this cut point. Interaction terms with p value ≤0.2 were evaluated further and retained if deemed important at this step. Although all covariates were assessed for potential confounding and effect modification, the general conceptual basis for considering a co-variate as a possible confounder or effect modifier was based on the literature review noted in Sections II A, B, C and a co-variate matrix displaying these considerations is shown below in Table I. Within the discussion section of this paper, results were interpreted in light of the generation of odds ratios rather than prevalence rate ratios.

With regard to missing data: if, in initial background descriptive analysis of combined 2011, 2013 BRFSS data evaluating participants with arthritis in Table II (found in Results chapter), variables were found to have greater than 5% weighted missing, a separate table was created for each variable, evaluating whether those missing were significantly different than those not missing for variables of interest in this study. The results of those background analyses (Tables XXIII-XXVIII, Appendix B) are discussed further in the Discussion. The overall analyses of interest (Tables IV-XXII), were restricted to the "analytic sample", which consisted of those participants with arthritis, and not missing data for any of: joint pain (main exposure), arthritis activity limitation (outcome), arthritis work limitation (outcome). Within the analytic sample, those co-variates with greater than 5% weighted missing were analyzed including a level specifying missing. This issue pertained only to income in the analytic sample, and that

Figure 4. Hypothesized general associations between arthritis attributable joint pain and arthritis attributable activity limitation/arthritis attributable work limitation



variable is discussed further in section III C, 3. Multivariable modeling was further restricted only to those non missing for all factors in the analytic sample, and this fully restricted (to non missing) sample is described in Table V, and crude odds ratios based on the fully restricted to non missing sample are given in Tables VI, and Tables XIX through XXII. Imputation to address missing data was not used in this study.

For all analyses, p-values ≤0.05 were considered statistically significant, however, as noted above, the variables age, race, sex, self-reported health status and physical activity were included in final models regardless of statistical significance, as they are commonly reported in the literature in this area and can be considered conceptually important with regard to the relationship between arthritis joint pain and the outcomes of interest.

All analyses were performed with SAS 9.3 using survey procedures to generate weighted results with appropriate variance estimates.

TABLE I. CO-VARIATE MATRIX: POSSIBLE ROLE OF CO-VARIATE IN THE RELATIONSHIP BETWEEN MAIN EXPOSURE AND OUTCOME: ARTHRITIS JOINT PAIN—ARTHRITIS ACTIVITY LIMITATION; ARTHRITIS JOINT PAIN—ARTHRITIS WORK LIMITATION			
Factor	**Possible Confounder**	**Possible Effect Modifier**	**Possible Mediator**
Age	Yes	No	No
Sex	Yes	Yes	No
Race	Yes	Yes	No
Education	Yes	Yes	No
Income	Yes	No for activity limitation Yes for work limitation→will not be used in work limitation models	No for activity limitation Possible for work limitation→will not be used in work limitation models
Self-reported health status	Yes	Yes	Possible for activity limitation Possible for work limitation
Diabetes	Yes	Yes	No
Hypertension	Yes	Yes	No
Weight	Yes	Yes	Possible for activity limitation Possible for work limitation
Smoking	Yes	No	No
Alcohol use	Yes	No	No
Physical Activity	Yes	No	Possible for activity limitation Possible for work limitation

IV. RESULTS

A. Participants

As shown in Figure 3 (found in the Methods chapter), the sample for the background analyses (Tables II and Tables XXIII-XXVIII, with Tables XXIII-XVIII found in Appendix B) was restricted to those participants with arthritis in the 2011 and 2013 BRFSS data, n=333675. The analytic sample used for the majority of the analyses (Tables IV through XVIII) was restricted to those participants with arthritis who were also non missing for joint pain, arthritis activity limitation and arthritis work limitation, n=295193 for all ages and n=158494 for ages 18-65. Multivariable modeling (Tables XIX through XXII) was performed on the sample restricted to those in the analytic sample with no missing on any variable considered, n=265170 for arthritis attributable activity limitation and n=142116 for arthritis attributable work limitation.

B. Background data

Table II provides information on the unweighted frequencies and weighted percents in the sample consisting of those with arthritis in the 2011 and 2013 BRFSS data. The main exposure and both outcomes (arthritis activity limitation and arthritis work limitation) all demonstrate greater than 5% missing (9.8%, 7.6% and 9.1% respectively). In addition, three other co-variates also demonstrated greater than 5% missing in this dataset including those with arthritis: income (missing 14.4%), having had an alcoholic drink in the last month (missing 5.8%), and physical activity (missing 9.0%). Tables XXIII through XVIII (not shown in Results section, found in Appendix B) represent separate tables for each of the variables found to have 5% or more weighted missing in Table II, and for each table, comparison is made between those missing and those non missing on the variable of interest, with regard to the other factors investigated in the study. The significant p values found for most factors in all tables from XXIII

TABLE II. UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, OF U.S. ADULTS WITH ARTHRITIS, BRFSS 2011 AND 2013 DATA, n=333675[a]		
Factor	**Frequency unweighted**	**Percent weighted (95% CI)**
Arthritis joint pain		
No joint pain (referent)	**22316**	**6.8 (6.6, 7.0)**
Mild-Moderate joint pain	**195639**	**55.6 (55.3, 56.0)**
Severe joint pain	**86067**	**27.8 (27.5, 28.1)**
Missing/don't know/refused	**29653**	**9.8 (9.6, 10.0)**
Arthritis activity limitation		
No arthritis activity limitation	**154576**	**45.4 (45.1, 45.8)**
Yes arthritis activity limitation	**157683**	**47.0 (46.7, 47.4)**
Missing/don't know/refused	**21416**	**7.6 (7.4, 7.8)**
Arthritis work limitation		
No arthritis work limitation	**205884**	**58.5 58.2, 58.9)**
Yes arthritis work limitation	**100992**	**32.4 (32.1, 32.7)**
Missing/don't know/refused	**26799**	**9.1 (8.8, 9.3)**
Age		
Mean age (95% CI)		**59.4 (59.2, 59.5)**
Missing/don't know/refused	**1415**	**0.4 (0.3, 0.4)**
Sex		
Male (referent)	**110989**	**40.7 (40.3, 41.0)**
Female	**222686**	**59.3 (59.0, 59.7)**
Missing/don't know/refused	**0**	**0**
Race/ethnicity		
White, non-Hispanic (referent)	**267532**	**73.1 (72.8, 73.5)**
Black, non-Hispanic	**27646**	**10.8 (10.6, 11.1)**
Asian, non-Hispanic	**2657**	**1.9 (1.7, 2.1)**
Hispanic	**16897**	**9.1 (8.9, 9.4)**
Other	**13925**	**3.4 (3.3, 3.5)**
Missing/don't know/refused	**5018**	**1.6 (1.5, 1.7)**
Education		
Less than high school	**38590**	**18.3 (18.0, 18.7)**
High school graduate/GED	**110058**	**31.6 (31.3, 32.0)**
Some college or technical school	**92724**	**30.0 (29.7, 30.3)**
College graduate (referent)	**91088**	**19.7 (19.4, 19.9)**
Missing/don't know/refused	**1215**	**0.4 (0.3, 0.4)**
Income		
≥50k (referent)	**90637**	**29.7 (29.4, 30.0)**
25k-$49,999	**78558**	**22.7 (22.5, 23.0)**

TABLE II. (continued) UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, OF U.S. ADULTS WITH ARTHRITIS, BRFSS 2011 AND 2013 DATA, n=333675[a]		
Factor	**Frequency unweighted**	**Percent weighted (95% CI)**
15k-$24,999	**63265**	**18.5 (18.2, 18.7)**
Less than 15k	**48737**	**14.6 (14.3, 14.8)**
Missing/don't know/refused	**52478**	**14.4 (14.2, 14.7)**
Self-reported health status		
Good or better (referent)	**218964**	**64.1 (63.8, 64.5)**
Fair or worse	**113039**	**35.3 (35.0, 35.6)**
Missing/don't know/refused	**1672**	**0.5 (0.5, 0.6)**
Diabetes		
No diabetes	**265554**	**80.0 (79.7, 80.3)**
Yes diabetes	**67566**	**19.8 (19.5, 20.1)**
Missing/don't know/refused	**555**	**0.2 (0.2, 0.2)**
Hypertension		
No hypertension	**137576**	**44.4 (44.1, 44.8)**
Yes hypertension	**195237**	**55.4 (55.0, 55.7)**
Missing/don't know/refused	**862**	**0.2 (0.2, 0.3)**
Weight		
Normal BMI (referent)	**85084**	**24.2 (23.9, 24.5)**
Underweight BMI	**4988**	**1.4 (1.3, 1.5)**
Overweight BMI	**111422**	**33.3 (33.0, 33.7)**
Obese BMI	**115888**	**36.4 (36.1, 36.8)**
Missing/don't know/refused	**16293**	**4.6 (4.5, 4.7)**
Smoking		
Non smoker	**273325**	**78.1 (77.8, 78.4)**
Smoker	**55084**	**20.1 (19.9, 20.4)**
Missing/don't know/refused	**5266**	**1.8 (1.7, 1.9)**
Alcohol		
No alcohol	**184405**	**51.9 (51.6, 52.3)**
Yes alcohol	**133056**	**42.3 (42.0, 42.7)**
Missing/don't know/refused	**16214**	**5.8 (5.6, 5.9)**
Physical Activity		
0 minutes	**112602**	**33.4 (33.0, 33.7)**
1-149 minutes	**48862**	**15.6 (15.4, 15.9)**
≥150 minutes (referent)	**143699**	**41.9 (41.6, 42.3)**
Missing/don't know/refused	**28512**	**9.0 (8.8, 9.2)**
[a]Restricted to those with arthritis out of 2011, 2013 data, includes missing		

through XVIII indicate that there is a significant difference between those missing on those non missing evaluated. See Discussion section for further information.

Table III provides information on the sample restricted to those with arthritis next to the sample restricted to those with arthritis and not missing for joint pain, arthritis activity limitation, and arthritis work limitation (the analytic sample). This qualitative comparison indicates there may be some differences between the two samples, and further information on these differences is provided in the missing versus non missing tables (Tables XXIII-XXVIII, Appendix B) as well as in the Discussion section. Briefly, those included in the analytic sample tended to be more educated (20.5% versus 19.7% college graduate), richer (31.1% versus 29.7% highest income group) and more likely to be white (73.9% versus 73.1%). Information on the analytic sample only is provided in Table IV.

C. <u>Descriptive data</u>

Table IV provides descriptive information (unweighted frequencies and weighted percents) for the analytic sample. Most of the sample indicated that they had arthritis attributable joint pain (92.4%), with 62.0% with mild-moderate joint pain and 30.4% indicating they experienced severe joint pain. About half the sample, 50.6%, had arthritis attributable activity limitation and more than a third of the sample had arthritis attributable work limitation, 35.8%. The sample was primarily older (mean age 59.2), female (59.4%) and white (73.9%). The most frequently reported education level was high school graduate/GED at 31.4%. The most frequently reported income level was the highest, $50,000 or more, at 31.1%. Most people reported good or better health for self-reported health status (65.0%). Most people in the sample did not have diabetes (80.3% no diabetes), but did have hypertension (55.1%). The most commonly reported BMI category was obese (37.0%). Most were non-smokers at 79.3% and denied alcohol use in the last month (54.0% no alcohol use in the last month). The most frequently reported physical activity category was the referent level of 150 minutes or more of moderate or

TABLE III. UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, U.S. ADULTS WITH ARTHRITIS, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS, INCLUDES MISSING), SHOWN WITH ALL AGES ANALYTIC SAMPLE, n=295193[a]				
Factor	**Frequency unweighted, those with arthritis n=333675**	**Percent weighted (95% CI)**	**Frequency unweighted, all ages analytic sample n=295193**	**Percent weighted (95% CI)**
Arthritis joint pain				
No joint pain (referent)	**22316**	**6.8 (6.6, 7.0)**	**21862**	**7.6 (7.4, 7.8)**
Mild-Moderate joint pain	**195639**	**55.6 (55.3, 56.0)**	**190573**	**62.0 (61.6, 62.3)**
Severe joint pain	**86067**	**27.8 (27.5, 28.1)**	**82758**	**30.4 (30.1, 30.8)**
Missing/don't know/refused	**29653**	**9.8 (9.6, 10.0)**	**0**	**0**
Arthritis activity limitation				
No arthritis activity limitation	**154576**	**45.4 (45.1, 45.8)**	**146808**	**49.4 (49.0, 49.7)**
Yes arthritis activity limitation	**157683**	**47.0 (46.7, 47.4)**	**148385**	**50.6 (50.3, 51.0)**
Missing/don't know/refused	**21416**	**7.6 (7.4, 7.8)**	**0**	**0**
Arthritis work limitation				
No arthritis work limitation	**205884**	**58.5 58.2, 58.9)**	**197666**	**64.2 (63.9, 64.6)**
Yes arthritis work limitation	**100992**	**32.4 (32.1, 32.7)**	**97527**	**35.8 (35.4, 36.1)**
Missing/don't know/refused	**26799**	**9.1 (8.8, 9.3)**	**0**	**0**
Age				
Mean age (95% CI)		**59.4 (59.2, 59.5)**		**59.2 (59.0, 59.3)**
Missing/don't know/refused	**1415**	**0.4 (0.3, 0.4)**	**1096**	**0.3 (0.3, 0.4)**
Sex				
Male (referent)	**110989**	**40.7 (40.3, 41.0)**	**98461**	**40.6 (40.3, 41.0)**

TABLE III. (continued) UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, U.S. ADULTS WITH ARTHRITIS, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS, INCLUDES MISSING), SHOWN WITH ALL AGES ANALYTIC SAMPLE, n=295193[a]				
Factor	**Frequency unweighted, those with arthritis n=333675**	**Percent weighted (95% CI)**	**Frequency unweighted, all ages analytic sample n=295193**	**Percent weighted (95% CI)**
Female	**222686**	**59.3 (59.0, 59.7)**	**196732**	**59.4 (59.0, 59.7)**
Missing/don't know/refused	**0**	**0**	**0**	**0**
Race/ethnicity				
White, non-Hispanic (referent)	**267532**	**73.1 (72.8, 73.5)**	**238090**	**73.9 (73.5, 74.3)**
Black, non-Hispanic	**27646**	**10.8 (10.6, 11.1)**	**23807**	**10.5 (10.2, 10.7)**
Asian, non-Hispanic	**2657**	**1.9 (1.7, 2.1)**	**2340**	**1.9 (1.7, 2.0)**
Hispanic	**16897**	**9.1 (8.9, 9.4)**	**14851**	**8.9 (8.7, 9.2)**
Other	**13925**	**3.4 (3.3, 3.5)**	**12245**	**3.4 (3.2, 3.5)**
Missing/don't know/refused	**5018**	**1.6 (1.5, 1.7)**	**3860**	**1.4 (1.4, 1.5)**
Education				
Less than high school	**38590**	**18.3 (18.0, 18.7)**	**32233**	**17.5 (17.2, 17.8)**
High school graduate/GED	**110058**	**31.6 (31.3, 32.0)**	**95981**	**31.4 (31.0, 31.7)**
Some college or technical school	**92724**	**30.0 (29.7, 30.3)**	**82989**	**30.4 (30.1, 30.8)**
College graduate (referent)	**91088**	**19.7 (19.4, 19.9)**	**83400**	**20.5 (20.3, 20.8)**
Missing/don't know/refused	**1215**	**0.4 (0.3, 0.4)**	**590**	**0.2 (0.2, 0.2)**
Income				
≥50k (referent)	**90637**	**29.7 (29.4, 30.0)**	**84075**	**31.1 (30.8, 31.4)**
25k-$49,999	**78558**	**22.7 (22.5, 23.0)**	**71230**	**23.4 (23.0, 23.7)**
15k-$24,999	**63265**	**18.5 (18.2, 18.7)**	**55701**	**18.4 (18.2, 18.7)**
Less than 15k	**48737**	**14.6 (14.3, 14.8)**	**42365**	**14.2 (13.9, 14.5)**
Missing/don't know/refused	**52478**	**14.4 (14.2, 14.7)**	**41822**	**12.9[b] (12.7, 13.2)**

TABLE III. (continued) UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, U.S. ADULTS WITH ARTHRITIS, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS, INCLUDES MISSING), SHOWN WITH ALL AGES ANALYTIC SAMPLE, n=295193[a]				
Factor	**Frequency unweighted, those with arthritis n=333675**	**Percent weighted (95% CI)**	**Frequency unweighted, all ages analytic sample n=295193**	**Percent weighted (95% CI)**
Self-reported health status				
Good or better (referent)	**218964**	**64.1 (63.8, 64.5)**	**196158**	**65.0 (64.6, 65.3)**
Fair or worse	**113039**	**35.3 (35.0, 35.6)**	**97821**	**34.6 (34.2, 34.9)**
Missing/don't know/refused	**1672**	**0.5 (0.5, 0.6)**	**1214**	**0.5 (0.4, 0.5)**
Diabetes				
No diabetes	**265554**	**80.0 (79.7, 80.3)**	**235564**	**80.3 (80.0, 80.6)**
Yes diabetes	**67566**	**19.8 (19.5, 20.1)**	**59165**	**19.5 (19.3, 19.8)**
Missing/don't know/refused	**555**	**0.2 (0.2, 0.2)**	**464**	**0.1 (0.1, 0.2)**
Hypertension				
No hypertension	**137576**	**44.4 (44.1, 44.8)**	**122665**	**44.7 (44.3 45.1)**
Yes hypertension	**195237**	**55.4 (55.0, 55.7)**	**171893**	**55.1 (54.7, 55.5)**
Missing/don't know/refused	**862**	**0.2 (0.2, 0.3)**	**635**	**0.2 (0.2, 0.2)**
Weight				
Normal BMI (referent)	**85084**	**24.2 (23.9, 24.5)**	**75122**	**24.2 (23.9, 24.5)**
Underweight BMI	**4988**	**1.4 (1.3, 1.5)**	**4281**	**1.4 (1.3, 1.4)**
Overweight BMI	**111422**	**33.3 (33.0, 33.7)**	**99273**	**33.5 (33.2, 33.9)**
Obese BMI	**115888**	**36.4 (36.1, 36.8)**	**104180**	**37.0 (36.6, 37.3)**
Missing/don't know/refused	**16293**	**4.6 (4.5, 4.7)**	**12337**	**3.9 (3.8, 4.1)**
Smoking				
Non smoker	**273325**	**78.1 (77.8, 78.4)**	**244681**	**79.3 (79.0, 79.6)**

TABLE III. (continued) UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, U.S. ADULTS WITH ARTHRITIS, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS, INCLUDES MISSING), SHOWN WITH ALL AGES ANALYTIC SAMPLE, n=295193[a]				
Factor	**Frequency unweighted, those with arthritis n=333675**	**Percent weighted (95% CI)**	**Frequency unweighted, all ages analytic sample n=295193**	**Percent weighted (95% CI)**
Smoker	**55084**	**20.1 (19.9, 20.4)**	**49151**	**20.3 (20.0, 20.6)**
Missing/don't know/refused	**5266**	**1.8 (1.7, 1.9)**	**1361**	**0.4 (0.4, 0.5)**
Alcohol				
No alcohol	**184405**	**51.9 (51.6, 52.3)**	**168191**	**54.0 (53.6, 54.3)**
Yes alcohol	**133056**	**42.3 (42.0, 42.7)**	**124312**	**45.1 (44.7, 45.5)**
Missing/don't know/refused	**16214**	**5.8 (5.6, 5.9)**	**2690**	**0.9 (0.9, 1.0)**
Physical Activity				
0 minutes	**112602**	**33.4 (33.0, 33.7)**	**103506**	**35.0 (34.6, 35.3)**
1-149 minutes	**48862**	**15.6 (15.4, 15.9)**	**46226**	**16.8 (16.5, 17.1)**
≥150 minutes (referent)	**143699**	**41.9 (41.6, 42.3)**	**135401**	**45.0 (44.6, 45.4)**
Missing/don't know/refused	**28512**	**9.0 (8.8, 9.2)**	**10060**	**3.2 (3.1, 3.4)**

[a]Restricted to those with arthritis out of 2011, 2013 BRFSS data not including missing joint pain, arthritis activity limitation and arthritis work limitation.

[b]Variables with 5% weighted or more missing data in the analytic sample had "missing/don't know/refused" included as a level in the variable. This affected the variable income only.

TABLE IV. UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, U.S. ADULTS, BRFSS 2011-2013 DATA, n=295193[a]		
Factor	**Frequency unweighted**	**Percent weighted (95% CI)**
Arthritis joint pain		
No joint pain (referent)	**21862**	**7.6 (7.4, 7.8)**
Mild-Moderate joint pain	**190573**	**62.0 (61.6, 62.3)**
Severe joint pain	**82758**	**30.4 (30.1, 30.8)**
Arthritis activity limitation		
No arthritis activity limitation	**146808**	**49.4 (49.0, 49.7)**
Yes arthritis activity limitation	**148385**	**50.6 (50.3, 51.0)**
Arthritis work limitation[b]		
No arthritis work limitation	**197666**	**64.2 (63.9, 64.6)**
Yes arthritis work limitation	**97527**	**35.8 (35.4, 36.1)**
Age		
Mean age (95% CI)		**59.2 (59.0, 59.3)**
18-35 (referent)	**9368**	**7.3 (7.1, 7.6)**
36-50	**35827**	**18.9 (18.6, 19.2)**
51-65	**112203**	**38.3 (38.0, 38.7)**
≥66	**136699**	**35.1 (34.8, 35.5)**
Missing/don't know/refused	**1096**	**0.3 (0.3, 0.4)**
Sex		
Male (referent)	**98461**	**40.6 (40.3, 41.0)**
Female	**196732**	**59.4 (59.0, 59.7)**
Missing/don't know/refused	**0**	**0**
Race/ethnicity		
White, non-Hispanic (referent)	**238090**	**73.9 (73.5, 74.3)**
Black, non-Hispanic	**23807**	**10.5 (10.2, 10.7)**
Asian, non-Hispanic	**2340**	**1.9 (1.7, 2.0)**
Hispanic	**14851**	**8.9 (8.7, 9.2)**
Other	**12245**	**3.4 (3.2, 3.5)**
Missing/don't know/refused	**3860**	**1.4 (1.4, 1.5)**
Education		
Less than high school	**32233**	**17.5 (17.2, 17.8)**
High school graduate/GED	**95981**	**31.4 (31.0, 31.7)**
Some college or technical school	**82989**	**30.4 (30.1, 30.8)**
College graduate (referent)	**83400**	**20.5 (20.3, 20.8)**
Missing/don't know/refused	**590**	**0.2 (0.2, 0.2)**
Income		
≥50k (referent)	**84075**	**31.1 (30.8, 31.4)**

TABLE IV. (continued) UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, U.S. ADULTS, BRFSS 2011-2013 DATA, n=295193[a]		
Factor	**Frequency unweighted**	**Percent weighted (95% CI)**
25k-$49,999	**71230**	**23.4 (23.0, 23.7)**
15k-$24,999	**55701**	**18.4 (18.2, 18.7)**
Less than 15k	**42365**	**14.2 (13.9, 14.5)**
Missing/don't know/refused[c]	**41822**	**12.9 (12.7, 13.2)**
Self-reported health status		
Good or better (referent)	**196158**	**65.0 (64.6, 65.3)**
Fair or worse	**97821**	**34.6 (34.2, 34.9)**
Missing/don't know/refused	**1214**	**0.5 (0.4, 0.5)**
Diabetes		
No diabetes	**235564**	**80.3 (80.0, 80.6)**
Yes diabetes	**59165**	**19.5 (19.3, 19.8)**
Missing/don't know/refused	**464**	**0.1 (0.1, 0.2)**
Hypertension		
No hypertension	**122665**	**44.7 (44.3 45.1)**
Yes hypertension	**171893**	**55.1 (54.7, 55.5)**
Missing/don't know/refused	**635**	**0.2 (0.2, 0.2)**
Weight		
Normal BMI (referent)	**75122**	**24.2 (23.9, 24.5)**
Underweight BMI	**4281**	**1.4 (1.3, 1.4)**
Overweight BMI	**99273**	**33.5 (33.2, 33.9)**
Obese BMI	**104180**	**37.0 (36.6, 37.3)**
Missing/don't know/refused	**12337**	**3.9 (3.8, 4.1)**
Smoking		
Non smoker	**244681**	**79.3 (79.0, 79.6)**
Smoker	**49151**	**20.3 (20.0, 20.6)**
Missing/don't know/refused	**1361**	**0.4 (0.4, 0.5)**
Alcohol		
No alcohol	**168191**	**54.0 (53.6, 54.3)**
Yes alcohol	**124312**	**45.1 (44.7, 45.5)**
Missing/don't know/refused	**2690**	**0.9 (0.9, 1.0)**
Physical Activity		
0 minutes	**103506**	**35.0 (34.6, 35.3)**
1-149 minutes	**46226**	**16.8 (16.5, 17.1)**
≥150 minutes (referent)	**135401**	**45.0 (44.6, 45.4)**
Missing/don't know/refused	**10060**	**3.2 (3.1, 3.4)**

TABLE IV. (continued) UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, U.S. ADULTS, BRFSS 2011-2013 DATA, n=295193[a]		
Factor	**Frequency unweighted**	**Percent weighted (95% CI)**

[a]BRFSS 2011 and 2013 data, restricted to those with arthritis not including missing joint pain, arthritis activity limitation and arthritis work limitation.

[b]The information shown is for ages ≥18, but the work limitation outcome was actually evaluated in 18-65 only, and those values are: unweighted frequency no limitation 95519, yes limitation 62975; weighted percent (95% confidence interval) 58.6 (58.1, 59.1); 41.4 (40.9, 41.9).

[c]Variables with ≥5% weighted missing data had "missing/don't know/refused" included as a level in the variable. This affected the variable income only.

vigorous equivalent physical activity, 45.0%. In this sample, the only variable with 5% or more missing was income, with 12.9% missing. For this variable, a missing income category was created and included within the variable in further analyses.

Table V shows the distribution of factors in the analytic sample, those with arthritis and not missing for joint pain, arthritis activity limitation and arthritis work limitation, next to the distribution of factors for the analytic sample with no missing for the studied factors, which was the sample used in multivariable modeling. In general, this qualitative comparison suggests that the distribution was very similar in the two samples.

D. Outcome data

Tables VI through X provide information on the crude associations between the main exposure and each of the outcomes, the co-variates and each outcome, and the exposure and each co-variate via Rao-Scott chi square p value and crude odds ratios (95% confidence intervals). Significant p values suggest a significant association in each relationship (exposure to outcome, covariate to outcome, and covariate to exposure), which is evaluated further in subsequent analyses. Crude odds ratios were significant for dichotomous and categorical joint pain variables for each of arthritis activity limitation and arthritis work limitation. Of the co-variates, self-reported health status had the greatest magnitude odds ratio for each outcome, 3.6 (3.5, 3.8) for arthritis activity limitation, and 3.6 (3.5, 3.7) for arthritis activity work limitation respectively.

Table VI provides information on the crude associations between the exposure (dichotomous joint pain and categorical joint pain) and the outcomes (arthritis activity limitation and arthritis work limitation). The crude odds ratios are provided for both the analytic sample (restricted to those with arthritis and without missing for joint pain, arthritis activity limitation and arthritis work limitation) and

TABLE V. UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, U.S. ADULTS, BRFSS 2011-2013 DATA, ANALYTIC SAMPLE, n=295193[a] SHOWN WITH FULLY RESTRICTED SAMPLE, n=265170[b]				
Factor	**Frequency unweighted n=295193**	**Percent weighted (95% CI)**	**Frequency unweighted n=265170**	**Percent weighted (95% CI)**
Arthritis joint pain				
No joint pain (referent)	**21862**	**7.6 (7.4, 7.8)**	**19412**	**7.6 (7.4, 7.8)**
Mild-Moderate joint pain	**190573**	**62.0 (61.6, 62.3)**	**172605**	**62.5 (62.1, 62.9)**
Severe joint pain	**82758**	**30.4 (30.1, 30.8)**	**73153**	**30.0 (30.0, 30.3)**
Arthritis activity limitation				
No arthritis activity limitation	**146808**	**49.4 (49.0, 49.7)**	**132315**	**49.7 (49.3, 50.1)**
Yes arthritis activity limitation	**148385**	**50.6 (50.3, 51.0)**	**132855**	**50.3 (49.9, 50.7)**
Arthritis work limitation				
No arthritis work limitation	**197666**	**64.2 (63.9, 64.6)**	**177941**	**64.4 (64.1, 64.8)**
Yes arthritis work limitation	**97527**	**35.8 (35.4, 36.1)**	**87229**	**35.6 (35.2, 35.9)**
Age				
Mean age (95% CI)		**59.2 (59.0, 59.3)**		**59.2 (59.1, 59.3)**
18-35 (referent)	**9368**	**7.3 (7.1, 7.6)**	**8354**	**7.2 (7.0, 7.5)**
36-50	**35827**	**18.9 (18.6, 19.2)**	**32547**	**19.0 (18.7, 19.3)**
51-65	**112203**	**38.3 (38.0, 38.7)**	**101215**	**38.5 (38.1, 38.9)**
≥66	**136699**	**35.1 (34.8, 35.5)**	**123054**	**35.3 (34.9, 35.6)**
Missing/don't know/refused	**1096**	**0.3 (0.3, 0.4)**	**0**	**0**
Sex				
Male (referent)	**98461**	**40.6 (40.3, 41.0)**	**91363**	**41,7 (41.3, 42.1)**
Female	**196732**	**59.4 (59.0, 59.7)**	**173807**	**58.3 (57.9, 58.7)**
Missing/don't know/refused	**0**	**0**	**0**	**0**
Race/ethnicity				
White, non-Hispanic (referent)	**238090**	**73.9 (73.5, 74.3)**	**217382**	**75.3 (74.9, 75.7)**
Black, non-Hispanic	**23807**	**10.5 (10.2, 10.7)**	**21111**	**10.4 (10.1, 10.7)**
Asian, non-Hispanic	**2340**	**1.9 (1.7, 2.0)**	**2187**	**1.9 (1.7, 2.1)**
Hispanic	**14851**	**8.9 (8.7, 9.2)**	**13420**	**9.0 (8.7, 9.3)**
Other	**12245**	**3.4 (3.2, 3.5)**	**11070**	**3.4 (3.2, 3.5)**
Missing/don't know/refused	**3860**	**1.4 (1.4, 1.5)**	**0**	**0**

TABLE V. (continued) UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, U.S. ADULTS, BRFSS 2011-2013 DATA, ANALYTIC SAMPLE, n=295193[a] SHOWN WITH FULLY RESTRICTED SAMPLE, n=265170[b]				
Factor	**Frequency unweighted n=295193**	**Percent weighted (95% CI)**	**Frequency unweighted n=265170**	**Percent weighted (95% CI)**
Education				
Less than high school	**32233**	**17.5 (17.2, 17.8)**	**27868**	**17.1 (16.7, 17.4)**
High school graduate/GED	**95981**	**31.4 (31.0, 31.7)**	**86128**	**31.3 (31.0, 31.7)**
Some college or technical school	**82989**	**30.4 (30.1, 30.8)**	**74900**	**30.7, 30.3, 31.1)**
College graduate (referent)	**83400**	**20.5 (20.3, 20.8)**	**76274**	**20.9 (20.6, 21.2)**
Missing/don't know/refused	**590**	**0.2 (0.2, 0.2)**	**0**	**0**
Income				
≥50k (referent)	**84075**	**31.1 (30.8, 31.4)**	**78420**	**32.1 (31.8, 32.5)**
25k-$49,999	**71230**	**23.4 (23.0, 23.7)**	**65551**	**23.9 (23.6, 24.2)**
15k-$24,999	**55701**	**18.4 (18.2, 18.7)**	**50451**	**18.6 (18.2, 18.9)**
Less than 15k	**42365**	**14.2 (13.9, 14.5)**	**37789**	**14.0 (13.7, 14.3)**
Missing/don't know/ refused (actual level in this variable)[c]	**41822**	**12.9 (12.7, 13.2)**	**32959**	**11.4 (11.1, 11.6)**
Self-reported health status				
Good or better (referent)	**196158**	**65.0 (64.6, 65.3)**	**177642**	**65.5 (65.1, 65.9)**
Fair or worse	**97821**	**34.6 (34.2, 34.9)**	**87528**	**34.5 (34.1, 34.9)**
Missing/don't know/refused	**1214**	**0.5 (0.4, 0.5)**	**0**	**0**
Diabetes				
No diabetes	**235564**	**80.3 (80.0, 80.6)**	**212442**	**80.6 (80.3, 80.9)**
Yes diabetes	**59165**	**19.5 (19.3, 19.8)**	**52728**	**19.4 (19.1, 19.7)**
Missing/don't know/refused	**464**	**0.1 (0.1, 0.2)**	**0**	**0**
Hypertension				
No hypertension	**122665**	**44.7 (44.3 45.1)**	**111159**	**45.0 (44.6, 45.4)**
Yes hypertension	**171893**	**55.1 (54.7, 55.5)**	**154011**	**55.0 (54.6, 55.4)**
Missing/don't know/refused	**635**	**0.2 (0.2, 0.2)**	**0**	**0**
Weight				
Normal BMI (referent)	**75122**	**24.2 (23.9, 24.5)**	**69962**	**25.1 (24.7, 25.4)**

TABLE V. (continued) UNWEIGHTED FREQUENCIES AND WEIGHTED PERCENTS OR MEANS, U.S. ADULTS, BRFSS 2011-2013 DATA, ANALYTIC SAMPLE, n=295193[a] SHOWN WITH FULLY RESTRICTED SAMPLE, n=265170[b]				
Factor	**Frequency unweighted n=295193**	**Percent weighted (95% CI)**	**Frequency unweighted n=265170**	**Percent weighted (95% CI)**
Underweight BMI	**4281**	**1.4 (1.3, 1.4)**	**3913**	**1.4 (1.3, 1.5)**
Overweight BMI	**99273**	**33.5 (33.2, 33.9)**	**93098**	**34.9 (34.5, 35.3)**
Obese BMI	**104180**	**37.0 (36.6, 37.3)**	**98197**	**38.7 (38.3, 39.0)**
Missing/don't know/refused	**12337**	**3.9 (3.8, 4.1)**	**0**	**0**
Smoking				
Non smoker	**244681**	**79.3 (79.0, 79.6)**	**220330**	**79.4 (79.1, 79.8)**
Smoker	**49151**	**20.3 (20.0, 20.6)**	**44840**	**20.6 (20.2, 20.9)**
Missing/don't know/refused	**1361**	**0.4 (0.4, 0.5)**	**0**	**0**
Alcohol				
No alcohol	**168191**	**54.0 (53.6, 54.3)**	**150191**	**53.8 (53.4, 54.2)**
Yes alcohol	**124312**	**45.1 (44.7, 45.5)**	**114979**	**46.2 (45.8, 46.6)**
Missing/don't know/refused	**2690**	**0.9 (0.9, 1.0)**	**0**	**0**
Physical Activity				
0 minutes	**103506**	**35.0 (34.6, 35.3)**	**94405**	**35.5 (53.1, 35.8)**
1-149 minutes	**46226**	**16.8 (16.5, 17.1)**	**43128**	**17.4 (17.1, 17.7)**
≥150 minutes (referent)	**135401**	**45.0 (44.6, 45.4)**	**127637**	**47.2 (46.8, 47.6)**
Missing/don't know/refused	**10060**	**3.2 (3.1, 3.4)**	**0**	**0**

[a]Restricted to those with arthritis out of 2011, 2013 data not including missing joint pain, arthritis activity limitation and arthritis work limitation.
[b]Restricted to those with arthritis out of 2011, 2013 data not including missing for any factor considered.
[c]Variables with 5% weighted or more missing data had "missing/don't know/refused" included as a level in the variable. This affected the variable income only.

TABLE VI. CRUDE ASSOCIATIONS: EXPOSURE TO OUTCOME. DICHOTOMOUS JOINT PAIN, CATEGORICAL JOINT PAIN—ARTHRITIS ACTIVITY LIMITATION OUTCOME; DICHOTOMOUS JOINT PAIN, CATEGORICAL JOINT PAIN—ARTHRITIS WORK LIMITATION OUTCOME. U.S. ADULTS, BRFSS 2011-2013 DATA[a]						
Relationship	**Prevalence of Limitation (95% CI)[b]**		**Crude Odds ratio (95% CI)[c]**		**Prevalence of Limitation (95% CI)**	**Crude Odds ratio (95% CI)**
Exposure to Arthritis activity limitation						
Yes/No joint pain (referent)-Arthritis activity limitation (analytic dataset)	**53.9 (53.6, 54.3)**		**10.1 (9.2, 11.0)**	**Yes/No joint pain (referent)-Arthritis activity limitation (fully restricted dataset)**	**53.6 (53.2, 54.0)**	**10.1 (9.2, 11.1)**
No joint pain/mild-moderate/severe joint pain-Arthritis activity limitation (analytic dataset)		**No pain (referent)**		**No joint pain/mild-moderate/severe joint pain-Arthritis activity limitation (fully restricted dataset)**		
	41.6 (41.1, 42.0)	**Mild-Moderate**	**6.1 (5.6, 6.7)**		**41.4 (40.9, 41.9)**	**6.1 (5.6, 6.7)**
	79.1 (78.5, 79.7)	**Severe**	**32.7 (29.8, 35.9)**		**79.1 (78.4, 79.7)**	**32.7 (29.8, 35.9)**
Exposure to Arthritis work limitation						
Yes/No joint pain (referent)-Arthritis work limitation (analytic dataset)	**43.9 (43.4, 44.4)**		**8.1 (6.9, 9.5)**	**Yes/No joint pain(referent)-Arthritis work limitation (fully restricted dataset)**	**43.7 (43.2, 44.3)**	**8.0 (6.7, 9.5)**

TABLE VI. (continued) CRUDE ASSOCIATIONS: EXPOSURE TO OUTCOME. DICHOTOMOUS JOINT PAIN, CATEGORICAL JOINT PAIN—ARTHRITIS ACTIVITY LIMITATION OUTCOME; DICHOTOMOUS JOINT PAIN, CATEGORICAL JOINT PAIN—ARTHRITIS WORK LIMITATION OUTCOME. U.S. ADULTS, BRFSS 2011-2013 DATA[a]

Relationship	Prevalence of Limitation (95% CI)[b]		Crude Odds ratio (95% CI)[c]		Prevalence of Limitation (95% CI)	Crude Odds ratio (95% CI)
No joint pain/mild-moderate/severe joint pain-Arthritis work limitation (analytic dataset)		No pain (referent)		No joint pain/mild-moderate/severe joint pain-Arthritis work limitation (fully restricted dataset)		
	29.5 (29.0, 30.1)	Mild-Moderate	4.3 (3.7, 5.1)		29.5 (28.9, 30.1)	4.3 (3.6, 5.1)
	69.6 (68.8, 70.4)	Severe	23.6 (20.1, 27.7)		69.7 (68.9, 70.6)	23.7 (19.9, 28.1)

[a]n=295193 (for all ages analytic dataset restricted to those with arthritis not including missing joint pain, arthritis activity limitation and arthritis work limitation), n=265170 (for all ages fully restricted dataset with no missing for any factor). For work limitation models, analytic dataset for ages 18 to 65 n=158494, fully restricted dataset n=142116.

[b]Weighted row percents shown for each co-variate category.

[c]Rao-Scott chi square p values for all odds ratios were highly significant at <.0001

the fully restricted sample with no missing for all factors that was used in multivariable modeling to predict the association between the exposure and the outcome. As indicated below, in general there was not a major difference between the odds ratios produced for each sample. Prevalence estimates of activity and work limitation indicates that the dichotomous joint pain variable is associated with an intermediate level of functional limitation compared to the mild-moderate and severe categories of the categorical joint pain variable, for both arthritis attributable activity and arthritis attributable work limitation, with the severe joint pain category having about 70% weighted prevalence of both arthritis attributable activity limitation and arthritis attributable work limitation. (Analytic dataset 79.1% activity limitation for severe joint pain, 69.6% work limitation for severe joint pain).

Table VII provides information on the crude relationship between co-variates and the outcome arthritis activity limitation. All factors were statistically significant by p-value. Prevalence of arthritis attributable activity limitation for each co-variate category generally ranged from percentages in the mid-40s to high 50s, with notably higher values being seen in less than $15,000 income (68.8%) and fair or poor self-reported health status (70.8%). The greatest magnitude odds ratio was found between self-reported health status and arthritis attributable activity limitation, odds ratio: 3.6 (3.5, 3.8)

Table VIII provides information on the crude association between co-variates and the outcome arthritis work limitation. All associations were statistically significant by p-value. Prevalence of arthritis attributable work limitation for each category of co-variate generally ranged from percentages in the mid 30s to the mid 50s, with the highest weighted percent being seen in poor or fair self-reported health status (63.4%), and the greatest magnitude odds ratio being between self-reported health status and arthritis attributable work limitation at 3.6 (3.5, 3.7).

Table IX provides information on the crude relationship between the exposure dichotomous joint pain and co-variates. P-values suggest all relationships are statistically significant. Prevalence of

TABLE VII. CRUDE ASSOCIATIONS: CO-VARIATES TO OUTCOME. ARTHRITIS ACTIVITY LIMITATION OUTCOME, U.S. ADULTS, BRFSS 2011-2013 DATA, n=295193[a]			
Relationship		**Prevalence of activity limitation (95% CI)[b]**	**Crude Odds ratio (95% CI)[c]**
Co-variates to Arthritis activity limitation			
Age (18-35 referent)	**36-50**	**53.5 (52.6, 54.5)**	**1.2 (1.1, 1.3)**
	51-65	**53.3 (52.7, 53.9)**	**1.2 (1.1, 1.3)**
	≥66	**46.6 (46.0, 47.1)**	**0.9 (0.9, 1.0)**
Sex (male referent)		**52.9 (52.5, 53.4)**	**1.3 (1.2, 1.3)**
Race/ethnicity (White referent)	**Black**	**54.8 (53.5, 56.1)**	**1.2 (1.2, 1.3)**
	Asian	**40.9 (35.9, 45.9)**	**0.7 (0.6, 0.9)**
	Hispanic	**53.4 (51.7, 55.1)**	**1.2 (1.1, 1.3)**
	Other	**61.1 (59.0 (63.2)**	**1.6 (1.5, 1.8)**
Education (College referent)	**Some college**	**50.7 (50.0, 51.3)**	**1.3 (1.2, 1.3)**
	High School	**50.3 (49.7, 50.9)**	**1.3 (1.2, 1.3)**
	Less Than HS	**58.5 (57.4, 59.7)**	**1.8 (1.7, 1.9)**
Income (≥55k referent)	**25-49.9k**	**47.5 (46.7, 48.2)**	**1.3 (1.2, 1.3)**
	15-24.9k	**57.3 (56.4, 58.1)**	**1.9 (1.8, 2.0)**
	Less than 15k	**68.8 (67.8, 69.8)**	**3.1 (3.0, 3.3)**
	Missing income	**49.3 (48.3, 50.3)**	**1.4 (1.3, 1.4)**
Self-reported reported health status (≥Good referent)		**70.8 (70.2, 71.4)**	**3.6 (3.5, 3.8)**
Diabetes (No referent)		**58.1 (57.3, 59.0)**	**1.5 (1.4, 1.5)**
Hypertension (No referent)		**54.7 (54.2, 55.1)**	**1.4 (1.4, 1.5)**
Weight (Normal referent)	**Underweight**	**52.0 (48.7, 55.2)**	**1.3 (1.2, 1.5)**
	Overweight	**46.7 (46.0, 47.3)**	**1.1 (1.0, 1.1)**
	Obese	**57.3 (56.7, 57.9)**	**1.6 (1.6, 1.7)**
Smoking (No referent)		**60.7 (59.8, 61.5)**	**1.7 (1.6, 1.7)**
Alcohol (No referent)		**45.4 (44.8, 45.9)**	**0.7 (0.7, 0.7)**
Physical activity (≥150 min/week referent)	**1-149 min/week**	**50.9 (49.9, 51.8)**	**1.3 (1.3, 1.4)**
	0 min/week	**59.6 (58.9, 60.2)**	**1.9 (1.8, 2.0)**

[a]Of those US adults with arthritis, n=295193 (for all ages analytic dataset restricted to those with arthritis not including missing joint pain, arthritis activity limitation and arthritis work limitation).
[b]Weighted row percent shown for each category of co-variate
[c]Rao-Scott chi square p value for the odds ratio was highly significant for each, <.0001.

TABLE VIII. CRUDE ASSOCIATIONS: CO-VARIATE TO OUTCOME. ARTHRITIS WORK LIMITATION OUTCOME, U.S. ADULTS, BRFSS 2011-2013 DATA, n=158494[a]			
Relationship		**Prevalence of Work limitation (95% CI)[b]**	**Crude Odds ratio (95% CI)[c]**
Co-variates to Arthritis work limitation			
Age (18-35 referent)	**36-50**	**44.0 (43.0, 44.9)**	**1.0 (0.9, 1.1)**
	51-65	**39.8 (39.2, 40.4)**	**0.9 (0.8, 0.9)**
Sex (Male referent)		**42.5 (41.9, 43.2)**	**1.1 (1.1, 1.2)**
Race/ethnicity (White referent)	**Black**	**50.7 (49.1, 52.2)**	**1.6 (1.5, 1.8)**
	Asian	**30.7 (25.1, 36.3)**	**0.7 (0.5, 0.9)**
	Hispanic	**48.8 (46.8, 50.8)**	**1.5 (1.4, 1.7)**
	Other	**53.2 (50.6, 55.8)**	**1.8 (1.6, 2.0)**
Education (College graduate referent)	**Some college**	**40.4 (39.5, 41.2)**	**2.1 (2.0, 2.2)**
	High School	**44.8 (44.0, 45.7)**	**2.5 (2.4, 2.6)**
	Less Than HS	**58.9 (57.3, 60.4)**	**4.4 (4.0, 4.7)**
Self-reported reported health status (≥Good referent)		**63.4 (62.6, 64.2)**	**4.2 (4.0, 4.4)**
Diabetes (No referent)		**49.4 (48.2, 50.6)**	**1.5 (1.4, 1.6)**
Hypertension (No referent)		**46.4 (45.6, 47.1)**	**1.5 (1.4, 1.5)**
Weight (Normal referent)	**Underweight**	**49.3 (45.1, 53.4)**	**1.5 (1.3, 1.8)**
	Overweight	**38.9 (38.0, 39.7)**	**1.0 (0.9, 1.1)**
	Obese	**44.8 (44.0, 45.6)**	**1.3 (1.2, 1.3)**
Smoking (No referent)		**53.9 (52.9, 54.9)**	**2.0 (1.9, 2.1)**
Alcohol (No referent)		**34.6 (33.9, 35.3)**	**0.6 (0.6, 0.6)**
Physical activity (≥150 min/week referent)	**1-149 min/week**	**40.4 (39.3, 41.6)**	**1.3 (1.2, 1.4)**
	0 min/week	**50.9 (50.1, 51.8)**	**2.0 (1.9, 2.1)**

[a]Restricted to those with arthritis not including missing joint pain, arthritis activity limitation and arthritis work limitation, ages 18 to 65.

[b]Weighted row percent shown for each category of co-variate.

[c]Rao-Scott chi square p values for odds ratios were all highly significant, <.0001.

TABLE IX. CRUDE ASSOCIATIONS: CO-VARIATES TO EXPOSURE: CO-VARIATES TO YES/NO JOINT PAIN, U.S. ADULTS, BRFSS 2011-2013, n=295193[a]			
Relationship		**Prevalence of joint pain (95% CI)[b]**	**Crude Odds ratio (95% CI)[c]**
Co-variates to Yes/No Joint Pain			
Age (18-35 referent)	**36-50**	**92.2 (91.6, 92.7)**	**1.1 (0.9, 1.3)**
	51-65	**93.6 (93.3, 93.9)**	**1.4 (1.2, 1.6)**
	≥66	**91.5 (91.2, 91.7)**	**1.0 (0.9, 1.1)**
Sex (Male referent)		**93.3 (93.1, 93.5)**	**1.4 (1.3, 1.4)**
Race/ethnicity (White referent)	**Black**	**91.9 (91.1, 92.6)**	**0.9 (0.8, 1.0)**
	Asian	**84.2 (80.6, 87.9)**	**0.4 (0.3, 0.6)**
	Hispanic	**92.6 (91.7, 93.6)**	**1.0 (0.9, 1.2)**
	Other	**93.6 (92.6, 94.6)**	**1.2 (1.0, 1.4)**
Education (College graduate referent)	**Some college**	**92.8 (92.4, 93.1)**	**1.4 (1.3, 1.5)**
	High School	**92.9 (92.6, 93.3)**	**1.4 (1.3, 1.5)**
	Less Than HS	**93.5 (92.9, 94.1)**	**1.5 (1.4, 1.7)**
Income (≥55k referent)	**25-49.9k**	**92.8 (92.4, 93.2)**	**1.3 (1.3, 1.5)**
	15-24.9k	**93.7 (93.2, 94.1)**	**1.5 (1.4, 1.7)**
	Less than 15k	**95.2 (94.7, 95.7)**	**2.1 (1.9, 2.3)**
	Missing income	**91.5 (90.9, 92.1)**	**1.1 (1.0, 1.2)**
Self-reported health status (≥Good referent)		**95.8 (95.5, 96.1)**	**2.4 (2.2, 2.5)**
Diabetes (No referent)		**93.6 (93.1, 94.0)**	**1.2 (1.1, 1.3)**
Hypertension (No referent)		**93.2 (93.0, 93.5)**	**1.3 (1.2, 1.4)**
Weight (Normal referent)	**Underweight**	**92.4 (90.9, 93.9)**	**1.2 (0.9, 1.4)**
	Overweight	**91.6 (91.3, 92.0)**	**1.0 (1.0, 1.1)**
	Obese	**93.8 (93.5, 94.1)**	**1.4 (1.3, 1.5)**
Smoking (No referent)		**94.7 (94.3, 95.1)**	**1.6 (1.4, 1.7)**
Alcohol (No referent)		**91.8 (91.5, 92.1)**	**0.8 (0.8, 0.9)**
Physical activity (≥150 min/week referent)	**1-149 min/week**	**92.4 (91.9, 92.9)**	**1.1 (1.1, 1.2)**
	0 min/week	**93.8 (93.4, 94.1)**	**1.4 (1.3, 1.5)**

[a]n=295193 (restricted to those with arthritis out of 2011, 2013 data not including missing joint pain, arthritis activity limitation and arthritis work limitation.

[b]Weighted row percents shown for each category of co-variate.

[c]Rao-Scott chi square p values for each odds ratio were highly significant, <.0001

presence of joint pain is given by weighted percents for each category of co-variate and is shown to be very high throughout the sample, at around the mid-80s to mid-90s throughout, with the highest value being for fair or poor self-reported health status at 95.8% and the greatest magnitude odds ratio also being for this association, with odds ratio 2.4 (2.2, 2.5).

Table X provides information on the crude association between categorical joint pain and each of the co-variates. P-values suggest a statistically significant relationship in each case. As far as prevalence of categorical joint pain as provided by weighted percentages of categories of each co-variate, for most co-variates there was a lower weighted percentage of severe joint pain as compared to mild-moderate joint pain, with exceptions being those with income less than $15,000 and those reporting fair or poor self-reported health status. These characteristics also had the highest magnitude odds ratios for the association (less than $15,000 income level 6.8 (6.1, 7.7) for severe joint pain; poor/fair self-reported health status 6.1 (5.6, 6.6) for severe joint pain).

Tables XI through XVIII provide information on possible confounders or effect modifiers by evaluating each co-variate in association with joint pain and each outcome. Variables were considered a possible confounder and designated as such if there was a 10% or greater difference between the crude and the adjusted odds ratios. Regardless of these findings, in multivariable models age, sex, race/ethnicity, self- reported health status and physical activity were included given importance in published literature as well as conceptual importance. Variables were considered as possible effect modifier at this stage if p value was ≤0.2, and if so, were evaluated further for possible inclusion in final models via stratum specific odds ratios and 95% confidence intervals.

Table XI provides information on possible confounder and effect modifiers of the relationship between dichotomous joint pain and arthritis activity limitation. No variables met criteria as a

TABLE X. CRUDE ASSOCIATIONS: CO-VARIATES TO EXPOSURE: CO-VARIATES TO CATEGORICAL JOINT PAIN, U.S. ADULTS, BRFSS 2011-2013 DATA, n=295193[a]					
Relationship		**Mild-Moderate**		**Severe**	
		Prevalence of Joint pain (95% CI)[b]	**Crude Odds ratio (95% CI)[c]**	**Prevalence of Joint pain (95% CI)[d]**	**Crude Odds ratio (95% CI)[e]**
Co-variates to Categorical Joint Pain					
Age (18-35 referent)	**36-50**	**56.4 (55.4, 57.4)**	**1.0 (0.9, 1.2)**	**35.8 (34.8, 36.8)**	**1.3 (1.1, 1.5)**
	51-65	**60.8 (60.2, 61.4)**	**1.3 (1.2, 1.5)**	**32.8 (32.3, 33.4)**	**1.5 (1.2, 1.7)**
	≥66	**66.4 (65.9, 67.0)**	**1.1 (0.9, 1.2)**	**25.0 (24.5, 25.5)**	**0.8 (0.7, 1.0)**
Sex (Male referent)		**59.6 (59.1, 60.1)**	**1.2 (1.1, 1.3)**	**33.7 (33.2, 34.1)**	**1.7 (1.6, 1.8)**
Race/ethnicity (White referent)	**Black**	**44.1 (42.8, 45.4)**	**0.6 (0.5, 0.7)**	**47.7 (46.4, 49.0)**	**1.7 (1.5, 1.8)**
	Asian	**64.3 (59.2, 69.5)**	**0.5 (0.3, 0.6)**	**19.9 (15.2, 24.7)**	**0.4 (0.2, 0.5)**
	Hispanic	**48.5 (46.9, 50.2)**	**0.7 (0.6, 0.8)**	**44.1 (42.5, 45.7)**	**1.7 (1.5, 2.0)**
	Other	**51.9 (49.7, 54.1)**	**0.9 (0.8, 1.1)**	**41.7 (39.5, 43.9)**	**1.8 (1.6, 2.2)**
Education (College graduate referent)	**Some college**	**65.5 (64.9, 66.2)**	**1.2 (1.1, 1.3)**	**27.2 (26.6, 27.9)**	**2.4 (2.2, 2.6)**
	High School	**60.4 (59.8, 61.0)**	**1.1 (1.0, 1.2)**	**32.5 (31.9, 33.1)**	**2.9 (2.7, 3.1)**
	Less Than HS	**43.8 (42.6, 44.9)**	**0.9 (0.8, 1.0)**	**49.7 (48.6, 50.8)**	**4.8 (4.3, 5.4)**
Income (≥55k referent)	**25-49.9k**	**67.2 (66.5, 68.0)**	**1.2 (1.1, 1.3)**	**25.5 (24.8, 26.2)**	**2.1 (1.9, 2.3)**
	15-24.9k	**53.3 (52.5, 54.2)**	**1.1 (1.0, 1.2)**	**40.3 (39.4, 41.2)**	**3.7 (3.4, 4.1)**
	Less than 15k	**39.3 (38.3, 40.3)**	**1.0 (0.9, 1.2)**	**55.9 (54.8, 56.9)**	**6.8 (6.1, 7.7)**
	Missing income	**59.8 (58.8, 60.8)**	**0.9 (0.8, 1.0)**	**31.7 (30.8, 32.6)**	**2.2 (2.0, 2.4)**
Self-reported health status (≥Good referent)		**44.0 (43.4, 44.7)**	**1.4 (1.3, 1.5)**	**51.8 (51.1, 52.4)**	**6.1 (5.6, 6.6.)**

TABLE X. (continued) CRUDE ASSOCIATIONS: CO-VARIATES TO EXPOSURE: CO-VARIATES TO CATEGORICAL JOINT PAIN, U.S. ADULTS, BRFSS 2011-2013 DATA, n=295193[a]					
Relationship		**Mild-Moderate**		**Severe**	
		Prevalence of Joint pain (95% CI)[b]	**Crude Odds ratio (95% CI)[c]**	**Prevalence of Joint pain (95% CI)[d]**	**Crude Odds ratio (95% CI)[e]**
Co-variates to Categorical Joint Pain					
Diabetes (No referent)		**53.3 (52.5, 54.2)**	**1.0 (0.9, 1.1)**	**40.2 (39.4, 41.1)**	**1.8 (1.6, 1.9)**
Hypertension (No hypertension)		**58.5 (58.0, 59.0)**	**1.1 (1.1, 1.2)**	**34.7 (34.2, 35.2)**	**1.7 (1.6, 1.9)**
Weight (Normal weight referent)	**Underweight**	**55.9 (52.6 (59.1)**	**1.0 (0.8, 1.2)**	**36.6 (33.3, 39.8)**	**1.6 (1.3, 2.1)**
	Overweight	**65.3 (64.7, 65.9)**	**1.0 (1.0, 1.1)**	**26.3 (25.7, 26.9)**	**1.1 (1.0, 1.1)**
	Obese	**57.3 (56.7, 57.9)**	**1.2 (1.1, 1.3)**	**36.5 (35.9, 37.1)**	**2.0 (1.8, 2.1)**
Smoking (No smoking referent)		**51.0 (50.1, 51.9)**	**1.2 (1.1, 1.3)**	**43.7 (42.8, 44.6)**	**2.5 (2.3, 2.7)**
Alcohol (No alcohol referent)		**69.2 (68.7, 69.8)**	**1.1 (1.0, 1.1)**	**22.5 (22.0, 23.0)**	**0.5 (0.5, 0.5)**
Physical activity (≥150 minutes/week referent)	**1-149 min/week**	**63.9 (63.0, 64.9)**	**1.0 (1.0, 1.1)**	**28.5 (27.6, 29.4)**	**1.0 (1.0, 1.1)**
	0 min/week	**52.1 (51.4, 52.7)**	**1.4 (1.3, 1.6)**	**41.7 (41.0, 42.3)**	**2.6 (2.4, 2.8)**

[a]Restricted to those with arthritis out of 2011, 2013 data not including missing joint pain, arthritis activity limitation and arthritis work limitation.
[b, d]Weighted row percents shown for each category of covariate.
[c, e] Rao-Scott chi square p values for all odds ratio were highly significant, <.0001

TABLE XI. EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT[a, b] MODIFIER; DICHOTOMOUS JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[c]					
Relationship Evaluated	**Crude Odds Ratio (95% CI)**	**Adjusted Odds Ratio (95% CI)**	**Possible Confounder Yes/No**	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**
Yes/no Joint pain—Arthritis activity limitation	**10.1 (9.2, 11.0)**				
Yes/no Joint pain—Arthritis activity limitation—age		10.0 (9.2, 10.9)	No	**<0.0001**	**Yes**
Yes/no Joint pain—Arthritis activity limitation—sex		10.0 (9.1, 10.9)	No	0.37	No
Yes/no Joint pain—Arthritis activity limitation—race/ethnicity		10.1 (9.2, 11.0)	No	**0.11**	**Yes**
Yes/no Joint pain—Arthritis activity limitation—education		10.0 (9.1, 10.9)	No	0.38	No
Yes/no Joint pain—Arthritis activity limitation—income		9.8 (9.0, 10.8)	No	**<0.01**	**Yes**
Yes/no Joint pain—Arthritis activity limitation—self reported health status		9.3 (8.5, 10.2)	No	**<0.001**	**Yes**
Yes/no Joint pain—Arthritis activity limitation—diabetes		10.1 (9.2, 11.0)	No	0.39	No
Yes/no Joint pain—Arthritis activity limitation—hypertension		10.1 (9.2, 11.0)	No	0.58	No
Yes/no Joint pain—Arthritis activity limitation—weight		9.8 (9.0, 10.7)	No	0.88	No
Yes/no Joint pain—Arthritis activity limitation—smoking		9.9 (9.1, 10.8)	No	0.34	No
Yes/no Joint pain—Arthritis activity limitation—alcohol		10.1 (9.2, 11.0)	No	0.74	No

TABLE XI. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT[a, b] MODIFIER; DICHOTOMOUS JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[c]

Relationship Evaluated	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	Possible Confounder Yes/No	Interaction term Wald chi square p value	Possible Effect Modifier Yes/No
Yes/no Joint pain—Arthritis activity limitation—physical activity		10.1 (9.2, 11.1)	No	0.42	No

[a]Variable considered a possible confounder and designated as such if 10% or greater difference between crude and adjusted odds ratios. Regardless of these findings, in multivariable models age, sex, race/ethnicity, self- reported health status and physical activity were included given importance in published literature as well as conceptual importance.

[b]Variable considered a possible effect modifier at this stage if p value ≤0.2, and evaluated further for possible inclusion in final models.

[c]Restricted to those with arthritis out of 2011, 2013 data not including missing joint pain, arthritis activity limitation and arthritis work limitation

confounder. The following variables were investigated further in Table XII as possible effect modifiers: age, race/ethnicity, income, self-reported health status.

Table XII provides further information on possible effect modifiers of the relationship between dichotomous joint pain and arthritis activity limitation. Stratum specific odds ratios and 95% confidence limits are shown below for age, race/ethnicity, income and self-reported health status. This level of investigation led to the decision to not include interaction terms in this model as the stratum specific odds ratios and 95% confidence intervals were within a similar range for each category of the co-variates and did not seem to suggest important clinical or public health differences between co-variate levels.

Table XIII provides information on the relationship between categorical joint pain and the outcome arthritis activity limitation. The only co-variate that met criteria for inclusion in multivariable modeling based on this step in evaluation was self-reported health status. The co-variates identified as possible effect modifiers at this step were: age, race/ethnicity, education, income, self-reported health status, hypertension, alcohol, and physical activity. These relationships were investigated further with stratum specific odds ratios and 95% confidence intervals in Table XIV.

Table XIV provides further information on possible effect modifiers of the relationship between categorical joint pain and arthritis activity limitation. Stratum specific odds ratios and 95% confidence limits are shown below for age, race/ethnicity, education, income, self-reported health status, hypertension, alcohol use in the last month, and physical activity. This level of investigation led to the decision to not include interaction terms in this model as the stratum specific odds ratios and 95% confidence intervals were within a similar range for each category of the co-variates and did not seem to suggest important clinical or public health differences between co-variate levels.

Table XV provides information on possible confounders and effect modifiers of the association between dichotomous joint pain and arthritis work limitation. Self-reported health status was the only

TABLE XII. EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER FURTHER INFORMATION[a]; DICHOTOMOUS JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[b]				
Relationship Evaluated	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**		**Stratum specific OR (95% CI) for significant interaction terms**
Yes/no Joint pain—Arthritis activity limitation—age	**<0.0001**	**Yes**	**18-35**	**9.6 (5.5, 16.8)**
			36-50	**13.7 (10.8, 17.4)**
			51-65	**11.5 (10.0, 13.2)**
			≥66	**7.7 (6.9, 8.5)**
Yes/no Joint pain—Arthritis activity limitation—race/ethnicity	**0.11**	**Yes**	**White**	**9.6 (8.6, 10.2)**
			Black	**11.5 (8.9, 14.8)**
			Asian	**13.9 (6.4, 30.2)**
			Hispanic	**12.0 (7.0, 20.6)**
			Other	**14.7 (9.9, 21.8)**
Yes/no Joint pain—Arthritis activity limitation—income	**<0.01**	**Yes**	**≥50k**	**11.5 (9.9, 13.3)**
			25-49.9k	**8.2 (6.9, 9.7)**
			15-24.9k	**9.1 (7.4, 11.1)**
			Less than 15k	**12.9 (10.4, 16.0)**
			Missing income	**8.3 (6.3, 11.1)**
Yes/no Joint pain—Arthritis activity limitation—self reported health status	**<0.001**	**Yes**	**Good or better**	**8.3 (7.4, 9.3)**
			Fair or worse	**11.6 (10.0, 13.6)**

[a]Variable considered a possible effect modifier at this stage if p value ≤0.2, and evaluated further for possible inclusion in final models via stratum specific odds ratios (95% confidence intervals), shown above

[b]Restricted to those with arthritis not including missing joint pain, arthritis activity limitation and arthritis work limitation

TABLE XIII. EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER[a,b]; CATEGORICAL JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION. U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[c]					
Relationship Evaluated	**Crude Odds Ratio (95% CI)**	**Adjusted Odds Ratio (95% CI)**	**Possible Confounder Yes/No**	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**
No, Mild-Moderate, Severe Joint pain—Arthritis activity limitation	**No pain (referent)** **Mild-Moderate 6.1 (5.6, 6.7)** **Severe 32.7 (29.8, 35.9)**				
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—age		No pain (referent) Mild-Moderate 6.1 (5.6, 6.7) Severe 32.2 (29.3, 35.3)	No	**<0.0001**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—sex		No pain (referent) Mild-Moderate 6.1 (5.6, 6.7) Severe 32.3 (29.4, 35.5)	No	0.95	No
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—race/ethnicity		No pain (referent) Mild-Moderate 6.1 (5.6, 6.6) Severe 33.1 (30.1, 36.3)	No	**0.05**	**Yes**

TABLE XIII. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER[a,b]; CATEGORICAL JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION. U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[c]					
Relationship Evaluated	**Crude Odds Ratio (95% CI)**	**Adjusted Odds Ratio (95% CI)**	**Possible Confounder Yes/No**	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—education		No pain (referent) Mild-Moderate 6.1 (5.6, 6.7) Severe 32.8 (29.8, 36.0)	No	**<0.0001**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—income		No pain (referent) Mild-Moderate 6.2 (5.6, 6.7) Severe 29.6 (27.0, 32.5)	No	**<0.0001**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—self reported health status		**No pain (referent)** **Mild-Moderate 6.1 (5.6, 6.7)** **Severe 25.4 (23.1, 27.9)**	**Yes**	**<0.01**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—diabetes		No pain (referent) Mild-Moderate 6.1 (5.6, 6.7) Severe 32.2 (29.3, 35.3)	No	0.80	No

TABLE XIII. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER[a,b]; CATEGORICAL JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION. U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[c]					
Relationship Evaluated	**Crude Odds Ratio (95% CI)**	**Adjusted Odds Ratio (95% CI)**	**Possible Confounder Yes/No**	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation— hypertension		No pain (referent) Mild-Moderate 6.1 (5.6, 6.7) Severe 32.1 (29.2, 35.2)	No	**0.11**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—weight		No pain (referent) Mild-Moderate 6.0 (5.5, 6.6) Severe 31.3 (28.4, 34.4)	No	0.62	No
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—smoking		No pain (referent) Mild-Moderate 6.1 (5.6, 6.7) Severe 31.6 (28.7, 34.7)	No	0.56	No
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—alcohol		No pain (referent) Mild-Moderate 6.1 (5.6, 6.7) Severe 31.9 (29.0, 35.0)	No	**<0.01**	**Yes**

TABLE XIII. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER[a,b]; CATEGORICAL JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION. U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[c]

Relationship Evaluated	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	Possible Confounder Yes/No	Interaction term Wald chi square p value	Possible Effect Modifier Yes/No
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—physical activity		No pain (referent) Mild-Moderate 6.2 (5.7, 6.8) Severe 31.3 (28.5, 34.5)	No	**<0.01**	**Yes**

[a]Variable considered a possible confounder and designated as such if 10% or greater difference between crude and adjusted odds ratios. Regardless of these findings, in multivariable models age, sex, race/ethnicity, self- reported health status and physical activity were included given importance in published literature as well as conceptual importance.

[b]Variable considered a possible effect modifier at this stage if p value ≤0.2, and evaluated further for possible inclusion in final models.

[c]Restricted to those with arthritis not including missing joint pain, arthritis activity limitation and arthritis work limitation

TABLE XIV. EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER FURTHER INFORMATION[a]; CATEGORICAL JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[b]				
Relationship Evaluated	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**		**Stratum specific OR (95% CI) for significant interaction terms**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—age	**<0.0001**	**Yes**	**18-35 Mild-moderate vs. no**	**6.1 (3.5, 10.7)**
			36-50 Mild-moderate vs. no	**7.6 (6.0, 9.7)**
			51-65 Mild-moderate vs. no	**6.6 (5.8, 7.7)**
			≥66 Mild-moderate vs. no	**5.2 (4.6, 5.7)**
			18-35 Severe vs. no	**26.4 (14.9, 46.7)**
			36-50 Severe vs. no	**41.2 (32.1, 53.6)**
			51-65 Severe vs. no	**39.2 (33.8, 45.6)**
			≥66 Severe vs. no	**24.5 (21.8, 27.5)**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—race/ethnicity	**0.05**	**Yes**	**White Mild-Moderate vs. no**	**6.1 (5.6, 6.6)**
			Black Mild-Moderate vs. no	**4.9 (3.8, 6.4)**
			Asian Mild-Moderate vs. no	**9.7 (4.4, 21.1)**
			Hispanic Mild-Moderate vs. no	**6.1 (3.5, 10.5)**
			Other Mild-Moderate vs. no	**8.2 (5.5, 12.4)**
			White Severe vs. no	**34.1 (31.0, 37.5)**
			Black Severe vs. no	**28.7 (21.9, 37.6)**
			Asian Severe vs. no	**48.5 (18.4, 127.6)**
			Hispanic Severe vs. no	**27.8 (16.1, 48.2)**
			Other Severe vs. no	**36.5 (23.8, 55.9)**

TABLE XIV. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER FURTHER INFORMATION[a]; CATEGORICAL JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[b]				
Relationship Evaluated	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**		**Stratum specific OR (95% CI) for significant interaction terms**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—education	**<0.0001**	**Yes**	**College grad Mild-Moderate vs. no**	**8.2 (7.2, 9.4)**
			Some college Mild-Moderate vs. no	**6.9 (5.9, 8.1)**
			HS Mild-Moderate vs. no	**5.4 (4.6, 6.2)**
			≤HS Mild-Moderate vs. no	**4.2 (3.2, 5.5)**
			College grad Severe vs. no	**45.7 (39.0, 53.4)**
			Some college Severe vs. no	**37.9 (32.0, 44.8)**
			HS Severe vs. no	**29.9 (25.7, 34.9)**
			≤HS Severe vs. no	**20.8 (15.7, 27.4)**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—income	**<0.0001**	**Yes**	**≥50k Mild-Moderate vs. no**	**8.8 (7.6, 10.2)**
			25-49.9k Mild-Moderate vs. no	**5.5 (4.6, 6.5)**
			15-24.9k Mild-Moderate vs. no	**5.1 (4.2, 6.3)**
			Less than 15k Mild-Moderate vs. no	**5.8 (4.6, 7.2)**
			Missing income Mild-Moderate vs. no	**4.8 (3.6, 6.3)**
			≥50k Severe vs. no	**40.8 (34.5, 48.3)**
			25-49.9k Severe vs. no	**26.2 (21.96, 31.4)**
			15-24.9k Severe vs. no	**22.4 (18.1, 27.8)**
			Less than 15k Severe vs. no	**28.4 (22.7, 35.5)**
			Missing income Severe vs. no	**27.7 (20.6, 37.3)**

TABLE XIV. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER FURTHER INFORMATION[a]; CATEGORICAL JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[b]				
Relationship Evaluated	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**		**Stratum specific OR (95% CI) for significant interaction terms**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—self reported health status	**<0.01**	**Yes**	**Good or better Mild-Moderate vs. no**	**6.2 (5.6, 7.0)**
			Fair or worse Mild-Moderate vs. no	**5.8 (5.0, 6.8)**
			Good or better Severe vs. no	**24.3 (21.5, 27.4**
			Fair or worse Severe vs. no	**26.7 (22.7, 31.4)**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—hypertension	**0.11**	**Yes**	**No Hypertension Mild-Moderate vs no**	**6.4 (5.6, 7.5)**
			+Hypertension Mild-Moderate vs. no	**5.9 (5.3, 6.6)**
			No Hypertension Severe vs. no	**32.0 (27.4, 37.4)**
			+Hypertension Severe vs. no	**32.0 (28.5, 35.9)**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—alcohol	**<0.01**	**Yes**	**No Alcohol Mild-Moderate vs no**	**5.5 (4.9, 6.2)**
			+Alcohol Mild-Moderate vs. no	**7.1 (6.2, 8.0)**
			No Alcohol Severe vs. no	**29.5,(25.9, 33.5)**
			+Alcohol Severe vs. no	**35.0 (30.5, 40.1)**

TABLE XIV. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER FURTHER INFORMATION[a]; CATEGORICAL JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=295193[b]				
Relationship Evaluated	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**		**Stratum specific OR (95% CI) for significant interaction terms**
No, Mild-Moderate, Severe Joint pain — Arthritis activity limitation—physical activity	**<0.01**	**Yes**	**≥150 min Mild-Moderate vs no**	**6.7 (5.8, 7.7)**
			1-149 min Mild-Moderate vs no	**6.3 (5.1, 7.8)**
			0 min Mild-Moderate vs no	**5.7 (4.9, 6.5)**
			≥150 min Severe vs no	**31.3 (26.8, 36.4)**
			1-149 min Severe vs no	**30.4 (24.1, 38.4)**
			0 min Severe vs no	**31.2 (26.9, 36.1)**

[a]Variable considered a possible effect modifier at this stage if p value ≤0.2, and evaluated further for possible inclusion in final models via stratum specific odds ratios (95% confidence intervals), shown above.

[b]Restricted to those with arthritis out of 2011, 2013 data not including missing joint pain, arthritis activity limitation and arthritis work limitation

TABLE XV. EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER; DICHOTOMOUS JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011-2013, n=158494[a]					
Relationship Evaluated	**Crude Odds Ratio (95% CI)**	**Adjusted Odds Ratio (95% CI)**	**Possible Confounder Yes/No[b]**	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No[c]**
Yes/no Joint pain—Arthritis work limitation	**8.1 (6.9, 9.5)**				
Yes/no Joint pain—Arthritis work limitation—age		8.2 (7.0, 9.6)	No	**<0.01**	**Yes**
Yes/no Joint pain—Arthritis work limitation—sex		8.0 (6.9, 9.4)	No	**0.12**	**Yes**
Yes/no Joint pain—Arthritis work limitation—race/ethnicity		8.4 (7.1, 9.8)	No	0.70	No
Yes/no Joint pain—Arthritis work limitation—education		7.9 (6.8, 9.3)	No	0.42	No
Yes/no Joint pain—Arthritis work limitation—self reported health status		**6.9 (5.9, 8.2)**	**Yes**	0.56	No
Yes/no Joint pain—Arthritis work limitation—diabetes		8.1 (6.9, 9.5)	No	0.64	No
Yes/no Joint pain—Arthritis work limitation—hypertension		7.9 (6.7, 9.3)	No	**0.06**	**Yes**
Yes/no Joint pain—Arthritis work limitation—weight		7.9 (6.7, 9.3)	No	0.29	No
Yes/no Joint pain—Arthritis work limitation—smoking		7.8 (6.7, 9.2)	No	0.99	No
Yes/no Joint pain—Arthritis work limitation—alcohol		8.0 (6.8, 9.3)	No	0.66	No
Yes/no Joint pain—Arthritis work limitation—physical activity		7.9 (6.7, 9.2)	No	0.41	No

TABLE XV. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER; DICHOTOMOUS JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011-2013, n=158494[a]

Relationship Evaluated	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	Possible Confounder Yes/No[b]	Interaction term Wald chi square p value	Possible Effect Modifier Yes/No[c]

[a]Of those with arthritis, not including missing joint pain, arthritis activity limitation and arthritis work limitation, for the work limitation outcome

[b]Variable considered a possible confounder and designated as such if 10% or greater difference between crude and adjusted odds ratios. Regardless of these findings, in multivariable models age, sex, race/ethnicity, self- reported health status and physical activity were included given importance in published literature as well as conceptual importance.

[c]Variable considered a possible effect modifier at this stage if p value ≤0.2, and evaluated further for possible inclusion in final models

co-variate identified as a possible confounder. However, all final multivariable models included the co-variates age, race/ethnicity, sex, self-reported health status and physical activity regardless of identified statistical significance because these factors are considered conceptual imported and are widely reported in the literature in this area. The co-variates identified as possible effect modifiers at this step were: age, sex, and hypertension. These relationships were investigated further with stratum specific odds ratios and 95% confidence intervals in Table XVI.

Table XVI provides further information on possible effect modifiers of the relationship between dichotomous joint pain and arthritis work limitation. Stratum specific odds ratios and 95% confidence limits are shown below for age, sex, and hypertension. This level of investigation led to the decision to not include interaction terms in this model as the stratum specific odds ratios and 95% confidence intervals were within a similar range for each category of the co-variates and did not seem to suggest important clinical or public health differences between co-variate levels.

Table XVII provides information on possible confounders and effect modifiers of the association between categorical joint pain and arthritis work limitation. Age and self-reported health status were the only co-variates identified as a possible confounder. However, all final multivariable models included the co-variates age, race/ethnicity, sex, self-reported health status and physical activity regardless of identified statistical significance because these factors are considered conceptual imported and are widely reported in the literature in this area. The co-variates identified as possible effect modifiers at this step were: age, sex, race/ethnicity, education, self-reported health status, diabetes, hypertension, smoking, alcohol use, and physical activity. These relationships were investigated further with stratum specific odds ratios and 95% confidence intervals in Table XVIII.

Table XVIII provides further information on possible effect modifiers of the relationship between categorical joint pain and arthritis work limitation. Stratum specific odds ratios and 95% confidence

TABLE XVI. EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER FURTHER INFORMATION; DICHOTOMOUS JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=158494[a]				
Relationship Evaluated	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No[b]**		**Stratum specific OR (95% CI) for significant interaction terms**
Yes/no Joint pain—Arthritis work limitation				
Yes/no Joint pain—Arthritis work limitation—age	**<0.01**	**Yes**	**18-35**	**6.4 (3.9, 10.6)**
			36-50	**12.0 (9.3, 15.5)**
			51-65	**7.1 (5.8, 8.7)**
Yes/no Joint pain—Arthritis work limitation—sex	**0.12**	**Yes**	**Male**	**7.5 (6.4, 8.7)**
			Female	**7.8 (6.5, 9.4)**
Yes/no Joint pain—Arthritis work limitation—hypertension	**0.06**	**Yes**	**No Hypertension**	**6.8 (5.6, 8.3)**
			+Hypertension	**8.5 (7.5, 9.8)**

[a]Restricted to those with arthritis out of 2011, 2013 data not including missing joint pain, arthritis activity limitation and arthritis work limitation.

[b]Variable considered a possible effect modifier at this stage if p value ≤0.2, and evaluated further for possible inclusion in final models via stratum specific odds ratios (95% confidence intervals), shown above.

TABLE XVII. EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER: CATEGORICAL JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011-2013, n=158494[a]					
Relationship Evaluated	**Crude Odds Ratio (95% CI)**	**Adjusted Odds Ratio (95% CI)**	**Possible Confounder Yes/No[b]**	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No[c]**
No, Mild-Moderate, Severe Joint pain—Arthritis work limitation	**No pain (referent)** **Mild-Moderate 4.3 (3.7, 5.1)** **Severe 23.6 (20.1, 27.7)**				
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation—age		No pain (referent) Mild-Moderate 4.4 (3.7, 5.1) Severe 24.0 (20.4, 28.2)	No	**0.01**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation—sex		No pain (referent) Mild-Moderate 4.3 (3.7, 5.1) Severe 23.8 (20.2, 27.9)	No	**0.01**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation—race/ethnicity		No pain (referent) Mild-Moderate 4.5 (3.8, 5.2) Severe 23.6 (20.1, 27.8)	No	**<0.01**	**Yes**

TABLE XVII. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER: CATEGORICAL JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011-2013, n=158494[a]					
Relationship Evaluated	**Crude Odds Ratio (95% CI)**	**Adjusted Odds Ratio (95% CI)**	**Possible Confounder Yes/No[b]**	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No[c]**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— education		No pain (referent) Mild-Moderate 4.4 (3.7, 5.1) Severe 22.1 (17.9, 24.8)	No	**<0.0001**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation—self reported health status		**No pain (referent)** **Mild-Moderate 4.2 (3.6, 4.9)** **Severe 17.2 (14.6, 20.2)**	**Yes**	**<0.0001**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— diabetes		No pain (referent) Mild-Moderate 4.4 (3.7, 5.1) Severe 23.4 (19.9, 27.5)	No	**<0.0001**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— hypertension		No pain (referent) Mild-Moderate 4.3 (3.7, 5.0) Severe 22.9 (19.5, 26.9)	No	**0.05**	**Yes**

TABLE XVII. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER: CATEGORICAL JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011-2013, n=158494[a]					
Relationship Evaluated	**Crude Odds Ratio (95% CI)**	**Adjusted Odds Ratio (95% CI)**	**Possible Confounder Yes/No[b]**	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No[c]**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation—weight		No pain (referent) Mild-Moderate 4.3 (3.6, 5.0) Severe 23.1 (19.6, 27.2)	No	0.31	No
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation—smoking		No pain (referent) Mild-Moderate 4.3 (3.6, 5.0) Severe 22.2 (18.9, 26.1)	No	**0.01**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation—alcohol		No pain (referent) Mild-Moderate 4.3 (3.7, 5.1) Severe 22.5 (19.2, 26.5)	No	**<0.0001**	**Yes**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation—physical activity		No pain (referent) Mild-Moderate 4.3 (3.7, 5.1) Severe 22.2 (18.9, 26.2)	No	**<0.01**	**Yes**

TABLE XVII. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER: CATEGORICAL JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011-2013, n=158494[a]

Relationship Evaluated	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	Possible Confounder Yes/No[b]	Interaction term Wald chi square p value	Possible Effect Modifier Yes/No[c]

[a]Restricted to those with arthritis not including missing joint pain, arthritis activity limitation and arthritis work limitation, for the work limitation outcome.

[b]Variable considered a possible confounder and designated as such if 10% or greater difference between crude and adjusted odds ratios. Regardless of these findings, in multivariable models age, sex, race/ethnicity, self- reported health status and physical activity were included given importance in published literature as well as conceptual importance.

[c]Variable considered a possible effect modifier at this stage if p value ≤0.2, and evaluated further for possible inclusion in final models

TABLE XVIII. EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER FURTHER INFORMATION[a]; CATEGORICAL JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=158494[b]				
Relationship Evaluated	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**		**Stratum specific OR (95% CI) for significant interaction terms**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— age	**0.01**	**Yes**	**18-35 Mild-Moderate vs no**	**3.9 (2.3, 6.4)**
			36-50 Mild-Moderate vs. no	**6.1 (4.7, 7.9)**
			51-65 Mild-Moderate vs. no	**3.8 (3.1, 4.6)**
			18-35 Severe vs no	**17.9 (10.7, 30.1)**
			36-50 Severe vs. no	**34.5 (26.6, 44.9)**
			51-65 Severe vs. no	**21.0 (17.2, 25.7)**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— sex	**0.01**	**Yes**	**Male Mild-Moderate vs no**	**4.5 (3.9, 5.3)**
			Female Mild-Moderate vs no	**4.3 (3.6, 5.1)**
			Male Severe vs no	**23.5 (20.0, 27.6)**
			Female Severe vs no	**19.9 (16.6, 23.9)**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— race/ethnicity	**<0.01**	**Yes**	**White Mild-Moderate vs no**	**4.9 (4.4, 5.5)**
			Black Mild-Moderate vs no	**3.1 (2.2, 4.4)**
			Asian Mild-Moderate vs no	**5.0 (2.1, 11.9)**
			Hispanic Mild-Moderate vs no	**3.8 (2.2, 6.6)**
			Other Mild-Moderate vs no	**6.4 (4.0, 10.1)**
			White Severe vs no	**23.6 (20.9, 26.5)**
			Black Severe vs no	**15.6 (10.9, 22.2)**
			Asian Severe vs no	**21.0 (7.7, 57.4)**
			Hispanic Severe vs no	**15.2 (8.8, 26.2)**
			Other Severe vs no	**22.0 (13.8, 35.2)**

TABLE XVIII. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER FURTHER INFORMATION[a]; CATEGORICAL JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=158494[b]				
Relationship Evaluated	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**		**Stratum specific OR (95% CI) for significant interaction terms**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— education	**<0.0001**	**Yes**	**College graduate Mild-Moderate vs no**	**5.6 (4.4, 7.0)**
			Some college Mild-Moderate vs no	**5.2 (4.3, 6.3)**
			HS Mild-Moderate vs no	**4.0 (3.3, 4.9)**
			≤HS Mild-Moderate vs no	**3.7 (2.7, 5.1)**
			College graduate Severe vs no	**33.9 (26.8, 42.8)**
			Some college Severe vs no	**23.5 (19.5, 28.5)**
			HS Severe vs no	**16.7 (13.6, 20.5)**
			≤HS Severe vs no	**13.5 (9.9, 18.6)**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— self reported health status	**<0.0001**	**Yes**	**Good or better Mild-Moderate vs no**	**4.6 (3.9, 5.3)**
			Fair or worse Mild-Moderate vs no	**3.8 (3.1, 4.6)**
			Good or better Severe vs no	**19.0 (16.2, 22.3)**
			Fair or worse Severe vs no	**12.6 (10.3, 15.4)**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— diabetes	**<0.0001**	**Yes**	**No Diabetes Mild-Moderate vs no**	**4.6 (4.0, 5.2)**
			+Diabetes Mild-Moderate vs no	**3.9 (2.9, 5.1)**
			No Diabetes Severe vs no	**22.7 (19.8, 26.0)**
			+ Diabetes Severe vs no	**15.7 (11.8, 20.9)**

TABLE XVIII. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER FURTHER INFORMATION[a]; CATEGORICAL JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=158494[b]				
Relationship Evaluated	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**		**Stratum specific OR (95% CI) for significant interaction terms**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— hypertension	**0.05**	**Yes**	**No Hypertension Mild-Moderate vs no**	**4.1 (3.4, 5.0)**
			+ Hypertension Mild-Moderate vs no	**4.7 (4.1, 5.3)**
			No Hypertension Severe vs no	**20.9 (17.1, 25.5)**
			+ Hypertension Severe vs no	**21.5 (18.6, 24.7)**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— smoking	**0.01**	**Yes**	**No Smoking Mild-Moderate vs no**	**4.5 (3.9, 5.2)**
			+ Smoking Mild-Moderate vs no	**4.0 (3.2, 5.0)**
			No Smoking Severe vs no	**21.1 (18.2, 24.5)**
			+ Smoking Severe vs no	**16.6 (13.2, 20.7)**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— alcohol	**<0.0001**	**Yes**	**No Alcohol Mild-Moderate vs no**	**4.3 (3.6, 5.0)**
			+ Alcohol Mild-Moderate vs no	**4.6 (3.8, 5.5)**
			No Alcohol Severe vs no	**18.3 (15.5, 21.5)**
			+ Alcohol Severe vs no	**24.4 (20.4, 29.4)**
No, Mild-Moderate, Severe Joint pain — Arthritis work limitation— physical activity	**<0.01**	**Yes**	**≥150 min Mild-Moderate vs no**	**4.7 (3.9, 5.7)**
			1-149 min Mild-Moderate vs no	**3.9 (2.9, 5.1)**
			0 min Mild-Moderate vs no	**4.3 (3.5, 5.2)**
			≥150 min Severe vs no	**22.8 (18.7, 27.7)**
			1-149 min Severe vs no	**19.1 (14.3, 25.5)**
			0 min Severe vs no	**18.0 (14.8, 22.0)**

TABLE XVIII. (continued) EXPOSURE-OUTCOME-COVARIATE RELATIONSHIPS: POSSIBLE CONFOUNDER/EFFECT MODIFIER FURTHER INFORMATION[a]; CATEGORICAL JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011 AND 2013 DATA, n=158494[b]				
Relationship Evaluated	**Interaction term Wald chi square p value**	**Possible Effect Modifier Yes/No**		**Stratum specific OR (95% CI) for significant interaction terms**
[a]Variable considered a possible effect modifier at this stage if p value ≤0.2, and evaluated further for possible inclusion in final models via stratum specific odds ratios (95% confidence intervals), shown above. [b]Restricted to those with arthritis not including missing joint pain, arthritis activity limitation and arthritis work limitation, for 18-65				

limits are shown below for age, sex, race/ethnicity, education, self-reported health status, diabetes, hypertension, smoking, alcohol use, and physical activity. This level of investigation led to the decision to not include interaction terms in this model as the stratum specific odds ratios and 95% confidence intervals were within a similar range for each category of the co-variates and did not seem to suggest important clinical or public health differences between co-variate levels.

Table XIX shows the final model for multivariable logistic regression describing the relationship between dichotomous joint pain and arthritis activity limitation. The fully adjusted model finds the odds ratio for the dichotomous joint pain variable has been slightly decreased (odds ratio 10.1 (9.2, 11.1) p value <0.0001 in the crude model (analytic sample) and 9.2 (8.3, 10.1) pvalue <0.0001 in the fully adjusted model, indicating the association between dichotomous arthritis attributable joint pain and arthritis attributable activity limitation is slightly attenuated by the presence of the other included characteristics. Being in the oldest age group (≥66) was somewhat protective against reporting arthritis activity limitation (odds ratio 0.8 (0.8, 0.9)) while the other age levels: 36-50 and 51-65 were not significantly different from the referent age level of 18-35. Hispanic race was associated with decreased odds of reporting arthritis activity limitation (odds ratio 0.8 (0.7, 0.9) while being in the "Other" race category was associated with increased odds of the outcome (odds ratio 1.4 (1.3, 1.5). Female sex and having less than 150 minutes per week of moderate physical activity was also associated with slightly increased odds of the outcome. Other than the main exposure: joint pain, self- reported health status demonstrated the greatest magnitude association, with fair or worse self-reported health vs. good or better self-reported health having odds ratio of 3.3 (3.2, 3.4).

Table XX shows the final model for multivariable logistic regression describing the relationship between categorical joint pain and arthritis activity limitation. The fully adjusted model finds the odds ratio for the categorical joint pain variable is the same as the crude value (analytic sample) for mild-

TABLE XIX. MULTIVARIABLE LOGISTIC REGRESSION: RELATIONSHIP BETWEEN PRESENCE OR ABSENCE OF JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, U.S. ADULTS, BRFSS 2011-2013, FULLY RESTRICTED SAMPLE, n=265170[a, b]		
Factor	**Crude Odds Ratio (95% CI)**	**P value**
Dichotomous joint pain-arthritis activity limitation analytic sample n=295193	**10.1 (9.2, 11.0)**	**<0.0001**
Factor	**Adjusted Odds Ratio (95% CI)**	**P value**
Dichotomous joint pain	**9.2 (8.3, 10.1)**	**<0.0001**
Age (18-35 referent)		
36-50	1.1 (1.0, 1.2)	0.07
51-65	1.1 (1.0, 1.2)	0.22
≥66	**0.8 (0.8, 0.9)**	**<0.0001**
Race (white referent)		
Black	1.0 (1.0, 1.1)	0.39
Asian	0.8 (0.7, 1.0)	0.12
Hispanic	**0.8 (0.7, 0.9)**	**<0.0001**
Other	**1.4 (1.3, 1.5)**	**<0.0001**
Sex (male referent)		
Female	**1.2 (1.2, 1.3)**	**<0.0001**
Self- reported health status Fair or worse vs. Good or better	**3.3 (3.2, 3.4)**	**<0.0001**
Physical Activity (≥150 min/week referent)		
1-149 min/week	**1.2 (1.1, 1.2)**	**<0.0001**
0 min/week	**1.4 (1.4, 1.5)**	**<0.0001**

[a]BRFSS 2011 and 2013 data,(restricted to those with arthritis out of 2011, 2013 data and not missing data for any variable under consideration).

[b]In full multivariable models predicting each outcome, previously identified variables of interest were included, though the variables: age, sex, race/ethnicity, self-reported health status, and physical activity were included regardless of statistical significance as these variables are commonly reported in the literature and represent important factors in the domains: sociodemographic factors, health status factors, and health behaviors, which are theorized to affect the relationship between arthritis joint pain and each outcome of interest.

TABLE XX. MULTIVARIABLE LOGISTIC REGRESSION: RELATIONSHIP BETWEEN SEVERITY OF JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, U.S. ADULTS, BRFSS 2011-2013, FULLY RESTRICTED SAMPLE, n=265170[a, b]		
Factor	**Crude Odds Ratio (95% CI)**	**P value**
Categorical joint pain-arthritis activity limitation analytic sample, n=295193	**No pain (referent)**	**<0.0001**
	Mild-Moderate 6.1 (5.6, 6.7)	
	Severe 32.7 (29.8, 35.9)	
Factor	**Adjusted Odds Ratio (95% CI)**	**P value**
Categorical joint pain (no pain referent)		
Mild-Moderate	**6.1 (5.5, 6.7)**	**<0.0001**
Severe	**24.9 (22.4, 27.6)**	**<0.0001**
Age (18-35 referent)		
36-50	1.1 (1.0, 1.2)	0.30
51-65	1.1 (1.0, 1.2)	0.17
≥66	**0.9 (0.8, 1.0)**	**0.02**
Race (white referent)		
Black	**0.8 (0.7, 0.8)**	**<0.0001**
Asian	0.9 (0.7, 1.1)	0.16
Hispanic	**0.7 (0.6, 0.8)**	**<0.0001**
Other	**1.2 (1.1, 1.3)**	**<0.001**
Sex (male referent)		
Female	**1.1 (1.1, 1.2)**	**<0.0001**
Self reported health status Fair or worse vs. Good or better	**2.5 (2.4, 2.6)**	**<0.0001**
Physical Activity (≥150 min/week referent)		
1-149 min/week	**1.2 (1.1, 1.2)**	**<0.0001**
0 min/week	**1.2 (1.2, 1.3)**	**<0.0001**

[a]BRFSS 2011 and 2013 data, (restricted to those with arthritis out of 2011, 2013 data and not missing for any factor under consideration).

[b]In full multivariable models predicting each outcome, previously identified variables of interest were included, though the variables: age, sex, race/ethnicity, self-reported health status, and physical activity were included regardless of statistical significance as these variables are commonly reported in the literature and represent important factors in the domains: sociodemographic factors, health status factors, and health behaviors, which are theorized to affect the relationship between arthritis joint pain and each outcome of interest.

moderate pain (odds ratio 6.1 (5.5, 6.7) p value <0.0001, but is somewhat smaller in the fully adjusted model compared to the crude model (analytic sample) for the severe pain level: odds ratio 32.7 (29.8, 35.9) in the crude model, and 24.9 (22.4, 27.6) in the fully adjusted model , indicating the association between categorical arthritis attributable joint pain and arthritis attributable activity limitation is at the mild-moderate joint pain level is not affected by the presence of the selected co-variates, but at the severe joint pain level, is slightly attenuated by the presence of the other included characteristics. Being in the oldest age group (≥66) was somewhat protective against reporting arthritis activity limitation (odds ratio 0.9 (0.8, 1.0), p value 0.02 while the other age levels: 36-50 and 51-65 were not significantly different from the referent age level of 18-35. Black race and Hispanic race was associated with decreased odds of reporting arthritis activity limitation (odds ratio 0.8 (0.7, 0.8) and 0.7 (0.6, 0.8) respectively, while being in the "Other" race category was associated with increased odds of the outcome (odds ratio 1.2 (1.1, 1.3). Female sex and having less than 150 minutes per week of moderate physical activity were also associated with slightly increased odds of the outcome. Other than the main exposure: joint pain, self- reported health status demonstrated the greatest magnitude of association, with fair or worse self-reported health vs. good or better self-reported health having odds ratio of 2.5 (2.4, 2.6).

Table XXI provides information on the final model for multivariable logistic regression describing the relationship between dichotomous joint pain and arthritis work limitation. The fully adjusted model finds the odds ratio for the joint pain variable is somewhat smaller compared to the crude model: odds ratio 8.0 (6.7, 9.5) in the crude model (fully restricted sample which was similar to the analytic sample (8.1 (6.9, 9.5)), and 7.0 (5.9, 8.4) in the fully adjusted model , indicating the association between dichotomous arthritis attributable joint pain and arthritis attributable work limitation is slightly attenuated by the presence of the other included characteristics. Compared the referent age group of 18-35, being older is protective against reporting arthritis work limitation (odds ratio 0.9 (0.8, 1.0) for

TABLE XXI. MULTIVARIABLE LOGISTIC REGRESSION: RELATIONSHIP BETWEEN PRESENCE OR ABSENCE OF JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011-2013, FULLY RESTRICTED SAMPLE, n=142116[a, b]		
Factor	**Crude Odds Ratio (95% CI)**	**P value**
Dichotomous joint pain-arthritis work limitation analytic sample, n=158494	**8.1 (6.9, 9.5)**	**<0.0001**
Factor	**Adjusted Odds Ratio (95% CI)**	**P value**
Dichotomous joint pain	**7.0 (5.9, 8.4)**	**<0.0001**
Age (18-35 referent)		
36-50	**0.9 (0.8, 1.0)**	**0.04**
51-65	**0.7 (0.7, 0.8)**	**<0.0001**
Race (white referent)		
Black	**1.4 (1.3, 1.6)**	**<0.0001**
Asian	0.8 (0.6, 1.1)	0.13
Hispanic	**1.1 (1.0, 1.3)**	**<0.01**
Other	**1.6 (1.4, 1.8)**	**<0.0001**
Sex (male referent)		
Female	1.0 (1.0, 1.1)	0.10
Self-reported health status Fair or worse vs. Good or better	**3.7 (3.5, 3.9)**	**<0.0001**
Physical Activity (≥150 min/week referent)		
1-149 min/week	**1.1 (1.1, 1.2)**	**<0.001**
0 min/week	**1.4 (1.4, 1.5)**	**<0.0001**

[a]BRFSS 2011 and 2013 data (restricted to those with arthritis out of 2011, 2013 data and not including missing for any factor under consideration)

[b]In full multivariable models predicting each outcome, previously identified variables of interest were included, though the variables: age, sex, race/ethnicity, self-reported health status, and physical activity were included regardless of statistical significance as these variables are commonly reported in the literature and represent important factors in the domains: sociodemographic factors, health status factors, and health behaviors, which are theorized to affect the relationship between arthritis joint pain and each outcome of interest.

36-50 year olds, and 0.7 (0.7, 0.8) for 51 to 65 year olds. Being Black, Hispanic or Other race is associated with slightly increased odds of the outcome, as well as participating in less than 150 minutes per week of moderate physical activity or vigorous equivalent minutes. In this model, female sex was not statistically significant. The factor with greatest magnitude odds ratio other than the main exposure was self-reported health status with odds ratio 3.7 (3.5, 3.9).

Table XXII provides information on the final model for multivariable logistic regression describing the relationship between categorical joint pain and arthritis work limitation. The fully adjusted model finds the odds ratio for the joint pain variable is the same as the crude odds ratio for the mild-moderate pain level, and somewhat smaller for the severe pain level compared to the crude model: odds ratio 23.7 (19.9, 28.1) in the crude model (fully restricted sample which was very similar to the analytic sample (23.6 (20.1, 27.7)), and 17.1 (14.4, 20.4) in the fully adjusted model , indicating the association between categorical arthritis attributable joint pain and arthritis attributable work limitation is not affected by the presence of selected co-variates at the mild-moderate joint pain level, but at the severe joint pain level, the magnitude of the relationship is slightly attenuated by the presence of the other included characteristics. Compared to the referent age group of 18-35, being older is protective against reporting arthritis work limitation (odds ratio 0.9 (0.8, 1.0) for 36-50 year olds, and 0.7 (0.7, 0.8) for 51 to 65 year olds. Being Black or Other race is associated with slightly increased odds of the outcome, as well as participating in less than 150 minutes per week of moderate physical activity. In this model, female sex was not statistically significant. The factor with greatest magnitude odds ratio other than the main exposure was self-reported health status with odds ratio 2.7 (2.5, 2.8).

Additional analyses: although for conceptual reasons described in the Methods section, income was not included in analyses involving the work limitation outcome, additional analyses were performed later to confirm that income did not meet criteria for inclusion in arthritis attributable work limitation

TABLE XXII. MULTIVARIABLE LOGISTIC REGRESSION: RELATIONSHIP BETWEEN SEVERITY OF JOINT PAIN AND ARTHRITIS WORK LIMITATION, U.S. ADULTS, BRFSS 2011-2013, FULLY RESTRICTED SAMPLE, n=142116[a, b]		
Factor	**Crude Odds Ratio (95% CI)**	**P value**
Categorical joint pain-arthritis work limitation analytic sample, n= 158494	**No pain (referent)**	**<0.0001**
	Mild-Moderate 4.3 (3.7, 5.1)	
	Severe 23.6 (20.1, 27.7)	
Factor	**Adjusted Odds Ratio (95% CI)**	**P value**
Categorical joint pain (no pain referent)		
Mild-Moderate	**4.3 (3.6, 5.1)**	**<0.0001**
Severe	**17.1 (14.4, 20.4)**	**<0.0001**
Age (18-35 referent)		
36-50	**0.9 (0.8, 1.0)**	**<0.01**
51-65	**0.7 (0.7, 0.8)**	**<0.0001**
Race (white referent)		
Black	**1.1 (1.0, 1.2)**	**<0.01**
Asian	0.8 (0.6, 1.1)	0.20
Hispanic	1.0 (0.9, 1.1)	0.92
Other	**1.4 (1.2, 1.6)**	**<0.0001**
Sex (male referent)		
Female	1.0 (0.9, 1.0)	0.06
Self- reported health status Fair or worse vs. Good or better	**2.7 (2.5, 2.8)**	**<0.0001**
Physical Activity (≥150 min/week referent)		
1-149 min/week	**1.1 (1.0, 1.2)**	**<0.001**
0 min/week	**1.3 (1.2, 1.3)**	**<0.0001**

[a]BRFSS 2011 and 2013 data, (restricted to those with arthritis out of 2011, 2013 data and not including missing for any factor under consideration)

[b]In full multivariable models predicting each outcome, previously identified variables of interest were included, though the variables: age, sex, race/ethnicity, self-reported health status, and physical activity were included regardless of statistical significance as these variables are commonly reported in the literature and represent important factors in the domains: sociodemographic factors, health status factors, and health behaviors, which are theorized to affect the relationship between arthritis joint pain and each outcome of interest.

multivariable models. In addition, although age categories were determined based on conceptual background related to the two outcomes and related published literature (111), additional analyses were performed with standard age groups as used by CDC, with age groups 18-44, 45-64 for the arthritis attributable work limitation multivariable models (restricted to those under 65), and age groups 18-44, 45-64, and ≥65 for the arthritis attributable activity limitation models. Tables with results are shown in Appendix C and indicate the findings are very similar to the multivariable models in Tables XIX through XXII with age categories 18-35, 36-50, 51-65 for the arthritis attributable work limitation models and age categories 18-35, 36-50, 51-65, and ≥66 for the arthritis attributable activity limitation models.

V. DISCUSSION

A. Key results

The 2011-2013 BRFSS all ages analytic sample represents 52,275,712 individuals with arthritis. The prevalence of arthritis attributable joint pain was 92.4% among U.S. adults with arthritis, corresponding to 48,310,624 individuals, and the prevalence of participants with arthritis and severe arthritis attributable joint pain was 30.4%, corresponding to 15,913,801 individuals. 2013 U.S. Census Bureau estimates place the 2013 U.S. adult population at 242,470,820 (112), meaning about 21.6% of the U.S. adult population reports arthritis in this study, and 19.9% of the U.S. adult population reports arthritis attributable joint pain overall, with about 6.6% reporting severe arthritis attributable joint pain. The all ages analytic sample further finds 50.6% of U.S. adults with arthritis reporting arthritis attributable activity limitation, corresponding to 26,471,947 individuals, and the 18-65 year old analytic sample finds 41.4% of 18-65 year olds in the U.S. with arthritis reporting arthritis attributable work limitation, corresponding to 14,050,551 individuals. As hypothesized, in each model, the presence of joint pain and of greater severity joint pain was associated with significantly increased odds of each of the outcomes, even after controlling for sociodemographic, health status, and health behavior characteristics, and in general the magnitude of the measure of association between arthritis attributable joint pain and arthritis attributable activity limitation, and between arthritis attributable joint pain and arthritis attributable work limitation can be considered large for both the crude and fully adjusted relationship (113).

For each outcome, results were similar for the dichotomous arthritis attributable joint pain and the categorical joint pain variables, with different factors showing importance for the two outcomes. With regard to the relationship between joint pain severity and each outcome, the relationship between

the mild-moderate category of joint pain and both arthritis activity limitation and arthritis work limitation does not seem to be significantly affected by inclusion of age, race/ethnicity, sex, self-reported health status, and physical activity, while the magnitude of the association between the severe joint pain category and both outcomes is somewhat decreased by inclusion of those factors in the model, for both the arthritis activity limitation model and the arthritis work limitation model, indicating that the presence of these co-variates is somewhat attenuating the magnitude of the relationship between the exposure and the outcome .

B. Strengths and limitations/generalizability

This study has significant strengths as well as many limitations. As noted in Section III Methods, A. 3 Behavioral Risk Factor Surveillance System Benefits and Limitations, the data are from the Behavioral Risk Factor Surveillance System for years 2011 and 2013 and as such are designed to be representative of the adult, non-military, non-institutionalized population of each state, the District of Columbia, Guam and Puerto Rico. The large sample size allowed for more refined analysis of subgroups, and this dataset did contain many variables of interest in describing the relationship between joint pain and arthritis activity limitation and joint pain in arthritis work limitation, in those with arthritis, considering other factors of interest in the domains of sociodemographics, health status factors, and health behaviors. However, it is possible that some variables of importance were not identified and/or not available for inclusion such as specific information about body structure (e.g. changes to joint anatomy) or specific task information (e.g. gait speed, ability to climb a flight of stairs) (62, 93-94). The all state and Washington DC median response rate for 2011 and 2013 BRFSS data is 49.7% range (33.8-64.1) and 46.4% (29.0-60.3), respectively, which is comparable to similar surveys (114-115), with information from Pew Research Center showing that all telephone surveys in recent years have lower response rates (116). Regardless of lower response rates, evaluation of BRFSS data shows that

weighting ensures the accuracy of measures (117). Information is from self-report, though the surveillance case definition of arthritis in these data has been validated (101). An additional strength is that data collection for the BRFSS is ongoing, thus additional years of data will be available for comparison in the future.

In this analysis 45% of participants reported meeting or exceeding physical activity guidelines of 150 minutes of moderate or vigorous equivalent activity per week, the referent level. Studies have shown that self-report of meeting physical activity guidelines is usually an over-estimate as compared to objective measures such as accelerometer data (118). If this information were more accurately reported, it could likely affect results, creating a larger magnitude measure of association between non-referent levels of physical activity and the outcomes investigated. In addition, the cross-sectional nature of the data means that timeline and therefore causation cannot be determined with regard to the relationship between the exposure and the outcomes.

The main limitation of this study is that BRFSS arthritis data is not specific to osteoarthritis, but rather combines information on all types of arthritic conditions together, so although the most common arthritis condition, osteoarthritis, was an area of interest, this study cannot be considered specific to osteoarthritis. The relative lack of specificity with regard to the primary condition of interest may affect results, as the conceptual basis of the study and the evaluated co-variates were chosen with a main interest in helping elucidate the relationship between joint pain and arthritis activity limitation and arthritis work limitation in the condition osteoarthritis. As discussed in the Introduction section, arthritis conditions as a whole are a varied group and risk factors such as particular age level cut-offs may not be common across all arthritic conditions. Therefore, in order to provide specific information on osteoarthritis, a dataset focused on that condition would have been needed.

Another limitation of this study is use of SAS as a statistical program, which has some limits with regard to statistical analysis. As noted in the Methods section, prevalence rate ratio would have been the preferred measure of association, however there is currently no procedure available to easily obtain this information using SAS survey procedures, therefore odds ratios were generated and interpretation of results must reflect this issue, e.g. it is known that odds ratios will be biased away from the null value as compared to prevalence rate ratios depending on the prevalence of the disease condition and the exposure, though being more affected by the disease prevalence, with discrepancies being potentially significant when the disease is not rare (has prevalence greater than 10%) (119). In this study, the prevalence of arthritis attributable activity limitation in the analytic sample was 50.6%, and the prevalence of arthritis attributable work limitation in the analytic sample was 35.8%. Processing capability was also found to be an issue for SAS proc surveyfreq requiring the removal of the cluster statement, which has the possibility of slightly decreasing the size of the standard errors and slightly increasing the likelihood of deeming an association significant, though this issue would most likely not be of great concern given the large sample size (120).

The primary means of accounting for missing data in this study was to restrict to those non-missing all of the variables: joint pain (main exposure), arthritis activity limitation (outcome) and arthritis work limitation (outcome) to create the analytic sample, and further restrict to only those observations missing none of the factors under consideration for multivariable models. The background analyses provided on Tables XXIII through XXVIII (shown in Appendix B) provide some information on the relationship between those missing and those non missing for each of the variables that had more than 5% weighted missing in the 2011+2013 BRFSS data for those with arthritis: joint pain, arthritis activity limitation, arthritis work limitation, as well as the co-variates income, alcohol and physical activity. All missing versus non missing tables found statistically significant differences for most factors considered in this study as far as production of the analytic sample versus all those with arthritis.

The main findings across all tables XXIII through XVIII indicate that for each variable investigating missing versus non missing, those participants missing data on the variable under consideration tended to report lower income, lower educated, were less likely to be white, more likely to have lower physical activity and more likely to be missing data on other variables. Overall, these significant differences suggest that the resulting analyzed sample produces results more accurate for a sample that is more educated, richer, more active, and more likely to be white as opposed to be in a minority racial group than the general population. Overall 11.5% of the sample was lost due to missing data from the sample of all those with arthritis to the analytic sample. Table V provides a descriptive comparison of the analytic sample to the sample restricted to only those non missing for all factors, used in multivariable modeling, and suggests that those samples are comparable as the distribution of factors is very similar.

C. Interpretation

The results of this study suggest that the main exposure arthritis attributable joint pain in both its dichotomous and its categorical form is the most important characteristic associated with each of the two outcomes, as it has the largest magnitude odds ratio in all multivariable models. The overall association between arthritis attributable joint pain and each of the two outcomes: arthritis attributable activity limitation and arthritis attributable work limitation, while significant, is affected by the inclusion of co-variates representing the domains of sociodemographics, health status factors, and health behaviors into multivariable models. These factors appear to play a more important role within the severe joint pain category for both outcomes in that their inclusion more significantly attenuates the odds ratios for severe arthritis attributable joint pain compared to no joint pain than they do for the relationship between mild-moderate joint pain compared to no joint pain. This study is in line with the published literature in finding an association between joint pain and functional limitation (121). Specifically, this study evaluates the relationship between a.) arthritis attributable joint pain and arthritis

attributable activity limitation and b.) arthritis attributable joint pain and arthritis attributable work limitation--in many studies, pain limiting activity in general and specific activities such as work can be considered aspects of the actual definition of severe symptomatic arthritis/increased arthritis severity (25, 53-54). Therefore the finding of strong associations for these relationships makes sense. The underlying mechanism of this association is multifactorial, as noted in the Introduction and involves biological (e.g. genetics, joint structure), psychological (e.g. pain perception), and social factors (e.g. participation in work and type of work), all of which interplay to affect an individuals' overall functional level including perception of the extent of an individual's osteoarthritis burden (53). Potentially modifiable risk factors evaluated in this study include arthritis attributable joint pain itself, self-reported health status, and physical activity. Of these characteristics, the main exposure arthritis attributable joint pain had the greatest magnitude odds ratios in all multivariable models so may be the most worthwhile target for intervention. The larger magnitude odds ratio observed in the severe category arthritis attributable joint pain compared to no joint pain versus in mild-moderate joint pain compared to no joint pain suggests a possible dose-response of arthritis attributable joint pain with regard to the two outcomes evaluated. As the severe joint pain category was more strongly affected by the inclusion of co-variates, individuals with arthritis attributable severe joint pain may represent a group most amenable to intervention out of those with arthritis attributable joint pain. However, given that inclusion of age, race/ethnicity, sex, self-reported health status, and physical activity did not have much effect at all on the mild-moderate joint pain category and, though there was some effect on the odds ratio for the severe joint pain category, the magnitude of effect remained very large even with inclusion of these characteristics, there are likely other factors of importance related to the relationship between joint pain and each outcome that require identification. On the other hand, Cochrane reviews of land based exercise programs for treatment of symptomatic hip and knee osteoarthritis found an 8 and 6% reduction in pain and 7 and 3% reduction in functional limitation with these interventions respectively

(47, 122). Aquatic exercise programs also provide a comparable small but significant effect, a Cochrane review of aquatic exercise programs for treatment of hip and knee osteoarthritis found a 5% reduction in both pain and functional limitation with this intervention (123). Although the results of these studies are not directly comparable to U.S. adults with arthritis reporting arthritis attributable joint pain, a 5% reduction in U.S. adults with arthritis reporting arthritis attributable joint pain would affect almost 2.5 million people.

In general, associations are similar between the dichotomous joint pain model and the categorical joint pain model for each outcome. In models for outcome arthritis activity limitation, for both dichotomous and categorical joint pain, the oldest age group ≥66 showed decreased odds ratio in reporting arthritis activity limitation compared to younger age groups. A similar finding was also seen in the two models predicting arthritis work limitation, perhaps suggesting that older individuals may continue in activities including work despite the likelihood that they are experiencing the same or more pain or functional limitation than younger individuals, but, in the case of general activity, they may be unwilling to acknowledge limitation because they have either adjusted and adapted to a lower level of activity, or accept that activities may be more difficult for them and do not consider the level of difficulty they experience to merit calling “activity limitation”. In the case of the arthritis work limitation models, again, older individuals may expect a certain amount of difficulty in performing tasks and not think it merits reporting as work limitation. Older individuals may have more at stake with regard to work limitation as they may be more likely to be at a life stage in which they are the primary wage earners supporting other family members, which would also make them less inclined to report work limitation. These findings are contrary to some literature in the area (70). The discrepancy may be related to the fact that the findings from this study are from self-reported arthritis- attributable activity limitation and self-reported arthritis work limitation, which will be more affected by reporting bias due to the above described considerations than other forms of measurement. Of note, the issues described

here are in line with the compensatory strategies for functional limitations literature within the realm of geriatric rehabilitation (124).

The finding that female sex demonstrates slightly increased odds of arthritis activity limitation for both the dichotomous and the categorical pain models is supported in the literature model (71). Female sex is not significant in the work limitation models which may be related to the relatively older mean age of the sample and the likelihood that less women are participating in the work force, or functioning as the primary wage earners in their households. All models found slightly increased odds of activity or work limitation in those reporting less than the referent level of weekly physical activity. Self-reported health status was the co-variate with the largest magnitude odds ratio for each model, other than the main exposure, joint pain. The importance of race/ethnicity in the models is less clear and merits further investigation.

Although this study does provide information indicating the hypothesized associations were supported: those with arthritis attributable joint pain and with greater severity joint pain will have greater arthritis activity limitation and arthritis work limitation as indicated by greater magnitude odds ratios, even after controlling for sociodemographic, health status and health behavior characteristics, this area of study would benefit from future work with research questions focusing on the relative importance of co-variates in the production of each outcome, including elucidation of the pathway toward each outcome, in order to provide input on possible interventions to reduce arthritis activity limitation and arthritis work limitation and improve quality of life. Future work could specifically be targeted toward those with severe arthritis attributable joint pain as this group appears to be more strongly affected by consideration of other characteristics with regard to association with arthritis attributable activity limitation and arthritis attributable work limitation. In the future, longitudinal studies can help establish causation.

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APPENDICES

APPENDIX A

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Determination Notice
Research Activity Does Not Involve "Human Subjects"

March 31, 2016

Shanti Ganesh, MD, MPH
Epidemiology and Biostatistics
7 Whistle Stop Lane
Barboursville, WV 25504
Phone: (312) 371-4958

RE: Research Protocol # 2016-0369
"Arthritis activity limitation and work limitation in the Behavioral Risk Factor Surveillance System 2011 and 2013 data"

Dear Dr. Ganesh:

The above proposal was reviewed on March 31, 2016 by OPRS staff/members of IRB #7. From the information you have provided, the proposal does not appear to involve "human subjects" as defined in 45 CFR 46. 102(f).

The specific definition of human subject under 45 CFR 46.102(f) is:

Human subject means a living individual about whom an investigator (whether professional or student) conducting research obtains

(1) data through intervention or interaction with the individual, or

(2) identifiable private information.

Intervention includes both physical procedures by which data are gathered (for example, venipuncture) and manipulations of the subject or the subject's environment that are performed for research purposes. *Interaction* includes communication or interpersonal contact between investigator and subject. *Private information* includes information about behavior that occurs in a context in which an individual can reasonably expect that no observation or recording is taking place, and information which has been provided for specific purposes by an individual and

APPENDIX A (continued)

which the individual can reasonably expect will not be made public (for example, a medical record). Private information must be individually identifiable (i.e., the identity of the subject is or may readily be ascertained by the investigator or associated with the information) in order for obtaining the information to constitute research involving human subjects.

All the documents associated with this proposal will be kept on file in the OPRS and a copy of this letter is being provided to your Department Head for the department's research files.

If you have any questions or need further help, please contact the OPRS office at (312) 996-1711 or me at (312) 413-3202. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Teresa D. Johnston, B.S., C.I.P.
Assistant Director
Office for the Protection of Research Subjects

cc: Ronald C. Hershow, Epidemiology and Biostatistics, M/C 923
Sylvia E. Furner, Faculty Sponsor, Epidemiology and Biostatistics, M/C 923

APPENDIX B

TABLE XXIII. AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING JOINT PAIN VS. MISSING JOINT PAIN, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing joint pain Percent weighted (95% CI) n=304022**	**Missing joint pain Percent weighted (95% CI) n=29653**	**P value Rao-Scott chi square test**
Arthritis activity limitation			
No arthritis activity limitation	**48.7 (48.3, 491.)**	**15.0 (14.2, 15.7)**	**<.0001**
+Arthritis activity limitation	**50.6 (50.2, 51.0)**	**14.2 (13.4, 15.0)**	
Missing/don't know/refused	**0.7 (0.6, 0.8)**	**70.9 (70.0, 71.9)**	
Arthritis work limitation			
No arthritis work limitation	**63.0 (62.6, 63.3)**	**18.0 (17.2, 18.8)**	**<.0001**
+Arthritis work limitation	**35.0 (34.6, 35.3)**	**8.7 (8.0, 9.4)**	
Missing/don't know/refused	**2.1 (2.0, 2.2)**	**73.3 (72.3, 74.2)**	
Age			
18-35	**7.3 (7.0, 7.5)**	**9.1 (8.2, 10.0)**	**<.0001**
36-50	**18.7 (18.4, 19.1)**	**17.6 (16.7, 18.6)**	
51-65	**38.1 (37.8, 38.5)**	**32.9 (31.8, 34.0)**	
≥66	**35.5 (35.2, 35.8)**	**39.7 (38.6, 40.8)**	
Missing/don't know/refused	**0.3 (0.3, 0.3)**	**0.6 (0.4, 0.8)**	
Sex			
Male	40.6 (40.2, 41.0)	41.5 (40.3, 42.7)	0.14
Female	59.4 (59.0, 59.8)	58.5 (57.3, 60.0)	
Missing/don't know/refused	0	0	
Race/ethnicity			
White, non-Hispanic	**73.8 (73.5, 74.2)**	**66.4 (65.2, 67.7)**	**<.0001**
Black, non-Hispanic	**10.5 (10.3, 10.8)**	**13.8 (12.8, 14.8)**	
Asian, non-Hispanic	**1.8 (1.7, 2.0)**	**2.5 (1.9, 3.1)**	
Hispanic	**8.9 (8.7, 9.2)**	**11.0 (10.1, 11.9)**	
Other	**3.4 (3.2, 3.5)**	**3.6 (3.2, 4.1)**	
Missing/don't know/refused	**1.5 (1.4, 1.6)**	**2.6 (2.3, 2.9)**	

Appendix B (continued)

TABLE XXIII. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING JOINT PAIN VS. MISSING JOINT PAIN, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing joint pain Percent weighted (95% CI) n=304022**	**Missing joint pain Percent weighted (95% CI) n=29653**	**P value Rao-Scott chi square test**
Education			
Less than high school	**17.7 (17.4, 18.1)**	**23.9 (22.8, 25.0)**	**<.0001**
High school graduate/GED	**31.4 (31.1, 31.7)**	**33.9 (32.8, 35.0)**	
Some college or technical school	**30.3 (30.0, 30.7)**	**26.9 (25.8, 27.9)**	
College graduate (referent)	**20.3 (20.1, 20.6)**	**13.4 (12.7, 14.0)**	
Missing/don't know/refused	**0.2 (0.2, 0.3)**	**2.0 (1.6, 2.3)**	
Income			
50k or more	**30.7 (30.4, 31.1)**	**20.5 (19.6, 21.5)**	**<.0001**
25k-$49,999	**23.3 (23.0, 23.6)**	**18.0 (17.1, 18.8)**	
15k-$24,999	**18.5 (18.2, 18.8)**	**18.3 (17.4, 19.2)**	
Less than 15k	**14.3 (14.0, 14.6)**	**17.1 (16.1, 18.1)**	
Missing/don't know/refused	**13.2 (12.9, 13.4)**	**26.0 (25.0, 27.1)**	
Self-reported health status			
Good or better	**64.6 (64.2, 64.9)**	**60.3 (59.1, 61.4)**	**<.0001**
Fair or worse	**34.9 (34.6, 35.3)**	**38.7 (37.5, 39.8)**	
Missing/don't know/refused	**0.5 (0.4, 0.6)**	**1.1 (0.8, 1.3)**	
Diabetes			
No diabetes	80.1 (79.8, 80.4)	79.5 (78.5, 80.5)	0.07
+Diabetes	19.7 (19.4, 20.0)	20.2 (19.2, 21.2)	
Missing/don't know/refused	0.2 (0.2, 0.2)	0.3 (0.2, 0.4)	
Hypertension			
No hypertension	**44.5 (44.1, 44.8)**	**43.9 (42.7, 45.1)**	**<.0001**
+Hypertension	**55.3 (55.0, 55.7)**	**55.6 (54.4, 56.8)**	
Missing/don't know/refused	**0.2 (0.2, 0.2)**	**0.5 (0.3, 0.6)**	
Weight			
Normal BMI	**24.2 (23.9, 24.5)**	**24.5 (23.4, 25.5)**	**<.0001**
Underweight BMI	**1.4 (1.3, 1.4)**	**2.0 (1.7, 2.4)**	
Overweight BMI	**33.5 (33.2, 33.9)**	**31.7 (30.6, 32.8)**	

Appendix B (continued)

TABLE XXIII. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING JOINT PAIN VS. MISSING JOINT PAIN, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing joint pain Percent weighted (95% CI) n=304022**	**Missing joint pain Percent weighted (95% CI) n=29653**	**P value Rao-Scott chi square test**
Obese BMI	**37.0 (36.6, 37.3)**	**31.4 (30.3, 32.6)**	
Missing/don't know/refused	**4.0 (3.8, 4.1)**	**10.3 (9.7, 11.0)**	
Smoking			
Non smoker	**79.3 (79.0, 79.6)**	**67.1 (65.9, 68.3)**	
+Smoker	**20.3 (20.0, 20.6)**	**18.9 (17.9, 19.9)**	**<.0001**
Missing/don't know/refused	**0.4 (0.4, 0.5)**	**14.0 (13.1, 14.8)**	
Alcohol			
No alcohol	**54.2 (53.9, 54.6)**	**30.5 (29.5, 31.6)**	**<.0001**
+Alcohol	**44.8 (44.4, 45.1)**	**19.9 (18.9, 20.8)**	
Missing/don't know/refused	**1.0 (0.9, 1.1)**	**49.6 (48.4, 50.8)**	
Physical Activity			
0 minutes	**35.2 (34.8, 35.5)**	**16.6 (15.8, 17.5)**	**<.0001**
1-149 minutes	**16.7 (16.4, 16.9)**	**6.3 (5.7, 7.0)**	
≥150 minutes (referent)	**44.8 (44.4, 45.1)**	**15.9 (15.0, 16.8)**	
Missing/don't know/refused	**3.4 (3.3, 3.5)**	**61.1 (60.0, 62.3)**	

Appendix B (continued)

TABLE XXIV. AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING ARTHRITIS ACTIVITY LIMITATION VS. MISSING ARTHRITIS ACTIVITY LIMITATION, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing arthritis activity limitation Percent weighted (95% CI) n=312259**	**Missing arthritis activity limitation Percent weighted (95% CI) n=21416**	**P value Rao-Scott chi square test**
Arthritis joint pain			
No joint pain	**7.3 (7.1, 7.5)**	**0.4 (0.3, 0.6)**	**<.0001**
Mild-Moderate joint pain	**59.8 (59.4, 60.2)**	**4.6 (4.1, 5.1)**	
Severe joint pain	**29.8 (29.5, 30.2)**	**3.3 (2.7, 3.8)**	
Missing/don't know/refused	**3.1 (3.0, 3.2)**	**91.2 (91.0, 92.5)**	
Arthritis work limitation			
No arthritis work limitation	**62.9 (62.5, 63.2)**	**5.3 (4.7, 6.0)**	**<.0001**
+Arthritis work limitation	**34.9 (34.5, 35.2)**	**2.3 (1.9, 2.6)**	
Missing/don't know/refused	**2.2 (2.1, 2.3)**	**92.4 (91.7, 93.1)**	
Age			
18-35	**7.3 (7.0, 7.5)**	**9.8 (8.7, 10.9)**	**<.0001**
36-50	**18.6 (18.3, 18.9)**	**18.6 (17.4, 19.7)**	
51-65	**37.9 (37.6, 38.2)**	**34.2 (32.9, 35.5)**	
≥66	**35.6 (35.5, 36.2)**	**36.8 (35.5, 38.0)**	
Missing/don't know/refused	**0.3 (0.3, 0.4)**	**0.7 (0.4, 0.9)**	
Sex			
Male	40.6 (40.2, 40.9)	42.0 (40.6, 43.4)	0.06
Female	59.4 (59.1, 59.8)	58.0 (56.6, 59.4)	
Missing/don't know/refused	0	0	
Race/ethnicity			
White, non-Hispanic	**73.8 (73.4, 74.2)**	**64.9 (63.4, 66.4)**	**<.0001**
Black, non-Hispanic	**10.5 (10.3, 10.8)**	**14.4 (13.3, 15.5)**	
Asian, non-Hispanic	**1.8 (1.7, 2.0)**	**2.6 (1.9, 3.4)**	
Hispanic	**8.9 (8.6, 9.2)**	**11.9 (10.8, 13.0)**	
Other	**3.4 (3.3, 3.5)**	**3.6 (3.1, 4.1)**	
Missing/don't know/refused	**1.5 (1.4, 1.6)**	**2.5 (2.2, 2.9)**	
Education			
Less than high school	**17.9 (17.6, 18.3)**	**23.3 (22.0, 24.6)**	
High school graduate/GED	**31.4 (31.1, 31.7)**	**34.7 (33.4, 36.0)**	

Appendix B (continued)

TABLE XXIV. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING ARTHRITIS ACTIVITY LIMITATION VS. MISSING ARTHRITIS ACTIVITY LIMITATION, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing arthritis activity limitation Percent weighted (95% CI) n=312259**	**Missing arthritis activity limitation Percent weighted (95% CI) n=21416**	**P value Rao-Scott chi square test**
Some college or technical school	**30.3 (30.0, 30.7)**	**25.8 (24.6, 27.1)**	**<.0001**
College graduate (referent)	**20.1 (19.9, 20.4)**	**13.8 (13.0, 14.6)**	
Missing/don't know/refused	**0.2 (0.2, 0.3)**	**2.4 (1.9, 2.9)**	
Income			
50k or more	**30.5 (30.2, 30.8)**	**20.8 (19.6, 21.9)**	**<.0001**
25k-$49,999	**23.2 (22.9, 23.5)**	**17.5 (16.5, 18.5)**	
15k-$24,999	**18.5 (18.3, 18.8)**	**17.7 (16.7, 18.7)**	
Less than 15k	**14.3 (14.1, 14.6)**	**17.5 (16.4, 18.7)**	
Missing/don't know/refused	**13.5 (13.2, 13.7)**	**26.5 (25.3, 27.7)**	
Self-reported health status			
Good or better	**64.5 (64.1, 64.8)**	**60.2 (58.8, 61.5)**	**<.0001**
Fair or worse	**35.0 (34.7, 35.4)**	**39.0 (37.7, 40.4)**	
Missing/don't know/refused	**0.5 (0.5, 0.6)**	**0.8 (0.6, 1.0)**	
Diabetes			
No diabetes	80.0 (79.7, 80.3)	80.4 (79.3, 81.5)	0.8
+Diabetes	19.8 (19.5, 20.1)	19.4 (18.3, 20.5)	
Missing/don't know/refused	0.2 (0.2, 0.2)	0.2 (0.1, 0.3)	
Hypertension			
No hypertension	**44.4 (44.1, 44.8)**	**44.4 (43.0, 45.8)**	**<.0001**
+Hypertension	**55.4 (55.1, 55.7)**	**55.2 (53.8, 56.6)**	
Missing/don't know/refused	**0.2 (0.2, 0.2)**	**0.5 (0.3, 0.7)**	
Weight			
Normal BMI	**24.2 (23.9, 24.0)**	**24.2 (23.0, 25.4)**	**<.0001**
Underweight BMI	**1.4 (1.3, 1.5)**	**2.0 (1.6, 2.5)**	
Overweight BMI	**33.5 (33.1, 33.8)**	**31.9 (30.6, 33.2)**	
Obese BMI	**36.9 (36.5, 37.3)**	**30.6 (29.3, 31.9)**	

Appendix B (continued)

TABLE XXIV. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING ARTHRITIS ACTIVITY LIMITATION VS. MISSING ARTHRITIS ACTIVITY LIMITATION, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing arthritis activity limitation Percent weighted (95% CI) n=312259**	**Missing arthritis activity limitation Percent weighted (95% CI) n=21416**	**P value Rao-Scott chi square test**
Missing/don't know/refused	**4.0 (3.9, 4.2)**	**11.3 (10.5, 12.1)**	
Smoking			
Non smoker	**79.3 (79.0, 79.6)**	**62.7 (61.3, 64.1)**	**<.0001**
+Smoker	**20.2 (19.9, 20.5)**	**19.5 (18.3, 20.7)**	
Missing/don't know/refused	**0.5 (0.4, 0.5)**	**17.9 (16.7, 18.9)**	
Alcohol			
No alcohol	**54.3 (54.0, 54.7)**	**22.5 (21.3, 23.6)**	**<.0001**
+Alcohol	**44.4 (44.1, 44.8)**	**16.6 (15.6, 17.5)**	
Missing/don't know/refused	**1.2 (1.2, 1.3)**	**61.0 (59.6, 62.3)**	
Physical Activity			
0 minutes	**35.4 (35.1, 35.8)**	**8.0 (7.2, 8.7)**	**<.0001**
1-149 minutes	**16.6 (16.3, 16.9)**	**4.1 (3.4, 4.8)**	
≥150 minutes (referent)	**44.5 (44.1, 44.8)**	**11.1 (10.1, 12.0)**	
Missing/don't know/refused	**3.5 (3.4, 3.6)**	**76.8 (75.6, 78.1)**	

Appendix B (continued)

TABLE XXV. AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING ARTHRITIS WORK LIMITATION VS. MISSING ARTHRITIS WORK LIMITATION, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing arthritis work limitation Percent weighted (95% CI) n=306876**	**Missing arthritis work limitation Percent weighted (95% CI) n=26799**	**P value Rao-Scott chi square test**
Arthritis joint pain			
No joint pain	**7.4 (7.2, 7.5)**	**1.1 (0.9, 1.3)**	**<.0001**
Mild-Moderate joint pain	**60.2 (59.8, 60.5)**	**9.9 (9.3, 10.4)**	
Severe joint pain	**29.6 (29.2, 29.9)**	**9.8 (9.1, 10.5)**	
Missing/don't know/refused	**2.9 (2.8, 3.0)**	**79.2 (78.3, 80.1)**	
Arthritis activity limitation			
No arthritis activity limitation	**49.1 (48.8, 49.5)**	**8.0 (7.4, 8.6)**	**<.0001**
+Arthritis activity limitation	**50.2 (50.0, 50.6)**	**14.9 (14.0, 15.7)**	
Missing/don't know/refused	**0.6 (0.6, 0.7)**	**77.1 (76.1, 78.1)**	
Age			
18-35	**7.3 (7.1, 7.6)**	**8.6 (7.7, 9.5)**	**<.0001**
36-50	**18.8 (18.5, 19.1)**	**17.2 (16.2, 18.1)**	
51-65	**38.1 (37.7, 38.7)**	**33.1 (31.9, 34.3)**	
≥66	**35.5 (35.2, 35.8)**	**40.4 (39.3, 41.6)**	
Missing/don't know/refused	**0.3 (0.3, 0.4)**	**0.7 (0.5, 1.0)**	
Sex			
Male	40.6 (40.2, 41.0)	41.5 (40.2, 42.8)	0.2
Female	59.4 (59.0, 59.8)	58.5 (57.2, 60.0)	
Missing/don't know/refused	0	0	
Race/ethnicity			
White, non-Hispanic	**73.9 (73.5, 74.3)**	**65.4 (64.1, 66.7)**	**<.0001**
Black, non-Hispanic	**10.5 (10.2, 10.7)**	**14.4 (13.4, 15.4)**	
Asian, non-Hispanic	**1.8 (1.7, 2.0)**	**2.5 (1.9, 3.2)**	
Hispanic	**8.9 (8.6, 9.2)**	**11.5 (10.5, 12.4)**	
Other	**3.4 (3.3., 3.5)**	**3.5 (3.1, 3.9)**	
Missing/don't know/refused	**1.5 (1.4, 1.6)**	**2.7 (2.3, 3.1)**	
Education			

Appendix B (continued)

TABLE XXV. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING ARTHRITIS WORK LIMITATION VS. MISSING ARTHRITIS WORK LIMITATION, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing arthritis work limitation Percent weighted (95% CI) n=306876**	**Missing arthritis work limitation Percent weighted (95% CI) n=26799**	**P value Rao-Scott chi square test**
Less than high school	**17.7 (17.4, 18.0)**	**24.7 (23.5, 25.9)**	
High school graduate/GED	**31.4 (31.0, 31.7)**	**34.3 (33.2, 35.5)**	**<.0001**
Some college or technical school	**30.4 (30.1, 30.7)**	**25.7 (24.6, 26.8)**	
College graduate (referent)	**20.3 (20.1, 20.6)**	**13.2 (12.5, 13.8)**	
Missing/don't know/refused	**0.2 (0.2, 0.3)**	**2.1 (1.7, 2.5)**	
Income			
50k or more	**30.8 (30.5, 31.7)**	**18.9 (18.0, 19.9)**	**<.0001**
25k-$49,999	**23.3 (23.0, 23.6)**	**17.5 (16.7, 18.4)**	
15k-$24,999	**18.4 (18.1, 18.7)**	**18.9 (17.9, 19.8)**	
Less than 15k	**14.2 (13.9, 14.5)**	**18.4 (17.3, 19.4)**	
Missing/don't know/refused	**13.3 (13.0, 13.5)**	**26.3 (25.2, 27.3)**	
Self-reported health status			
Good or better	**64.9 (64.5, 65.2)**	**56.8 (55.6, 58.1)**	**<.0001**
Fair or worse	**34.6 (34.3, 35.0)**	**42.2 (41.0, 43.4)**	
Missing/don't know/refused	**0.5 (0.4, 0.6)**	**1.0 (0.8, 1.2)**	
Diabetes			
No diabetes	**80.2, (79.9, 80.5)**	**78.3 (77.2, 79.3)**	**.0006**
+Diabetes	**19.6 (19.3, 19.9)**	**21.5 (20.5, 22.6)**	
Missing/don't know/refused	**0.2 (0.2, 0.2)**	**0.2 (0.1, 0.3)**	
Hypertension			
No hypertension	**44.7 (44.3, 45.1)**	**41.6 (40.4, 42.8)**	**<.0001**
+Hypertension	**55.1 (54.8, 55.5)**	**57.9 (56.6, 59.1)**	
Missing/don't know/refused	**0.2 (0.2, 0.2)**	**0.5 (0.4, 0.7)**	
Weight			
Normal BMI	**24.2 (23.9, 24.5)**	**24.2 (23.7, 25.3)**	**<.0001**
Underweight BMI	**1.4 (1.3, 1.5)**	**2.0 (1.6, 2.3)**	
Overweight BMI	**33.5 (33.2, 33.9)**	**31.4 (30.3, 32.6)**	

Appendix B (continued)

TABLE XXV. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING ARTHRITIS WORK LIMITATION VS. MISSING ARTHRITIS WORK LIMITATION, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing arthritis work limitation Percent weighted (95% CI) n=306876**	**Missing arthritis work limitation Percent weighted (95% CI) n=26799**	**P value Rao-Scott chi square test**
Obese BMI	**36.9 (36.5, 37.2)**	**32.1 (30.9, 33.2)**	
Missing/don't know/refused	**4.0 (3.9, 4.2)**	**10.3 (9.6, 11.0)**	
Smoking			
Non smoker	**79.4 (79.0, 79.7)**	**65.2 (64.0, 66.4)**	**<.0001**
+Smoker	**20.2 (19.9, 20.5)**	**19.6 (18.5, 20.6)**	
Missing/don't know/refused	**0.4 (0.4, 0.5)**	**15.2 (14.3, 16.2)**	
Alcohol			
No alcohol	**54.1 (53.8, 54.5)**	**29.8 (28.7, 30.9)**	**<.0001**
+Alcohol	**44.7 (44.4, 45.1)**	**18.2 (17.3, 19.1)**	
Missing/don't know/refused	**1.2 (1.1, 1.2)**	**52.0 (50.8, 53.2)**	
Physical Activity			
0 minutes	**35.2 (34.8, 35.5)**	**15.4 (14.5, 16.3)**	**<.0001**
1-149 minutes	**16.7 (16.4, 17.0)**	**4.9 (4.4, 5.5)**	
≥150 minutes (referent)	**44.7 (44.4, 45.1)**	**14.1 (13.2, 15.0)**	
Missing/don't know/refused	**3.4 (3.3, 3.5)**	**65.6 (64.4, 66.8)**	

Appendix B (continued)

TABLE XXVI. AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING INCOME VS. MISSING INCOME, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing income Percent weighted (95% CI) n=281197**	**Missing income Percent weighted (95% CI) n=52478**	**P value Rao-Scott chi square test**
Arthritis joint pain			
No joint pain	**6.8 (6.6, 7.0)**	**6.9 (6.5, 7.4)**	**<.0001**
Mild-Moderate joint pain	**56.8 (56.4, 57.2)**	**48.7 (47.9, 49.6)**	
Severe joint pain	**28.0 (27.6, 28.3)**	**26.7 (25.9, 27.5)**	
Missing/don't know/refused	**8.5 (8.2, 8.7)**	**17.6 (16.9, 18.3)**	
Arthritis activity limitation			
No arthritis activity limitation	**45.8 (45.4, 46.1)**	**43.3 (42.4, 44.2)**	**<.0001**
+Arthritis activity limitation	**47.7 (47.4, 48.2)**	**42.8 (42.0, 43.7)**	
Missing/don't know/refused	**6.5 (6.3, 6.7)**	**13.9 (13.2, 14.5)**	
Arthritis work limitation			
No arthritis work limitation	**59.0 (58.6, 59.4)**	**55.9 (55.0, 56.8)**	**<.0001**
+Arthritis work limitation	**33.2 (32.9, 33.6)**	**27.6 (26.8, 28.4)**	
Missing/don't know/refused	**7.8 (7.6, 8.0)**	**16.5 (15.8, 17.1)**	
Age			
18-35	**7.6 (7.3, 7.8)**	**6.7 (6.1, 7.4)**	**<.0001**
36-50	**19.7 (19.4, 20.1)**	**12.0 (11.4, 12.7)**	
51-65	**38.8 (38.5. 39.2)**	**30.6 (29.8, 31.4)**	
≥66	**33.7 (33.3, 34.0)**	**49.4 (48.5, 50.3)**	
Missing/don't know/refused	**0.2 (0.2, 0.3)**	**1.2 (1.0, 1.4)**	
Sex			
Male	**42.3 (41.9, 42.7)**	**31.2 (30.3, 32.1)**	**<.0001**
Female	**57.7 (57.4, 58.2)**	**68.8 (67.9, 69.8)**	
Missing/don't know/refused	**0**	**0**	
Race/ethnicity			
White, non-Hispanic	**73.0 (72.6, 73.4)**	**73.7 (72.9, 74.9)**	**<.0001**
Black, non-Hispanic	**10.9 (10.7, 11.2)**	**10.3 (9.7, 11.0)**	
Asian, non-Hispanic	**2.0 (1.8, 2.2)**	**1.4 (1.1, 1.8)**	

Appendix B (continued)

TABLE XXVI. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING INCOME VS. MISSING INCOME, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing income Percent weighted (95% CI) n=281197**	**Missing income Percent weighted (95% CI) n=52478**	**P value Rao-Scott chi square test**
Hispanic	**9.3 (9.0, 9.6)**	**8.2 (7.6, 8.8)**	
Other	**3.5 (3.3, 3.6)**	**3.0 (2.6, 3.3)**	
Missing/don't know/refused	**1.3 (1.3, 1.4)**	**3.3 (3.0, 3.6)**	
Education			
Less than high school	**17.3 (16.9, 17.6)**	**24.7 (23.8, 25.6)**	**<.0001**
High school graduate/GED	**31.3 (30.9, 31.6)**	**33.9 (33.1, 34.7)**	
Some college or technical school	**30.8 (30.5, 31.2)**	**25.1 (24.3, 25.8)**	
College graduate (referent)	**20.5 (20.3, 20.8)**	**14.5 (14.0, 14.9)**	
Missing/don't know/refused	**0.1 (0.1, 0.2)**	**1.9 (1.6, 2.2)**	
Self-reported health status			
Good or better	**64.8 (64.4, 65.1)**	**60.6 (59.7, 61.4)**	**<.0001**
Fair or worse	**34.8 (34.4, 35.1)**	**38.5 (37.6, 39.3)**	
Missing/don't know/refused	**0.5 (0.4, 0.5)**	**1.0 (0.8, 1.1)**	
Diabetes			
No diabetes	**80.2 (79.9, 80.5)**	**79.0 (78.2, 79.7)**	**<.0001**
+Diabetes	**19.6 (19.3, 19.9)**	**20.6 (19.9, 21.4)**	
Missing/don't know/refused	**0.2 (0.1, 0.2)**	**0.4 (0.3, 0.5)**	
Hypertension			
No hypertension	**44.9 (44.5, 45.3)**	**41.3 (40.4, 42.2)**	**<.0001**
+Hypertension	**54.9 (54.5, 55.3)**	**58.2 (57.3, 59.1)**	
Missing/don't know/refused	**0.2 (0.1, 0.2)**	**0.5 (0.4, 0.6)**	
Weight			
Normal BMI	**23.9 (23.6, 24.3)**	**26.0 (25.2, 26.7)**	**<.0001**
Underweight BMI	**1.3 (1.2, 1.4)**	**1.9 (1.7, 2.2)**	
Overweight BMI	**33.7 (33.3, 34.1)**	**31.2 (30.4, 32.1)**	
Obese BMI	**37.7 (37.3, 38.1)**	**28.8 (28.0, 29.2)**	
Missing/don't know/refused	**3.3 (3.2, 3.5)**	**12.0 (11.4, 12.6)**	

Appendix B (continued)

TABLE XXVI. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING INCOME VS. MISSING INCOME, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing income Percent weighted (95% CI) n=281197**	**Missing income Percent weighted (95% CI) n=52478**	**P value Rao-Scott chi square test**
Smoking			
Non smoker	**77.8 (77.5, 78.1)**	**79.6 (78.9, 80.4)**	**<.0001**
+Smoker	**20.8 (20.5, 21.1)**	**16.3 (15.6, 17.0)**	
Missing/don't know/refused	**1.4 (1.3, 1.5)**	**4.1 (3.7, 4.4)**	
Alcohol			
No alcohol	**51.0 (50.7, 51.4)**	**57.1 (56.3, 58.0)**	**<.0001**
+Alcohol	**44.7 (43.8, 44.5)**	**31.5, 30.7, 32.3)**	
Missing/don't know/refused	**4.8 (4.6, 5.0)**	**11.4 (10.8, 12.0)**	
Physical Activity			
0 minutes	**33.1 (32.7, 33.4)**	**35.1 (34.3, 35.9)**	**<.0001**
1-149 minutes	**16.2 (15.9, 16.5)**	**12.2 (11.6, 12.8)**	
≥150 minutes (referent)	**43.1 (42.7, 43.5)**	**35.0 (34.2, 35.9)**	
Missing/don't know/refused	**7.6 (7.4, 7.8)**	**17.7 (17.0, 18.4)**	

Appendix B (continued)

TABLE XXVII. AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING ALCOHOL VS. MISSING ALCOHOL, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing alcohol Percent weighted (95% CI) n=317461**	**Missing alcohol Percent weighted (95% CI) n=16214**	**P value Rao-Scott chi square test**
Arthritis joint pain			
No joint pain	**7.1 (6.9, 7.4)**	**1.2 (0.9, 1.4)**	**<.0001**
Mild-Moderate joint pain	**58.5 (58.1, 58.8)**	**9.0 (8.1, 9.8)**	
Severe joint pain	**29.2 (28.8, 29.5)**	**5.5 (4.8, 6.2)**	
Missing/don't know/refused	**5.2 (5.1, 5.4)**	**84.4 (83.3, 85.5)**	
Arthritis activity limitation			
No arthritis activity limitation	**47.6 (47.2, 47.9)**	**10.3 (9.4, 11.2)**	**<.0001**
+Arthritis activity limitation	**46.8 (49.0, 49.7)**	**9.6 (8.8, 10.5)**	
Missing/don't know/refused	**3.1 (3.0, 3.3)**	**80.0 (78.8, 81.3)**	
Arthritis work limitation			
No arthritis work limitation	**61.4 (61.0, 61.7)**	**11.8 (10.9, 12.8)**	**<.0001**
+Arthritis work limitation	**34.0 (33.7, 34.4)**	**6.4, (5.6, 7.1)**	
Missing/don't know/refused	**4.6 (4.5, 4.8)**	**81.8 (80.6, 83.0)**	
Age			
18-35	**7.4 (7.1, 7.6)**	**8.8 (7.6, 10.1)**	**<.0001**
36-50	**18.7 (18.4, 19.0)**	**17.6 (16.3, 18.8)**	
51-65	**37.8 (37.4, 38.1)**	**35.3 (33.8, 36.9)**	
≥66	**35.9 (35.5, 36.2)**	**37.2 (35.8, 38.7)**	
Missing/don't know/refused	**0.3 (0.3, 0.4)**	**1.0 (0.7, 1.4)**	
Sex			
Male	**40.5 (40.2, 40.9)**	**42.9 (41.3, 44.5)**	**.0050**
Female	**59.5 (59.1, 59.8)**	**57.1 (55.5, 58.7)**	
Missing/don't know/refused	**0**	**0**	
Race/ethnicity			
White, non-Hispanic	**73.7 (73.3, 74.1)**	**63.9 (62.2, 65.5)**	**<.0001**
Black, non-Hispanic	**10.6 (10.3, 10.8)**	**14.7 (13.5, 15.9)**	
Asian, non-Hispanic	**1.8 (1.7, 2.0)**	**2.9 (2.0, 3.9)**	

Appendix B (continued)

TABLE XXVII. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING ALCOHOL VS. MISSING ALCOHOL, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing alcohol Percent weighted (95% CI) n=317461**	**Missing alcohol Percent weighted (95% CI) n=16214**	**P value Rao-Scott chi square test**
Hispanic	**8.9 (8.7, 9.2)**	**12.2 (10.9, 13.4)**	
Other	**3.4 (3.3, 3.5)**	**3.7 (3.1, 4.3)**	
Missing/don't know/refused	**1.5 (1.4, 1.6)**	**2.6 (2.2, 3.0)**	
Education			
Less than high school	**18.0 (17.7, 18.3)**	**23.7 (22.2, 25.2)**	**<.0001**
High school graduate/GED	**31.5 (31.2, 31.8)**	**33.8 (32.3, 35.3)**	
Some college or technical school	**30.2 (29.9, 30.5)**	**26.3 (24.9, 27.7)**	
College graduate (referent)	**20.0 (19.8, 20.3)**	**13.3 (12.4, 14.2)**	
Missing/don't know/refused	**0.2 (0.2, 0.3)**	**2.9 (2.4, 3.4)**	
Income			
50k or more	**30.3 (30.0, 30.7)**	**20.1 (18.8, 21.4)**	**<.0001**
25k-$49,999	**23.1 (22.8, 23.4)**	**16.6 (15.5, 17.7)**	
15k-$24,999	**18.5 (18.3, 18.8)**	**17.3 (16.2, 18.5)**	
Less than 15k	**14.4 (14.1, 14.7)**	**17.4 (16.0, 18.8)**	
Missing/don't know/refused	**13.6 (13.3, 13.8)**	**28.6 (27.2, 30.0)**	
Self-reported health status			
Good or better	**64.4 (64.1, 64.8)**	**59.5 (57.9, 61.1)**	**<.0001**
Fair or worse	**35.0 (34.7, 35.4)**	**39.6 (38.0, 41.1)**	
Missing/don't know/refused	**0.5 (0.5, 0.6)**	**1.0 (0.6, 1.3)**	
Diabetes			
No diabetes	80.0 (79.7, 80.3)	80.2 (78.9, 81.5)	0.5672
+Diabetes	19.8 (19.5, 20.1)	19.5 (18.3, 20.8)	
Missing/don't know/refused	0.2 (0.2, 0.2)	0.3 (0.1, 0.4)	
Hypertension			
No hypertension	**44.5 (44.1, 44.8)**	**43.5 (41.9, 45.1)**	**<.0001**
+Hypertension	**55.3 (55.0, 55.7)**	**55.8 (54.2, 57.4)**	
Missing/don't know/refused	**0.2 (0.2, 0.2)**	**0.7 (0.4, 0.9)**	

Appendix B (continued)

TABLE XXVII. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING ALCOHOL VS. MISSING ALCOHOL, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA)			
Factor	**Not missing alcohol Percent weighted (95% CI) n=317461**	**Missing alcohol Percent weighted (95% CI) n=16214**	**P value Rao-Scott chi square test**
Weight			
Normal BMI	**24.2 (23.9, 24.5)**	**24.7 (23.2, 26.1)**	**<.0001**
Underweight BMI	**1.4 (1.3, 1.5)**	**1.9 (1.4, 2.4)**	
Overweight BMI	**33.5 (33.1, 33.8)**	**31.3 (29.8, 32.8)**	
Obese BMI	**36.9 (36.5, 37.2)**	**29.4 (27.9, 30.8)**	
Missing/don't know/refused	**4.1 (4.0, 4.2)**	**12.7 (11.7, 13.7)**	
Smoking			
Non smoker	**79.3 (79.0, 79.6)**	**58.3 (56.6, 60.0)**	**<.0001**
+Smoker	**20.3 (20.0, 20.6)**	**18.3 (16.9, 19.7)**	
Missing/don't know/refused	**0.5 (0.4, 0.5)**	**23.4 (22.0, 24.8)**	
Physical Activity			
0 minutes	**43.7 (43.3, 44.0)**	**13.8 (12.6, 15.0)**	**<.0001**
1-149 minutes	**16.3 (16.0, 16.6)**	**5.1 (4.3, 5.9)**	
≥150 minutes (referent)	**34.6 (34.3, 35.0)**	**12.9 (11.8, 14.0)**	
Missing/don't know/refused	**5.4 (5.3, 5.6)**	**68.2 (66.7, 69.7)**	

Appendix B

TABLE XXVIII. AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING PHYSICAL ACTIVITY VS. MISSING PHYSICAL ACTIVITY, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA			
Factor	**Not missing physical activity Percent weighted (95% CI) n=305163**	**Missing physical activity Percent weighted (95% CI) n=28512**	**P value Rao-Scott chi square test**
Arthritis joint pain			
No joint pain	**7.2 (7.0, 7.4)**	**2.7 (2.3, 3.0)**	**<.0001**
Mild-Moderate joint pain	**59.2 (58.8, 59.6)**	**19.8 (18.9, 20.6)**	
Severe joint pain	**29.4 (29.1, 29.8)**	**11.4 (10.6, 12.1)**	
Missing/don't know/refused	**4.2 (4.0, 4.3)**	**66.2 (65.1, 67.3)**	
Arthritis activity limitation			
No arthritis activity limitation	**48.1 (47.8, 48.5)**	**17.9 (17.0, 18.7)**	**<.0001**
+Arthritis activity limitation	**50.0 (50.0, 50.3)**	**17.8 (17.0, 18.6)**	
Missing/don't know/refused	**1.9 (1.8, 2.0)**	**64.3 (63.2, 65.4)**	
Arthritis work limitation			
No arthritis work limitation	**62.2 (61.8, 62.5)**	**22.0 (21.1, 22.9)**	**<.0001**
+Arthritis work limitation	**34.3 (34.1, 34.8)**	**12.3 (11.6, 13.0)**	
Missing/don't know/refused	**3.4 (3.3, 3.6)**	**65.7 (64.7, 66.8)**	
Age			
18-35	**7.4 (7.1, 7.6)**	**8.4 (7.5, 9.2)**	**<.0001**
36-50	**18.7 (18.4, 19.1)**	**17.5 (16.6, 18.5)**	
51-65	**38.0 (37.7, 38.4)**	**33.5 (32.4, 34.6)**	
≥66	**35.7 (35.4, 36.1)**	**37.8 (36.7, 38.9)**	
Missing/don't know/refused	**0.1 (0.1, 0.1)**	**2.8 (2.4, 3.2)**	
Sex			
Male	40.7 (40.3, 41.0)	41.0 (39.8, 42.2)	0.6268
Female	59.3 (59.0, 59.7)	59.0 (57.8, 60.2)	
Missing/don't know/refused	0	0	
Race/ethnicity			
White, non-Hispanic	**73.8 (73.4, 74.1)**	**66.8 (65.5, 68.0)**	
Black, non-Hispanic	**10.4 (10.2, 10.7)**	**15.0 (14.0, 16.1)**	

Appendix B (continued)

TABLE XXVIII. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING PHYSICAL ACTIVITY VS. MISSING PHYSICAL ACTIVITY, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA			
Factor	**Not missing physical activity Percent weighted (95% CI) n=305163**	**Missing physical activity Percent weighted (95% CI) n=28512**	**P value Rao-Scott chi square test**
Asian, non-Hispanic	**1.9 (1.7, 2.1)**	**1.7 (1.2, 2.2)**	
Hispanic	**9.1 (8.9, 9.4)**	**9.2 (8.3, 10.0)**	**<.0001**
Other	**3.4 (3.2, 3.5)**	**4.0 (3.5, 4.5)**	
Missing/don't know/refused	**1.4 (1.3, 1.5)**	**3.4 (3.0, 3.8)**	
Education			
Less than high school	**17.9 (17.5, 18.2)**	**23.1 (22.0, 24.2)**	**<.0001**
High school graduate/GED	**31.4 (31.0, 31.7)**	**34.5 (33.4, 35.6)**	
Some college or technical school	**30.4 (30.0, 30.7)**	**25.9 (24.9, 27.0)**	
College graduate (referent)	**20.2 (19.9, 20.4)**	**14.4 (13.7, 15.1)**	
Missing/don't know/refused	**0.2 (0.2, 0.3)**	**2.0 (1.7, 2.4)**	
Income			
50k or more	**30.8 (30.5, 31.1)**	**19.2 (18.3, 20.2)**	**<.0001**
25k-$49,999	**23.3 (22.9, 23.6)**	**17.7 (16.8, 18.5)**	
15k-$24,999	**18.3 (18.2, 18.8)**	**18.2 (17.2, 19.1)**	
Less than 15k	**14.4 (14.1, 14.7)**	**16.7 (15.7, 17.6)**	
Missing/don't know/refused	**13.1 (12.8, 13.3)**	**28.3 (27.2, 29.3)**	
Self-reported health status			
Good or better	**64.5 (64.2, 64.9)**	**60.3 (59.1, 61.5)**	**<.0001**
Fair or worse	**35.0 (34.6, 35.3)**	**38.6 (37.4, 39.7)**	
Missing/don't know/refused	**0.5 (0.4, 0.6)**	**1.1 (0.8, 1.4)**	
Diabetes			
No diabetes	80.1 (79.8, 80.4)	79.8 (78.8, 80.7)	0.2920
+Diabetes	19.8 (19.5, 20.1)	20.0 (19.0, 20.9)	
Missing/don't know/refused	0.2 (0.1, 0.2)	0.3 (0.2, 0.4)	
Hypertension			
No hypertension	**44.6 (44.2, 44.9)**	**42.7 (41.6, 43.9)**	**<.0001**
+Hypertension	**55.2 (54.9, 55.6)**	**56.7 (55.5, 57.9)**	

Appendix B (continued)

TABLE XXVIII. (continued) AMONG THOSE WITH ARTHRITIS, DISTRIBUTION OF FACTORS IN THOSE NOT MISSING PHYSICAL ACTIVITY VS. MISSING PHYSICAL ACTIVITY, BRFSS 2011 AND 2013 DATA, n=333675 (RESTRICTED TO THOSE WITH ARTHRITIS OUT OF 2011, 2013 DATA			
Factor	**Not missing physical activity Percent weighted (95% CI) n=305163**	**Missing physical activity Percent weighted (95% CI) n=28512**	**P value Rao-Scott chi square test**
Missing/don't know/refused	**0.2 (0.2, 0.2)**	**0.5 (0.4, 0.7)**	
Weight			
Normal BMI	**24.2 (23.9, 24.5)**	**24.5 (23.5, 25.5)**	**<.0001**
Underweight BMI	**1.4 (1.3, 1.4)**	**2.0 (1.7, 2.4)**	
Overweight BMI	**33.5 (33.2, 33.9)**	**31.5 (30.4, 32.6)**	
Obese BMI	**37.0 (36.6, 37.4)**	**30.7 (29.5, 31.8)**	
Missing/don't know/refused	**3.9 (3.8, 4.1)**	**11.3 (10.6, 12.0)**	
Smoking			
Non smoker	**79.3 (79.0, 79.6)**	**66.0 (64.8, 67.2)**	**<.0001**
+Smoker	**20.3 (20.0, 20.6)**	**18.5 (17.5, 19.5)**	
Missing/don't know/refused	**0.4 (0.4, 0.5)**	**15.5 (14.5, 16.5)**	
Alcohol			
No alcohol	**53.7 (53.5, 54.0)**	**34.2 (33.1, 35.3)**	**<.0001**
+Alcohol	**44.3 (44.0, 44.7)**	**22.3 (21.4, 23.3)**	
Missing/don't know/refused	**2.0 (1.9, 2.1)**	**43.4 (42.3, 44.6)**	

APPENDIX C

TABLE XXIX. MULTIVARIABLE LOGISTIC REGRESSION: RELATIONSHIP BETWEEN PRESENCE OR ABSENCE OF JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, FULLY RESTRICTED SAMPLE, ALTERNATIVE AGE CATEGORIES, n=265170[a, b]		
Factor	**Adjusted Odds Ratio (95% CI)**	**P value**
Dichotomous joint pain	**9.1 (8.3, 10.1)**	**<0.0001**
Age (18-44 referent)		
35-64	1.1 (1.0, 1.1)	0.07
≥65	**0.8 (0.8, 0.9)**	**<0.0001**
Race (white referent)		
Black	1.0 (1.0, 1.1)	0.38
Asian	0.8 (0.7, 1.0)	0.12
Hispanic	**0.8 (0.8, 0.9)**	**<0.0001**
Other	**1.4 (1.3, 1.5)**	**<0.0001**
Sex (male referent)		
Female	**1.2 (1.2, 1.3)**	**<0.0001**
Self reported health status Fair or worse vs. Good or better	**3.3 (3.2, 3.4)**	**<0.0001**
Physical Activity (≥150 min/week referent)		
1-149 min/week	**1.2 (1.1, 1.2)**	**<0.0001**
0 min/week	**1.4 (1.4, 1.5)**	**<0.0001**

[a]BRFSS 2011 and 2013 data,(restricted to those with arthritis out of 2011, 2013 data and not missing data for any variable under consideration).

[b]In full multivariable models predicting each outcome, previously identified variables of interest were included, though the variables: age, sex, race/ethnicity, self-reported health status, and physical activity were included regardless of statistical significance as these variables are commonly reported in the literature and represent important factors in the domains: sociodemographic factors, health status factors, and health behaviors, which are theorized to affect the relationship between arthritis joint pain and each outcome of interest.

APPENDIX C (continued)

TABLE XXX. MULTIVARIABLE LOGISTIC REGRESSION: RELATIONSHIP BETWEEN SEVERITY OF JOINT PAIN AND ARTHRITIS ACTIVITY LIMITATION, FULLY RESTRICTED SAMPLE, ALTERNATIVE AGE CATEGORIES, n=265170[a, b]		
Factor	**Adjusted Odds Ratio (95% CI)**	**P value**
Categorical joint pain (no pain referent)		
Mild-Moderate	**6.1 (5.5, 6.7)**	**<0.0001**
Severe	**24.9 (22.4, 27.6)**	**<0.0001**
Age (18-44 referent)		
45-64	**1.1 (1.0, 1.1)**	**0.04**
≥65	**0.9 (0.8, 0.9)**	**<0.001**
Race (white referent)		
Black	**0.8 (0.7, 0.8)**	**<0.0001**
Asian	0.9 (0.7, 1.1)	0.16
Hispanic	**0.7 (0.6, 0.8)**	**<0.0001**
Other	**1.2 (1.1, 1.3)**	**<0.0001**
Sex (male referent)		
Female	**1.1 (1.1, 1.2)**	**<0.0001**
Self reported health status Fair or worse vs. Good or better	**2.5 (2.4, 2.6)**	**<0.0001**
Physical Activity (≥150 min/week referent)		
1-149 min/week	**1.2 (1.1, 1.2)**	**<0.0001**
0 min/week	**1.2 (1.2, 1.3)**	**<0.0001**

[a]BRFSS 2011 and 2013 data, (restricted to those with arthritis out of 2011, 2013 data and not missing for any factor under consideration).

[b]In full multivariable models predicting each outcome, previously identified variables of interest were included, though the variables: age, sex, race/ethnicity, self-reported health status, and physical activity were included regardless of statistical significance as these variables are commonly reported in the literature and represent important factors in the domains: sociodemographic factors, health status factors, and health behaviors, which are theorized to affect the relationship between arthritis joint pain and each outcome of interest.

APPENDIX C (continued)

TABLE XXXI. MULTIVARIABLE LOGISTIC REGRESSION: RELATIONSHIP BETWEEN PRESENCE OR ABSENCE OF JOINT PAIN AND ARTHRITIS WORK LIMITATION, FULLY RESTRICTED SAMPLE, ALTERNATIVE AGE CATEGORIES, n=133705[a, b]		
Factor	**Adjusted Odds Ratio (95% CI)**	**P value**
Dichotomous joint pain	**7.0 (5.9, 8.4)**	**<0.0001**
Age (18-44 referent)		
45-64	**0.8 (0.8, 0.9)**	**<0.0001**
Race (white referent)		
Black	**1.4 (1.3, 1.6)**	**<0.0001**
Asian	0.8 (0.6, 1.1)	0.21
Hispanic	**1.1 (1.0, 1.3)**	**0.01**
Other	**1.6 (1.4, 1.8)**	**<0.0001**
Sex (male referent)		
Female	1.0 (1.0, 1.1)	0.13
Self- reported health status Fair or worse vs. Good or better	**3.7 (3.5, 3.9)**	**<0.0001**
Physical Activity (≥150 min/week referent)		
1-149 min/week	**1.1 (1.1, 1.2)**	**<0.001**
0 min/week	**1.4 (1.4, 1.5)**	**<0.0001**

[a]BRFSS 2011 and 2013 data (restricted to those with arthritis out of 2011, 2013 data and not including missing for any factor under consideration)

[b]In full multivariable models predicting each outcome, previously identified variables of interest were included, though the variables: age, sex, race/ethnicity, self-reported health status, and physical activity were included regardless of statistical significance as these variables are commonly reported in the literature and represent important factors in the domains: sociodemographic factors, health status factors, and health behaviors, which are theorized to affect the relationship between arthritis joint pain and each outcome of interest.

APPENDIX C (continued)

TABLE XXXII. MULTIVARIABLE LOGISTIC REGRESSION: RELATIONSHIP BETWEEN SEVERITY OF JOINT PAIN AND ARTHRITIS WORK LIMITATION, FULLY RESTRICTED SAMPLE, ALTERNATIVE AGE CATEGORIES, n=133705[a, b]		
Factor	**Adjusted Odds Ratio (95% CI)**	**P value**
Categorical joint pain (no pain referent)		
Mild-Moderate	**4.3 (3.6, 5.1)**	**<0.0001**
Severe	**17.0 (14.3, 20.4)**	**<0.0001**
Age (18-44 referent)		
45-64	**0.8 (0.8, 0.9)**	**<0.0001**
Race (white referent)		
Black	**1.1 (1.0, 1.2)**	**<0.01**
Asian	0.9 (0.7, 1.1)	0.30
Hispanic	1.0 (0.9, 1.1)	0.81
Other	**1.4 (1.2, 1.6)**	**<0.0001**
Sex (male referent)		
Female	1.0 (0.9, 1.0)	0.07
Self- reported health status Fair or worse vs. Good or better	**2.7 (2.5, 2.8)**	**<0.0001**
Physical Activity (≥150 min/week referent)		
1-149 min/week	**1.1 (1.0, 1.2)**	**<0.01**
0 min/week	**1.3 (1.2, 1.3)**	**<0.0001**

[a]BRFSS 2011 and 2013 data, (restricted to those with arthritis out of 2011, 2013 data and not including missing for any factor under consideration)

[b]In full multivariable models predicting each outcome, previously identified variables of interest were included, though the variables: age, sex, race/ethnicity, self-reported health status, and physical activity were included regardless of statistical significance as these variables are commonly reported in the literature and represent important factors in the domains: sociodemographic factors, health status factors, and health behaviors, which are theorized to affect the relationship between arthritis joint pain and each outcome of interest.

VITA

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Recent/Current Positions

Full time Staff Physiatrist, VA Huntington WV 9-20-2015 to present; Clinical Assistant Professor, Department of Orthopedic Surgery, Marshall University, Jan 2016 to present

Full time Attending physiatrist, VA North Chicago/Lovell Federal Health Care Center June 2014 to 9-19-2015; Assistant Professor, Clinical Educator Track, Department of PM&R, Rosalind Franklin University of Medicine and Science, Jan 2015 to 9-19-2015

Full time clinical Staff physiatrist, VA Illiana Health Care System (Danville, IL VA Hospital) Jan 2013 to June 2014

Full time clinical Attending position at Community Hospital Private Practice with Associates in Rehabilitation Medicine July 2012 to October 2012

Attending Physician, Physical Medicine and Rehabilitation, Hines, IL VA (~25% time)

Physician Post-Residency Health Services Research and Development Fellow, Hines, IL VA (~75% time)

07 / 2010- July 2012

Medical Education

Postgraduate

Physician Post-Residency Health Services Research and Development Fellow (VA Advanced Fellowship Program), Hines, IL VA (~75% time spent in fellowship physician research activities, ~25% time working as a clinical attending physician)

Certificate of completion awarded, 07 / 2010-July 2012

Rehabilitation Institute of Chicago, Chicago, Illinois. Physical Medicine and Rehabilitation Residency Program

Certificate of completion awarded, 06 / 2006 – 06 / 2010

Undergraduate

Duke University School of Medicine, Durham, North Carolina

08 / 2001 – 05 / 2006

MD, 05 / 2006

Education

Graduate

University of Illinois at Chicago, School of Public Health, Chicago, IL

08 / 2010-

Current Master of Science (MS) Epidemiology student.

University of North Carolina, Chapel Hill, School of Public Health, Chapel Hill, NC

08 / 2003 - 08 / 2004

MPH, Epidemiology 08 / 2004

Undergraduate

Agnes Scott College, Decatur/Atlanta, Georgia

08 / 1997 - 12 / 2000

BA, Major (double) French, Biochemistry and Molecular Biology 05 / 2001

Summa cum laude, Phi Beta Kappa

Awards & Membership in Professional Societies

Recipient of the Hartford/AFAR Medical Student Geriatrics Scholars Program Scholarship 2004 - 2005
Recipient of the Mary Angela Herbin Medical Scholarship awarded by Agnes Scott College, 2003 - 2004, 2004-2005, 2005 – 2006

Recipient of the Sewell Research Resident Award for the resident physician with the greatest achievement and future potential in academics and research, Rehabilitation Institute of Chicago, 2009

American Academy of Physical Medicine and Rehabilitation, 2005 – current

Illinois Society of Physical Medicine and Rehabilitation, 2007 – 2015

Association of Academic Physiatrists, 2007 – 2013

American Congress of Rehabilitation Medicine, 2007 – 2013

American Medical Association, 2004 – 2010

American Medical Women's Association, 2002 – 2006

Teaching Experience

June 2014 to 9-19-2015, routinely provided clinical training including electrodiagnostic ,

musculoskeletal and general rehabilitation based for rotating medical students and PM&R residents at North Chicago VAMC/Lovell Federal Health Care Center PM&RS department

Jan 2013-June 2014 provided regular bedside clinical training for rotating internal medicine resident physicians, medical students and chiropractic students at Danville, IL VAMC PM&RS department

Aug 2010-May 2012 (for Fall 2010, Spring 2011, Fall 2011, and Spring 2012 semesters) Teaching Assistant, EPID 403 and EPID 400, introductory epidemiology-online, University of Illinois at Chicago School of Public Health

July 2010-July 2012 routinely supervised and taught premedical and medical students, as well as resident physicians in PM&R general clinic and electrodiagnostic clinic at RIC/Northwestern University

2006-2010 responsible for approximately 4 lectures in each subject area for all medical students, resident physicians, and fellows primarily in the areas of anatomy, musculoskeletal radiology, musculoskeletal medicine and stroke at RIC/Northwestern University

2006-2009 senior resident on in/outpatient services: orthopedics, stroke, spinal cord injury, general rehabilitation, brain injury, pediatric rehabilitation, electrodiagnostic medicine. Responsible for daily teaching of applicable clinical, research, and basic science information for 1-3 medical students depending on service at RIC/NW Univ.

4/2008, 11/2009, 1/2010 taught musculoskeletal physical exam short course for medical students on the Physical Medicine and Rehabilitation rotation at the Rehabilitation Institute of Chicago at Northwestern University

12/2009 taught problem based learning sessions (3 sessions, 10 students) for medical student physiatry elective at Rehabilitation Institute of Chicago/Northwestern University

Publications

Rogers T, Smith B, Weaver F, Ganesh SP, et al. Healthcare utilization following mild traumatic brain injury in women veterans. *Brain Inj*, 2014;28(11):1406-12.

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Ganesh S, Pietrobon R, Cecilio W, et al. The impact of diabetes on patient outcomes after ankle fracture. *J Bone Joint Surg Am*. 2005; 87(8):1712-1718.

Presentations/Poster Sessions

Abstract/Poster Presentation Association of Academic Physiatry, Chronic Obstructive Pulmonary Disease in Veterans with Spinal Cord Injury, From 2004-2008, Ganesh SP, Smith BM, Weaver FM, Publication Date: 04 / 2011

Abstract/Poster Presentation VA Health Services Research and Development National Meeting, Chronic Kidney Disease in Veterans with Spinal Cord Injury, Krishnamoorthi VR, Stroupe KT, Smith BM, Evans CT, St. Andre JR, Ganesh SP, Huo Z, Li K, Fischer MJ, Publication Date: 02 / 2011

Abstract/Poster Presentation Association of Academic Physiatry, The Association Between Comorbidity and Mortality in Geriatric Spinal Cord Injury Patients: A Systematic Review, Ganesh SP, Publication Date: 04 / 2010

Abstract/Poster Presentation American Academy of PM&R, Spinal Cord Injury in Elderly Medicare Patients, Ganesh SP, Deutsch AF, Chen D, Heinemann A, Publication Date: 10 / 2009

Abstract/Poster Presentation American Geriatrics Society, Pain and Recovery in Geriatric Hip Fracture Patients, Ganesh SP, Deutsch AF, Publication Date: 5 / 2009

Abstract/Poster Presentation Association of Academic Physiatrists, Pain and Functional Recovery in Elderly Patients After Hip Fracture, Ganesh SP, Deutsch, AF, Publication Date: 02 / 2009

Abstract/Poster Presentation Association of Academic Physiatrists, Outcomes in Delirious Geriatric Patients After Hip Fracture, Ganesh SP, Colón-Emeric CS, Pieper C, Publication Date: 02 / 2008

Abstract/Paper Presentation American Academy of PM&R Annual Meeting, Physical Performance, Mobility Difficulty and Compensatory Strategies for Mobility Impairment in Elderly Women, Ganesh SP, Hoenig HM, Taylor DH, Pieper CF, Guralnik JM, Fried LP, Publication Date: 11 / 2006

Abstract/Poster Presentation American Geriatrics Society Annual Meeting, Adaptive Strategies in Elderly Women, Shanti Ganesh, MPH; Donald Taylor Jr., PhD; Carl Pieper, DrPH; Linda Fried, MD, MPH; Jack Guralnik, MD, PhD; Helen Hoenig, MD, MPH, Publication Date: 05 / 2006

Abstract/Paper Presentation American Academy of PM&R Annual Meeting, Discrepancies Between the Adaptive Strategies Used for Mobility Tasks and Measured Physical Performance, Shanti Ganesh, MPH; Donald Taylor Jr., PhD; Carl Pieper, DrPH; Linda Fried, MD, MPH; Jack Guralnik, MD, PhD; Helen Hoenig, MD, MPH, Publication Date: 10 / 2005

Abstract/Poster Presentation American Academy of PM&R Annual Meeting, Manual Wheelchair Use by Community Dwelling and Institutionalized Veterans, Shanti Ganesh, MPH; Helen Hoenig, MD, MPH; Anthony Hayter, PhD; Phil Kim, MS; Jon Sanford, MArch; Stephen Sprigle, PhD, Publication Date: 10 / 2005

Publication Reviews

12 / 2013—current

Journal of Aging and Health. Reviewer

09 / 2013—current

Women & Health. Reviewer.

03 / 2010—current

Topics in Stroke Rehabilitation. Reviewer.

09 / 2007—current

Archives of Physical Medicine and Rehabilitation. Reviewer.