Arthritis Prevalence and Disability Among Young to Early Middle Age Adults in the US: Findings from the 2017 Behavioral Risk Factor Surveillance System

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Abstract

Objective: This study profiles the prevalence of an arthritis diagnosis by key clinical and sociodemographic characteristics of the adult U.S. population age 18-55.

Methods: The study included 195,822 respondents which represent an estimated 136.7 million residents of the United States, Guam, and Puerto Rico. The 2017 Behavioral Risk Factor Surveillance System (BFRSS) data was used to compare self-reported physical activity, mental health and physical health between respondents with and without an arthritis diagnosis within three age groups, young adults (age 18-34 years), older young adults (age 35-44 years), and early middle age adults (age 45-54 years). We used logistic regression to test the significance of social, demographic and clinical factors associated with the likelihood of an arthritis diagnosis under age 55. We then compare young to early middle age adults who reported being diagnosed with arthritis by three levels of reported pain and by the degree to which they perceive that arthritis limits their functional, social and work lives.

Results: Across all three age groups, adults with arthritis reported increased inactivity and poorer mental and physical health compared to age-matched controls without arthritis. Being diagnosed with arthritis before age 55 was strongly associated with having ever been diagnosed with a depressive disorder (OR:3.10), being obese (OR:2.06), and reporting the lowest household income level as compared with the highest (<$15,000 versus >$75,000, OR:2.26). Among respondents under age 55 with arthritis, being female, obese, reporting poor mental health, lower socioeconomic status, and minority race and ethnicity were all significantly associated with higher reported pain levels and greater arthritis-related functional, social, and work limitations.

Conclusion: Arthritis prevalence and disability among adults under age 55 follows a steep social class gradient that is closely associated with mental health and obesity. These findings can guide

targeted primary and secondary preventive interventions to encourage healthy weight and support mental health, with the goal of limiting the impact of the disease.

Introduction

This study was undertaken to understand the experience of young and early middle age adults diagnosed with arthritis and related conditions, as described by the Center for Disease Control (CDC) case definition.[1] The high prevalence and large burden of disability associated with arthritis in the older population is well known.[2,3] Between 2010-2012, an estimated 49.6% of people over the age of 65 reported physician-diagnosed arthritis.[4] What is less well known is the prevalence and burden of arthritis and related conditions in younger adults. While arthritis is less common at younger ages, 7.1% of adults between 18-44 years old report having been diagnosed with arthritis including osteoarthritis, rheumatoid arthritis, fibromyalgia and other connective tissue disorders.[4] However, there is little known about recent social and demographic trends in arthritis prevalence specific to the young adult and early middle age population under age 55.

Evidence from a longitudinal study investigating arthritis prevalence across four different generations suggests that arthritis prevalence is increasing among younger individuals.[5] This increase may in part be due to the growing obesity epidemic.[5] Obesity is a known risk factor for the development of osteoarthritis[6] and has tripled in the last 25 years among children.[7] The current childhood obesity crisis may be placing a cumulative burden on weightbearing joints resulting in an increase in the development of joint symptoms that could accelerate the likelihood of an arthritis diagnosis.

We present 2017 Behavioral Risk Factor Surveillance System (BRFSS) data to estimate the prevalence of a self-reported healthcare provider diagnosis of arthritis in the United States adult population in three distinct age cohorts: young adults age 18-34 years, older young adults age 35-44 years, and early middle age adults age 45-54 years. We compare self-reported physical

and mental health status and physical activity differences between those reporting an arthritis diagnosis and other respondents of the same age group, controlling for sociodemographic and clinical characteristics. Finally, for respondents age <55 years who did report an arthritis diagnosis, we evaluate reported levels of arthritis disability in relation to pain, overall functioning, work limitation, and social limitation. These data provide a sociodemographic portrait of arthritis in young to early middle age adults, as well as national estimates of the number of individuals with the most severe arthritis-related limitations and pain. The findings provide insight into current primary and secondary prevention challenges and opportunities.

Methods

Behavioral Risk Factor Surveillance System (BRFSS)

BRFSS is a landline and cellular telephone based survey administered by the CDC in all states and US territories to noninstitutionalized individuals 18 years of age and older. The survey contains questions about physical and mental health status, use of preventive services, and health related risk behavior. In 2017, all 50 states, Washington DC, Guam, and Puerto Rico participated in the telephone survey. BRFSS uses raking to best ensure that the population sampled represents the demographics of the US population.[8] Respondents are weighted to reflect the US adult population estimates.

Prior Diagnosis of Arthritis, Pain, and Disability

To identify those respondents who have arthritis, the following BRFSS survey question was used: *"Has a doctor, nurse, or other health professional ever told you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"* Interviewers were advised to include rheumatism, polymyalgia rheumatica, osteoarthritis, tendonitis, bursitis, bunion, tennis

elbow, carpal tunnel syndrome, tarsal tunnel syndrome, joint infection, Reiter's syndrome, ankylosing spondylitis, spondylosis, rotator cuff syndrome, connective tissue disease, scleroderma, polymyositis, and Raynaud's syndrome vasculitis as a form of arthritis. An affirmative response to this question was used separate those individuals with arthritis from those without arthritis for the analysis. Respondents who responded affirmatively to the arthritis question were then asked to rate their pain. *"Please think about the past 30 days, keeping in mind all of your joint pain or aching and whether or not you have taken medication. 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, DURING THE PAST 30 DAYS, how bad was your joint pain ON AVERAGE?"* The numerical pain rating was stratified into three pain severity groups based on associations found between subjective pain ratings and interference in functioning (low 0-3, moderate 4-6 and high 7-10).[9] Respondents diagnosed with arthritis were also asked about functional disability associated with arthritis and joint symptoms. *"Are you now limited in any way in any of your usual activities because of arthritis or joint symptoms? Do arthritis or joint symptoms now affect whether you work, the type of work you do, or the amount of work you do? During the past 30 days, to what extent has your arthritis or joint symptoms interfered with your normal social activities, such as going shopping, to the movies, or to religious or social gatherings?"* These questions were used to profile the burden of arthritis faced by individuals under 55.

Calculated Physical Activity Variables

The CDC computes many variables based on the BRFSS data to allow for easier analysis of the data. Physical activity computed variables were used to categorize both aerobic and strengthening exercise in relation to US Department of Health and Human Services physical activity recommendations. The US Department of Health and Human Services recommends that

all adults perform between 150 and 300 minutes of moderate intensity or between 75 and 150 minutes of high intensity aerobic exercise per week and 2 days per week or more of strengthening exercise.[10]

For aerobic exercise, the CDC stratified respondents into 4 categories (highly active, active, insufficiently active, and inactive) based on their responses to the following questions. "*During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise? What type of physical activity or exercise did you spend the most time doing during the past month? How many times per week or per month did you take part in this activity during the past month? And when you took part in this activity, for how many minutes or hours did you usually keep at it? What other type of physical activity gave you the next most exercise during the past month? How many times per week or per month did you take part in this activity during the past month? And when you took part in this activity, for how many minutes or hours did you usually keep at it?"* Each activity was assigned a metabolic equivalent (MET) value and total MET minutes for each activity were computed based on reported frequency and duration of each activity. Maximum oxygen uptake in METS was calculated for each respondent based on sex and age. The following formulas were used:

Estimated VO_{2max} (METs) for men = (60 – 0.55 * age in years) / 3.5

Estimated VO_{2max} (METs) for women = (48 – 0.37 * age in years) / 3.5

For an activity to be considered vigorous intensity, 60% of estimated VO_{2max} is required.[11] Moderate intensity activity is defined as greater or equal to 3 METS, independent of VO_{2max}.[11] Total minutes of vigorous intensity and moderate intensity aerobic exercise were

summed, with vigorous activity counting double relative to moderate activity. Based on the number of minutes of moderate intensity aerobic exercise per week or the vigorous equivalent, respondents were stratified into activity levels. "Highly active" described respondents who reported more than 300 minutes of moderate intensity aerobic exercise or the vigorous equivalent per week. "Active" described respondents who reported between 150 and 300 minutes of moderate intensity aerobic exercise per week or the vigorous equivalent. "Insufficiently active" described respondents who reported between 11 and 149 minutes of moderate intensity physical activity or the vigorous equivalent. "Inactive" described respondents who reported doing no aerobic activity.[11] Besides measuring aerobic activity, respondents were also classified as to whether they meet the recommended strengthening guidelines. Respondents answered the following question, "*During the past month, how many times per week or per month did you do physical activities or exercises to STRENGTHEN your muscles? Do NOT count aerobic activities like walking, running, or bicycling. Count activities using your own body weight like yoga, sit-ups, or push-ups and those using weight machines, free weights, or elastic bands.*" If respondents reported 2 times or greater, they were considered to have met strengthening guidelines.[10]

Demographic and Socioeconomic Characteristics

The BRFSS includes demographic information such as gender, race and ethnicity (non-Hispanic White, non-Hispanic black, Hispanic and other), educational attainment, and annual household income level. For the analysis, educational attainment was divided into three levels (high school graduate or less, some college, and college graduate). Approximately 16% of respondents with missing household income had values imputed using a regression model based on race, physical and mental health status, marital status, home ownership status, sex, education,

and age. Estimated annual household income was divided into 5 groups (<$15,000, $15,000-$25,0000, $25,000-$50,000, $50,000-$75,000, and >$75,000). BRFSS state data were used to classify respondents into one of nine U.S. census regions or a US territory.

Physical and Mental Health Status and Obesity

One question about physical heath *"Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?*" was used to understand health differences between individuals with and without an arthritis diagnosis. Two questions about mental health were used to understand characteristics that may be associated with disability in individuals diagnosed with arthritis. The following two questions about mental health were used: "*Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good? Has a doctor, nurse, or other healthcare professional ever told you have a depressive disorder, including depression, major depression, dysthymia, or minor depression?"* The 30 day items were dichotomized as those reporting at least one day of bad health vs. those with no days of bad health. Additionally, a CDC computed variable divided BMI into four categories (underweight, normal weight, overweight, and obese).

Statistical Analysis

Population weighted data were used for all statistical analyses with standard errors of statistical tests adjusted by the Stata Version 15 complex survey module. Within each age group (18-34 years, 35-44 years, and 45-54 years), chi square tests were used to compare individuals with and without a reported arthritis diagnosis by physical activity level, adherence to muscle strengthening guidelines, report of one or more days when mental health was not good, prevalence of ever having had a depressive disorder, and the proportion reporting one or more

days of bad physical or mental health. We used logistic regression to test the significance of social, demographic and clinical factors associated with the likelihood of an arthritis diagnosis. We used chi square tests to test the significance of sociodemographic differences between young adults who reported being diagnosed with arthritis by three levels of reported pain and by the degree to which arthritis limits their functional, social and work lives.

Results

Differences in Physical Activity and Health Status among Respondents with and without an Arthritis Diagnosis

Table 1 compares respondents in each age group with and without a reported arthritis diagnosis by physical activity level, adherence to muscle strengthening guidelines, any days in the last month when physical and mental health was not good, and having ever been diagnosed with a depressive disorder. The prevalence of reporting an arthritis diagnosis was 5.2% among respondents age 18-34, 12.4% among respondents age 35-44, and 24.3% among respondents age 45-54. Respondents with arthritis were more likely to have been told by a physician or other healthcare provider that they ever had a depressive disorder. Among respondents age 18-34 years old with arthritis, there was a 29.4% higher prevalence of having a depressive disorder compared to age matched respondents without arthritis. This disparity decreased slightly with age. Consistent with these results, respondents with arthritis reported one or more days per month when mental health was not good approximately 20% more often across all age groups compared to respondents without arthritis. Respondents with arthritis also reported one or more days per month when physical health was not good approximately twice as often as respondents without arthritis in all age groups.

Among all age groups, respondents with arthritis were significantly more likely to be inactive. This disparity in physical activity habits increased as the age of respondents increased. Respondents age 18-34 with arthritis reported being inactive 6.8% more often than respondents without arthritis, while this difference increased to 11.9% among respondents age 45-54 years with and without arthritis. Compared to age matched respondents without arthritis, respondents with arthritis were also slightly less likely to adhere to strengthening guidelines, reporting a 5.4%, 3.7%, and 5.5% difference in adherence to strengthening guidelines at age 18-34, age 35-44, and age 45-54 respectively.

Factors Associated with Being Diagnosed with Arthritis Diagnosis Under Age 55

Table 2 presents logistic regression results for respondent factors associated with a higher likelihood of being diagnosed with arthritis under 55 years old. The adjusted odds ratios reflect comparisons to all other respondents age 18-55 years. Within this age group, women were 40% more likely (OR:1.40) to report an arthritis diagnosis compared to men. Relative to respondents with a household income greater than $75,000, respondents who reported a household income of less than $15,000 were over twice as likely (OR: 2.26) to report having been diagnosed with arthritis. Relative to respondents who graduated from college, having a high school education or less (OR:1.33) or completing some college (OR:1.47) both increased the likelihood of an arthritis diagnosis. As compared to normal-weight respondents, reporting being overweight (OR:1.26) and especially reporting being obese (OR: 2.06) conferred significantly higher risk for an arthritis diagnosis. Respondents reporting having had a depressive disorder (OR: 3.10) were over three times more likely to report an arthritis diagnosis. Respondents reporting being inactive (OR:1.06) relative to being highly active and respondents residing in the East South Central Region (OR:1.23) relative to New England had higher odds of an arthritis diagnosis. Younger

age (OR: 0.17 for 18-34 years old and OR: 0.45 for 35-44 years old) was associated with a decreased likelihood of being diagnosed with arthritis relative to respondents age 45-54 years old. Non-Hispanic Black (OR: 0.76) and Hispanic (OR: 0.43) respondents had lower odds of reporting an arthritis diagnosis than non-Hispanic Whites. Being active (OR: 0.92) relative to highly active, and respondents residing in either the West North Central region (OR: 0.83), Pacific region (OR: 0.88), or Guam (OR: 0.72) as compared to residing in New England also had significantly lower odds of being diagnosed with arthritis.

As BMI category increased, the percentage of respondents who reported an arthritis diagnosis also increased (Figure 1). Figure 2 highlights the inverse relationship between household income and the likelihood of reporting an arthritis diagnosis.

Sociodemographic and Clinical Characteristics Associated with High Arthritis Pain Among Respondents who Reported an Arthritis Diagnosis

High arthritis pain (pain level 7-10) was common among young adults, with more than one third of adults 18-55 years old diagnosed with arthritis reporting high arthritis pain (Table 3). Women reported high pain 10.9% more frequently than their male counterparts. The proportion of respondents who reported high levels of arthritis pain increased with age, increasing by 11.3% between the age 18-34 group and the age 45-54 group. High pain was also disproportionately associated with minority race and ethnicity, with Non-Hispanic Black and Hispanic respondents reporting high pain 22.5% and 14.3% more often than non-Hispanic White respondents. Respondents in the highest household income group >$75,000 reported high pain 51.5% less often compared to the lowest income group, and respondents who graduated from college reported high pain 29.6% less often compared to those with a high school education or less.

High pain corresponded with higher levels of sedentary behavior. Almost half of all respondents who reported being inactive, also reported high levels of pain. Respondents who reported one or more days per month when mental health was not good reported high versus low pain 18.5% more often. Similarly, almost half of respondents who have been told they have had a depressive disorder also reported high pain. Being underweight or obese was associated with only a slightly increased likelihood of also reporting high pain.

Sociodemographic and Clinical Characteristics Associated With Functional, Social, and Work Limitations Among Respondents who Reported an Arthritis Diagnosis

Both males and females under 55 years old told they have arthritis face significant functional, social, and work limitations, with women being disproportionately affected. Women with arthritis reported functional limitations 8.8% more often, a lot of social limitations 8.0% more often and work limitations 4.5% more often than men with arthritis. The percentage of respondents who reported arthritis related disability increased only modestly with age. The age group 18-34 years reported the lowest level of arthritis related functional limitation, social limitation, and work limitations but only by 6.0%, 6.9% and 1.9% respectively compared to age group 35-44 years. There was little difference in rates of arthritis related limitations between respondents in age group 35-44 years and respondents in age group 45-54 years. Non-Hispanic Black respondents reported a lot of arthritis-related social limitations 7.2% more often than Non-Hispanic White respondents and 5.8% more often than Hispanic respondents. Non-Hispanic Black respondents and Hispanic respondents both reported work limitations approximately 10% more often than non-Hispanic White respondents. Household income level and educational attainment had a graded relationship with increasing prevalence of arthritis limitations. Being in the lowest household income category (<$15,000) was associated with reporting functional

limitations 34.9% more often, reporting a lot of social limitation 42.5% more often, and reporting work limitation 44.4% more often compared to the highest income group (>$75,000). Similarly, respondents with less than a high school education reported functional limitations 15.6% more often, a lot of social limitations 20.2% more often, and work limitations 26.5% more often than respondents who graduated from college.

As activity level trended towards more sedentary, higher proportions of respondents reported functional, work, and social limitations. Highly active respondents reported functional limitations 15.0% less often, a lot of social limitations 21.6% less often, and work limitations 15.5% less often as compared to inactive respondents. Poor mental health resulted in a higher likelihood of reporting arthritis limitation. Specifically, respondents who reported ever having a depressive disorder reported functional limitation 23.2% more often, significant social limitation 24.6% more often, and work limitation 23.0% more often, as compared to respondents who did not report a depressive disorder. Respondents who reported any days per month when mental health was not good also reported functional limitation 20.1% more often, significant social limitation 19.5% more often, and work limitation 19.8% more often compared to respondents who reported no days per month when mental health was not good. Both obese and underweight respondents reported greater prevalence of arthritis-related functional, social, and work limitations compared to normal weight respondents.

Discussion

The New Age Demographic of Arthritis

This analysis serves to profile young adults with arthritis as well as to highlight the burden of arthritis endured by this population. Based on our analysis, 18.1 million adults in the

United States under the age of 55 report being told by a healthcare provider that they have arthritis. Of those 18.1 million individuals, 2.9 million are under the age of 35. While autoimmune connective tissue disorders and fibromyalgia can often occur in people under the age of 55,[12,13], growing rates of osteoarthritis are thought to be increasing in young adults.[14] Obesity, which is a known risk factor for the development of osteoarthritis and increasing in prevalence in the US population, is hypothesized to be a large contributing factor to increased incidence of osteoarthritis in the younger population.[5] Increased participation in youth sports and resulting injuries also contributes to changing the age distribution of arthritis.[14] Post-traumatic osteoarthritis occurs in young adulthood as a result of sports related injuries during childhood or adolescence.[15] A meta-analysis found that 10 years after an ACL injury, there is a relative risk of 3.84 of developing moderate to severe osteoarthritis.[16] Increased prevalence of total joint replacement in individuals 45-64 years of age,[17] further provides evidence that arthritis can no longer be viewed solely as an elderly person's disease.

Young and middle aged adults with arthritis share a unique experience of managing symptoms over a greater proportion of the lifespan. Arthritis produces physical limitations which can lead to work disability[18] and affect ability to complete parental responsibilities.[19] There are often difficult decisions about what to do to control arthritis pain. Joint-replacement surgery, which is effective at reducing pain and disability in the elderly,[20] is often not recommended for younger patients with arthritis who are at higher risk for subsequent revision surgery.[21] Guglielmo et al describes the fundamentally unique experience of arthritis in young adulthood, reporting higher age-specific prevalence for anxiety and depression among young adults with arthritis compared to the same population over 65 years old.[22]

Arthritis in Adults Under Age 55 and Sociodemographic Characteristics

We found that lower educational attainment and lower household incomes were both independently associated with a significantly increased likelihood of being diagnosed with arthritis. Respondents who started but did not finish college were almost 1.5 times more likely to be diagnosed with arthritis compared to respondents who did graduate from college. With every increase in annual household income, the likelihood of being diagnosed with arthritis decreased. It has been well established that socioeconomic disadvantage is a risk factor for arthritis[23,24], and our results indicate that socioeconomic disadvantage is also a risk factor for developing arthritis at a young age. Strenuous occupation may be one mechanism by which lower socioeconomic status is associated with increased arthritis risk.[25]

Within the arthritis population under 55 years of age, our data demonstrated a social gradient with lower social class being associated with greater pain and disability. With each decrease in educational attainment or household income, there was an increased report of high pain, functional limitation, social limitation, and work limitation. It has been well established that lower social class is associated with poorer outcomes in a variety of rheumatic diseases.[26] This may be explained through decreased access to healthcare which results in decreased medication use which is important for modifying rheumatic diseases as well as decreased access to lifestyle modification information and resources.[26] A study of individuals with hip and knee OA found that having less than a high school degree was associated with decreased likelihood of receiving weight loss advice, while those individuals with a college degree were more likely to receive exercise recommendations.[27] Besides access to healthcare, a study by Rios et al showed that stress and worry, consistent with lower socioeconomic status, was associated with greater sensitivity to pain among individuals with osteoarthritis and fibromyalgia.[28] Greater sensitivity to

pain may result in both an increased likelihood of receiving an arthritis diagnosis as well as increased likelihood of experiencing higher arthritis related disability.

Arthritis in Adults Under Age 55 and Obesity

Being obese more than doubled a respondent's likelihood of being diagnosed with arthritis in young and early middle age. Forty seven percent of respondents under age 55 with arthritis were also obese. Obese respondents with arthritis reported higher pain and more functional, social, and work limitations compared to normal weight respondents with arthritis. Obesity in young adulthood has been associated with many serious health conditions including increased risk of stroke[29], hypertension, polycystic ovarian syndrome, and diabetes.[30] This analysis further adds to our understanding of the negative health consequences of obesity in younger populations, showing that early onset arthritis is another likely consequence. Obesity is considered the most modifiable risk factor for the development of arthritis, and weight loss has been shown to slow the progression of arthritis and to improve symptoms.[31] Among adults under age 55 already diagnosed with arthritis, losing or maintaining weight is one way to improve function in a population that still faces societal expectations to maintain a high level of productivity.

Arthritis in Adults Under Age 55 and Mental Health

This analysis also demonstrates that young and early middle-aged adults diagnosed with arthritis face poorer mental health relative to their counterparts without arthritis. Across all age groups, people with arthritis reported having been diagnosed with a depressive disorder significantly more often than respondents without arthritis. We found slightly increased disparity in reporting a depressive disorder among respondents under age 45 with and without arthritis, compared to respondents age 45-54 suggesting a stronger association between arthritis and

depression in young adults compared to middle age adults. The association between younger age and increased rates of depression in adults with arthritis is consistent with previous research showing higher rates of anxiety and depression in young and middle aged adults with arthritis compared to adults over age 65 with arthritis.[22]

The World Health Organization, International Classification, Disability, and Health (ICF) provides a framework for further analysis of why this disparity may exist.[32] Under the ICF, not only are impairments accounted for but, also the impact of the impairments on an individual's ability to participate in daily life. The participation limitations that arthritis related impairments produce may have a more significant impact on a younger person's quality of life and mental health, given higher physical demands for work, leisure, and family responsibilities.

Alternatively, individuals under 55 with a depressive disorder may be more likely to report pain and thus more likely to receive an arthritis diagnosis. Depressive disorder has been associated with increased report of pain symptoms in individuals with arthritis with minimal to moderate radiographic findings,[33] suggesting that higher sensitivity to recognizing arthritis pain may be another explanation for the association between arthritis and depression. Regardless the cause, providing mental health screening for young and middle-aged adults with arthritis has the potential to minimize pain and decrease disability associated with arthritis.

Arthritis in Adults Under Age 55 and Gender, Race, and Ethnicity

Consistent with other studies looking at the general arthritis population[34], we found that young women were more likely to be diagnosed with arthritis compared to young men. Hormonal, anatomical, and genetic differences[35], increased susceptibility to fibromyalgia[13] and arthritis related to autoimmune conditions[36], and increased use of the healthcare system[37] may account for this increased arthritis prevalence among women. Women also face a higher

incidence of depression[38], which has been associated with greater sensitivity to arthritis pain[33] and may also contribute to an increased likelihood of being diagnosed with arthritis and greater arthritis related limitations.

Non-Hispanic White race was also associated with increased likelihood of receiving an arthritis diagnosis, which may in part be explained by disparity in access to the healthcare system. According to the Kaiser Family Foundation in 2017, among non-elderly population, 7% of the White population was uninsured compared to 11% of the Non-Hispanic Black population, and 19% of the Hispanic population.[39] Among older adults, both Non-Hispanic Black and Hispanic race and ethnicities have been associated with increased prevalence of arthritis.[3] Increased access to Medicare in the over age 65 population may explain this inconsistency with reported arthritis diagnoses among younger populations. We found that despite lower incidence of arthritis among minority race and ethnicities, Non-Hispanic Black and Hispanic respondents who did report an arthritis diagnosis also reported higher pain and greater arthritis related limitations compared to Non-Hispanic White respondents. This racial and ethnic disparity may be part of a larger pattern of greater arthritis burden in individuals with lower socioeconomic status,[40] who consistently experience poorer arthritis outcomes.[26]

Arthritis in Adults Under Age 55 and Physical Activity

An arthritis diagnosis in adults under age 55 also negatively impacts physical activity habits. This analysis demonstrated that young adults and early middle age adults with arthritis were progressively more inactive with age compared to their peers without arthritis. Inactivity in individuals under 55 with arthritis was also associated with greater arthritis attributable pain and disability. This is problematic because physical activity is an important mediator of both physical and mental health and improved function in people with arthritis. Exercise has numerous benefits

including decreasing cardiovascular risk, slowing progression of disease, improving sleep quality, and decreasing symptoms of depression.[41] A 12-week walking program for adults with severe osteoarthritis was associated with improved systolic blood pressure and a decreased waist circumference.[42] Another study demonstrated that walking as little as 10 minutes per week is associated with decreased functional decline in adults with arthritis.[43] Conversely, increased sedentary behavior in adults with osteoarthritis was associated with higher negative affect.[44] Despite the evidence that physical activity can improve a variety of important measures of health in adults with arthritis, we found an untapped potential to improve quality of life through physical activity in many young and early middle aged adults with arthritis.

We also found that that reporting activity corresponding with "highly active" was associated with an increased risk for being diagnosed with arthritis relative to reporting activity corresponding with "active." "Highly active" individuals may be more likely to investigate musculoskeletal pain and thus receive a diagnosis in a desire to continue to participate in athletic activities. "Highly active" individuals may also be a greater risk for sports related injury which is a risk factor for the development of osteoarthritis.[15]

Primary and Secondary Preventive Opportunities

Increased understanding of the younger arthritis population can help guide the development of targeted primary and secondary preventive interventions. The strong associations between arthritis in young and early middle age and obesity, depression, and socioeconomic status gives insight into the types of interventions that may be the most impactful and the communities that may benefit most. As the age demographic of arthritis shifts towards younger adults, the targeted age group for primary preventive interventions should also shift downward to target the population's youth. Interventions to decrease sedentary behavior, promote fruit and

vegetable consumption, and limit sugary beverages not only serve to prevent childhood obesity, but also may decrease future risk for arthritis. An educational curriculum which prioritizes social-emotional health has been shown to promote mental wellbeing in children,[45] which may lead to resilience and positive coping in managing arthritis pain and limitations in adulthood. Understanding that individuals with the least education and lowest income level are at greatest risk for an arthritis diagnosis and arthritis attributable pain and disability helps to identify communities that would most benefit from targeted programs to decrease obesity and to improve mental health.

Prioritization of improving access to healthcare among racial and ethnic minorities and people of lower socioeconomic status is also an important part of primary and secondary prevention. Regular contact with the healthcare system can result in improved likelihood of receiving personalized behavioral and lifestyle recommendations associated with lowering risk for arthritis. Access to healthcare also results in access to physical and occupational therapy which have been shown to decrease arthritis pain[46] as well as access to the earliest medical management of rheumatic disease, which is associated with improved outcomes.[47]

Limitations

The BFRSS uses the CDC case definition for arthritis which includes a variety of conditions associated with musculoskeletal pain, some of which are not associated with actual joint damage. The BFRSS does not distinguish between various types of arthritis and arthritis-related conditions, allowing for only a very general analysis. This study relies on a physician or other healthcare provider diagnosis of arthritis which excludes individuals with arthritis who have not seen a healthcare provider or who have limited access to healthcare, thus providing a conservative estimate of arthritis prevalence. Because the BFRSS relies on self-report, it also

faces response and recall bias. Finally, the cross-sectional nature of this study results in an inability to draw causative conclusions.

Conclusions

This study provides insight about characteristics associated with arthritis and arthritis attributable limitations in young and early middle age adults. In this population, we found a strong association between arthritis and resulting limitations and depressive disorders, obesity, and lower socioeconomic status. Profiling this unique and likely growing population of adults under age 55 with arthritis is the first step to better target primary and secondary prevention interventions.

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Table 1. Comparison of Population-Weighted Percent of Respondents Told They Have Arthritis Versus All Other Respondents by Reported Physical Activity Level, Mental and Physical Health

Weighted N=136.7 million

2017 Behavioral Risk Factor Surveillance System

		Age 18-34 years Weighted n=56.1 million		Age 35-44 years Weighted n=36.5 million		Age 45-54 years Weighted n=44.1 million	
Percent Reporting Arthritis*		**Yes 5.2% N=2.9 million**	**No 94.8% N=53.2 million**	**Yes 12.4% N=4.5 million**	**No 87.6% N=32.0 million**	**Yes 24.3% N=10.7 million**	**No 75.7% N=33.4 million**
Physical Activity Level**							
	Highly active	29.25	27.15	24.29	27.62	24.53	30.65
	Active	18.49	22.60	17.19	21.99	16.48	21.28
	Insufficiently Active	22.64	27.42	22.38	24.26	20.53	21.54
	Inactive	29.62	22.83	36.10	26.13	38.46	26.53
Strengthening							
	Adherence to Strengthening Guidelines***	31.23	36.63	24.56	28.26	20.79	26.32
Mental Health							
	Reported 1 or More Days Per Month When Mental Health Was Not Good	66.40	45.97	58.89	35.83	53.95	31.12
	Ever Been Told You Have a Depressive Disorder	46.81	17.45	44.43	15.24	40.96	14.56
Physical health							
	Reported 1 or More Days Per Month When Physical Health Was Not Good	62.70	32.04	64.82	30.38	63.33	30.23

$p \leq .001$ for all comparisons
* Arthritis diagnosis question, " Has a doctor, nurse or other health professional ever told you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"
**Activity level categories computed based on estimated MET minutes in relationship to 2008 physical activity recommendations by the U.S. Department of Health and Human Services
***Strengthening exercise question, "During the past month, how many times per week or per month did you do physical activities or exercises to STRENGTHEN your muscles? Do NOT count aerobic activities like walking, running, or bicycling. Count activities using your own body weight like yoga, sit-ups or push-ups and those using weight machines, free weights, or elastic bands." Adherence to strengthening guidelines computed based on above question in relationship to US Department of Health and Human Services 2008 physical activity recommendations.

Table 2. Adjusted Regression Results for the Likelihood of an Arthritis Diagnosis Among Respondents Age 18-54 Years Old Weighted n= All People Under 55 Years Old 2017 Behavioral Risk Factor Surveillance System

		Sample Column Percent	Row Percent Reporting an Arthritis Diagnosis	OR (95% CI)
Sex				
	Female	51.05	15.98	1.40 (1.33-1.47)
	Male	48.95	10.45	Reference
Race and Ethnicity				
	Non-Hispanic White	56.70	15.54	Reference
	Non-Hispanic Black	11.16	14.59	0.76 (0.70-0.82)
	Hispanic	20.50	7.73	0.43 (0.39-0.47)
	Other	11.64	10.75	0.84 (0.77-0.92)
Education				
	High School Graduate or Less	32.34	15.07	1.33 (1.24-1.42)
	Some College	26.70	16.09	1.47 (1.38-1.56)
	College graduate	40.95	10.04	Reference
Household Income				
	< $15,000	9.18	23.01	2.26 (2.07-2.48)
	$15,000-$25,000	17.78	14.92	1.66 (1.54-1.80)
	$25,000-$50,000	24.28	12.61	1.37 (1.27-1.47)
	$50,000-$75,000	14.08	12.34	1.17 (1.09- 1.26)
	>$75,000	34.68	10.70	Reference
Age				
	18-34 years old	41.05	5.17	0.17 (0.16 -0.18)
	35-44 years old	26.70	12.41	0.45 (0.43-0.48)
`	**45-54 years old**	32.26	24.30	Reference
BMI				
	Underweight	1.85	9.92	1.10 (0.87-1.38)
	Normal Weight	34.34	8.75	Reference
	Overweight	34.61	11.70	1.26 (1.18-1.34)
	Obese	29.20	21.77	2.06 (1.94-2.20)
Mental Health				
	Been Told You Have a Depressive Disorder	19.59	28.97	3.10 (2.94-3.27)

Physical Activity Level				
	Highly Active	27.84	12.26	Reference
	Active	21.38	10.75	0.92 (0.86-0.99)
	Insufficiently Active	24.44	11.82	0.98 (0.91-1.06)
	Inactive	26.33	18.74	1.06 (1.04-1.07)
Strengthening				
	Meets Strengthening Recommendations	30.40	10.21	1.02 (0.97-1.08)
Region				
	New England	4.32	13.98	Reference
	Middle Atlantic	12.60	13.33	1.01 (0.91- 1.11)
	East North Central	13.82	15.23	1.04 (0.94-1.14)
	West North Central	6.25	12.91	0.83 (0.76-0 .91)
	South Atlantic	19.22	13.26	0.96 (0.87-1.05)
	East South Central	5.58	19.46	1.23 (1.11-1.36)
	West South Central	12.70	13.15	1.01 (0.89-1.15)
	Mountain	7.17	12.59	0.97 (0.89-1.07)
	Pacific	17.30	10.15	0.88 (0.78-0.98)
	Guam	0.05	10.00	0.72 (0.56-0.93)
	Puerto Rico	0.98	11.28	0.95 (0.78-1.15)

Population Size: 136.7 million

Table 3. Population-Weighted Percent of Respondents Age 18-55 Reporting Arthritis-Related Pain, Functional, Social and Work Limitations
2017 Behavioral Risk Factor Surveillance System

	Column Percent Reporting An Arthritis Diagnosis	Pain 0-10 ratings			Functional Limitation	Social Limitation			Work Limitation
		Low pain (pain rating 0-3)	Moderate pain (pain rating 4-6)	High pain (pain rating 7-10)		Not at all	A little	A lot	
Row Percent Reporting An Arthritis Diagnosis		32.88	31.95	35.18	56.39	43.29	29.84	26.87	47.47
Female N=11.1 million	61.45	28.38	32.27	39.35	59.77	38.80	31.24	29.96	49.19
Male N=7.0 million	38.55	40.08	31.44	28.47	50.97	50.51	27.59	21.92	44.69
Age									
18-34 years old N=2.9 million	15.98	37.45	35.64	26.90	51.06	43.09	37.65	19.26	45.87
35-44 years old N=4.5 million	24.96	33.79	32.87	33.35	57.05	44.41	29.48	26.11	47.76

	45-54 years N=10.7 million	59.06	31.24	30.56	38.21	57.55	42.89	27.87	29.26	47.78
Race and Ethnicity										
	Non-Hispanic White N=12.0 million	66.36	36.15	33.87	29.98	55.49	46.19	28.26	25.55	44.54
	Non-Hispanic Black N=2.2 million	12.27	23.04	24.59	52.45	60.22	34.96	32.19	32.76	55.83
	Hispanic N=2.2 million	11.94	24.62	31.14	44.32	57.04	37.12	35.95	26.92	53.85
	Unknown/ other N=1.7 million	9.43	33.08	29.01	37.79	56.95	41.60	30.16	28.34	49.10
Household Income										
	<$15,000 N=2.9 million	15.90	10.62	23.26	66.12	77.36	18.35	28.06	53.59	71.45
	$15,000-$25,000 N=3.6 million	19.99	17.70	30.79	51.50	66.78	27.35	33.97	36.68	62.83
	$25,000- $50,000 N=4.2 million	23.07	30.15	37.61	32.23	55.48	42.18	34.16	23.67	48.50
	$50,000-$75,000 N=2.4 million	13.09	42.05	36.16	21.87	46.22	55.59	28.48	15.85	36.75
	>$75,000 N=5.1 million	27.95	54.30	31.06	14.64	42.50	63.93	24.95	11.12	27.01
Education										
	High School Graduate or Less N=6.6 million	36.69	20.64	30.68	48.68	62.12	33.16	31.55	35.29	58.27
	Some College N=5.8 million	32.35	30.40	34.54	35.03	59.23	40.20	31.39	28.42	50.14
	College Graduate N=5.6 million	30.96	50.11	30.81	19.08	46.54	58.54	26.36	15.10	31.78
BMI										

	Underweight N=225.7 Thousand	1.35	27.41	37.04	35.56	71.85	30.15	38.97	30.15	49.63
	Normal Weight N=3.7 million	2.23	37.42	31.58	31.00	53.95	46.32	29.01	24.66	46.14
	Overweight N=4.9 million	29.58	37.32	31.10	31.58	52.97	48.06	28.73	23.22	44.49
	Obese N=7.8 million	46.77	27.97	32.50	39.53	59.80	38.47	30.69	30.82	50.76
Physical Activity Level										
	Highly Active N=4.0 million	25.22	39.29	34.42	26.30	49.76	50.59	31.49	17.88	41.28
	Active N=2.7 million	16.98	42.70	33.23	24.13	50.47	50.56	30.04	19.40	40.16
	Insufficiently active N=3.4 million	21.34	36.90	34.18	28.97	54.55	45.09	31.76	23.11	43.91
	Inactive N= 8 million	36.46	22.08	29.22	48.67	64.73	33.57	27.00	39.43	56.80
Mental Health										
	Reported 1 or More Days Per Month When Mental Health Was Not Good N=10.4 million	57.16	25.38	31.52	43.09	64.99	33.94	30.81	35.24	55.97
	Reported 0 days When Mental Health Was Not Good N=7.7 million	42.84	42.90	32.52	24.60	44.91	55.75	28.55	15.72	36.13

	Been Told You Have a Depressive Disorder N=7.8 million	42.76	21.43	30.81	47.74	69.69	28.77	30.27	40.96	60.64
	Never Been Told You Have a Depressive Disorder N=10.3	57.24	41.45	32.80	25.75	46.45	54.12	29.52	16.34	37.63

p≤.001 for all comparisons

* Arthritis diagnosis question, " Has a doctor, nurse, or other health professional ever told you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"

1. Household Income imputed for 16% missing using race, ethnicity, reported physical and health status, employment status, homeownership status, marital status, gender, and educational attainment

*Activity level categories computed based on estimated MET minutes in relationship to 2008 physical activity recommendations by the US Department of Health and Human Services

* Functional Limitation Question, "Are you now limited in any way in any of your usual activities because of arthritis or joint symptoms?"

*Social Limitation Question, "During the past 30 days, to what extent has your arthritis or joint symptoms interfered with your normal social activities, such as going shopping, to the movies, or to religious or social gatherings?"

*Work Limitation Question, "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?

Figure 1

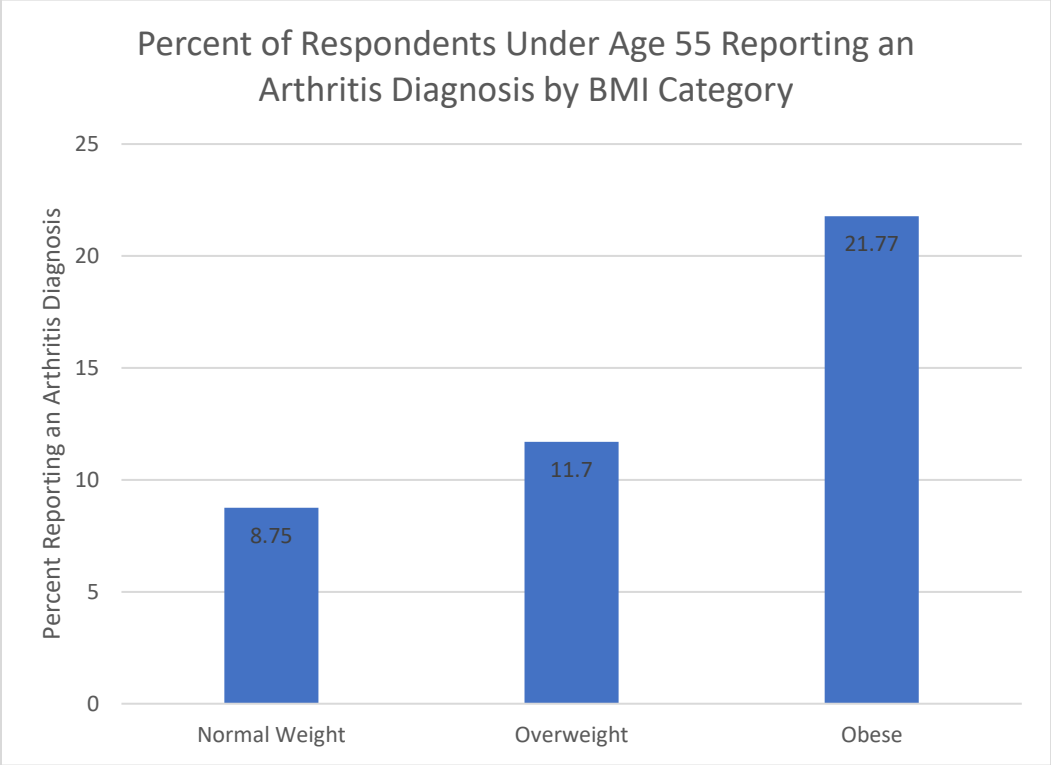
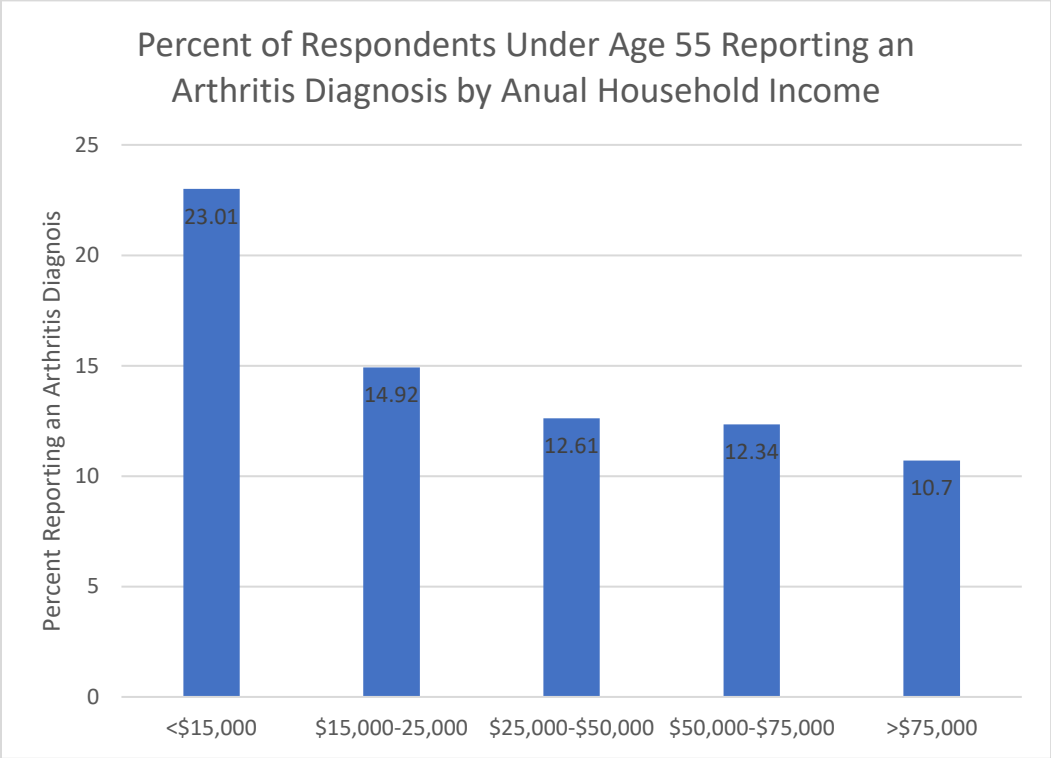

Percent of Respondents Under Age 55 Reporting an Arthritis Diagnosis by BMI Category
Percent Reporting an Arthritis Diagnosis
25
20
15
10
5
0
8.75
11.7
21.77
Normal Weight
Overweight
Obese

Figure 2


Percent of Respondents Under Age 55 Reporting an Arthritis Diagnosis by Anual Household Income
Percent Reporting an Arthritis Diagnois
25
20
15
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5
0
23.01
14.92
12.61
12.34
10.7
<$15,000
$15,000-25,000
$25,000-$50,000
$50,000-$75,000
>$75,000