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Original Article

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Social determinants of health in patients with arthritis: a cross-sectional analysis of the 2017 Behavioral Risk Factor Surveillance System

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Abstract

Context: Social determinants of health (SDOH) are economic, social, and political conditions that affect a person's overall health or the health of a group of people. Researchers have investigated the effects of SDOH on various diseases, such as asthma, obesity, and chronic stress, but few publications have been made regarding its effects on arthritis.
Objectives: Our primary objective was to analyze the implications of SDOH on disease severity relating to pain levels and limitations experienced among people with diagnosed arthritis.
Methods: We performed a cross-sectional analysis of the 2017 Behavioral Risk Factor Surveillance System (BRFSS). We included individuals who reported having arthritis, were over the age of 45, and who also completed the SDOH module. Pain scores from the four-question Arthritis Burden Module were correlated to question responses pertaining to SDOH to determine their associations.
Results: For the analysis, our sample size was 25,682, with response rates varying slightly among the SDOH questions. Individuals diagnosed with arthritis were more likely to report functional limitations if they experienced food insecurity (χ^2=234.0, p<0.001), financial instability (χ^2=149.7, p<0.001), or frequent stress (χ^2=297.6, p<0.001). Further, we found that individuals with arthritis experiencing any domain of SDOH reported higher mean pain scores than those not experiencing that domain, with the highest pain score difference among those reporting frequent stress (Coefficient: 1.93, CI=1.74–2.13, t=19.43, p<0.001).
Conclusions: Our results show that SDOH profoundly impact pain levels and limitations experienced by patients with arthritis. Although work has already begun to help alleviate burdens associated with SDOH, more research and actions are required to create equitable health throughout the population.

Keywords: arthritis; BRFSS; obesity; SDOH

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Approximately one in four Americans, or 58 million individuals, are currently diagnosed with arthritis [1–3]. Nearly half of all individuals over 65, almost a third of those between 45 and 64, and approximately 7 % of 18–44 year-olds report doctor-diagnosed arthritis [4]. The prevalence of arthritis is projected to increase to 79 million adults by 2040 due to increases in life expectancy and obesity [1, 5]. While arthritis is primarily a musculoskeletal disease, it also impacts mental health, quality of life, and mortality [5, 6]. Arthritis is the leading cause of work disability, and it has an estimated annual cost of $303.5 billion due to the healthcare cost and loss of earnings [7]. In addition to decreasing quality of life, other socio-environmental aspects such as depression, social isolation, activity limitations, and work limitations [3] play an essential role in the progression and management of arthritis [8]. Thus, many factors should be considered when assessing the impact of arthritis on patients.

According to the World Health Organization, social determinants of health (SDOH) are the combination of political, economic, and social policies of a country that lead to an unequal distribution of resources, subsequent living conditions, and health outcomes [9]. The lack of resource equity predisposes individuals to the deterioration of various chronic diseases. For example, a survey study of 33,201 households with children ages 6 to 17 demonstrated that poor housing conditions were strongly associated with asthma morbidity [10]. Other studies have explored the impact of SDOH on patients with obesity [11], chronic stress, decreased working memory [12], and poor sleep outcomes [13]. A survey including over 2000 adults found that individuals who perceived to reside in an unsafe neighborhood had an average BMI of 2.81 kg/m^2 higher than those who perceived living in a safe neighborhood [14]. Another survey study showed that an individual's perceived safety of their neighborhood showed an impact on adherence to medication regimens in patients with type 2 diabetes [15]. The previously mentioned available research provides evidence that certain SDOH have a profound impact on chronic illnesses. However, most studies fail to address the extent of SDOH fully. When analyzing the effect of SDOH on health and health equity, there are several domains to consider: distribution of power, social gradients, level of income, access to goods, access to services, working conditions, housing conditions, and neighborhood safety are major components of maintaining a healthy lifestyle [16].

Although there is a plethora of literature identifying the relationships of SDOH to various diseases, there is not much literature discussing the relationship between SDOH and arthritis. Moreover, the available research on arthritis and SDOH narrowly focuses on socioeconomic status, although many other previously mentioned factors may be involved [17]. Given the sparsity of literature on SDOH and its impact on arthritis, our primary objective was to assess potential relationships between various SDOH and arthritis severity utilizing data from the 2017 Behavioral Risk Factor Surveillance System (BRFSS), which included a specific SDOH module. The BRFSS arthritis module does not specify which type of arthritis an individual has, and the survey prompt also includes rheumatoid arthritis (RA), gout, lupus, or fibromyalgia. However, osteoarthritis is the most common form of arthritis, affecting about 32 million Americans to date [4]. Approximately 3.0 % of US adults with arthritis are diagnosed with RA—the next most common type [18]. Our study established a sample criteria focused on individuals greater than the age of 45; however, we understand that a population of individuals exists that are diagnosed with arthritis under the age of 45. Our study will provide a more complete understanding of the impact of SDOH on arthritis, which is critical for supporting public health efforts aimed at improving the overall health of patients with arthritis. Further, understanding how SDOH relate to arthritis may also help tailor treatment plans for arthritis patients and optimize their outcomes.

Methods

Data collection

We performed a cross-sectional analysis of the 2017 BRFSS, a public data survey performed by the Centers for Disease Control and Prevention, to gain information, including demographics, survey replies, and much more to establish a relationship between SDOH in patients with arthritis and its impact on their health. BRFSS is an annual phone-based survey conducted in all 50 states, as well as Puerto Rico and Guam, that includes noninstitutionalized US adults.

Arthritis

The pain score, the self-reported experience of pain and/or increased difficulty in performing daily activities, was assessed by the 4-question Arthritis Burden Module. Survey participants were first asked, "Are you limited in any way in any of your usual activities because of arthritis or joint symptoms?" If participants confirmed the initial inquiry, they were asked an additional two questions looking for the amount of interference of daily life ("affect whether you work, ability to do normal social activities such as going shopping or to the movies") and the severity of pain associated with their arthritis ("on a scale of 0–10 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?"). Only individuals responding affirmatively to the arthritis questions were included. Refused or unknown responses were excluded. Demographics of age, race/ethnicity, and BMI classification were also extracted.

Social determinants of health

To assess financial stability, we analyzed responses to the following questions from the SDOH BRFSS module: "Were you able to pay your bills?" and "Do you have enough money at the end of the month?" To assess housing security, we analyzed the question, "How many times have you moved in the last 12 months?" To analyze neighborhood safety, we assessed, "How safe from crime do you consider your neighborhood to be?" To assess food security, we analyzed the questions, "Did you run out of food sometime during the last 12 months?" and "Can you afford a well-balanced diet?" To assess stress level, we assessed, "How often were you stressed within the last 30 days?"

Statistical analysis

We calculated the sample and weighted prevalence of individuals by: (1) demographic variables, and then by those with and without (2) social and (3) work limitations among those diagnosed with arthritis. To determine the association between these limitations and SDOH from the BRFSS module, we utilized designed-based chi-square tests. We then constructed regression models to measure the association between SDOH and an individual's pain level, controlling for age, race, and education. The following variables—age, race, and education—were controlled due to their well-established relationship with SDOH [19].

Confidence intervals were reported at 95 %. Sampling weights provided by BRFSS were utilized to compute population estimates (N) and standard errors. Statistical analyses were performed utilizing Stata 16.1 in April 2022.

Results

The response rate of the 2017 BRFSS was 45.3 % for landlines and 44.5 % for cell phones. There were 449,732 respondents to the 2017 BRFSS. Of the responses to whether they had arthritis (n=446,951), 147,217 reported affirmatively—of which 135,407 were over the age of 45. Of these individuals (having arthritis and 45+ years of age), approximately 25,682, representing a population estimate of 10,765,385 US residents, also responded to the SDOH module, with response rates varying slightly among the SDOH questions. The average age of participants was 65.15 (SD=10.06), with 51.6 % of individuals being over the age of 65, 30.5 % between 54 and 65, and 17.8 % being between 45 and 54 (Table 1). A majority of the sample reported as being White (80.6 %), 10.2 % were Black, and 6.5 % were Hispanic, with those reporting as Native American/Alaskan Native or Asian comprising less than 1 % of the sample each (Table 1). Approximately 74.2 % of the sample had a BMI over 25.00 (Table 1).

Table 1: Demographics among BRFSS participants with arthritis who are over 45 years of age and completed the SDOH module.

Variable	Sample, n	Population estimate, N, %
Age group, years		
45–54	3,552	1,978,765 (17.84)
55–64	7,518	3,385,221 (30.52)
65+	15,392	5,728,472 (51.64)
Race		
White, non-Hispanic	23,141	8,938,601 (80.58)
Black, non-Hispanic	1741	1,130,763 (10.19)
Asian, non-Hispanic	67	67,924 (0.61)
American Indian/Alaskan Native, non-Hispanic	329	73,064 (0.66)
Hispanic	706	717,537 (6.47)
Other race, non-Hispanic	478	164,570 (1.48)
BMI category		
Underweight (<18.50)	376	170,361 (1.63)
Normal weight (18.50–24.99)	6,043	2,520,187 (24.18)
Overweight (25.00–30.00)	8,614	3,529,667 (33.86)
Obese (>30.00)	9,858	4,204,537 (40.33)

BMI, body mass index; BRFSS, Behavioral Risk Factor Surveillance System; SDOH, social determinants of health; n, sample size; N, population estimate; %, weighted percent.

SDOH and work/life limitations

We observed statistically noteworthy associations between individuals' work and life limitations with evaluated domains of SDOH. Patients with issues paying bills showed to have more arthritis-related functional limitations compared to those without payment problems (75.7 vs. 48.9 %; χ^2=149.66, p<0.001; Table 2). Similar results were noted in patients reporting work limitations (65.5 vs. 30.2 %; χ^2=301.15, p<0.001; Table 2). Individuals who moved more than once in the past 12 months did not result in an increase in arthritis-related functional limitations compared to those who did not move more than once in the past 12 months (51.5 vs. 63.5 %; χ^2, p=0.006; Table 2), which were also found regarding work limitations (33.4 vs. 55.0 %; χ^2, p<0.001; Table 2). Findings followed the same pattern for food insecurity, the ability to afford balanced meals, having enough money at the end of the month, and being stressed most or all days. Respondents who reported living in a neighborhood they felt was unsafe or extremely unsafe had more arthritis-related functional limitations (χ^2=29.13, p<0.001; Table 2) and work limitations (χ^2=37.45, p<0.001; Table 2) compared to those who felt that their neighborhood was safe or extremely safe.

SDOH and pain score

We found remarkable differences in pain scores between variations in SDOH. Persons who reported issues with bill payments had a higher reported arthritis-related pain score compared to those without bill payment issues (6.67 vs. 4.57; Coefficient: 1.61, 95 % CI 1.38–1.84; Table 3). Patients reporting issues of running out of food reported higher arthritis-related pain scores compared to those who did not run out of food (6.66 vs. 4.42; Coefficient: 1.73, 95 % CI 1.54–1.92; Table 3). Individuals who reported an inability to afford balanced meals had a higher reported arthritis-related pain score compared to those able to afford balanced meals (6.57 vs. 4.39; Coefficient: 1.71, 95 % CI 1.53–1.88; Table 3). This trend of higher pain scores among those experiencing negative SDOH circumstances continued through each domain—with each negatively impacted group reporting nearly 2 points higher on the pain scale, except for having frequently moved residences (which was still higher among those moving often; Coefficient: 0.70; 95 %CI: 0.2–1.2, t=2.77, p<0.006; Table 3). Full results are provided in Table 3.

Discussion

Our findings suggest that individuals reporting arthritis as a functional limitation or as a barrier to work were more

Table 2: Prevalence of individuals over 45 years of age with arthritis reporting functional limitations due to arthritis and those who report that arthritis affects their ability to work.

Social determinant of health (SDOH) question	Functional limitations			Total	Work limitations			Total
	No No., %	Yes No., %	Designed based Chi-square	No., %	No No., %	No No., %	Designed based Chi-square	No., %
Problems paying bills								
No	12,243, (51.06)	11,646, (48.94)	F(1, 25,842)=149.66, <0.001	23,889 (89.80)	16,630, (69.81)	6,885, (30.19)	F(1, 25,432)=301.15, <0.001	23,515, (89.85)
Yes	511, (24.28)	1881, (75.72)		2,392 (10.20)	780, (34.51)	1,576, (65.49)		2,356, (10.15)
Moved more than 1 time in past 12 months								
No	12,590, (48.54)	13,243, (51.46)	F(1, 25,930)=7.53, 0.006	25,833 (97.90)	17,194, (66.65)	8,239, (33.35)	F(1, 25,518)=26.08, <0.001	25,433, (97.89)
Yes	193, (36.51)	343, (63.49)		536 (2.10)	262, (45.04)	262, (54.96)		524, (2.11)
Ran out of food								
No	11,715, (52.59)	10,474, (47.41)	F(1, 25,691)=239.98, <0.001	22,189 (83.79)	15,826, (70.99)	6,049, (29.01)	F(1, 25,293)=304.28, <0.001	21,875, (83.83)
Yes	954, (25.84)	2,987, (74.16)		3,941 (16.21)	1,486, (41.17)	2,371, (58.83)		3,857, (16.17)
Not able to afford balanced meals								
No	11,664, (53.14)	10,175, (46.86)	F(1, 25,697)=260.01, <0.001	21,839 (82.59)	15,697, (71.62)	5,840, (28.38)	F(1, 25,297)=337.07, <0.001	21,537, (82.7)
Yes	1,027, (25.66)	3,270, (74.34)		4,297 (17.41)	1,637, (41.13)	2,562, (58.87)		4,199, (17.3)
Not enough money at the end of the month								
No	11,716, (51.62)	10,919, (48.38)	F(1, 25,110)=140.70, <0.001	22,635 (87.10)	15,857, (69.94)	6,445, (30.06)	F(1, 24,721)=181.71, <0.001	22,302, (86.7)
Yes	631, (24.52)	2,283, (75.48)		2,914 (12.90)	1,037, (41.06)	1821, (58.94)		2,858, (13.3)
Stressed most or all days								
No	11,820, (53.23)	10,639, (46.77)	F(1, 25,631)=297.61, <0.001	22,459 (84.19)	15,802, (70.59)	6,325, (29.41)	F(1, 25,225)=224.79, <0.001	22,127, (84.2)
Yes	832, (22.3)	2,779, (77.7)		3,611 (15.81)	1,475, (43.39)	2062, (56.61)		3,537, (15.8)
How safe from crime do you consider your neighborhood to be?								
Extremely safe	5,776, (54.90)	4,949, (45.1)	F(2.80, 71,820)=29.13, <0.001	4,949 (32.47)	7,772, (73.26)	2,811, (26.74)	F(2.93, 73,990)=37.45, <0.001	10,583, (37.41)
Safe	6,542, (45.71)	7,569, (54.29)		14,111 (56.63)	8,951, (63.83)	4,922, (36.17)		13,873, (56.53)
Unsafe	296, (30.29)	757, (69.71)		1,053 (5.11)	490, (48.33)	540, (51.67)		1,030, (5.13)
Extremely unsafe	47, (25.76)	152, (74.24)		199 (0.95)	83, (39.56)	113, (60.44)		196, (0.94)

Percentages given are weighted utilizing sampling weights provided by BRFSS/CDC. Information regarding sampling weights can be found at: www.cdc.gov/brfss/annual_data/2017/pdf/Complex-Smple-Weights-Prep-Module-Data-Analysis-2017-508.pdf. BRFSS, Behavioral Risk Factor Surveillance System; CDC, Centers for Disease Control and Prevention.

Table 3: Differences in pain scores related to arthritis were reported by individuals over 45 years of age by SDOH experience.

Social determinant of health (SDOH) question	Pain score	Unadjusted model		Adjusted model[a]	
	Mean, SD	Coefficient (95 % CI)	*t*, *P*	Coefficient (95 % CI)	*t*, *P*
Problems paying bills					
No	4.57 (2.77)	1 (reference)	20.39, <0.001	1 (reference)	13.69, <0.001
Yes	6.67 (2.36)	1.91 (1.73–2.1)		1.61 (1.38–1.84)	
Moved more than 1 time in past 12 months					
No	4.76 (2.8)	1 (reference)	4.46, <0.001	1 (reference)	2.77, <0.006
Yes	5.93 (2.91)	1.09 (0.61–1.57)		0.70 (0.2–1.2)	
Ran out of food					
No	4.42 (2.72)	1 (reference)	24.91, <0.001	1 (reference)	17.9, <0.001
Yes	6.66 (2.45)	2.04 (1.88–2.21)		1.73 (1.54–1.92)	
Not able to afford balanced meals					
No	4.39 (2.73)	1 (reference)	25.32, <0.001	1 (reference)	19.18, <0.001
Yes	6.57 (2.41)	1.98 (1.83–2.13)		1.71 (1.53–1.88)	
Not enough money at the end of the month					
No	4.47 (2.74)	1 (reference)	23.24, <0.001	1 (reference)	16.65, <0.001
Yes	6.82 (2.31)	2.26 (2.07–2.45)		1.82 (1.61–2.04)	
Stressed most or all days					
No	4.42 (2.72)	1 (reference)	23.5, <0.001	1 (reference)	19.43, <0.001
Yes	6.63 (2.44)	2.09 (1.91–2.26)		1.93 (1.74–2.13)	
How safe					
Extremely safe	4.18 (2.85)	1 (reference)	–	1 (reference)	–
Safe	5.00 (2.69)	0.82 (0.68–0.97)	11.42, <0.001	0.50 (0.36–0.64)	6.98, <0.001
Unsafe	6.30 (2.47)	2.13 (1.80–2.45)	12.85, <0.001	1.53 (1.21–1.85)	9.34, <0.001
Extremely unsafe	6.60 (2.90)	2.43 (1.56–3.29)	5.5, <0.001	1.67(0.82–2.51)	3.85, <0.001

[a]Adjusted models control for age, race, and education. CI, confidence interval; SD, standard deviation; SDOH, social determinants of health.

likely to report experiencing poor SDOH conditions. For example, participants with arthritis were less likely to report being able to pay their bills at the end of the month and were much more likely to have difficulty working or performing daily activities. The association of reporting arthritis and poor SDOH conditions was true for each SDOH domain except for housing permanence. Importantly, we found that increasing pain scores were associated with worse SDOH conditions. In the adjusted model, which controls for age, race, and ethnicity, it was found that higher pain scores were associated with difficulty paying bills, running out of food and money, an inability to afford a healthy diet, low neighborhood safety, and increased stress levels. Higher pain scores were not observed to be meaningfully associated with housing permanence.

The data collected from this study reflect trends found in previous research, which observed higher rates of chronic disease including arthritis in populations with less financial resources or otherwise at a social disadvantage. A recent secondary data analysis of men and women between ages 45 and 79 by Vennu et al. [20] found that those who did not complete their high school education were twice as likely to develop arthritis and chronic obstructive pulmonary disease (COPD) compared to those who finished high school. Multiple studies found a correlation between lower financial income and increased rates of arthritis and obesity [21, 22]. A secondary analysis utilizing individuals with knee arthritis found notable correlations between ethnicity, education, gender, and neighborhood poverty to chronic disease rates [21]. Much like these other studies and chronic illnesses, SDOH are highly correlated with functional status in patients with arthritis, creating a greater need to address these determinants as possible avenues for improved health.

Although SDOH may not be the primary cause of poor health, as Marmot [23] states, they are the cause of causes; thus, addressing them may prove beneficial when forming treatment plans for those with chronic diseases—particularly arthritis. Due to the pathogenesis of arthritis, stressors stemming from negative SDOH and barriers to medication adherence due to financial insecurity can exacerbate individuals' symptoms and disease progression [17]. An inability to afford or attend necessary treatments such as physical therapy, joint injections, or surgery can hinder the fulfillment of their management plan. For arthritis and rheumatic arthritis in particular, poor SDOH can increase stress, which in turn can alter immune function [24] and lead to higher levels of inflammatory markers [25], thus worsening disease progression [26, 27]. Our own results show that

individuals who felt stress most or all days reported more functional and work limitations along with higher pain scores. This implicates an association between SDOH and RA, along with other rheumatic diseases. A study looking at patients with RA found that remission rates at 6 and 12 months were better in individuals without adverse SDOH compared to those with poor SDOH [28]. Another study utilizing data from the American College of Rheumatology's Rheumatology Informatics System for Effectiveness (RISE) found that functionality was significantly worse in individuals of lower socioeconomic status [29].

The small available research mentioned above strengthens our hypothesis that SDOH have a profound impact on arthritis. With so many determinants influencing health, one solution would not be sufficient to address the underlying needs of patient populations. Some hospitals and organizations have begun work in this area. For example, in 2021, Johns Hopkins Healthcare updated its coding system to provide its patients with more specific care [30]. This classification system, referred to as the ICD-10 code, now includes prompts Z55-Z65, which explicitly address social determinants such as employment status, education, literacy levels, housing and economic circumstances, social support, and much more. With this information, physicians can provide better options to their patients to accommodate their financial or other social needs. Given the universal nature of ICD-10 codes, implementation of these and the development of local and community resources may be coupled to provide an invaluable tool across many more healthcare systems.

In addition to utilizing these resources, physicians should make it a priority to discuss a patient's social and financial circumstances. Our study and numerous others have proven that SDOH have a profound impact on chronic diseases. Therefore, having a holistic understanding of an individual's social situation will allow a provider to partner with the patient to create a more personalized healthcare plan that supports adherence and improved health outcomes. We recommend that hospitals and practices provide a list of referrals of resources available for patients who need care, whether it be financial or social.

Future studies should examine whether alterations in patients' SDOH will change their pain scores. Efforts should also be placed into studies that include individuals younger than 45. Finally, we know that SDOH and arthritis are interrelated, which warrants further investigation into this relationship.

The limitations to this study included data being subjective based on self-reported responses on SDOH and arthritis conducted by the BRFSS survey administration. Additionally, BRFSS did not delineate between other forms of arthritis and osteoarthritis, which limits our ability to explore what forms of arthritis are the most impacted by SDOH. Our study focused on those above the age of 45, leaving out individuals diagnosed with any arthritis from our sample. Further research needs to be done to establish trends of SDOH and arthritis in populations younger than 45 years old. Another limitation of BRFSS is that it alienates individuals without phones, which could limit the results/responses of individuals with serious housing insecurities. Future studies looking into SDOH and arthritis should look at the impact of other demographic variables for which we did not control. Also, our study is cross-sectional in nature and in no way can establish causality. The strengths of this study include a large sample that is more generalizable to the US population than previous SDOH and arthritis studies. This study also focused on more SDOH compared to the research that is available.

Conclusions

Patients with arthritis and poor SDOH, including food and financial insecurity, were more likely to have arthritis with higher pain and work-limiting symptoms than those with positive social determinants, thus confirming our claim that SDOH can have a profound impact on an individual's severity and the progression of their arthritis. These results further the breadth of literature supporting efforts to address SDOH and reduce morbidity and mortality among many chronic diseases. This study highlights the importance of personalized medicine when caring for patients with arthritis that addresses multiple aspects of health, including food security, safety, and economic health.

Research ethics: This project does not qualify as human subject research as defined in 45 CFR 46.102 (d) and (f) and is not subject to oversight by the Institutional Review Board.
Informed consent: Not applicable.
Author contributions: M.H. provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; J.W. and E.M. drafted the article or revised it critically for important intellectual content; A.R., N.B., B.G., and M.H. gave final approval of the version of the article to be published; and all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
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Data availability: The raw data can be obtained on request from the corresponding author.

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