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Associations of arthritis with functional disability and depressive symptoms in general US adults: NHANES 1988–1994 and 1999–2018

Xiaoting Liu[1,2] | Yunzhen Huang[3] | Jinjing Fu[4] | Mayila Mohedaner[4] | Danzengzhuoga[4] | Gan Yang[4] | Zhenqing Yang[4] | Xueqin Li[4] | Xinye Ma[5] | Qiqi Zhang[5] | Zuyun Liu[4] | Xifeng Wu[4] | Zhimin Ying[6]

[1]Institute of Wenzhou, Zhejiang University, Wenzhou, Zhejiang, China

[2]School of Public Affairs, Zhejiang University, Hangzhou, Zhejiang, China

[3]School of Public Health, Zhejiang University School of Medicine, Hangzhou, Zhejiang, China

[4]Department of Big Data in Health Science School of Public Health, Center for Clinical Big Data and Analytics of the Second Affiliated Hospital, Zhejiang University School of Medicine, Hangzhou, Zhejiang, China

[5]The Center for Ageing and Health Study, Zhejiang University, Hangzhou, Zhejiang, China

[6]Department of Orthopedic Surgery, the Second Affiliated Hospital, Zhejiang University School of Medicine, Hangzhou, Zhejiang, China

Correspondence
Zuyun Liu and Xifeng Wu, Department of Big Data in Health Science School of Public Health, Center for Clinical Big Data and Analytics of the Second Affiliated Hospital, Zhejiang University School of Medicine, 866 Yuhangtang Rd, Hangzhou, Zhejiang 310058, China.
Email: zuyun.liu@outlook.com; zuyunliu@zju.edu.cn and xifengw@zju.edu.cn

Zhimin Ying, Department of Orthopedic Surgery, the Second Affiliated Hospital, Zhejiang University School of Medicine, 88 Jiefang Rd, Hangzhou, Zhejiang 310009, China.
Email: olivery@zju.edu.cn

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Abstract

Objectives: This study aimed to examine the associations of arthritis with functional disability and depressive symptoms among general US adults. Additionally, it explored the relationship between radiographic knee osteoarthritis (assessed by X-ray examination) and functional disability. Above findings seek to highlight the need for comprehensive physical and mental health management in individuals with arthritis.

Methods: We designed a cross-sectional study utilizing multivariable logistic regression models to examine the associations. Odds ratios (OR) and corresponding 95% confidence intervals (CI) were documented in a crude model and three adjusted models. Participants were from the National Health and Nutrition Examination Survey (NHANES) 1988–1994 and 1999–2018. Arthritis was self-reported or graded by the Kellgren–Lawrence score after an objective X-ray examination. Functional disability included disability in activities of daily living (ADL disability), instrumental activities of daily living (IADL disability), and mobility disability. Depressive symptom was assessed using the Patient Health Questionnaire (PHQ).

Results: We included 22,566 older adults (≥60 years; 10,961 had self-reported arthritis) for functional disability analysis (2377 older adults with data on X-ray examination; 1012 had radiographic knee osteoarthritis) and 32,056 adults (≥20 years; 9175 had self-reported arthritis) for depressive symptom analysis. After controlling for all

Xiaoting Liu, Yunzhen Huang, Jinjing Fu, and Mayila Mohedaner contributed equally to this work.

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covariates, self-reported arthritis was associated with ADL disability (odds ratios [OR]: 2.677; 95% confidence interval [CI]: 2.499–2.868), IADL disability (OR: 2.064; 95% CI: 1.940–2.196), and mobility disability (OR: 2.954; 95% CI: 2.778–3.142), and depressive symptom (OR: 2.177; 95% CI: 1.979–2.395). In participants with data on X-ray examination, radiographic knee osteoarthritis was only associated with mobility disability (OR: 1.437; 95% CI: 1.183–1.744).

Conclusions: Self-reported arthritis was associated with ADL disability, IADL disability and mobility disability, and depressive symptoms. Among participants with X-ray data, radiographic knee osteoarthritis was only associated with mobility disability in general US adults. Appropriate managements of both physical and mental health are needed for individuals with arthritis.

KEYWORDS
arthritis, depressive symptom, functional disability, US adults

1 | BACKGROUND

Arthritis is a prevalent chronic disease, affecting an estimated 23.7% of adults and 50.4% of older adults aged ≥65 years in the US.[1] It imposes an economic burden on families and society, as well as healthcare challenges for caregivers.[2–7] The poor quality of life experienced by adult patients, including physical and mental disorders, has received significant attention in recent years.

Functional disability is defined as acquired difficulty in performing basic everyday tasks or more complex tasks needed for independent living.[8] Arthritis at a severe stage leads to functional disability, such as dependency on bathing and dressing,[9,10] which is associated with a high risk of mortality.[11,12] Additionally, the psychiatric condition most commonly associated with arthritis is depression.[13] The symptoms relevant to arthritis are stressors leading to depressive symptoms.[14] The prevalence of major depressive disorder in rheumatoid arthritis patients was 16.8%.[15] Therefore, exploring associations between arthritis, functional disability, and depressive symptoms has important implications for the improved management of arthritis patients.

To date, there are only four studies on the associations of arthritis with functional disability. One focused solely on activities of daily living (ADL),[16] another addressed both upper-lower extremity functional limitations and ADL disability,[17] one further considered disability in instrumental activities of daily living (IADL) and mobility,[18] and the last one on examined difficulties in mobility, self-care, and usual activities.[19] However, the sample size of these studies was relatively small, and most assessed arthritis status only through self-reports without radiographic method (X-ray examination).[16–18] These limitations also extend to previous studies investigating the association between arthritis with depressive symptoms. Among six studies, one examined rheumatoid arthritis with a small sample size,[20] and all six assessed arthritis through self-reports.[20–25] It remains unclear whether self-reported and objectively assessed arthritis is associated with functional disability and depressive symptoms in a large, nationally representative population.

In this study, we utilized data from the National Health and Nutrition Examination Survey (NHANES) 1988–1994 and 1999–2018, a national survey in the US, to examine associations of arthritis with functional disability and depressive symptoms. Of note, we included around 2400 participants with X-ray data to evaluate the associations of objectively assessed arthritis with functional disability. We hypothesize that patients with arthritis experience more severe functional disability and higher levels of depressive symptoms. Additionally, it is hypothesized that arthritis assessed by the radiographic method will demonstrate weaker associations with these outcomes than self-reported measures.

2 | METHODS

2.1 | Study population

The NHANES is an ongoing series of national surveys, conducted by the National Center for Health Statistics.[26] Participants are randomly selected from households in the US, and comprehensive data are collected through household interviews and examinations at mobile examination centers (MEC).[27] The survey first began in the 1960s and turned into a continuous program since 1999. Among the series, NHANES III was conducted between 1988 and 1994, consisting of two phases of equal period. NHANES IV is conducted every two years, with evolving focuses to meet emerging needs. Despite the fact that NHANES III data is not recent, it has been widely utilized in recent studies to draw meaningful conclusions,[28,29] demonstrating its reliability and validity.

In this study, we included a total of 23,545 older adults (≥60 years) with both interview and body measurements data from NHANES III (1988–1994) and NHANES IV (1999–2018) for functional disability analysis. Participants with missing data on self-reported arthritis ($n=53$), educational level ($n=100$), marital status ($n=173$), smoking status ($n=27$), physical activity ($n=12$), body mass index (BMI) ($n=652$), chronic diseases ($n=7$), and functional disability ($n=3$) were

excluded, leaving 22,566 participants available, among which 2377 participants had complete data on X-ray examination (Figure 1).

We included a total of 38,185 adults (≥20 years) with both interview and body measurement data from NHANES IV (2005–2018) for depressive symptom analysis. Female participants with missing data on pregnancy status ($n=1492$), pregnant female participants ($n=627$), and participants with missing data on self-reported arthritis ($n=81$), educational level ($n=47$), marital status ($n=25$), smoking status ($n=25$), physical activity ($n=1$), BMI ($n=539$), chronic diseases ($n=6$), and depressive symptom ($n=3307$) were excluded, leaving 32,056 participants available (Figure 2).

2.2 | Self-reported measures

Self-reported arthritis is a critical factor in this study. Previous research has demonstrated that the accuracy of self-reported OA and RA is acceptable for large-scale studies where rheumatologist examination is not feasible.[30] Self-reported arthritis has been applied in research.[31] A large community-based study demonstrated that self-reported arthritis is associated with depression.[32] Additionally, a study utilizing longitudinal data involving 5715 adults with arthritis indicated that the odds of functional decline over 2 years almost doubled among individuals not engaged in regular vigorous physical activity.[33]

2.3 | Assessment of arthritis

Data on self-reported arthritis were collected through a questionnaire. All adult participants were asked, "Has a doctor or other health professional ever told you that you had arthritis?" Participants who answered "yes" were classified as having arthritis, while those who answered "no" were classified as not having arthritis. This definition

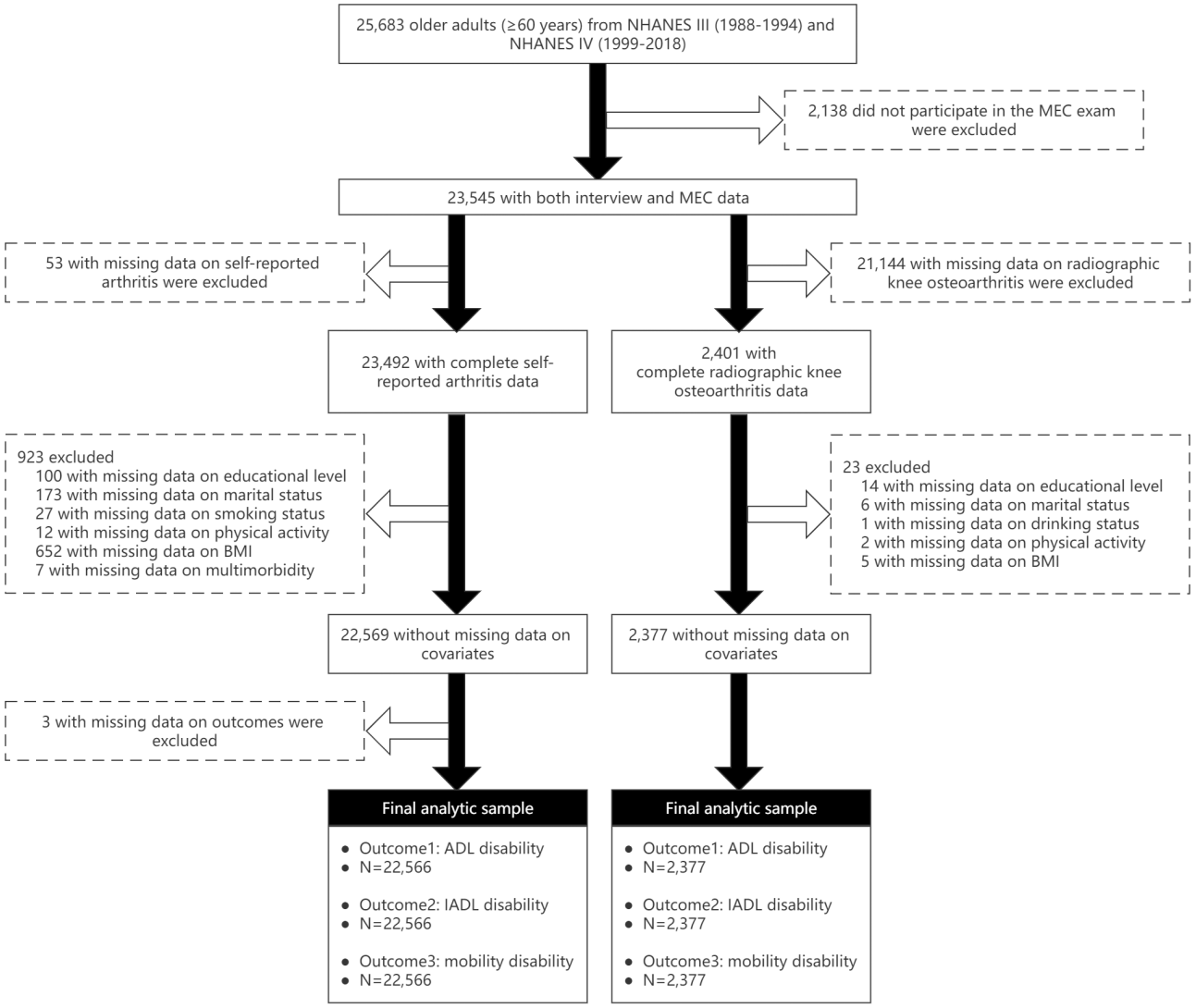

FIGURE 1 Flowchart of assembling study participants in functional disability analysis. ADL, activities of daily living; BMI: body mass index; IADL, instrumental activities of daily living; MEC, mobile examination centers; NHANES, the National Health and Nutrition Examination Survey.

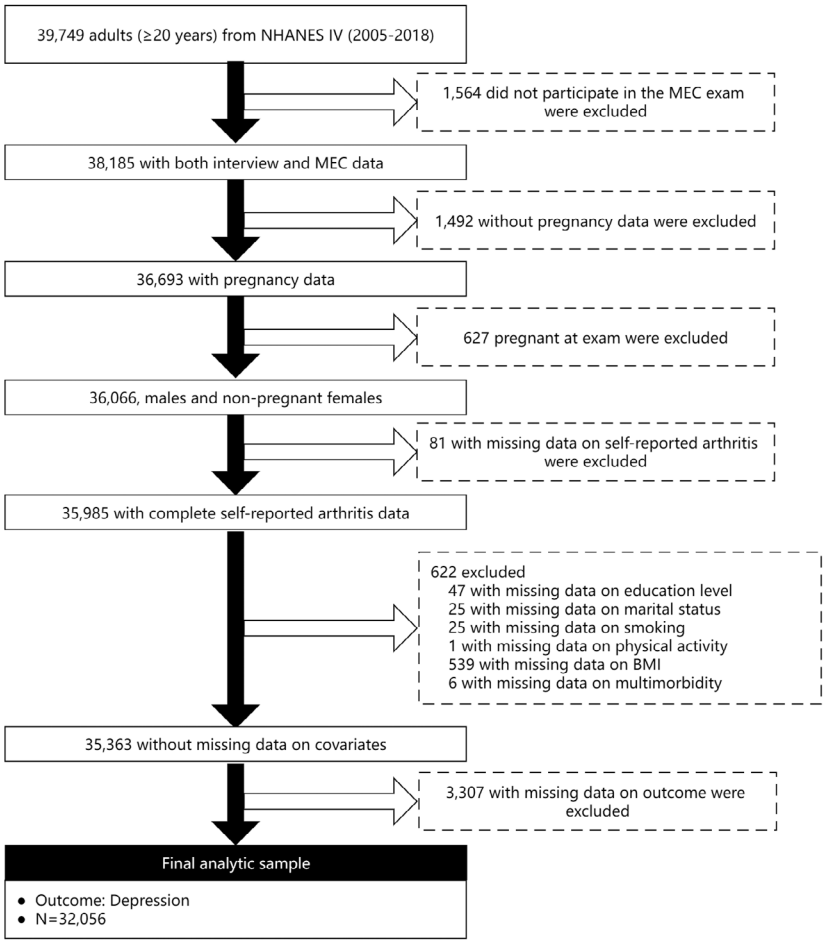

FIGURE 2 Flowchart of assembling study participants in depressive symptom analysis. BMI: body mass index; MEC, mobile examination centers; NHANES, the National Health and Nutrition Examination Survey.

of arthritis has been widely used[34,35] and shown to be valid[36,37] in previous studies.

Radiographic knee osteoarthritis was determined by an objective X-ray examination. Participants aged ≥60 years in the 1991–1994 NHANES had non-weight-bearing anteroposterior knee X-rays at MEC. All the knee radiographs were read and scored independently by two specially trained radiologists, based on the Kellgren-Lawrence (KL) classification, and a KL score of either knee ≥2 was considered the radiographic knee osteoarthritis group.[38]

2.4 | Assessment of functional disability

In this study, we considered three types of physical function: ADL, IADL, and mobility, assessed by questionnaires.

ADL was assessed by four daily activities: walking between rooms on the same floor, getting in or out of bed, eating, and dressing.[39] Participants were asked to indicate the level of difficulty they experienced in performing the above activities, with response options of "no difficulty," "some difficulty," "much difficulty," and "unable to do." Participants reporting any difficulty in performing at least one of the four activities were classified as having ADL disability. IADL disability and mobility disability were defined similarly but assessed by different daily activities. IADL was evaluated based on three activities: managing money, doing household chores, and preparing meals.[40] Mobility was assessed by seven activities: walking for a quarter mile, walking up ten steps, stooping or crouching or kneeling, lifting or carrying, standing up from an armless chair, reaching up overhead, and grasping small objects.

2.5 | Assessment of depressive symptom

The depressive symptom was assessed using the Patient Health Questionnaire (PHQ) in nine symptoms: anhedonia, depressed mood, sleep disturbance, fatigue, appetite changes, low self-esteem, concentration problems, psychomotor disturbances, and suicidal ideation.[41,42] Each item was scored from 0 (not at all) to 3 (nearly every day). Participants with a total score ≥10 were defined as having clinically significant depressive symptoms.

2.6 | Covariates

Covariates included age, sex, race/ethnicity, family poverty income ratio (PIR), educational level, marital status, smoking status, drinking status, physical activity, BMI, and multimorbidity. Race/

ethnicity was categorized as non-Hispanic white, non-Hispanic black, Mexican-American, and others. Family PIR was defined as ≤1, 1–3, and >3, with a higher score indicating a higher family income level.[38] Educational level was categorized into never finished primary school, primary school, high school, some college, and college or above. Marital status was defined as married or living with a partner, and others (including widowed, divorced, separated, and never married). Smoking status encompassed three groups: never smokers, former smokers, and current smokers.[26] Drinking status was defined as non-drinker, moderate drinker, and heavy drinker.[43] Physical activity was defined as inactive and active.[38] BMI was defined as underweight (BMI < 18.5 kg/m^2), normal (18.5 kg/m^2 ≤ BMI < 25.0 kg/m^2), overweight (25.0 kg/m^2 ≤ BMI < 30.0 kg/m^2), and obese (BMI ≥30.0 kg/m^2).[26] Multimorbidity (yes) was defined as having two or more of the nine self-reported chronic diseases (i.e., congestive heart failure, stroke, cancer, chronic bronchitis, emphysema, cataracts, diabetes, hypertension, heart attack).[26] Of note, we calculated the medians of family PIR and drinking status, and imputed the corresponding missing values (family PIR: $n = 2590$ in functional disability analysis, $n = 3296$ in depressive symptom analysis; drinking status: $n = 1322$ in functional disability analysis, $n = 2279$ in depressive symptom analysis).

2.7 | Statistical analyses

Basic characteristics of study participants by arthritis were presented as mean ± standard deviation (*SD*) for continuous variables and number (percentage) for categorical variables. Differences between groups were assessed by *t*-test or Chi-squared test.

In the primary analyses, we used multivariable logistic regression models to estimate the associations of arthritis with functional disability and depressive symptoms, respectively. Odds ratios (OR) and corresponding 95% confidence intervals (CI) were documented in a crude model and three adjusted models. Model 1 adjusted for age and sex. Model 2 was further adjusted for race/ethnicity, family PIR, educational level, marital status, smoking status, drinking status, physical activity, and BMI. Model 3 was further adjusted for multimorbidity based on model 2.

Several sensitivity analyses were conducted to assess the robustness of the results. First, we repeated multivariable logistic regression models after excluding the participants with missing data on family PIR and drinking status. Second, we repeated the primary analyses in sex subgroups to examine whether the results differed by sex. Third, due to a significant discrepancy in the number of samples with data on self-reported arthritis compared to those with data on radiographic knee osteoarthritis, we also repeated functional disability analysis among participants with data on both self-reported arthritis and radiographic knee osteoarthritis.

All the statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). $p < 0.05$ was considered to be statistically significant.

3 | RESULTS

3.1 | Basic characteristics of study participants

In functional disability analysis, there were 22,566 participants (10,961 with self-reported arthritis) and the mean age (±*SD*) of participants with and without self-reported arthritis were 71.2 ± 6.9 years and 70.0 ± 7.0 years, respectively ($P < 0.001$). There were 2377 participants (1012 with radiographic knee osteoarthritis) with X-ray data and the mean age (±*SD*) of participants with and without radiographic knee osteoarthritis was 72.2 ± 6.6 years and 69.9 ± 6.8 years, respectively ($P < 0.001$). In depressive symptom analysis, there were 32,056 participants (9175 with arthritis) and mean age (±*SD*) of participants with and without arthritis were 62.1 ± 13.5 years and 46.0 ± 17.0 years, respectively ($P < 0.001$). Details of the characteristics are shown in Table 1.

3.2 | Associations of self-reported and objectively assessed arthritis with functional disability

Table 2 shows associations of self-reported and objectively assessed arthritis with functional disability. We observed that self-reported arthritis was significantly associated with ADL disability (OR: 3.006; 95% CI: 2.820–3.205), IADL disability (OR: 2.413; 95% CI: 2.279–2.555), and mobility disability (OR: 3.563; 95% CI: 3.366–3.772) in the crude model. After adjusting for age and sex (model 1), self-reported arthritis was associated with ADL disability (OR: 2.961; 95% CI: 2.774–3.161), IADL disability (OR: 2.307; 95% CI: 2.176–2.446), and mobility disability (OR: 3.372; 95% CI: 3.181–3.574). After adjusting for more covariates, results were maintained in models 2 and 3.

In participants with data on X-ray examination, radiographic knee osteoarthritis was associated with ADL disability (OR: 1.478; 95% CI: 1.212–1.802), IADL disability (OR: 1.546; 95% CI: 1.281–1.865), and mobility disability (OR: 1.931; 95% CI: 1.630–2.288) in the crude model. After adjusting for age and sex (model 1), the strength of associations was reduced but remained statistically significant. However, after adjusting for more covariates, radiographic knee osteoarthritis was only associated with mobility disability in model 2 (OR: 1.446; 95% CI: 1.195–1.750) and model 3 (OR: 1.437; 95% CI: 1.183–1.744).

3.3 | Associations of self-reported arthritis and depressive symptom

The results of depressive symptom analysis are shown in Table 3. We observed that self-reported arthritis was significantly associated with depressive symptoms (OR: 2.400; 95% CI: 2.220–2.596) in the crude model. After controlling for age and sex in model 1, self-reported arthritis was associated with depressive symptoms (OR: 2.916; 95% CI: 2.666–3.190). After adjusting for more covariates in

TABLE 1 Basic characteristics of the study participants.

Characteristics	Participants for functional disability analysis ($n=22,566$)			Participants with data on radiographic knee osteoarthritis ($n=2377$)			Participants for depressive symptom analysis ($n=32,056$)		
	No arthritis ($n=11,605$)	Arthritis ($n=10,961$)	*P* Value	No radiographic knee osteoarthritis ($n=1365$)	radiographic knee osteoarthritis ($n=1012$)	*P* Value	No arthritis ($n=22,881$)	Arthritis ($n=9175$)	*P* Value
Age, years, mean ± *SD*	70.0 ± 7.0	71.2 ± 6.9	<0.001	69.9 ± 6.8	72.2 ± 6.6	<0.001	46.0 ± 17.0	62.1 ± 13.5	<0.001
20–39 years (%)	—	—	—	—	—	—	9259 (40.4)	6217 (6.8)	<0.001
40–59 years (%)	—	—	—	—	—	—	7974 (34.9)	2791 (30.4)	
60–79 years (%)	9364 (80.7)	8396 (76.6)	<0.001	1116 (81.8)	749 (74.0)	<0.001	4746 (20.7)	4632 (50.5)	
≥80 years (%)	2241 (19.3)	2565 (23.4)		249 (18.2)	263 (26.0)		911 (4.0)	1125 (12.3)	
Sex, female (%)	4975 (42.9)	6497 (59.3)	<0.001	638 (46.7)	615 (60.8)	<0.001	10,126 (31.6)	5346 (58.3)	<0.001
Race/ethnicity (%)									
Non-Hispanic white	5846 (50.4)	6133 (56.0)	<0.001	797 (58.4)	542 (53.6)	<0.001	9080 (39.7)	4824 (52.6)	<0.001
Non-Hispanic black	2209 (19.0)	2269 (20.7)		214 (15.7)	235 (23.2)		4855 (21.2)	2030 (22.1)	
Mexican-American	2035 (17.5)	1501 (13.7)		289 (21.2)	196 (19.4)		3932 (17.2)	970 (10.6)	
Other	1515 (13.1)	1058 (9.7)		65 (4.8)	39 (3.9)		5014 (21.9)	1351 (14.7)	
Family PIR (%)									
≤1	1822 (15.7)	1915 (17.5)	<0.001	247 (18.1)	235 (23.2)	0.006	4289 (18.7)	1788 (19.5)	<0.001
1–3	6207 (53.5)	6056 (55.3)		756 (55.4)	540 (53.4)		10,478 (45.8)	4525 (49.3)	
>3	3576 (30.8)	2990 (27.3)		362 (26.5)	237 (23.4)		8114 (35.5)	2862 (31.2)	
Educational level (%)									
Never finished primary school	2856 (24.6)	2650 (24.2)	<0.001	501 (36.7)	452 (44.7)	<0.001	2171 (9.5)	1115 (12.2)	<0.001
Primary school or junior high school	1559 (13.4)	1689 (15.4)		160 (11.7)	112 (11.1)		3174 (13.9)	1382 (15.1)	
High School Grad/GED or Equivalent	2921 (25.2)	2843 (25.9)		439 (32.2)	325 (32.1)		5194 (22.7)	2284 (24.9)	
Some college or AA degree (2 years of study)	2189 (18.9)	2181 (19.9)		102 (7.5)	47 (4.6)		6735 (29.4)	2710 (8.5)	
College graduate or above (3 years or more)	2080 (17.9)	1598 (14.6)		163 (11.9)	76 (7.5)		5606 (24.5)	1684 (18.4)	
Marital status, married or living with partner (%)	7164 (61.7)	5905 (53.9)	<0.001	870 (63.7)	533 (52.7)	<0.001	13,874 (60.6)	5208 (56.8)	<0.001
Smoking status (%)									
Never smoker	5576 (48.1)	5277 (48.1)	<0.001	582 (42.6)	564 (55.7)	<0.001	13,129 (57.4)	4194 (45.7)	<0.001
Former smoker	4351 (37.5)	4368 (39.9)		551 (40.4)	335 (33.1)		4887 (21.4)	3138 (34.2)	
Current smoker	1678 (14.5)	1316 (12.0)		232 (17.0)	113 (11.2)		4865 (21.3)	1843 (20.1)	

TABLE 1 (Continued)

Characteristics	Participants for functional disability analysis ($n = 22,566$)			Participants with data on radiographic knee osteoarthritis ($n = 2377$)			Participants for depressive symptom analysis ($n = 32,056$)		
	No arthritis ($n = 11,605$)	Arthritis ($n = 10,961$)	*P* Value	No radiographic knee osteoarthritis ($n = 1365$)	radiographic knee osteoarthritis ($n = 1012$)	*P* Value	No arthritis ($n = 22,881$)	Arthritis ($n = 9175$)	*P* Value
Drinking status (%)									
Non-drinker	5927 (51.1)	6082 (55.5)	<0.001	899 (65.9)	737 (72.8)	0.001	6676 (29.7)	3789 (41.3)	<0.001
Moderate drinker	4939 (42.6)	4251 (38.8)		402 (29.5)	238 (23.5)		14,066 (61.5)	4681 (51.0)	
Heavy drinker	739 (6.4)	628 (5.7)		64 (4.7)	37 (3.7)		2139 (9.4)	705 (2.2)	
Physical activity, active (%)	3281 (28.3)	2250 (20.5)	<0.001	630 (46.2)	376 (37.2)	<0.001	6419 (28.1)	1723 (18.8)	<0.001
BMI (%)									
Underweight	232 (2.0)	146 (1.3)	<0.001	35 (2.6)	11 (1.1)	<0.001	368 (1.6)	103 (1.1)	<0.001
Normal	3635 (31.3)	2596 (23.7)		528 (38.7)	209 (20.7)		6820 (29.8)	1755 (19.1)	
Overweight	4621 (39.8)	3891 (35.5)		564 (41.3)	414 (40.9)		7903 (24.7)	2810 (8.8)	
Obese	3117 (26.9)	4328 (39.5)		238 (17.4)	378 (37.4)		7790 (34.1)	4507 (49.1)	
Chronic disease counts, mean ± *SD*	1.4 ± 1.2	1.8 ± 1.4	<0.001	1.5 ± 1.3	1.6 ± 1.2	0.02	0.6 ± 1.0	1.6 ± 1.4	<0.001
Multimorbidity, yes (%)	4438 (38.2)	5847 (53.3)	<0.001	571 (41.83)	478 (47.2)	0.009	3449 (15.1)	4106 (44.8)	<0.001
ADL disability (%)	1768 (15.2)	3845 (35.1)	<0.001	248 (18.2)	250 (24.7)	0.001	—	—	—
IADL disability (%)	2749 (23.7)	4694 (42.8)	<0.001	288 (21.1)	296 (29.3)	<0.001	—	—	—
Mobility disability (%)	5440 (46.9)	8316 (75.9)	<0.001	718 (52.6)	690 (68.2)	<0.001	—	—	—
Depressive symptom (%)	—	—	—	—	—	—	1597 (6.6)	1328 (14.5)	<0.001

Abbreviations: AA, associate of arts; ADL, activities of daily living; BMI, body mass index; GED, general educational development; IADL, instrumental activities of daily living; PIR, family poverty income ratio; *SD*, standard deviation.

TABLE 2 Multivariable logistic regression analysis of the associations of self-reported arthritis and radiographic knee osteoarthritis with functional disability.

	Crude model		Model 1		Model 2		Model 3	
	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
ADL disability								
No arthritis	Ref.		Ref.		Ref.		Ref.	
Arthritis	3.006 (2.820–3.205)	<0.001	2.961 (2.774–3.161)	<0.001	2.838 (2.651–3.038)	<0.001	2.677 (2.499–2.868)	<0.001
No radiographic knee osteoarthritis	Ref.		Ref.		Ref.		Ref.	
Radiographic knee osteoarthritis	1.478 (1.212–1.802)	0.001	1.375 (1.124–1.683)	0.002	1.209 (0.970–1.508)	0.092	1.202 (0.962–1.502)	0.105
IADL disability								
No arthritis	Ref.		Ref.		Ref.		Ref.	
Arthritis	2.413 (2.279–2.555)	<0.001	2.307 (2.176–2.446)	<0.001	2.197 (2.067–2.336)	<0.001	2.064 (1.940–2.196)	<0.001
No radiographic knee osteoarthritis	Ref.		Ref.		Ref.		Ref.	
Radiographic knee osteoarthritis	1.546 (1.281–1.865)	<0.001	1.347 (1.110–1.634)	0.003	1.181 (0.955–1.460)	0.126	1.172 (0.945–1.452)	0.148
Mobility disability								
No arthritis	Ref.		Ref.		Ref.		Ref.	
Arthritis	3.563 (3.366–3.772)	<0.001	3.372 (3.181–3.574)	<0.001	3.120 (2.936–3.315)	<0.001	2.954 (2.778–3.142)	<0.001
No radiographic knee osteoarthritis	Ref.		Ref.		Ref.		Ref.	
Radiographic knee osteoarthritis	1.931 (1.630–2.288)	<0.001	1.732 (1.455–2.062)	<0.001	1.446 (1.195–1.750)	0.002	1.437 (1.183–1.744)	<0.001

Note: Model 1 adjusted for age and sex. Model 2 was further adjusted for race/ethnicity, family poverty income ratio, educational level, marital status, smoking status, drinking status, physical activity, and body mass index based on model 1. Model 3 was further adjusted for multimorbidity based on model 2.

Abbreviations: ADL, activities of daily living; CI, confidence interval; IADL, instrumental activities of daily living; OR, odds ratio.

TABLE 3 Multivariable logistic regression analysis of the association of self-reported arthritis with depressive symptoms.

	Crude model		Model 1		Model 2		Model 3	
	OR (95% CI)	P Value	OR (95% CI)	P Value	OR (95% CI)	p Value	OR (95% CI)	P Value
No arthritis	Ref.		Ref.		Ref.		Ref.	
Arthritis	2.400 (2.220–2.596)	<0.001	2.916 (2.666–3.190)	<0.001	2.446 (2.228–2.685)	<0.001	2.177 (1.979–2.395)	<0.001

Note: Model 1 adjusted for age and sex. Model 2 was further adjusted for race/ethnicity, family poverty income ratio, educational level, marital status, smoking status, drinking status, physical activity, and body mass index based on model 1. Model 3 was further adjusted for multimorbidity based on model 2.

Abbreviations: CI, confidence interval; OR, odds ratio.

model 2 and model 3, the association between self-reported arthritis and depressive symptoms remained robust.

3.4 | Sensitivity analyses

First, after excluding participants with missing data on family PIR and drinking status, results for functional disability analysis (Table S1) and depressive symptom analysis (Table S2) remained robust. In functional disability analysis, self-reported arthritis was significantly associated with ADL disability (OR: 2.740; 95% CI: 2.539–2.956), IADL disability (OR: 2.054; 95% CI: 1.919–2.198), and mobility disability (OR: 2.888; 95% CI: 2.702–3.086) in model 3. Conversely, radiographic knee osteoarthritis was only associated with mobility disability (OR: 1.424; 95% CI: 1.160–1.747) in model 3. In depressive symptom analysis, arthritis was significantly associated with depressive symptoms (OR: 2.175; 95% CI: 1.967–2.405) after controlling for all covariates (model 3). Second, in subgroup analyses stratified by sex, we found that associations of arthritis with IADL disability were more pronounced in females (Table S3). Third, we found similar results with the primary functional disability analyses in participants with data on both self-reported arthritis and radiographic knee osteoarthritis (Table S4).

4 | DISCUSSION

In this extensive sample (over 20,000 participants for functional disability analysis and over 30,000 participants for depressive symptom analysis) of US adults, we found that self-reported arthritis was associated with ADL disability, IADL disability, mobility disability, and depressive symptoms. Among participants with X-ray data, objectively assessed arthritis (i.e., radiographic knee osteoarthritis) was associated solely with mobility disability. These findings highlight the substantial burden of functional disability and depressive symptoms in US adults with arthritis.

In this study, our results are generally consistent with previous literature.[16–18,20–22] For instance, a recent study using data from the Health and Retirement Study demonstrated that arthritis was strongly associated with the high prevalence of functional limitations, including impairments in mobility, ADL, and IADL.[18] Additionally, a cross-sectional study from NHANES 2007-2018 indicated that adults with arthritis may have a risk of major depression.[22] The findings of this study confirm and extend previous findings on associations of arthritis with functional disability and depressive symptoms to a general US population. We also found that the association between arthritis and IADL disability was more pronounced in females. This may be related to changes in female sex hormones and the menopausal state.[44] A study suggests that mechanisms connecting RA and mental health likely have a reciprocal influence, and emotional distress may coexist with physiological stressors, thereby exacerbating emotional distress.[12] Furthermore, a cross-sectional study revealed that depression prevalence was highest among

arthritis patients who reported "a lot" of difficulties dressing and bathing.[45] The current study carries significant public health implications by emphasizing the importance of addressing both physical functioning and mental health to diminish life stress and enhance the quality of life for arthritis patients.

However, associations of radiographic knee osteoarthritis with functional disability in this study differ from those in previous studies.[19] In a UK cohort study, researchers have observed an association of radiographic knee osteoarthritis with mobility disability exclusively in females.[19] Whereas we found associations of radiographic knee osteoarthritis with mobility disability in males and females. We speculate that these discrepancies may be related to heterogeneity within the study population and the definition of outcomes.

Furthermore, in functional disability analysis, self-reported arthritis was associated with three types of functional disability, whereas radiographic knee osteoarthritis was only associated with mobility disability. This disparity may be explained in several ways. First, radiographic knee osteoarthritis primarily reflects structural changes, which may precede physical dysfunction, particularly in populations with early-stage arthritis.[46] In fact, a study indicated that radiographic knee osteoarthritis correlates poorly with physical symptoms of OA.[47] Second, although ADL disability, IADL disability, and mobility disability reflect the decline in physical function, they involve different parts of the body and measure different aspects of functional decline. For instance, ADL (e.g., eating, dressing) refers to basic daily activities necessary for independent living, whereas IADL (e.g., managing money) refers to more complex and more cognitively-driven activities than ADL.[48,49] Third, while mobility disability can impact mental health, radiographic evidence of knee osteoarthritis alone does not necessarily imply depressive outcomes. A study indicated that the probability of depression onset did not consistently increase with greater knee OA progression over time.[50]

This study has several strengths. First, to our knowledge, it is the first to examine associations of arthritis with functional disability and depressive symptoms in the same study. Second, we included the largest sample available from NHANES, a nationally representative survey of the US population across all ages, with rigorous data-collection procedures. Third, by including both self-reported and objectively assessed diagnoses of arthritis and examining three types of functional disability, we were able to provide a relatively comprehensive assessment of associations between arthritis and disability.

This study also has limitations. First, as a cross-sectional study, it lacks capacity to prove a causal correlation. Second, we did not take more details about arthritis into account, including severity, duration, and medication status. In this study, self-reported arthritis served as an umbrella term for various subtypes of arthritis, and objectively assessed arthritis is a specific subtype of arthritis. This limits the ability to directly analyze concordance between self-reported and objectively assessed arthritis diagnoses. Third, some arthritis cases may not have been captured, as frail participants were unable to reach MEC to complete the examination, and there were undiagnosed cases based on self-reports. In moving forward, prospective studies are needed to investigate the burden of arthritis in the same population with a combination of subjective and objective diagnoses.

5 | CONCLUSION

Arthritis is one of the primary causes of disability among US adults[51] and is projected to increase in prevalence.[52] Arthritis at a severe stage leads to functional disability and is associated with an increased risk of depression.[9–13] In general US adults, self-reported arthritis was strongly associated with ADL disability, IADL disability, and mobility disability, and depressive symptoms, while radiographic knee osteoarthritis was only associated with mobility disability. Increased attention and appropriate management of both physical and mental health are needed to improve the quality of life for individuals with arthritis.

AUTHOR CONTRIBUTIONS

Xiaoting Liu: Writing original manuscript; writing—review and editing; methodology; conceptualization. **Yunzhen Huang:** writing original manuscript; writing—review and editing. **Jinjing Fu:** Statistical analyses; writing original manuscript; writing—review and editing. **Mayila Mohedaner:** Statistical analyses; writing original manuscript; writing—review and editing. **Danzengzhuoga:** Statistical analyses; review and editing. **Gan Yang, Zhenqing Yang, Xueqin Li, Xinye Ma, Qiqi Zhang:** Review and editing. **Zuyun Liu, Xifeng Wu, Zhimin Ying:** Conceptualization; review and editing; funding acquisition; supervision.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data from the US National Health and Nutrition Examination Survey (NHANES) are available at the NHANES website: https://www.cdc.gov/nchs/nhanes/index.htm.

ORCID

Qiqi Zhang https://orcid.org/0000-0001-6146-2784

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SUPPORTING INFORMATION

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