BMC Geriatrics

RESEARCH Open Access

Association of improvement and worsening of depressive symptoms with arthritis

Ruxi Liu[2], Yinuo Xin[5], Yining Shao[2], Bo Wu[3*] and Yan Liu[1,4*]

Abstract

Purpose The longitudinal association between changes in depressive symptoms (improvement/worsening) and arthritis is unclear.

Methods Study data were obtained from the China Health and Retirement Longitudinal Study (CHARLS) 2011–2018. The 10-item Center for Epidemiological Studies Depression Scale (CES-D-10) was used to examine participant depressive symptoms and data on self-reported history of arthritis were collected. Depressive symptoms improving is defined as depression at baseline and no depression at follow-up. Similarly, depressive symptoms worsening is defined as no depression at baseline and depression at follow-up. Cox proportional hazards models were used to evaluate the effects of improvement or deterioration in depressive symptoms on arthritis. Participants with missing data on depression and arthritis, having arthritis in 2011 CHARLS and lost to follow-up was excluded.

Results A total of 8556 participants free of arthritis were included from 2011 to 2018. After adjustment for confounders, depressive symptoms were associated with a 54% increased risk of developing arthritis. Each 1-point increase in CES-D-10 score was associated with a 4% higher risk of arthritis. Participants with depressive symptoms at baseline but improved symptoms (without depressive symptoms) at follow-up had a 25% lower rate of arthritis, and a 1-point reduction in CES-D-10 score during 8 years of follow-up was associated with a 5% lower risk of developing arthritis. Participants with no depressive symptoms at baseline but depression at follow-up had a 66% higher rate of arthritis, and a 1-point increase in CES-D-10 score during 8 years of follow-up was associated with a 5% higher risk of arthritis.

Conclusions Improvement in depressive symptoms was associated with lower risk of arthritis and worsening of depression was associated with higher risk of arthritis. These findings suggest that the relationship between depression and arthritis is complex.

Keywords Depressive symptoms, Arthritis, Longitudinal study, China, Middle-aged and older participants

*Correspondence:
Bo Wu
wuboshiwuboshi@126.com
Yan Liu
yliu17@cmu.edu.cn
[1]Department of Biomedical Engineering, School of Intelligent Medicine, China Medical University, Shenyang, Liaoning 110122, People's Republic of China
[2]Department of Rheumatology and Immunology, The First Affiliated Hospital, China Medical University, Shenyang, Liaoning, People's Republic of China
[3]Department of Anal and Rectal Diseases, The First Affiliated Hospital, China Medical University, Shenyang, Liaoning 110001, People's Republic of China
[4]Human Resources Office, China Medical University, Shenyang, Liaoning, People's Republic of China
[5]Accounting Department, Dongbei University of Finance and Economics, Dalian, Liaoning, People's Republic of China

Introduction

Arthritis is an acute or chronic disease that affects one or more joints, and is a common cause of chronic pain and disability worldwide [1]. Middle-aged and older people are particularly affected by arthritis [2]. Research shows that approximately 154.4 million (31.4%) middle-aged and older people in China have arthritis [3], and approximately 55% of people living with arthritis worldwide are older than 55 years [4]. Patients with arthritis report limited activity, frequent fatigue, and substantial dysfunction [5, 6]. Because of rapid population aging in many countries, arthritis has become a major global health challenge and an increasing health burden for middle-aged and older people [7].

According to the 2022 World Mental Health Report by the World Health Organization, approximately one in eight people worldwide have mental disorders [8], and more than three-quarters of people with mental disorders live in low- or middle-income countries (LMICs) [9]. Mental disorders impair individual and family well-being and have increasingly become an important health problem in LMICs. Depression is one of the most common mental disorders. It affects approximately 7% of the global older population and accounts for a substantial proportion of the global burden of disease [10]. China is still classed as an LMIC, and depression is a major problem, especially for middle-aged and older people. In a nationwide survey in China, approximately 30-43% of people aged 45 years or older reported depressive symptoms [11]. There is epidemiological evidence that depressive symptoms in middle-aged and older people are associated with poor quality of life and adverse health outcomes, such as joint diseases, arthritis, and arthritis-related complications [12–14].

Most of previous studies on the association between depressive symptoms and arthritis have shown that arthritis patients are at higher risk for depression [15–18]. Some relatively recent studies have demonstrated that depressive symptoms are a major risk factor for arthritis [19–28]. MC Lu's founding is the first evidence-based cohort study applying a Taiwan nationwide claims-based data to address the bidirectional relationships between rheumatoid arthritis (RA) and depression [20]. Then Ng C.Y.H., et al. reviewed the bidirectional association between RA and depression [19]. The latest researches showed that a bidirectional causal relationship of depressive symptoms with osteoarthritis (OA) and found that depression increases the risk of knee osteoarthritis (KOA) [27, 28]. However, a community survey involving 7,076 subjects found no relationship between the occurrence of depression and the predisposition of arthritis [29], and one Korean study showed that depression did not increase the risk of arthritis in adults [30]. Thus, previous study findings on the association between depressive symptoms and arthritis are controversial. Race, study location, and study size are factors that may have contributed to these inconsistent conclusions. Therefore, further research is needed to elucidate the association between depressive symptoms and arthritis.

Additionally, previous studies have showed depressive symptoms might impact the incidence of arthritis, rather than considering the effect of changes (i.e., aggravation or improvement) in depressive symptoms over time on the development of arthritis. Depressive symptoms are affected by many factors and vary with time [31–35]. Exploring the changing of depressive symptoms (from depressed status to non-depressed status or from non-depressed status to depressed status) can expand our understanding of the long-term effects of depressive symptoms on arthritis. Hence, in this study, we aimed to clarify the longitudinal association between changes in depressive symptoms and incidence of arthritis in middle-aged and older participants of the China Health and Retirement Longitudinal Study (CHARLS). We hypothesized that worsening of depressive symptoms would be associated with higher risk of arthritis, and that improvement of depressive symptoms would be related to lower risk of arthritis. These findings could help to increase the understanding of depressive symptoms and inform strategies to support people in managing their mental health problems.

Methods

Study population

The CHARLS is a nationwide prospective follow-up study of middle-aged and older participants from 450 villages or residential communities in 150 counties (districts) in 28 provinces across China. From May 2011 to March 2012, the CHARLS baseline survey was performed and more detailed information about CHARLS can be found in previously study [36]. About every two years on average, a follow-up survey was conducted. Four waves of data from CHARLS were collected: (1) wave 1(2011), (2) wave 2 (2013), (3) wave 3 (2015) and (4) wave 4 (2018).

The current study was based on the CHARLS that was analyzed from 2011 to 2018. 17,708 participants were surveyed in the wave 1 (baseline), and we excluded participants who lacked data on depressive symptoms at wave 1 (n=1670). We further excluded participants who had arthritis and had missing data on arthritis at wave 1 (n=5431). Finally, participants who lost to follow-up in the next wave 2 to wave 4 were also excluded (n=2051). A total of 8556 participants were included in the cohort analysis (Fig. 1).

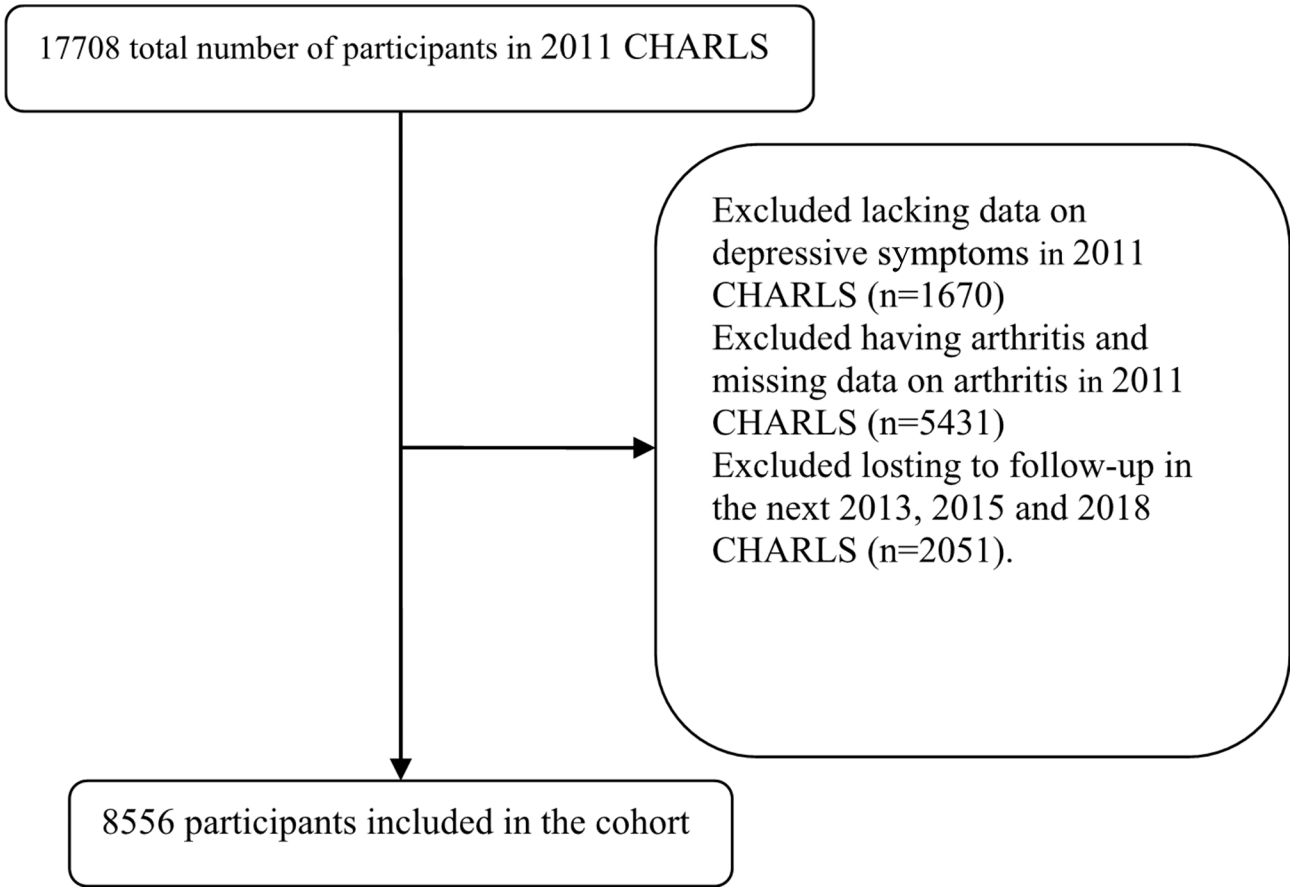

Fig. 1 Flowchart of the inclusion of participants

Depressive symptoms

The 10-item Center for Epidemiological Studies Depression Scale (CES-D-10) was used to assess depressive symptoms experienced by the informants in the previous week. The CES-D-10 scale consists of 10 questions with respect to emotions or behaviors in a week, which comprised two parts: eight negative items and two positive items. Having negative emotions or behaviors in less than one day, one to two days, three to four or five to seven days is rated as 0, 1, 2 or 3, respectively. The two positive emotions or behaviors were scored using this scale in reverse. The 10 items' scores were added to get the total score (range, 0–30); the higher the number, the more severe the depressive symptoms. The reliability and validity of CES-D-10 scale have been well verified by previous study [37]. We defined a binary depression variable with a cut-off value of 10 points or more [38].

Arthritis

Self-reports based on baseline and follow-up surveys determine the presence or absence of arthritis. When asked "Have you been diagnosed with arthritis?" [3], if the respondent's answer was "yes",they were according as arthritis.

Covariates

On the basis of other studies, we choose the covariates [20, 24, 25], including age, sex, residence (rural/urban), education (no school/1–6 years/7 years or more), marital (yes/no), smoking (yes/no), drinking (yes/no), socioeconomic status (low/fair/good), sleeping time, body mass index (BMI), hypertension (yes/no), diabetes (yes/no), dyslipidemia (yes/no), and cardiovascular disease (yes/no) at baseline.

In this study, participants' educational attainment was achieved by asking "What is the highest level of education?". Answers without formal education (illiteracy) were categorized as having no school; did not complete primary school but could read and write, four books/home school, or graduated from primary school with 1–6 years of education; Graduate from other levels with 7 years school or more. Respondents who smoked more than 100 cigarettes including present and in the past, were defined as smokers. Participants with no drinking were estimated by no consumed any alcohol in the past year. Socioeconomic status was got through the question "How would you rate your standard of living? Is it very high, relatively high, average, relatively poor or poor?" The answers were categorized into three types: poor (relatively poor and

poor), average, and well (relatively high and very high). Sleeping time was defined as the average time spent actually sleeping each night within the past month. Hypertension was defined as (1) self-reported physician-diagnosed history of hypertension or (2) measured SBP ≥ 140 mm HG and/or DBP ≥ 90 mm Hg. Diabetes includes impaired glucose tolerance or increased fasting blood glucose levels. Dyslipidemia may include elevated Low-density lipoprotein, triglyceride and total cholesterol, or low high-density lipoprotein levels. Cardiovascular diseases include heart disease, coronary artery disease or other heart attacks and strokes.

Statistical analysis

The distributions of the characteristics of study participants were described based on the depressive symptoms at baseline. Results are presented as means and standard deviations (SDs) for continuous variables and numbers and percentages for categorical variables. We used Cox proportional hazards models to assess hazard ratios (HRs) and 95% CIs for associations between depressive symptoms and arthritis. The condition of the proportional hazard assumption was checked in the Cox proportional hazards models with Schoenfeld residuals and we did not find any violation.

Follow-up ended at the time of death or at the wave 4 concluded, whichever came first. Occurrence of arthritis or the wave 4 concluded was considered the endpoint event. We employed a multiple imputation (MI) approach to account for missing covariates. We employed three Cox models, in which model 1 was unadjusted; model 2 was adjusted for age, sex and BMI; and model 3 was adjusted for 14 possible related factors (the female was assigned a value of 1, and the male was assigned a value of 0; education level of no school was assigned a value of 1 (the reference group), 1–6 years was assigned a value of 2, and 7 years or more was assigned a value of 3; married was assigned a value of 1, and other marital statue was assigned a value of 0; rural was assigned a value of 1, and urban was assigned a value of 0; current smoker was assigned a value of 1, and current non-smokers was assigned a value of 0;current drinker was assigned a value of 1, and current non-drinker was assigned a value of 0;socioeconomic status of low was assigned a value of 1 (the reference group), fair was assigned a value of 2, and good was assigned a value of 3; hypertension was assigned a value of 1, and without hypertension was assigned a value of 0; diabetes was assigned a value of 1, and without diabetes was assigned a value of 0; dyslipidemia was assigned a value of 1, and without dyslipidemia was assigned a value of 0; cardiovascular disease was assigned a value of 1, and without cardiovascular disease was assigned a value of 0;age, BMI and sleeping time were evaluated as numerical variables). This present study also explored the associations between improving or worsening of depressive symptoms and arthritis with additional adjusted for baseline CES-D-10 score based on model 3. We also analyzed the association of depressive symptoms changing with arthritis during follow-up and the association of CES-D-10 score changing per 1 with arthritis. Depressive symptoms improving is defined as depression at baseline and no depression during the follow-up period. Similarly, depressive symptoms worsening is defined as no depression at baseline and depression during the follow-up period. The changing of depressive symptoms is presented as the difference in the CES-D-10 score between baseline and follow-up. Stratified analyses were also performed between depressive symptoms and arthritis according to participant characteristics (sex, age, residence, smoking status, drinking status and BMI) to evaluate potential effect modification. We performed three sets of sensitive analyses. First, we only included complete cases with no missing variables. Second, considering the development of arthritis is generally a chronic progress, we excluded participants who developed arthritis in the first two years of follow-up. Third, we excluded participants who experienced multiple changes in depressive status to avoid possible self-reported inaccuracy. All models were analyzed using R software (version 3.5.2).

Results

Study population

8556 participants included in the present study during 55861.64 person-years of follow-up and the mean follow-up time was 6.53 years (range 1.33–7.26). 5974 participants has no depression and 2582 has depression at baseline (Table 1). The mean age was 58.1 ± 9.7 years old in participants with no depression and 59.4 ± 10.1 years old in participants suffered from depression. Compared to participants without depression at baseline, participants having depressed symptoms were more likely to be women (59.2% and 46.6%, respectively) and living in rural (84.3% and 75.4%, respectively), tended to be unmarried (84.6% and 90.8%, respectively), had a lower percentage of current smokers (35.9% and 41.7%, respectively) and current drinkers (27.3% and 36.3%, respectively), had a decreased years of education (25.1% received 7 years or more and 40.1% received 7 years or more, respectively) and a higher percentage of low socioeconomic status (55.4% and 35.9%, respectively). Compared with participants included in the analysis, those excluded were more likely to be old, women, living in urban, reported no school and had a higher proportion with CVD (Table 2).

Association of depressive symptoms with arthritis

In the 2018 wave survey during 5163.86 person-years of follow-up, 1129 individuals (13.2%) developed arthritis,

Table 1 Study population according to depressive symptoms at baseline

Characteristic	No depression *N* (%) or mean (SD)	Depression *N* (%) or mean (SD)
Total participants	5974 (69.8)	2582 (30.2)
Age (years, mean (SD))	58.1 (9.7)	59.4 (10.1)
Women	2784 (46.6)	1528 (59.2)
Rural	4503 (75.4)	2176 (84.3)
Education		
No school	1341 (22.5)	858 (33.2)
1–6 years	2232 (37.4)	1075 (41.6)
7 years or more	2396 (40.1)	649 (25.1)
Married	5425 (90.8)	2184 (84.6)
Current smoker	2492 (41.7)	928 (35.9)
Current drinker	2169 (36.3)	704 (27.3)
Socioeconomic status		
Low	2143 (35.9)	1430 (55.4)
Fair	3526 (59.0)	1073 (41.6)
Good	269 (4.5)	70 (2.7)
Body mass index (kg/m^2, mean (SD))	23.6 (3.6)	23.0 (3.6)
Sleep time (hours, mean (SD))	7.5 (2.3)	7.0 (2.0)
Hypertension	2173 (36.4)	1006 (39.0)
Diabetes	287 (4.8)	168 (6.5)
Dyslipidemia	491 (8.3)	249 (9.8)
CVD	519 (8.7)	389 (15.1)

Table 2 Baseline characteristics of participants included and excluded from analysis

Characteristic	Included in the analyses *N* (%) or mean (SD)	Excluded from the analyses *N* (%) or mean (SD)
Total participants	8556 (48.3)	9152 (51.7)
Age (years, mean (SD))	58.5 (9.9)	59.6 (10.3)
Women	4312 (50.4)	4917 (53.7)
Rural	6679 (78.1)	6765 (73.9)
Education		
No school	2199 (25.7)	2604 (28.6)
1–6 years	3307 (38.7)	3645 (40.0)
7 years or more	3045 (35.6)	2853 (31.3)
Married	7609 (88.9)	7808 (85.6)
Current smoker	3420 (40.0)	3511 (39.0)
Current drinker	2873 (33.6)	2894 (32.2)
Socioeconomic status		
Low	3573 (41.8)	3512 (38.4)
Fair	4599 (53.8)	3871 (42.3)
Good	339 (4.0)	1530 (16.7)
Body mass index (kg/m^2, mean (SD))	23.5 (3.6)	23.5 (3.7)
Sleep time (hours, mean (SD))	7.3 (2.2)	7.1 (1.8)
Hypertension	3179 (37.2)	3444 (38.2)
Diabetes	455 (5.4)	538 (6.0)
Dyslipidemia	740 (8.8)	855 (9.7)
CVD	908 (10.6)	1500 (16.7)

including 706 and 423 cases in participants without depressed symptoms and having depressed symptoms at the first wave (2011), respectively. We conducted Cox proportional hazards models to assess the association between depressive symptoms and arthritis (Table 3). The HR estimates were similar with and without controlling age, sex, and BMI. Additional adjustment for potential confounders modestly attenuated the association and remained significant (HR, 1.54; 95% CI, 1.35 to 1.75). When we considered the association of depression score

Table 3 Association of depressive symptoms with arthritis

	N / *N* events	Model 1[a] HR(95% CI)	Model 2[b] HR(95% CI)	Model 3[c] HR (95% CI)
No depression	5974/706	Ref	Ref	Ref
Depression	2582/423	1.63 (1.44–1.84)	1.61 (1.42–1.82)	1.54 (1.35–1.75)
CES-D-10 score increase per 1	8556/1129	1.04 (1.03–1.05)	1.04 (1.03–1.05)	1.04 (1.03–1.05)

[a] Unadjusted model

[b] Adjusted for age, sex, and BMI

[c] Adjusted for age, sex, BMI, education, marital status, residence, smoking status, drinking status, socioeconomic status, sleeping time, hypertension, diabetes, dyslipidemia, and cardiovascular disease

Table 4 Association between improvement of depressive symptoms and arthritis

	N / *N* events	Model 1[a] HR(95% CI)	Model 2[b] HR(95% CI)	Model 3[c] HR (95% CI)
Depression at baseline and follow-up	1843/286	Ref	Ref	Ref
Depression at baseline and no depression at follow-up	739/137	0.71 (0.58–0.87)	0.73 (0.59–0.90)	0.75 (0.60–0.94)
CES-D-10 score decrease per 1	2582/423	0.97 (0.95–0.99)	0.97 (0.95–0.99)	0.95 (0.93–0.98)

[a] Unadjusted model

[b] Adjusted for age, sex, and BMI

[c] Adjusted for age, sex, BMI, education, marital status, residence, smoking, drinking, socioeconomic status, sleeping time, hypertension, diabetes, dyslipidemia, cardiovascular disease and baseline CES-D-10 score

Table 5 Association between worsening of depressive symptoms and arthritis

	N / *N* events	Model 1[a] HR(95% CI)	Model 2[b] HR(95% CI)	Model 3[c] HR (95% CI)
No depression at baseline and follow-up	3751/357	Ref	Ref	Ref
No depression at baseline and depression at follow	2223/349	1.79 (1.54–2.07)	1.77 (1.52–2.06)	1.66 (1.42–1.95)
CES-D-10 score increase per 1	5974/706	1.05 (1.03–1.06)	1.05 (1.03–1.06)	1.05 (1.03–1.06)

[a] Unadjusted model

[b] Adjusted for age, sex, and BMI

[c] Adjusted for age, sex, BMI, education, marital status, residence, smoking, drinking, socioeconomic status, sleeping time, hypertension, diabetes, dyslipidemia, cardiovascular disease and baseline CES-D-10 score

with arthritis, we found that a 1 increase in CES-D-10 score was associated with a 4% increased risk of development of arthritis after 8 years in unadjusted models and adjusting for different potential confounders did not alter the HR value (HR, 1.04; 95% CI, 1.03 to 1.05) (Table 3).

Association of changes in depressive symptoms with arthritis

Among 2582 participants with depressive symptoms in the 2011 wave survey during 16485.97 person-years of follow-up, 739 participants experiencing depressive symptomatic improvement and 18.1% (134/739) of them developed arthritis after 8 years. Compared with participants who consistently had depressive symptoms at baseline and over the 8 years of follow-up, participants with depressive symptomatic improvement was associated with lower risk of arthritis (HR, 0.75; 95% CI, 0.60 to 0.94) and a 1 decrease in CES-D-10 score during 8 years follow-up was associated with a 5% lower risk of development of arthritis (HR, 0.95; 95% CI, 0.93 to 0.98) (Table 4).

Among 5974 participants without depressive symptoms in the 2011 wave survey during 39375.67 person-years of follow-up, worsening depressive symptoms occurred in 2223 participants and 15.6% (346/2223) of them developed arthritis after 8 years. Participants new-onset depressive symptoms during 8 years follow-up were more likely to have a higher risk of arthritis than those without depressive symptoms at baseline and 8 years follow-up (HR, 1.66; 95% CI, 1.42 to 1.95) and a 1 increase in CES-D-10 score during 8 years follow-up was associated with a 5% higher risk of arthritis (HR, 1.05; 95% CI, 1.03 to 1.06) (Table 5).

Stratified and sensitive analyses for depressive symptoms and arthritis

A stratified analysis of depressive symptoms and arthritis is presented in Table 6. Each stratified analysis was conducted without including the stratification variable itself, except age and BMI as continuous variables. Analysis stratified by sex, age, residence, smoking status, drinking status and BMI further confirmed that depression was independent risk factor for arthritis in both men and women and different characteristics population. There was no significant interactions were observed. Three sets of sensitive analyses were presented in Table 7. depressive

Table 6 Association of depressive symptoms with arthritis stratified by potential modifiers

	N / *N* events	Model 3[a] HR (95% CI)	*P* for interaction
Sex			0.32
Men	4244/487	1.40 (1.14–1.72)	
Women	4312/642	1.67 (1.41–1.97)	
Age			0.91
< 60	5031/731	1.56 (1.32–1.83)	
≥ 60	3525/398	1.53 (1.23–1.89)	
Residence			0.50
Rural	6679/913	1.57 (1.37–1.81)	
Urban	1877/216	1.33 (1.06–1.85)	
Smoking status			0.89
Nonsmoker	5134/715	1.54 (1.32–1.81)	
Smoker	3420/414	1.55 (1.25–1.92)	
Drinking status			0.20
Nondrinker	5683/779	1.50 (1.28–1.74)	
Drinker	2873/350	1.68 (1.33–2.13)	
BMI (kg/m^2)[b]			0.42
Less than or equal to median	4277/542	1.45 (1.20–1.74)	
Above median	4279/587	1.64 (1.37–1.96)	

[a] Adjusted for age, sex (if appropriate), BMI, education, marital status, residence, smoking (if appropriate), drinking (if appropriate), socioeconomic status, sleeping time, hypertension, diabetes, dyslipidemia, and cardiovascular disease

[b]The median of BMI is 23.19

symptoms and depressive symptoms improvement and depressive symptoms worsening remained associated with arthritis on all sensitive analyses.

Discussion

This study investigated the association between changes in depressive symptoms and arthritis in a national prospective cohort of middle-aged and older Chinese adults. The findings showed that depressive symptoms increased the risk of the incidence of arthritis. Arthritis incidence was 54% higher in people with depressive symptoms than in those without. We also found that improvement in depressive symptoms was associated with lower risk of arthritis and that worsening of depressive symptoms was related to higher risk of arthritis. Participants with depressive symptoms at baseline but improved symptoms at follow-up had a 25% lower rate of arthritis than those with no improvement. Participants with no depressive symptoms at baseline but depressive symptoms at follow-up had a 66% higher rate of arthritis than those with no depression.

Given the rising prevalence of arthritis in the aging population and the significant impact of depression on overall functioning, it is imperative to recognize the potential interconnection between depressive symptoms and arthritis in adults. This understanding is crucial for informed decision-making in health care budget allocation to ensure the availability and accessibility of

Table 7 Results of sensitivity analyses

	Complete cases		Excluding arthritis in the first two year of follow-up		Excluding multiple changes in depressive status	
	N / *N* events	HR (95% CI)	*N* / *N* events	HR (95% CI)	*N* / *N* events	HR (95% CI)
The association of depressive symptoms with arthritis						
No depression	4380/662	Ref	5798/530	Ref	5472/577	Ref
Depression	1700/406	1.49 (1.32–1.69)	2460/301	1.35 (1.18–1.61)	2363/386	1.48 (1.27–1.72)
The association of depressive symptoms improvement with arthritis						
Depression at baseline and follow-up	1272/277	Ref	1776/205	Ref	1843/286	Ref
Depression at baseline and no depression at follow-up	428/129	0.76 (0.60–0.94)	684/96	0.73 (0.55–0.98)	520/100	0.71 (0.56–0.91)
The association of depressive symptoms worsening with arthritis						
No depression at baseline and follow-up	2779/332	Ref	3623/269	Ref	3751/357	Ref
No depression at baseline and depression at follow	1601/330	1.63 (1.39–1.92)	2175/261	1.62 (1.33–1.98)	1721/220	1.65 (1.37–1.86)

[a] Adjusted for age, sex, BMI, education, marital status, residence, smoking status, drinking status, socioeconomic status, sleeping time, hypertension, diabetes, dyslipidemia, and cardiovascular disease

[b] Adjusted for age, sex, BMI, education, marital status, residence, smoking, drinking, socioeconomic status, sleeping time, hypertension, diabetes, dyslipidemia, cardiovascular disease and baseline CES-D-10 score

appropriate services. This article underscores the necessity that (1) caretakers should be aware that depressive symptoms are a risk feature of arthritis, (2) valid screening tools for depressive symptoms should to be made available and (3) guidelines should be developed to inform caretakers how to improve and treat patients with depressive symptoms.

We demonstrated that development of depressive symptoms was associated with higher risk of arthritis and improvement of depressive symptoms was associated with lower risk of arthritis. In addition to showing that participants with new depressive symptoms had a higher incidence of arthritis than those who had never had depression, we found that participants with worsening depressive symptoms had a higher incidence of arthritis than those without exacerbating. In contrast, the participants who had depressive symptoms at baseline but who experienced improvement at follow-up had a clear lower risk of arthritis. Furthermore, we also found that just a 1-point reduction or increase in scores on the CES-D-10 during 8 years of follow-up was associated with a 5% reduced or elevated risk of developing arthritis. There are few studies on the association between changes in depressive symptoms and arthritis. However, a study by Vallerand et al. showed that patients who took antidepressants had a lower risk of arthritis compared with those who did not take antidepressants for major depressive disorder [21], a finding that is consistent with the present findings to some extent.

Our findings extend current understanding of the connection between depressive symptoms and arthritis in middle-aged and older adults. They also indicate the need for greater awareness of the complex relationship between depression and arthritis, and the need for more robust treatment measures at all stages of the development of depression.

Most previous analyses of the relationship between arthritis and depression have shown results similar to the present findings; that is, the presence of depressive symptoms may increase the risk of arthritis. Studies from Taiwan [20], the UK [21, 22], the USA [23–25], China [28, 39, 40], and other countries [26, 27] have demonstrated a strong positive association between arthritis and depressive symptoms. Conversely, studies found that depression did not increase the risk of arthritis in adults in Netherlands [29] and Korea [30]. The inconsistencies between study findings may reflect characteristics of the study participants. Hedda et al. studied Netherlands participants between 18 and 65 years of age for 3 years [29], so younger people (<45 years) might lead to inconsistencies of our study. Kim et al. included Korean individuals who were diagnosed with depression and had been treated two or more times [30], so the participants can be considered as people with improved depressive symptoms. However, the present study sample included participants who had depressive symptoms whether be treated or not.

There are several explanations for why depressive symptoms may increase the risk of arthritis. First, depressive symptoms may increase the likelihood of unhealthy lifestyles and behaviors, like smoking and obesity, which may in turn increase the risk of arthritis [12] and cardiovascular disease [41]. Second, depressive disorders may be associated with increased peripheral blood cell deformability [42], which indicates that depressive symptoms can lead to physical deterioration. An increase in interleukin-6, which is an important inflammatory mediator in mood disorders, is associated with the development of rheumatoid arthritis, which may explain the link between arthritis and depression [43]. Third, long-term or ongoing worsening of depressive symptoms may lead to persistent joint pain that develops into arthritis. There is a strong longitudinal association between depressive mood and pain, morning stiffness, and joint pain counts [44]. Possible biological mechanisms underlying this association are the immune system, the hypothalamic–pituitary–adrenal axis, and metabolic dysregulation, which may be caused by a common genetic vulnerability that leads to arthritis. In addition to pertinent biological mechanisms, heightened medical awareness may enable a majority of patients to actively seek treatment, thereby identifying more cases of arthritis. Individuals experiencing improvements in depressive symptoms tend to be more health-conscious and, consequently, may pay greater attention to physical health issues, facilitating the earlier detection of arthritis.

This study had several major strengths, including the prospective design, the use of a large sample from mainland China, and the long-term follow-up. However, some limitations should be acknowledged. First, the identification of depressive symptoms using the CES-D-10 may be less accurate than a clinical diagnosis. However, the CES-D-10 has shown good reliability and fair validity in Chinese adults and is a practical option for use in large-scale cohort studies. Second, arthritis status was measured using self-reported, and so may have been subject to recall bias. However, Arokiasamy et al. reported that the prevalence of self-reported arthritis in a World Health Organization global study on aging and adult health [45] was comparable to that of Chinese participants of similar ages (26.05% vs. 20.00%), which suggests that the assessment of arthritis status in the present study may be reliable. In addition, this investigation did not include any survey about differentiate between various types of arthritis (i.e., osteoarthritis or rheumatoid arthritis). Therefore, the association we observe between depressive symptoms and arthritis should be considered with cautions, due to the impact of depressive symptoms may vary across detailed types of arthritis. Finally,

some potential confounders, such as dietary patterns and antidepressant medications, were not adjusted for in the analysis models owing to data unavailability, which may have contributed to residual confounding.

In conclusion, in this study, we demonstrated that individuals with depressive symptoms have increased risk of developing arthritis. Compared with participants who consistently had depressive symptoms at baseline and follow-up, participants with depressive symptomatic improvement (having depressive symptoms at baseline but without depressive symptomatic at follow-up) was associated with a reduced risk of arthritis. Compared with participants who consistently without depressive symptoms at baseline and follow-up, participants with depressive symptomatic worsen (without depressive symptoms at baseline but having depressive symptomatic at follow-up) was associated with a higher risk of arthritis. The improvement of depressive symptoms during 8 years of follow-up was associated with a reduced risk of arthritis, and the worsening of depressive symptoms was associated with a higher risk of arthritis. More prospective longitudinal studies are needed to confirm the complex association between depressive symptoms and arthritis suggested by our findings.

Author contributions

Y Liu and B Wu conceptualized and designed the study, R Liu performed the data analysis. R Liu and Y Liu wrote the main manuscript text. Y Xin and Y Shao contributed to the data interpretation and revision of the manuscript.

Funding

None.

Data availability

The datasets generated and analyzed during the current study are available in the CHARLS website, available in http://charls.pku.edu.cn/en.

Declarations

Ethics approval and consent to participate

The study is publicly available (https://charls.pku.edu.cn/en/) with no direct contact with the individual participants.

Competing interests

The authors declare no competing interests.

Received: 20 April 2024 / Accepted: 21 October 2024
Published online: 05 November 2024

References

1. Verbrugge LM, Juarez L. Arthritis disability and heart disease disability. Arthritis Rheum. 2008;59(10):1445–57.
2. Furner SE, et al. Health-related quality of life of US adults with arthritis: analysis of data from the behavioral risk factor surveillance system, 2003, 2005, and 2007. Arthritis Care Res (Hoboken). 2011;63(6):788–99.
3. Li C, et al. Prevalence and risk factors of arthritis in a middle-aged and older Chinese population: the China health and retirement longitudinal study. Rheumatology (Oxford). 2015;54(4):697–706.
4. Diseases GBD, Injuries C. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of Disease Study 2019. Lancet. 2020;396(10258):1204–22.
5. Theis KA, et al. Social participation restriction among US adults with arthritis: a population-based study using the International classification of Functioning, disability and health. Arthritis Care Res (Hoboken). 2013;65(7):1059–69.
6. Gong GL, Mao J. Health-related quality of life among Chinese patients with rheumatoid arthritis. Nurs Res. 2016;65(1):55–67.
7. Murphy LB, et al. Medical expenditures and earnings losses among US adults with arthritis in 2013. Arthritis Care Res (Hoboken). 2018;70(6):869–76.
8. Freeman M. The World Mental Health Report: transforming mental health for all. World Psychiatry. 2022;21(3):391–2.
9. Iemmi V. Philanthropy for global mental health 2000–2015. Glob Ment Health (Camb). 2020;7:e9.
10. *Mental Health of Older Adults*. http://www.who.int/mediacentre/factsheets/fs381/en/
11. Lei X, et al. Depressive symptoms and SES among the mid-aged and elderly in China: evidence from the China Health and Retirement Longitudinal Study national baseline. Soc Sci Med. 2014;120:224–32.
12. Vallerand IA, Patten SB, Barnabe C. Depression and the risk of rheumatoid arthritis. Curr Opin Rheumatol. 2019;31(3):279–84.
13. Fakra E, Marotte H. Rheumatoid arthritis and depression. Joint Bone Spine. 2021;88(5):105200.
14. Blazer DG. Depression in late life: review and commentary. J Gerontol Biol Sci Med Sci. 2003;58(3):249–65.
15. Marrie RA, et al. Increased Burden of Psychiatric disorders in Rheumatoid Arthritis. Arthritis Care Res (Hoboken). 2018;70(7):970–8.
16. Marrie RA, et al. Physical comorbidities increase the risk of psychiatric comorbidity in immune-mediated inflammatory disease. Gen Hosp Psychiatry. 2018;51:71–8.
17. Xue Q, et al. Association between arthritis and depression risk: a prospective study and meta-analysis. J Affect Disord. 2020;273:493–9.
18. Jones Amaowei EE, et al. Correlation of depression and anxiety with rheumatoid arthritis. Cureus. 2022;14(3):e23137.
19. Ng CYH, et al. Elucidating a bidirectional association between rheumatoid arthritis and depression: a systematic review and meta-analysis. J Affect Disord. 2022;311:407–15.
20. Lu MC, et al. Bidirectional associations between rheumatoid arthritis and depression: a nationwide longitudinal study. Sci Rep. 2016;6:20647.
21. Vallerand IA, et al. Depression as a risk factor for the development of rheumatoid arthritis: a population-based cohort study. RMD Open. 2018;4(2):e000670.
22. Brooks JM, et al. Prevalence rates of arthritis among US older adults with varying degrees of depression: findings from the 2011 to 2014 National Health and Nutrition Examination Survey. Int J Geriatr Psychiatry. 2018;33(12):1671–9.
23. Lewinson RT, et al. Depression is Associated with an increased risk of psoriatic arthritis among patients with psoriasis: a Population-based study. J Invest Dermatol. 2017;137(4):828–35.
24. Sparks JA, et al. Depression and subsequent risk for Incident Rheumatoid Arthritis among women. Arthritis Care Res (Hoboken). 2021;73(1):78–89.
25. Vennu V, Misra H, Misra A. Depressive symptoms and the risk of arthritis: a survival analysis using data from the osteoarthritis initiative. Indian J Psychiatry. 2019;61(5):444–50.
26. Apfelbacher C, et al. Depression and inflammatory arthritis are associated in both western and non-western countries: findings from the World Health Survey 2002. J Psychosom Res. 2017;92:49–54.
27. Wu MY et al. Depression and risk of arthritis: a mendelian randomization study.pdf. Brain Behav, 2024. 14(6).
28. Lu H, et al. Bidirectional association between knee osteoarthritis and depressive symptoms: evidence from a nationwide population-based cohort. BMC Musculoskelet Disord. 2022;23(1):213.
29. Land Hvt, et al. The association between arthritis and psychiatric disorders; results from a longitudinal population-based study. J Psychosom Res. 2010;68(2):187–93.
30. Kim SY, et al. Association between depression and rheumatoid arthritis: two longitudinal follow-up studies using a national sample cohort. Rheumatology (Oxford). 2020;59(8):1889–97.
31. Jordan DG, et al. Negative affect interference and fear of happiness are independently associated with depressive symptoms. J Clin Psychol. 2021;77(3):646–60.
32. Verhallen AM, et al. Romantic relationship breakup: an experimental model to study effects of stress on depression (-like) symptoms. PLoS ONE. 2019;14(5):e0217320.

33. Smagula SF, Capps CS, Krafty RT. Evaluating the timing of differences in activity related to depression symptoms across adulthood in the United States. J Affect Disord. 2021;284:64–8.
34. Zhu JY, et al. Dynamics of daily positive and negative affect and relations to anxiety and depression symptoms in a transdiagnostic clinical sample. Depress Anxiety. 2022;39(12):932–43.
35. Nielson SA, Kay DB, Dzierzewski JM. Sleep and depression in older adults: a narrative review. Curr Psychiatry Rep. 2023;25(11):643–58.
36. Deng Y, et al. Indoor solid fuel use and incident arthritis among middle-aged and older adults in rural China: a nationwide population-based cohort study. Sci Total Environ. 2021;772:145395.
37. Chen H, Mui AC. Factorial validity of the Center for Epidemiologic Studies Depression Scale short form in older population in China. Int Psychogeriatr. 2014;26(1):49–57.
38. Boey KW. Cross-validation of a short form of the CES-D in Chinese elderly. Int J Geriatr Psychiatry. 1999;14(8):608–17.
39. Wang L, et al. Development of a model for predicting the 4-year risk of symptomatic knee osteoarthritis in China: a longitudinal cohort study. Arthritis Res Ther. 2021;23(1):65.
40. Ke C, et al. Longitudinal research on the bidirectional association between depression and arthritis. Soc Psychiatry Psychiatr Epidemiol. 2021;56(7):1241–7.
41. Harshfield EL, et al. Association between depressive symptoms and Incident Cardiovascular diseases. JAMA. 2020;324(23):2396–405.
42. Walther A, et al. Depressive disorders are associated with increased peripheral blood cell deformability: a cross-sectional case-control study (Mood-Morph). Transl Psychiatry. 2022;12(1):150.
43. Choy EHS, Calabrese LH. Neuroendocrine and neurophysiological effects of interleukin 6 in rheumatoid arthritis. Rheumatology (Oxford). 2018;57(11):1885–95.
44. Holla JFM, et al. Depressive mood and low social support are not associated with arthritis development in patients with seropositive arthralgia, although they predict increased musculoskeletal symptoms. RMD Open. 2018;4(1):e000653.
45. Arokiasamy P, et al. Chronic noncommunicable diseases in 6 low- and Middle-Income countries: findings from Wave 1 of the World Health Organization's study on Global Ageing and Adult Health (SAGE). Am J Epidemiol. 2017;185(6):414–28.

Publisher's note