Journal of Psychosomatic Research 151 (2021) 110662

Contents lists available at ScienceDirect

Journal of Psychosomatic Research

journal homepage: www.elsevier.com/locate/jpsychores

Arthritis status changes and depressive symptoms among middle-aged and older Koreans: Analysis of data from the Korean Longitudinal Study of Aging survey

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ARTICLE INFO

Keywords:
Chronic disease
Depression
Mental disorders
Osteoarthritis
Psychological distress
Rheumatic diseases

ABSTRACT

Objective: Arthritis can negatively affect physical and mental health, especially among middle-aged and older people. This study investigated the longitudinal association between changes in arthritis status and depressive symptoms among Korean adults aged ≥45 years.

Methods: We analyzed data from the Korean Longitudinal Study of Aging 2008–2018, using a generalized estimating equation model to investigate associations between arthritis status change and depressive symptoms, which were assessed using five categories according to measurements based on the Center for Epidemiological Studies Depression Scale (CES-D-10).

Results: Both men and women whose arthritis status changed to "worse" or remained "same" scored higher for depressive symptoms than those who reported "no symptoms of arthritis" (men, worse = β: 1.07, $P \leq .001$, same = β: 0.25 $P = .031$; women, worse = β: 0.99, $P \leq .001$, same = β: 0.13, $P = .049$). Conversely, men with a "better" arthritis status (β: -0.71, $P \leq .001$) and women with a "recovered" arthritis status (β: -0.56, $P = .031$) scored lower for depressive symptoms than those who reported "no symptoms of arthritis."

Conclusions: Arthritis status changes are associated with depressive symptoms in middle-aged and older Koreans. Therefore, mental health evaluation and management interventions are recommended for patients with arthritis and changes in disease status.

1. Introduction

Worldwide, musculoskeletal disorders represent a global threat to healthy aging and are rated the second most common cause of disability as measured by years lived with disability (YLD) [1,2]. Arthritis is a major contributor to the global burden of disability related to diseases of the musculoskeletal system [3]. Arthritis, a chronic, painful, and debilitating disease, is a comprehensive term that includes multiple types of arthritic conditions characterized by inflammation or swelling of one or more joints [3,4]. Unfortunately, the chronic nature of the disease causes various psychosocial problems in addition to functional limitations due to pain, fatigue, swelling, and powerlessness. It results in reduced quality of life and loss of independence, contributing greatly to increased medical expenses [5–7]. In fact, in 2003, direct and indirect expenditure from arthritis in the United States was estimated to be over $128 billion [6]. The prevalence of arthritis in the Korean middle-aged and older adult population is approximately 25%, the second-highest prevalence rate among chronic diseases after hypertension [8]. Notably, the prevalence of arthritis is increasing not only in Korea but worldwide, with it increasing significantly among older people, especially those over the age of 45 years [7,9].

Another disorder that is common globally is depression, a mental disorder that affects more than 300 million people and has a strong negative impact on the quality of life [10]. Depression is a major concomitant disease with arthritis, and there is evidence of their coexistence [4]. As many as 13%–20% of patients with arthritis could have

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https://doi.org/10.1016/j.jpsychores.2021.110662
Received 30 June 2021; Received in revised form 27 October 2021; Accepted 27 October 2021
Available online 30 October 2021

comorbid depressive symptoms [11].

There are more than 100 types of arthritic conditions, and all forms of arthritis can be highly disabling [12]. Studies on the potential association between arthritis and depression conducted in Canada [13], Denmark [14], Germany [15], and the United States [16] showed that depression is common among patients with various types of arthritis, including rheumatoid arthritis, osteoarthritis, systemic lupus erythematosus, and gout [4]. It has been reported that Koreans also have various types of arthritis, such as osteoarthritis, rheumatoid arthritis, and gout [17]. Most studies have focused on populations of people with one form of arthritis (such as rheumatoid arthritis) or were clinic-based, rather than population-based, sample studies [18–21]. Therefore, the question of whether similar effects are present in the larger population of adults with arthritis has to be addressed.

In this study, we stratified men and women. Evidence from previous studies confirms a pathological difference between men and women owing to the involvement of sex hormones in the pathological generation of arthritis. Sex hormones interact with immune regulation, inflammatory mediators, and the cytokine system to directly affect cartilage itself [22]. Furthermore, an extensive review of depression confirmed that gender differences exist due to adverse experiences in childhood, socio-cultural dynamics, vulnerability to life events and coping skills, and hormonal factors [23].

Therefore, this study investigated the longitudinal association between depressive symptoms and changes in the arthritis status of middle-aged Koreans by stratifying the sexes. The disease progression factors were also investigated.

2. Methods

2.1. Study population

This study was conducted using data from the Korean Longitudinal Study of Aging (KLoSA) conducted by The Korean Labor Institute and Korean Employment Institute Information Service. KLoSA is a nationally representative longitudinal study of Koreans over the age of 45 years in households, selected using a multi-stage probability sample technique (based on geographic area) by the Korea Labor Institute. Surveys are conducted every two years using computer-aided personal interview technology and cover topics such as demographics, family and social networks, physical and mental health status, employment and retirement income, and wealth. For this study, we used a sample drawn from the second through the seventh waves of the KLoSA (2008, 2010, 2012, 2014, 2016, and 2018). The first wave of KLoSA (2006) was excluded because it did not include a question about changes in arthritis status.

The first survey conducted in 2006 consisted of 10,254 people in 6171 households. The second wave of the KLoSA (in 2008) included 8688 of the original participants (84.7% of the primary panel), the third (in 2010) included 7920 participants (77.2%), and the fourth (in 2012) included only 7486 of participants from the first wave (73.0%). Accordingly, 920, 872, and 804 people were added to the fifth, sixth, and seventh surveys in 2014, 2016, and 2018, respectively. Therefore, a total of 7949 participants (of which 7209 participated in the original panel) were surveyed in the fifth survey, 7490 participants (6618 of whom were in the original panel) in the sixth survey (2016), and 6940 participants (6136 of whom were of the original panel) in the seventh survey (2018). Detailed information about the survey is available on the panel survey organization website (http://survey.keis.or.kr/eng/klosa/klosa01.jsp).

In this study, participants who did not complete questions about independent variables (e.g., changes in arthritis status or sociodemographic and health-related factors) or dependent variables (Center for Epidemiological Studies Depression Scale; CES-D-10) and those who died were excluded. Consequently, the number of participants were 7938 (men: 3557, women: 4381) in 2008, 7137 (men: 3126, women: 4011) in 2010, 6977 (men: 3041, women: 3936) in 2012, 6506 (men: 2808, women: 3698) in 2014, 6107 (men: 2602, women: 3505) in 2016, and 5568 (men: 2359, women: 3209) in 2018 (Fig. 1).

2.2. Measures

2.2.1. Depressive symptoms

The purpose of this study was to determine whether there was a difference in the CES-D-10 scores, an instrument developed at an established population site for the Boston Elderly Epidemiological Study [24]. The CES-D-10 is a simplified form of the CES—D, a simple screening tool that evaluates the symptoms of depression experienced in the previous week. Its feasibility as a testing tool for older adults has been evaluated and proven [25]. The CES-D-10 has 10 items that can be answered in "Yes" or "No" format, with the total score ranging from 0 to 10. We used the CES-D-10 as a continuous variable in this study because it was developed as a screening test rather than a comprehensive diagnostic test [26]. Discrepancies may arise when using specific cutoffs to differentiate between depressed and nondepressed groups in different populations [27]. All individuals' CES-D-10 scores were estimated based on changes in their arthritis status in the last panel survey.

The KLoSA study was approved by the National Statistical Office (Approval number: 33602) and was conducted after acquiring verbal consent from the participants. As the KLoSA database has been released to the public for scientific use, ethical approval was not required for the study.

2.2.2. Arthritis

The KLoSA survey involves a wide range of questions about the progression of the arthritic condition. This study used two questions to estimate arthritis status. First, participants were asked: "Have you been diagnosed with arthritis or rheumatism by a doctor since the last survey?" Participants who answered "Yes" responded to the second question: "Compared with the previous interview, how are your symptoms of arthritis or rheumatism?" Participants responded with "completely recovered," "improved," "same," "exacerbated," or "severely exacerbated." Participants who answered "No" to the first question and those who did not respond to the second question were assumed to be without arthritis symptoms. Subsequently, we classified arthritic conditions into four categories: recovered (completely recovered), better (improved), the same (identical), and worse (exacerbated and severely exacerbated). Participants without arthritis symptoms were established as the reference group.

2.2.3. Covariates

The study included sociodemographic and health-related covariates. Sociodemographic variables included age group (45–54, 55–64, 65–74, and $\geq$ 75 years old), education level (below elementary school, middle school, high school, and higher than university), residential area (large city, urban, and rural), working status (employed and unemployed), and household income level (low, mid-low, mid-high, and high). Health-related variables were perceived health status (healthy, average, and unhealthy), regular physical activity (yes or no), smoking status (yes or no), alcohol consumption status (current, past, and none), and number of chronic diseases (none, 1, and $\geq$ 2). Activities of daily living (ADL) (independent and dependent) and instrumental activities of daily living (IADL; independent and dependent) were also included as covariates.

2.3. Statistical analysis

We performed stratified analyses by gender based on previous studies that reported significant differences in arthritis status across all analyses (due to differences in physiological levels of sex hormones) [22]. We calculated the general characteristics of the study participants distributed at baseline. *t*-tests and analysis of variance (ANOVA) were used to analyze the average CES-D-10 score according to the general characteristics of the participants by gender. In addition, the Cochran-

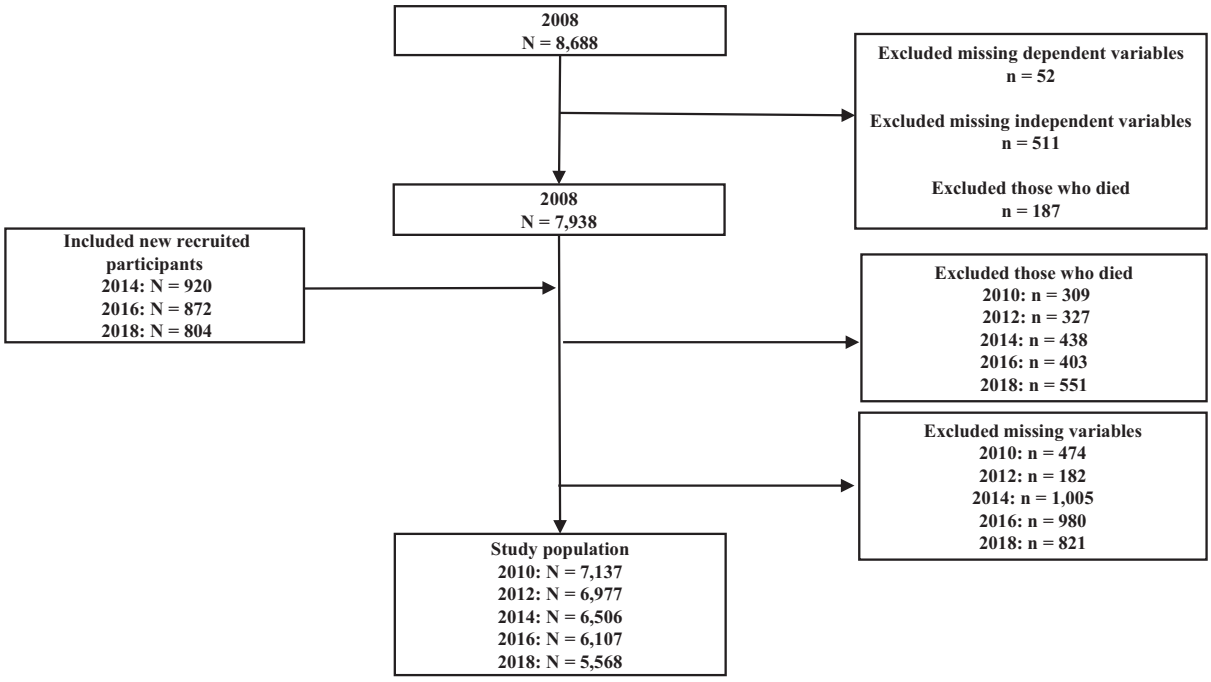

Fig. 1. Flow diagram of participant inclusion and exclusion.

Armitage test was applied to evaluate the proportion of respondents according to changes in their arthritis status during the 6-year follow-up period. Generalized estimating equation (GEE) model, an extension of the quasi-likelihood approach used to analyze longitudinal correlation data, was chosen because it accounts for the time fluctuations and correlations between repeated measurements observed in the longitudinal study design [28]. The GEE model is known to be efficient and to provide unbiased regression estimates for use in analyzing longitudinal or repeated measures research designs with non-normal response variables [29,30]. The correlation structure was modeled as an exchangeable correlation to determine the repeated outcome measurement of delivery [31,32]. The GEE models provide a quasi-likelihood under the independence model criterion (QIC), which was used to assess the model's goodness-of-fit. A lower QIC value indicated a better-fit model [33]. In addition, we investigated the relationship between arthritis status and depressive symptoms by gender, which was stratified by working status, smoking status, and ADL variables, identified as effect modifiers in previous studies [34–36]. All statistical analyses were performed using SAS software version 9.4 (SAS Institute, Cary, NC, USA). $P < .05$ was considered statistically significant.

3. Results

Table 1 shows the general characteristics of the study population at the first time point (2008). The independent variables were expressed as mean values through the dependent variable (CES-D-10 score). For men and women, the mean value of the CES-D-10 score was 3.20 and 4.03, and the standard deviation was 2.81 and 2.97, respectively. The mean value of the total population was 3.45 and the standard deviation was 2.91. Four (0.1%) men had "recovered" from arthritis since the last survey, 27 (0.8%) had a "better" status, 130 (3.7%) had the "same" status, 78 (2.2%) had a "worse" status, and 3318 (93.4%) had "no symptoms." The average CES-D-10 score was the highest in the "worse" group at 6.01 (SD = 2.56) and the lowest in the "recovered" group at 2.25 (SD = 2.06). In the case of women, 7 (0.2%) had "recovered" from arthritis since the last survey, 67 (1.5%) had a "better" status, 430 (9.8%) had the "same" status, 598 (13.6%) had a "worse" status, and 3279 (74.8%) had "no symptoms." The average CES-D-10 score was the highest in the "worse" group at 6.15 (SD = 2.59), and the lowest in the "recovered" group at 3.57 (SD = 2.99; Table 1).

According to descriptive statistics, the temporal pattern for changes in arthritis status was 88–90% in "no symptoms" for men, and 1–9% for "recovered," "better," "same," and "worse." In addition, "no symptoms" among women was 88–93%, and "recovered," "better," "same," and "worse" were 1–10% (Fig. 2). The differences in temporal patterns for both men and women were relatively small and stable.

Table 2 describes the factors associated with CES-D-10 scores. For men, those who reported a "worse" (β: 1.07, $P < .001$) or "same" (β: 0.25, $P = .031$) arthritis status had higher CES-D-10 scores than those with "no symptoms." Conversely, those who reported a "better" (β: -0.71, $P < .001$) arthritis status had lower CES-D-10 scores than those with "no symptoms of arthritis." For women, those who reported "worse" (β: 0.99, $P < .001$) or "same" (β: 0.13, $P = .049$) arthritis status had higher CES-D-10 scores than those with "no symptoms." Conversely, those who reported a "recovered" (β: -0.56, $P = .031$) arthritis status had lower CES-D-10 scores than those with "no symptoms of arthritis." Other arthritis status groups did not report significant results (Table 2).

Table 3 shows the results of the hierarchical subgroup analysis of the relationship between the arthritis status and the CES-D-10 scores, classified by gender, according to work status, smoking status, and ADL. There were significant relationships between arthritis status and CES-D-10 scores among those who reported a "worse" arthritis status in each subgroup. In the case of working status, the CES-D-10 score was the highest in the employed group for both men and women, and a significant score was observed (men, β: 1.13, $P < .001$; women, β: 0.97, $P < .001$). In the case of smoking, the CES-D-10 score was the highest among current smokers, and a significant score was observed (men, β: 1.61, $P < .001$; women, β: 1.49, $P < .001$). Finally, in the case of ADL, the CES-D-10 score was the highest in the *needs help/difficulty* with ADL group, and a significant score was observed (men, β: 1.25, $P < .001$; women, β: 1.03, $P < .001$; Table 3).

4. Discussion

In this study, we examined the longitudinal association between change in arthritis status and depressive symptoms in Koreans aged 45

Table 1
General characteristics of the study participants and average CES-D-10 scores at baseline (2008).

Variables	CES-D-10							
	Men				Women			
	N	%	Mean ± S·D	*P*-value	N	%	Mean ± S·D	*P*-value
Total	3557	100.0	3.20 ± 2.81		4381	100.0	4.03 ± 2.97	
Arthritis status				<0.001				<0.001
No symptoms of Arthritis status	3318	93.3	3.13 ± 2.79		3279	74.8	3.66 ± 2.89	
Recovered	4	0.1	2.25 ± 2.06		7	0.2	3.57 ± 2.99	
Better	27	0.8	3.52 ± 2.49		67	1.5	4.76 ± 2.93	
Same	130	3.7	4.11 ± 2.86		430	9.8	4.58 ± 2.96	
Worse	78	2.2	6.01 ± 2.56		598	13.6	6.15 ± 2.59	
Age				<0.001				<0.001
45–54	943	26.5	2.59 ± 2.51		1213	27.7	2.94 ± 2.59	
55–64	1068	30.0	2.82 ± 2.65		1139	26.0	3.51 ± 2.84	
65–74	1039	29.2	3.56 ± 2.91		1198	27.3	4.73 ± 2.94	
≥75	507	14.3	4.58 ± 2.98		831	19.0	5.40 ± 2.93	
Educational Level				<0.001				<0.001
Elementary school or less	1123	31.6	4.06 ± 2.97		2521	57.5	4.74 ± 2.99	
Middle school	593	16.7	3.32 ± 2.87		693	15.8	3.48 ± 2.79	
High school	1233	34.7	2.83 ± 2.67		965	22.0	2.92 ± 2.60	
University or beyond	608	17.1	2.39 ± 2.33		202	4.6	2.74 ± 2.53	
Residential Area				<0.001				<0.001
Metropolitan	1322	37.2	3.30 ± 2.87		1648	37.6	4.11 ± 3.05	
City	893	25.1	2.82 ± 2.67		1082	24.7	3.63 ± 2.93	
Rural	1342	37.7	3.43 ± 2.85		1651	37.7	4.25 ± 2.90	
Working Status				<0.001				<0.001
Employed	2104	59.2	2.62 ± 2.52		1323	30.2	3.22 ± 2.66	
Unemployed	1453	40.8	4.10 ± 2.99		3058	69.8	4.40 ± 3.03	
Household Income Level				<0.001				<0.001
Low	731	20.6	4.46 ± 3.00		1198	27.3	5.28 ± 2.94	
Mid-low	993	27.9	3.41 ± 2.83		1203	27.5	4.06 ± 2.90	
Mid-high	995	28.0	2.81 ± 2.64		1032	23.6	3.45 ± 2.85	
High	838	23.6	2.43 ± 2.44		948	21.6	3.12 ± 2.70	
Regular Physical Activities				<0.001				<0.001
Yes	1397	39.3	2.72 ± 2.56		1438	32.8	3.33 ± 2.80	
No	2160	60.7	3.55 ± 2.94		2943	67.2	4.39 ± 3.00	
Smoking				<0.001				<0.001
Current	1355	38.1	3.19 ± 2.78		148	3.4	5.76 ± 3.05	
Past	930	26.1	3.39 ± 2.83		50	1.1	5.28 ± 2.93	
Never	1272	35.8	3.14 ± 2.86		4183	95.5	3.97 ± 2.95	
Alcohol				<0.001				<0.001
Current	2162	60.8	2.91 ± 2.67		817	18.6	3.58 ± 2.85	
Past	582	16.4	4.08 ± 2.97		193	4.4	4.60 ± 3.14	
Never	813	22.9	3.46 ± 2.96		3371	76.9	4.13 ± 2.98	
The number of chronic diseases				<0.001				<0.001
0	1995	56.1	2.80 ± 2.66		2444	55.8	3.55 ± 2.85	
1	1019	28.6	3.48 ± 2.80		1289	29.4	4.32 ± 2.98	
≥2	543	15.3	4.32 ± 3.07		648	14.8	5.35 ± 2.95	
Diagnosis of cancer				<0.001				0.16
Yes	44	1.2	5.11 ± 3.01		29	0.7	4.79 ± 3.18	
No	3513	98.8	3.20 ± 2.81		4352	99.3	4.04 ± 2.97	
ADL				<0.001				<0.001
Independent	3409	95.8	3.08 ± 2.74		4184	95.5	3.93 ± 2.94	
Needs help/difficulty with ADL	148	4.2	6.64 ± 2.61		197	4.5	6.57 ± 2.60	
IADL				<0.001				<0.001
Independent	3029	85.2	2.99 ± 2.72		3943	90.0	3.82 ± 2.91	
Needs help/difficulty with ADL	528	14.8	4.62 ± 3.01		438	10.0	6.08 ± 2.72	

CES-D-10: Center for Epidemiological Studies Depression; ADL: Activities of daily living; IADL: Instrumental activities of daily living.

years or older using data from six phases of the KLoSA. After adjusting for potential confounders, our results revealed that arthritis status changes were associated with depressive symptoms among middle-aged and older Korean adults. This study is one of the few conducted to investigate the effects of status change in arthritis conditions on depressive symptoms, particularly in the Korean population.

Our results show that arthritis status and changes in arthritis status are closely related to depressive symptoms in middle-aged and older Korean men and women. These results were reinforced after adjustment for age, educational level, residential area, working status, equalized household income level, regular physical activities, smoking status, alcohol consumption status, number of chronic diseases, diagnosis of cancer, and ADL and IADL, which are considered risk factors for depression.

Our findings are consistent with previous studies from China that have examined the relationship between various arthritis or rheumatoid symptoms and depression [4]. Furthermore, the results were consistent with previous studies that reported a relationship between various types of arthritis (including primary Sjögren's syndrome, rheumatoid arthritis, osteoarthritis, and gout) and depression among people in other parts of the world [15,18,37,38]. In contrast, a prospective study of 3491 participants (aged 45 and older) in the United States found no significant relationship between osteoarthritis and depression (20-item CES-D score ≥ 16) [39]. This inconsistency could be due to the US study's relatively small population sample size. Moreover, there were differences in the type of arthritis, definition of depression, and population characteristics in the US study. This study is consistent with most previous research that has consistently demonstrated a positive association

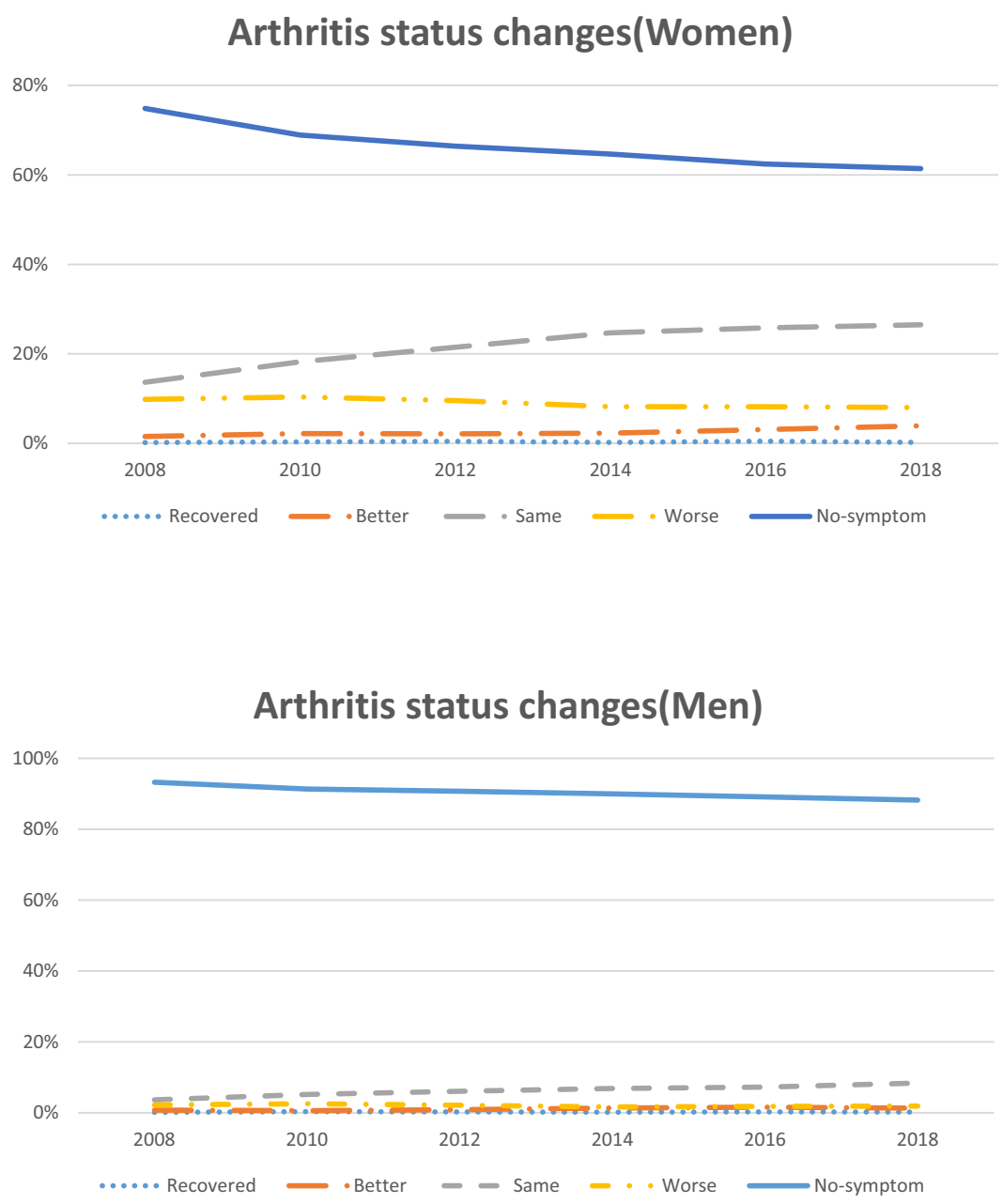

Fig. 2. Proportion of participants in each of the five arthritic status change domains at each study time point.

between arthritis and depression.

One of the key findings of our study is the impact of changes in arthritis status over time. Clinical studies have shown the effects of treating arthritis-related diseases on depressive symptoms [40,41], but most studies have been cross-sectional and have investigated the relationship between the severity of arthritis pain and depression. Therefore, changes in variables over time and causal relationships cannot be assessed from the results of those studies [42–44].

We found that worsening arthritic conditions resulted in the greatest increase in depression among the working population. In the case of the older population, occupational activity affects the exacerbation of arthritis, and pain caused by worsening symptoms can directly affect depression [43]. For the smoking group and those in need of assistance in daily life, the increase in depressive symptoms was greatest when the arthritis condition worsened. Smoking affects cartilage repair by causing cellular dysfunction, inhibiting cell growth, applying oxidative stress that causes loss of cartilage integrity, and causing hypoxia by increasing carbon monoxide levels in the blood [44]. The increased pain caused by these negative effects of smoking can accelerate depression as well as worsen arthritis symptoms. In addition, for those who require help in daily life, it causes a number of negative and complex consequences, such as reduced self-esteem, limited role, difficulty at work, and loss of income [45]. Understandably, additional pain due to the worsening condition of arthritis increases the likelihood of depression [45]. Therefore, we propose a comprehensive approach, such as performing a psychological evaluation between physical treatments, for the working group, smoking group, and daily life limitation group suffering from arthritis.

Although mechanisms underlying the association between arthritis and depression are not fully understood, some evidence exists. Arthritis is a chronic and persistent disease. Therefore, functional limitations in people with arthritis may impair behavioral changes associated with reducing depression, such as physical activity, community participation, work, family life, and social and recreational activities [46]. In addition,

Table 2
Results of analyzing factors associated with CES-D-10.

Variables	CES-D-10					
	Men			Women		
	ß	S.E	P-value	ß	S.E	P-value
Arthritis status						
No symptoms of Arthritis status	Ref.			Ref.		
Recovered	0.04	0.42	0.92	-0.56	0.26	0.031
Better	-0.71	0.17	<0.001	−0.21	0.12	0.08
Same	0.25	0.12	0.031	0.13	0.06	0.049
Worse	1.07	0.17	<0.001	0.99	0.08	<0.001
Age						
45–54	Ref.			Ref.		
55–64	−0.13	0.06	0.032	−0.17	0.06	0.004
65–74	−0.21	0.08	0.011	−0.24	0.08	0.002
≥75	−0.11	0.10	0.25	−0.32	0.09	0.001
Educational Level						
Elementary school or less	0.78	0.10	<0.001	0.96	0.14	<0.001
Middle school	0.40	0.11	0.001	0.36	0.15	0.016
High school	0.25	0.09	0.007	0.04	0.14	0.78
University or beyond	Ref.			Ref.		
Residential Area						
Metropolitan	Ref.			Ref.		
City	−0.45	0.08	<0.001	−0.67	0.07	<0.001
Rural	−0.30	0.08	<0.001	−0.46	0.07	<0.001
Working Status						
Employed	Ref.			Ref.		
Unemployed	0.62	0.06	<0.001	0.39	0.05	<0.001
Household Income Level						
Low	Ref.			Ref.		
Mid-low	−0.20	0.07	0.002	−0.30	0.06	<0.001
Mid-high	−0.32	0.08	<0.001	−0.53	0.06	<0.001
High	−0.47	0.08	<0.001	−0.60	0.07	<0.001
Regular Physical Activities						
Yes	Ref.			Ref.		
No	−0.34	0.04	<0.001	−0.28	0.04	<0.001
Smoking						
Current	0.07	0.08	0.39	1.08	0.17	<0.001
Past	−0.12	0.08	0.12	0.34	0.19	0.06
Never	Ref.			Ref.		
Alcohol						
Current	−0.12	0.08	0.14	−0.20	0.07	0.004
Past	0.23	0.09	0.001	−0.09	0.10	0.33
Never	Ref.			Ref.		
The number of chronic diseases						
0	Ref.			Ref.		
1	0.07	0.06	0.24	0.15	0.06	0.012
≥2	0.28	0.08	0.001	0.51	0.07	<0.001
Diagnosis of cancer						
Yes	Ref.			Ref.		
No	−0.95	0.17	<0.001	−0.79	0.19	<0.001
ADL						
Independent	Ref.			Ref.		
Needs help/difficulty with ADL	1.47	0.13	<0.001	0.68	0.11	<0.001
IADL						
Independent	Ref.			Ref.		
Needs help/difficulty with ADL	0.49	0.07	<0.001	0.75	0.08	<0.001

CES-D-10: Center for Epidemiological Studies Depression Scale; ADL: Activities of daily living; IADL: Instrumental activities of daily living.

patients with arthritis are less likely to have access to depression interventions [47]. Previous research has confirmed that both clinicians and patients focus on the physical aspect of the disease. When patients are in pain, they do not seek help from mental health professionals because they fear the stigma associated with getting mental health care [48]. This may also be one of the reasons for the increased rate of depression among people with arthritis. The pathophysiological mechanisms linking depression and arthritis are more complex and unclear [49]. Some investigations have suggested that proinflammatory biomarkers, such as cytokines and C-reactive protein, may be associated with depression [50]. This relationship between inflammation and depression increases the risk of depression among individuals with inflammatory diseases such as rheumatoid arthritis [42]. Furthermore, inflammation can have a direct functional effect on the hypothalamic–pituitary–adrenal (HPA) axis, and changes in HPA function are strongly related to depression [4,51]. Evidence suggests that depression among people with arthritis may be due to systemic inflammation caused by proinflammatory cytokine milieu of arthritis [52]. Reports also suggest that depression and arthritis may be linked via a dysfunctional neuroendocrine system [52,53]. Intracellular pathways, including PI-3 K/AKT/mTOR and stress- and mitogen-activated protein kinases (SAPK/MAPK), can also account for the connection between the two chronic conditions [54,55].

Consequently, arthritis can affect individuals and groups in several ways, causing mental problems due to physical discomfort. These results may be reinforced in the occupational activity group, the smoking group, and the group with limited ability to perform ADLs. Therefore, appropriate management measures for arthritis should be taken to prevent depression among middle-aged and older adults.

4.1. Limitations

The KLoSA is a well-established database, but it has some limitations. First, we set arthritis as “rheumatism” or “arthritis” and examined effects of depression according to changes in general arthritis status. Due to data limitations, it was not possible to subdivide the types of arthritis, which have different mechanisms. However, our findings can be generalized to a larger adult population with arthritis because we considered several broad types of arthritis rather than specific types of arthritis. Specifying the subtype will yield more detailed results. Second, it was not possible to consider the duration of arthritis symptoms. If arthritis had developed during the study period, it was possible to approximate the duration of the onset; however, there was no way to determine the duration of the arthritis symptoms among participants who started experiencing symptoms before the study period. Third, data limitations prevented us from determining the cause of participants' arthritis. To minimize these limitations, we adjusted variables that could affect the occurrence of arthritis or changes in the arthritis status. Fourth, in our study, it was assumed that there was no temporal effect due to time for the period from 2008 to 2018. In fact, the change in arthritic status in our data is limited to two time points because it reflects only the most recent KLoSA year's arthritic status compared to two years prior. Therefore, even though the GEE model was used to overcome these limitations [29,31], there is a possibility that the temporal effect over the entire period may not be fully reflected. Therefore, future studies should investigate the relationship between changes in arthritis status, including temporal effects, and depressive symptoms over a long period of time. Fifth, despite good follow-up rates, there were people who dropped out of the study. This could bias the results. There is also the possibility of selection bias due to differences in characteristics between inclusion and exclusion of participants. However, the proportion of participants excluded from our study may introduce some bias but do not pose a serious threat to validity [56,57](Supplementary 1). Finally, based on the answers from our self-report questionnaire, we summarized the changes in arthritis status. Therefore, potential recall bias and misclassification bias due to false reporting should also be considered when interpreting results.

Table 3
Results of subgroup analysis of arthritis status with CES-D-10.

	CES-D-10											
	Arthritis status											
Variables	No symptoms of Arthritis status	Recovered			Better			Same			Worse		
	β	ß	S.E	P- value	ß	S.E	P- value	ß	S.E	P- value	ß	S.E	P- value
Men													
Working Status[a]													
Working	Ref.	0.20	0.62	0.75	−0.34	0.24	0.16	0.34	0.18	0.06	1.13	0.27	<0.001
Non-working	Ref.	−0.08	0.60	0.89	−0.97	0.25	<0.001	0.14	0.14	0.30	1.00	0.20	<0.001
Smoking[b]													
Current	Ref.	0.78	0.71	0.27	−0.25	0.31	0.41	0.22	0.22	0.32	1.61	0.32	<0.001
Past	Ref.	−0.84	0.61	0.16	−0.94	0.27	0.001	0.43	0.17	0.012	1.16	0.25	<0.001
Never	Ref.	0.14	0.49	0.77	−0.90	0.31	0.003	0.15	0.20	0.43	0.75	0.28	0.008
ADL[c]													
Independent	Ref.	−0.05	0.44	0.90	−0.64	0.18	0.001	0.27	0.12	0.025	1.10	0.18	<0.001
Needs help/difficulty with ADL	Ref.	1.58	0.32	<0.001	−2.41	0.89	0.007	−0.28	0.42	0.49	1.25	0.28	<0.001
Women													
Working Status[a]													
Working	Ref.	−0.63	0.35	0.07	−0.22	0.22	0.31	0.22	0.13	0.08	0.97	0.16	<0.001
Non-working	Ref.	−0.33	0.37	0.37	−0.20	0.14	0.14	0.14	0.07	0.047	0.97	0.09	<0.001
Smoking[b]													
Current	Ref.	–	–	–	−1.97	0.96	0.039	0.72	0.40	0.06	1.49	0.35	<0.001
Past	Ref.	–	–	–	−2.07	0.57	0.001	0.30	0.40	0.44	0.42	0.51	0.40
Never	Ref.	−0.49	0.26	0.06	−0.15	0.12	0.22	0.13	0.07	0.06	0.97	0.08	<0.001
ADL[c]													
Independent	Ref.	−0.52	0.27	0.06	−0.19	0.12	0.11	0.17	0.07	0.011	1.01	0.08	<0.001
Needs help/difficulty with ADL	Ref.	–	–	–	1.82	0.98	0.06	0.88	0.22	<0.001	1.03	0.23	<0.001

CES-D-10: Center for Epidemiological Studies Depression Scale; ADL: Activities of daily living; IADL: Instrumental activities of daily living.
[a] Adjusted for sociodemographic and health-related factor (age, education level, residential area, household income level, regular physical activities, smoking, the number of chronic diseases, diagnosis of cancer, ADL, IADL).
[b] Adjusted for sociodemographic and health-related factor (age, education level, residential area, working status, household income level, regular physical activities, the number of chronic diseases, diagnosis of cancer, ADL, IADL).
[c] Adjusted for sociodemographic and health-related factor (age, education level, residential area, working status, household income level, regular physical activities, the number of chronic diseases, diagnosis of cancer, IADL).

5. Conclusions

This study highlights the association between changes in arthritis status and depressive symptoms among the middle-aged and older Korean population. These results were reinforced in the working group, the smoking group, and the group with limited ability to perform ADLs. For the mental health of middle-aged and older patients, it is recommended that management and evaluation be carried out through appropriate interventions for changes in the arthritis status.

Consent for publication

There are no details of individual participants in the manuscript.

Availability of data and materials

The datasets generated during and analyzed during the current study are available in the Korean Longitudinal Study of Aging (KLOSA), http://survey.keis.or.kr/eng/klosa/klosa01.jsp

Funding

This study received no external funding.

Author contributions

SHJ, SHK, and JHK designed the study. SHJ collected the data, performed statistical analysis, and drafted the manuscript. SHJ, SHK, MP, JHK, HJL, and *E*-CP contributed to the discussion, and reviewed and edited the manuscript. E-CP is the guarantor of this work, and as such had full access to all study data. E-CP assumes responsibility for the integrity of the data and the accuracy of the data analysis. All authors have read and agreed to the published version of the manuscript.

Declaration of Competing Interest

All authors declare that they have no conflicts of interest.

Acknowledgements

We thank our colleagues at Yonsei University's Health Research Institute for their advice on writing the literature.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychores.2021.110662.

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