Check for updates

Research in Nursing & Health

WILEY

RESEARCH IN NURSING & HEALTH

RESEARCH ARTICLE OPEN ACCESS

Weekly Walking Attenuates the Association Between Frailty and Depressive Symptoms in Patients With Rheumatoid Arthritis

Wonhee Baek[1] | Ji Yea Lee[2] | Ari Min[3] | Chang Gi Park[4] | Minkyung Kang[2]

[1]College of Nursing, Gyengsang National University, Jinju, Gyeongnam, South Korea | [2]College of Nursing, Research Institute of Nursing Science, Ajou University, Suwon, South Korea | [3]Department of Nursing, Chung-Ang Univeristy, Seoul, South Korea | [4]College of Nursing, University of Illinois at Chicago, Chicago, Illinois, USA

Correspondence: Minkyung Kang (mkang@ajou.ac.kr)

Received: 24 July 2025 | **Revised:** 10 February 2026 | **Accepted:** 22 February 2026

Funding: the National Research Foundation of Korea (NRF), Grant/Award Number: RS-2024-00350086

Keywords: depression | frailty | moderation effect | rheumatoid arthritis | walking

ABSTRACT

This study aimed to examine whether engagement in weekly walking moderates the relationship between frailty and depressive symptoms among patients with rheumatoid arthritis, a population known to be vulnerable to both physical and psychological decline. This cross-sectional observational study used data from the 2016 and 2018 Korea National Health and Nutrition Examination Surveys. The sample included 206 adults aged 45 years or older who were diagnosed with rheumatoid arthritis. Survey-weighted multivariable linear regression analyses accounting for the complex sampling design were employed to examine the moderating effects of walking frequency on the frailty-depression relationship. Subsequently, the conditional effect of the moderator was examined using the Johnson–Neyman technique to identify the levels of weekly walking days at which the relationship between frailty and depressive symptoms varied. Frailty emerged as a significant predictor of depressive symptoms. A significant interaction was found between frailty and walking frequency, indicating a buffering effect of walking ($\beta = -3.68$, $p = 0.010$). The Johnson–Neyman analysis revealed that the positive association between frailty and depressive symptoms emerged when individuals walked less than approximately 3.5 days per week. Engagement in weekly walking attenuated the relationship between frailty and depressive symptoms among patients with rheumatoid arthritis. These findings highlight the importance of promoting even low levels of physical activity, such as short walking sessions, to support mental health and reduce the risk of depression in frail patients with rheumatoid arthritis. However, the cross-sectional design, self-reported data, and lack of control for clinical factors limit causal interpretation.

1 | Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory disease that affects the joints. The global prevalence ranges from 0.24% to 1% (Venetsanopoulou et al. 2023), with 1.1% prevalence in Korea (Lee 2025). Although the prevalence rate is not very high, RA is associated with persistent joint pain and functional impairment, which can diminish physical activity and significantly reduce quality of life (Canning et al. 2022; World Health Organization 2023). Consequently, individuals with RA are at a higher risk for mental health disorders, particularly depressive symptoms.

Depressive symptoms are among the most common comorbidities in individuals with RA. A meta-analysis of 72 studies reported a 38.8% prevalence of depression in patients with RA (Matcham et al. 2013). Moreover, individuals with RA are at a 1.5 to 1.7-fold higher risk of developing depression compared to

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

© 2026 The Author(s). *Research in Nursing & Health* published by Wiley Periodicals LLC.

those without the condition (Jeon et al. 2024; Ng, Tay, et al. 2022). Depressive symptoms are associated with reduced remission (Manning-Bennett et al. 2022; Zhang et al. 2020), reduced health-related quality of life (Zhang et al. 2020), and higher mortality (Ng, Xiao, et al. 2022). Therefore, identifying modifiable risk factors associated with depressive symptoms in patients with RA is essential for early intervention and improved disease management.

Frailty is a complex, multidimensional syndrome marked by progressive decline in physiological function, resulting in increased vulnerability and adverse outcomes (Doody et al. 2023). It affects approximately 23%–34% of patients with RA (Gao et al. 2022; Germonpré et al. 2023). Notably, a well-established association between frailty and depression exists (Zhou et al. 2024), which may stem from shared pathophysiological mechanisms such as chronic inflammation and neuroendocrine dysfunction (Aprahamian et al. 2022). This association has been consistently observed among patients with RA. For example, one study involving 375 Japanese patients with RA found a significant correlation between frailty and depressive symptoms (Kojima et al. 2021). Similarly, another study revealed that approximately 74% of frail patients with RA reported depressive symptoms, compared to only 11.5% among their non-frail counterparts. Considering the interconnection between frailty and depressive symptoms, there is a need to investigate modifiable factors that can mitigate the relationship between frailty and depressive symptoms in patients with RA.

Walking stands out as a simple, feasible, and safe form of physical activity. The American College of Rheumatology strongly recommends regular physical activity for patients with RA (England et al. 2023), particularly low-impact aerobic exercises such as walking (American College of Rheumatology 2025). This recommendation is supported by the fluctuating clinical course of RA, characterized by alternating periods of disease flare and remission (Bozzalla-Cassione et al. 2022). Walking can be considered the most appropriate, feasible, and safe form of physical activity for patients with RA among various forms of physical activity.

Studies have suggested that walking can improve fatigue, vitality, and depressive symptoms (Brady et al. 2021; Fenton et al. 2018). For example, in a study involving 345 patients with RA, higher levels of walking were significantly associated with lower levels of depressive symptoms, independent of functional disability (Brady et al. 2021). Similar research using objective measures such as accelerometers has confirmed that walking has a significant direct effect on low depressive symptoms in patients with RA (Fenton et al. 2018). Moreover, a meta-analysis of 44 randomized controlled trials concluded that a walking intervention significantly reduces depressive symptoms in patients with RA (Xu et al. 2024).

Extensive evidence indicates that walking exerts beneficial effects on depressive symptoms among individuals with RA. Nevertheless, the role of walking in the relationship between frailty and depressive symptoms among patients with RA has not been elucidated. Previous research has demonstrated the moderating effect of physical activity on the association between perceived stress and depression in individuals with ischaemic heart disease (Yeom and Lee 2023); however, this investigation did not encompass patients with RA or address the distinct interrelation between frailty and depressive symptoms in this group. Accordingly, the present study seeks to address this gap by examining whether walking moderates the association between frailty and depressive symptoms in patients with RA, thereby contributing to the development of targeted interventions aimed at enhancing psychological well-being in this high-risk population.

Therefore, this study aimed to examine the moderating effect of weekly walking days on the association between frailty and depressive symptoms in patients with RA using data from the Korea National Health and Nutrition Examination Survey (KNHANES). KNHANES is a large-scale, national representative survey conducted by the Korea Disease Control and Prevention Agency to assess health, nutritional status, and health behaviors in the Korean population. Insights gained from this interaction may inform the development of targeted interventions that incorporate physical activity to improve mental health outcomes in this population.

2 | Methods

2.1 | Study Design and Participant Selection

This cross-sectional study aimed to examine the moderating effect of weekly walking days on the relationship between frailty and depressive symptoms among patients with RA, using data from the 1st (2016) and 3rd (2018) years of the seventh waves of the KNHANES. The KNHANES was conducted every 3 years from 1998 to 2005 and has been implemented annually since 2007. This survey was designed to collect essential data to inform public health policies, including information on health status, health behaviors, and food and nutritional intake. The KNHANES uses the most recent Population and Housing Census and Publicly Announced Housing Price data as its sampling frames. The study was stratified by region and housing type and utilized a two-stage stratified cluster sampling method to select survey districts and households. Within the sampled households in the KNHANES, all household members aged 1 year and above were selected as survey participants. The 1st and 3rd data in the seventh wave of this study included 8150 and 7992 participants, respectively. Since middle-aged frailty may have a negative impact on participants' health outcomes (Baek and Min 2022) and RA can occur in all adults in the Korean population (Sung et al. 2013), the participants were limited to middle-aged patients with RA aged 45 years or older. Participants were included if they self-reported having been diagnosed with RA by a physician. The exclusion criteria were as follows: (1) participants with missing data in key variables and (2) those with fewer than 21 available Frailty Index (FI) deficits.

2.2 | Measures

2.2.1 | Depressive Symptoms

Depressive symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9), a widely used screening and severity tool for depression. The PHQ-9 consists of nine questions that correspond to the diagnostic criteria for major depressive episodes as outlined in the Diagnostic and Statistical Manual of

1098240x, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/nur.70066 by MS HYEON - Chung-Ang University , Wiley Online Library on [29/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Mental Disorders, 4th Edition (Kroenke et al. 2001). Respondents were asked how often they had been bothered by each of the nine symptoms over the past 2 weeks. Responses were scored on a scale from "Not at all = 0" to "Nearly every day = 3," with a total score ranging from 0 to 27. Higher scores indicate more severe depressive symptoms. The PHQ-9 scores were classified as follows 0–4 (none), 5–9 (mild), 10–14 (moderate), 15–19 (moderately severe), and 20–27 (severe) (Kroenke et al. 2001). The PHQ-9 has demonstrated validity for assessing depression in patients with RA in a large prospective multi-center study (Englbrecht et al. 2019), and its validity has also been confirmed in South Korea through a nationally representative epidemiological survey in the community population (Kim et al. 2023). The internal consistency of the PHQ-9 was 0.88 in a previous study (Kim et al. 2023) and 0.83 in this study.

2.2.2 | *Frailty*

Frailty is commonly assessed using two approaches: the frailty phenotype and FI. The frailty phenotype defines frailty by the presence of three or more criteria—weight loss, exhaustion, weakness, slow walking speed, and low physical activity (Fried et al. 2001). In contrast, the FI provides a multidimensional, continuous measure that captures subtle differences in frailty by quantifying accumulated deficits such as symptoms, functional impairments, and laboratory abnormalities (Clegg et al. 2013). Because the FI includes biological parameters, it is effective in predicting health outcomes and potential therapeutic responses (Clegg et al. 2013; Baek and Min 2022). In this study, frailty was assessed using the FI developed based on previous research that examined the trend in frailty among older adults in Korea from 2008 to 2020 using the same dataset as the present study (Kang et al. 2023). The FI comprises 30 deficits across four domains: comorbidities, functional abilities, signs and symptoms, and laboratory test values. The frailty score is calculated as the sum of the individual deficit scores divided by the total number of measured deficits, with scores ranging from 0 to 1, with higher scores indicating greater frailty. When coding the health deficits, questionnaire responses were systematically translated into binary or ordinal variables. For example, the presence of physician-diagnosed depression was coded as 1; otherwise, it was coded as 0. This variable reflects a clinical diagnosis and is considered conceptually distinct from current depressive symptom severity, as assessed using the PHQ-9. Limitations in self-care were coded as follows: 0 for no difficulty in bathing or dressing, 0.5 for some difficulty, and 1 if the patient was unable to bathe or dress independently. For comorbidities, prevalence was determined based on physician-diagnosed conditions as reported by patients. However, in the case of hypertension, diabetes mellitus, and dyslipidaemia, the prevalence was determined based on clinical test results. Hypertension was considered present if it was diagnosed by a physician, if the individual had a systolic blood pressure of ≥140 mmHg or a diastolic blood pressure ≥ 90 mmHg, or if they were taking antihypertensive medication. Diabetes was considered present if it was diagnosed by a physician, if the individual was administered insulin or diabetes medication, if fasting blood glucose was ≥126, or if hemoglobin A1c was ≥6.5. Dyslipidaemia was considered present if diagnosed by a physician, or based on the following criteria: total cholesterol level > 240, triglyceride > 200, low-density lipoprotein > 160, or high-density lipoprotein < 40 for men and <50 for women (Baek et al. 2021). Details of the items used for each deficit and the corresponding coding method are presented in Supporting Information S1: Table 1. In general, when more than 20–30% of the FI items are missing, the FI cannot be calculated; therefore, cases with missing data for more than 21 items were defined as exclusion criteria. However, no participants were excluded based on this criterion in the present study.

2.2.3 | *Physical Activities*

Physical activity level was assessed based on two indicators: weekly walking days and muscle-strengthening exercises. The moderating variable in this study was weekly walking days, measured by the question: "During the past week, on how many days did you walk at least 10 min at a time?" Responses ranged from 0 (not walking at all) to 7 (walking every day) and were used as a continuous variable, with higher scores indicating an increase in the number of walking days. Muscle-strengthening exercise was measured using the question: "During the past week, on how many days did you perform muscle-strengthening exercise?" The answer was categorized as "No" if the individual did not exercise at all, and "Yes" if the activity was performed on more than 1 day.

2.2.4 | *General Characteristics*

Demographic characteristics included age, sex, marital status (unmarried or married), education level (elementary school or lower, middle school, high school, and university or higher), and employment status (unemployed or employed).

2.2.5 | *Health-Related Characteristics*

Health-related characteristics included current RA status and duration of RA. Subjective health status was assessed on a 5-point Likert scale, ranging from 1 (very good health) to 5 (very poor health). Although this measure is ordinal in nature, it was treated as an approximately continuous variable for the purpose of regression analyses.

2.3 | Statistical Analyses

Descriptive statistics were used to summarize participants' general characteristics, health-related characteristics, and depressive symptoms. All analyses accounted for the complex survey design, including stratification, clustering, and sampling weights. Continuous variables are presented as weighted means with standard errors or medians with interquartile ranges, as appropriate, and categorical variables are presented as unweighted frequencies with weighted percentages. For Supporting Information S1: Table 1, which describes the distribution of health deficits used to construct the frailty index, prevalence estimates were calculated using unweighted proportions from the analytic sample.

Differences in depressive symptoms according to categorical variables were examined using survey-weighted regression analyses. Associations between depressive symptoms and continuous variables were assessed using survey-weighted linear

1098240x, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/nur.70066 by MS HYEON - Chung-Ang University , Wiley Online Library on [29/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

regression models rather than correlation coefficients, given the complex sampling design.

To investigate the moderating effect of weekly walking days on the association between FI and depressive symptoms, survey-weighted multivariable linear regression models with interaction terms were fitted. In the basic model, weekly walking days and FI were entered as independent variables. In moderation model 1, an interaction term between weekly walking days and FI was included without covariates to assess the unadjusted moderating effect. In moderation model 2, the same interaction term was included with adjustment for sex, marital status, employment status, current RA status, and subjective health status. Weekly walking days and FI were mean-centered prior to analysis to reduce potential multicollinearity associated with the interaction term. To address concerns regarding potential item overlap between the FI and depressive symptoms, a sensitivity analysis was conducted by recalculating the FI after excluding the depression-related item (physician-diagnosed depression). The moderation analyses were then repeated using the revised FI. Regression coefficients, standard errors, and 95% confidence intervals were estimated using design-based variance estimation. Statistical significance was determined based on whether the 95% confidence interval of the estimate excluded zero.

The conditional effect of the moderator was examined using the Johnson–Neyman technique, which identifies the specific values of the moderating variable at which the relationship between the FI and depressive symptoms becomes significant or nonsignificant (Hayes 2017). This technique also enables us to estimate the magnitude of the effect at specific levels of the moderating variable.

Finally, a sensitivity analysis was performed to determine the minimum detectable effect size for the regression model with eight predictors, given the available sample size ($N = 206$). With a significance level of 0.05 and a power of 0.80, the study was sensitive to an effect size of $f^2 = 0.076$. This indicates that the study had sufficient power to detect a small-to-medium effect size. Because formal power calculations for complex survey designs are not straightforward, this analysis should be interpreted as an approximation. Data were analyzed using R (version 4.2.1; R Foundation for Statistical Computing, Vienna, Austria).

2.4 | Ethical Considerations

The Institutional Review Board of Ajou University approved this study (approval no. AJOUIRB-EX-2025-021), and the requirement for written informed consent was waived.

3 | Results

A total of 16,142 participants from the 2016 and 2018 KNHANES were included. The exclusion criteria were: participants without RA ($n = 15{,}899$), <45 years of age ($n = 29$), and those with missing data ($n = 8$). Finally, 206 participants were analyzed. Missing data included PHQ-9 ($n = 1$) and disease duration ($n = 1$) (Figure 1).

3.1 | Characteristics of Study Participants

The participants' characteristics are presented in Table 1. The median age of the participants was 65 years, and the majority were female participants (79.6%, $n = 169$). Most participants were married (67.2%, $n = 132$), and 42.8% ($n = 103$) had an educational level of elementary school or lower. The median duration of RA was 10 years, and most participants currently had RA (89.7%, $n = 183$).

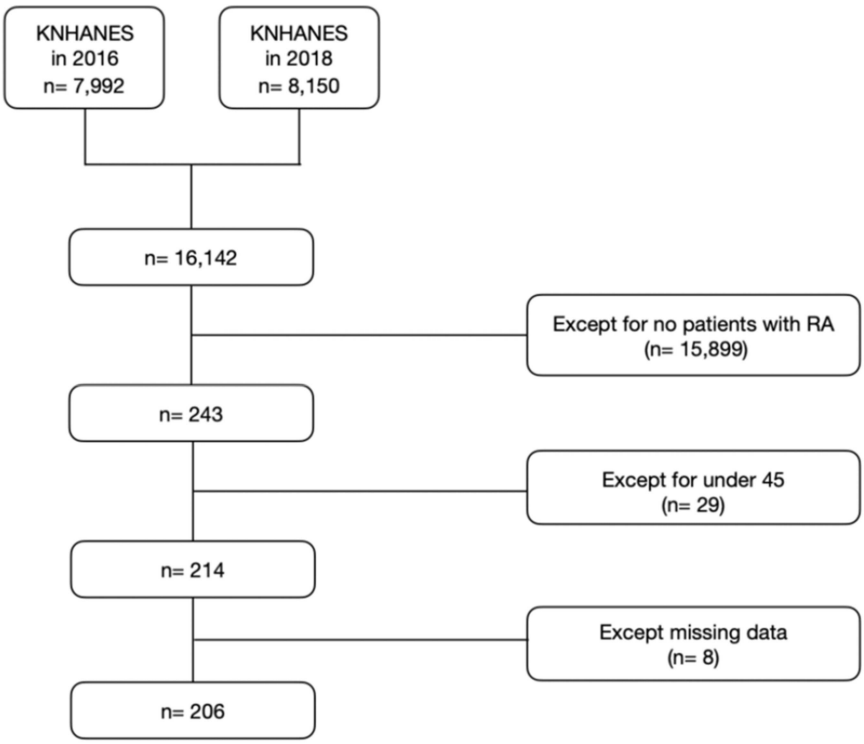


FIGURE 1 | Participant's selection diagram. KNHANES = The Korea National Health and Nutrition Examination Surveys.

10982240x, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/nur.70066 by MS HYEON - Chung-Ang University , Wiley Online Library on [29/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 | Characteristics of the study participants ($N = 206$).

Variables	Category	Unweighted *n* (Weighted %)	Mean (SE) or median [IQR]
Age (years)			65 [56, 73]
Sex	Male	37 (20.4)	
	Female	169 (79.6)	
Marital status	Unmarried	74 (32.8)	
	Married	132 (67.2)	
Final education	Elementary school or under	103 (42.8)	
	Middle school	39 (19.3)	
	High school	43 (27.3)	
	University or higher	21 (10.7)	
Employment status	Not employed	121 (55.6)	
	Employed	85 (44.4)	
Current RA status	No	23 (10.3)	
	Yes	183 (89.7)	
Duration for RA (years)			10 [5, 21]
Subjective health status (1–5)			3.6 (0.1)
Weekly walking days (0–7days)			3 [0, 6]
Weekly muscle exercise	No	178 (86.3)	
	Yes	28 (13.7)	
Frailty index			0.2 [0.1, 0.3]
Frailty status (0–1)	Robust	59 (30.4)	
	Prefrail	76 (37.2)	
	Frail	71 (32.4)	
Depressive symptoms (0–27)			3 [1, 7]
	None (0–4)	128 (61.2)	
	Mild (5–9)	40 (22.0)	
	Moderate (10–14)	21 (8.5)	
	Moderately severe (15–19)	13 (6.5)	
	Severe (20–27)	4 (1.8)	

Note: Continuous variables are presented as survey-weighted means with standard errors or medians with interquartile ranges, as appropriate. Categorical variables are presented as unweighted sample sizes and survey-weighted percentages. Interquartile range (IQR) was expressed as the values between the first and third quartiles. Depressive symptoms were defined as the Patient Health Questionnaire-9 scores.
Abbreviations: 1 USD = 1330 KRW, RA = rheumatoid arthritis, SE = standard error.

The mean subjective health status score was 3.6 (standard error = 0.1), indicating moderate perceived health. The median number of weekly walking days was 3 days, and 86.3% of participants did not engage in weekly muscle exercise. The median FI was 0.2, with 30.4% classified as robust, 37.2% as prefrail, and 32.4% as frail. The median depressive symptoms score was 3, and 38.8% of participants exhibited depressive symptoms ranging from mild to severe. Comorbidities were common, with more than half of the participants reporting hypertension ($n = 115$), diabetes ($n = 121$), or dyslipidaemia ($n = 135$) (Supporting Information S1: Table 1).

3.2 | Differences in Depressive Symptoms According to Categorical Variables

The differences in depressive symptoms based on categorical variables (sex, marital status, final education, employment status, current RA status, and muscle exercise) are presented in Table 2. Using survey-weighted regression analyses accounting for the complex sampling design, depressive symptoms differed significantly according to sex ($p < 0.001$), marital status ($p = 0.013$), employment status ($p = 0.005$), and current RA status ($p = 0.005$).

3.3 | Associations Between Continuous Variables and Depressive Symptoms

As presented in Table 3, based on survey-weighted linear regression analyses, depressive symptoms were negatively associated with weekly walking days ($\beta = -0.40$, $p = 0.003$), and positively associated with subjective health status ($\beta = 2.91$, $p < 0.001$) and the FI ($\beta = 25.10$, $p < 0.001$).

1098240x, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/nur.70066 by MS HYEON - Chung-Ang University , Wiley Online Library on [29/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 | Differences in Patient Health Questionnaire-9–measured depressive symptoms according to categorical variables ($N = 206$).

Variables	Category	Median [IQR]	*p*
Sex			< 0.001
	Male	2.0 [0, 3.0]	
	Female	3.0 [1.0, 9.0]	
Marital status			0.013
	Unmarried	4.0 [1.0, 10.0]	
	Married	3.0 [1.0, 6.0]	
Final education			0.493
	Elementary school or under	3.0 [1.0, 7.0]	
	Middle school	2.0 [0, 9.0]	
	High school	4.0 [2.0, 7.0]	
	University or higher	2.0 [0, 6.0]	
Employment status			0.005
	Not employed	3.0 [1.0, 8.0]	
	Employed	2.0 [0, 6.0]	
Current RA status			0.005
	No	2.0 [1.0, 3.0]	
	Yes	3.0 [1.0, 7.0]	
Muscle exercise			0.413
	No	3.0 [1.0, 7.0]	
	Yes	2.0 [2.0, 7.0]	

Note: Values are survey-weighted medians with interquartile ranges. P-values were obtained using survey-adjusted Wald tests that accounted for the complex sampling design. The interquartile range (IQR) was expressed as the values between the first and third quartiles.
Abbreviation: RA = rheumatoid arthritis.

TABLE 3 | Associations between Patient Health Questionnaire-9–measured depressive symptoms and continuous variables ($N = 206$).

Variables	Estimate	*p*
Age	−0.030	0.361
Duration of RA	−0.003	0.735
Subjective health status	2.91	< 0.001
Weekly walking days	−0.40	0.003
Frailty index	25.1	< 0.001

Note: Estimates were obtained from survey-weighted linear regression models accounting for the complex sampling design.
Abbreviation: RA = rheumatoid arthritis.

3.4 | Multiple Linear Regression Analysis

The results of the survey-weighted multivariable linear regression and moderation analyses are presented in Table 4. In the basic model with covariates, the FI ($\beta = 11.60$, $p = 0.021$) was associated with depressive symptoms. In moderation model 1, which included weekly walking days, the FI, and their interaction without covariates, both weekly walking days ($\beta = -0.27$, $p = 0.026$) and the FI ($\beta = 22.04$, $p < 0.001$) were associated with depressive symptoms. A moderating effect was observed for the interaction between weekly walking days and the FI ($\beta = -3.42$, $p = 0.025$). Even after including covariates in moderation model 2, weekly walking days ($\beta = -0.24$, $p = 0.038$) and the FI ($\beta = 9.16$, $p = 0.036$) remained associated with depressive symptoms. In addition, the interaction between weekly walking days and the FI ($\beta = -3.68$, $p = 0.010$) indicated that the moderating effect of walking frequency on the relationship between frailty and depressive symptoms remained evident.

Supporting Information S1: Table 2 presents the conditional effects of the FI on depressive symptoms across weekly walking days. The Johnson–Neyman analysis indicated that the association between frailty and depressive symptoms was statistically significant when walking frequency was below approximately 3.5 days per week. Beyond this threshold, the conditional effect of frailty on depressive symptoms was no longer significant, suggesting a potential buffering role of walking. Figure 2 illustrates this moderation effect: the slope of frailty on depressive symptoms was steeper at lower levels of walking frequency and gradually flattened as walking frequency increased.

3.5 | Sensitivity Analysis

In sensitivity analyses using a modified FI that excluded the depression-related item, the interaction between weekly walking days and the modified FI remained evident ($\beta = -3.65$, $p = 0.011$) (Supporting Information S1: Table 3). The pattern of conditional effects across levels of weekly walking days was consistent with the main analysis, indicating that the association between frailty and depressive symptoms was stronger at lower levels of walking frequency and attenuated as walking days increased (Supporting Information S1: Table 4).

4 | Discussion

This study examined the moderating effects of weekly walking on the association between frailty and depressive symptoms in patients with RA. The findings revealed that frailty was significantly associated with depressive symptoms; however, this association appeared weaker at higher levels of walking frequency. These findings suggest that walking may be a potential behavioral buffer in the frailty-depression relationship.

The observed association between frailty and depressive symptoms is consistent with previous studies that have identified frailty as a predictor of psychological distress, including depression, in individuals with RA (Kojima et al. 2021; Zhou et al. 2024). Frailty in RA may arise from biological pathways, such as systemic inflammation, persistent pain, and reduced physical function, all of which can reduce independence and elevate emotional stress. Combined with psychological factors such as social isolation and low self-efficacy, these physical challenges can further increase susceptibility to depression (Aprahamian et al. 2022). Given that frailty in RA involves both physical and psychosocial dimensions, the association observed in this study emphasises the need for comprehensive care that addresses both physical and mental well-being.

1098240x, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/nur.70066 by MS HYEON - Chung-Ang University , Wiley Online Library on [29/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 4 | Survey-weighted multivariable linear regression and moderation analyses of depressive symptoms ($N = 206$).

	Basic model with covariates			Moderation model 1 without covariates			Moderation model 2 with covariates		
	β	*p*	95% CI	*β*	*p*	95% CI	*β*	*p*	95% CI
Weekly walking days	−0.23	0.063	−0.46; 0.01	−0.27	0.026	−0.51; −0.03	−0.24	0.038	−0.46; −0.01
Frailty index	11.60	0.011	2.66; 20.54	22.04	< 0.001	15.13; 28.94	9.16	0.036	.59; 17.73
Weekly walking days*Frailty index				−3.42	0.025	−6.40; −0.43	−3.68	0.010	−6.48; −0.89

Note: In both the basic model and the moderation model 2, sex, marital status, employment status, current rheumatoid arthritis status, and subjective health status were controlled for as covariates. In contrast, moderation model 1 was tested without any covariates. The frailty index and weekly walking days were mean-centered.
Abbreviation: CI = confidence interval.

Notably, this study highlighted the substantial burden of depressive symptoms among patients with RA. More than one-third of the participants experienced depressive symptoms ranging from mild to severe, a prevalence consistent with existing literature (Matcham et al. 2013; Ng, Tay, et al. 2022). In addition, depression in patients with RA is not merely a comorbid condition, but one that exacerbates disease outcomes, leading to increased pain perception, reduced treatment adherence, and impaired disease remission (Manning-Bennett et al. 2022). Furthermore, depression has been associated with higher rates of suicidal ideation and attempts in patients with RA (Jeon et al. 2024), underscoring the importance of integrated care models that include routine screening and management of depressive symptoms alongside physical health monitoring.

Consistent with earlier research, this study also highlights the high prevalence of comorbidities such as hypertension, diabetes, and dyslipidaemia, which collectively contribute to frailty progression (Germonpré et al. 2023). The clustering of chronic conditions may be linked to accelerated biological ageing and functional decline, suggesting that frailty management should be a critical component of RA care, particularly for older adults with multimorbidity.

One of the most notable findings of this study was the identified moderating effect of walking. The association between frailty and depressive symptoms differed according to the walking frequency. Frailty showed the strongest association with depressive symptoms among participants who walked less frequently, whereas this association became weaker at high levels of walking frequency. This pattern indicates that walking frequency may be an important factor in understanding the frailty-depression relationship. These results align with existing evidence of positive effects of walking on depressive symptoms (Brady et al. 2021; Fenton et al. 2018; Xu et al. 2024) and extend this literature by suggesting a potential moderating role. Importantly, to ensure the validity of this finding, we performed a rigorous sensitivity analysis to address potential collinearity between frailty and depressive symptoms; by using a modified frailty index that excluded the depression item, we confirmed that the buffering effect of walking remained robust ($p = 0.011$), independent of overlapping measurement items.

The moderating effects of walking might be linked to multiple mechanisms. Regular walking can reduce inflammatory markers, improve cardiovascular and muscular function, and delay the onset of frailty (Metsios et al. 2020). Psychologically, walking may foster autonomy, enhance mood through endorphin release, and increase opportunities for social interaction—all of which are potential protective factors against depression (Cooney et al. 2013). Importantly, even modest and consistent walking may be sufficient to attenuate the negative effects of frailty on mental health. Particularly, walking does not need to be intensive or long to be effective; consistent and regular practice may be a significant factor in this relationship.

Taken together, promoting walking may serve as a potentially sustainable strategy for supporting mental health improvement among frail patients with RA. As structured exercise programmes may be difficult for frail individuals to maintain, walking offers an inclusive alternative that can be easily tailored to individual capabilities. Walking recommendations should

1098240x, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/nur.70066 by MS HYEON - Chung-Ang University , Wiley Online Library on [29/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

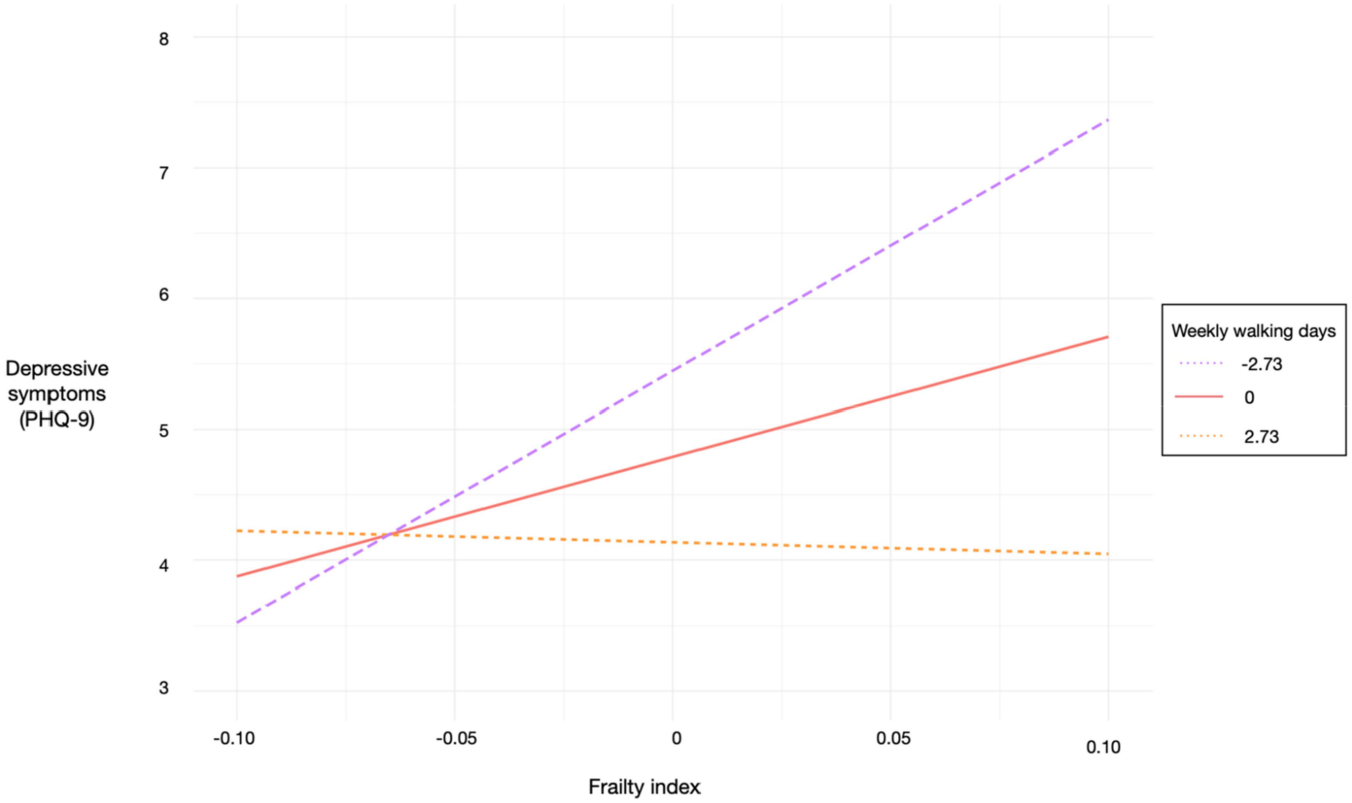


FIGURE 2 | Moderating effect of weekly walking days. Frailty index and weekly walking days were mean-centered. PHQ = Patient Health Questionnaire-9.

incorporate individualized pacing and gradual progression to ensure safety and sustainability for frail patients, with the goal of supporting mental well-being and overall quality of life. Health professionals should incorporate walking education into self-management programmes and encourage community-based walking groups designed for older or frail individuals with RA. Moreover, an interdisciplinary collaboration involving rheumatologists, nurses, physiotherapists, and mental health professionals will be essential to successfully implement and evaluate activity-based approaches. These practical recommendations may also guide public health policies aimed at promoting physical activity and psychosocial well-being in patients with chronic rheumatic conditions.

4.1 | Limitations and Future Direction

Despite the valuable insights gained in this study, certain limitations must be acknowledged. First, the cross-sectional design inherently limits causal inferences. Although significant associations and moderating effects were observed, the directionality between frailty, depressive symptoms, and walking frequency could not be definitively established. Therefore, longitudinal studies are needed to clarify the temporal relationships and potential causal pathways. Second, the reliance on self-reported measures, including weekly walking days and depressive symptoms assessed via the PHQ-9, may be subject to recall and social desirability biases. In addition, there is a potential limitation related to subjective bias in variable coding for the FI (e.g., self-care limitation coded as 0–0.5–1), noting that these variables may involve subjective interpretation and introduce bias. To minimize such biases, future research should integrate objective measures (e.g., wearable activity trackers) along with validated questionnaires. Third, although this study focused on middle-aged and older adults diagnosed with RA, it did not control for several clinical factors, such as pain severity, disease activity, or medication use, which may confound the associations between frailty and depressive symptoms. Future studies should adjust for these clinical variables and also examine how different forms of physical activity, such as resistance training or stretching, interact with frailty and mental health. Finally, the relatively small sample size and the fact that this study was conducted among Korean participants limit the generalizability of our findings. To strengthen external validity, future large-scale longitudinal studies are recommended. Moreover, intervention-based studies are warranted to assess the effectiveness of structured walking programs in reducing depressive symptoms and delaying the progression of frailty in patients with RA.

5 | Conclusion

This study investigated the moderating effect of weekly walking days on the association between frailty and depressive symptoms in middle-aged and older patients with RA, using nationally representative data. The findings revealed that frailty was significantly associated with depressive symptoms and that walking frequency moderated this relationship. Specifically, individuals who walked more frequently exhibited a weaker association between frailty and depression.

1098240x, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/nur.70066 by MS HYEON - Chung-Ang University , Wiley Online Library on [29/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

These results underscore the importance of physical activity, particularly walking, as a potential protective factor for mental health in frail patients with RA. Given the high burden of comorbidities, frailty, and depression in this population, strategies to promote regular walking—at a frequency of approximately 3.5 or more days per week—may be a feasible approach to explore. Moving forward, integrated approaches that combine physical, psychological, and behavioral support may be valuable for improving the overall quality of life of individuals with RA.

6 | Relevance for Clinical Practice

The findings of this study have exploratory clinical implications for the management of frailty and mental health in patients with RA. First, routine screening for frailty and depressive symptoms may help healthcare professionals identify individuals at high risk for adverse outcomes. Given the high prevalence of these conditions among patients with RA, early identification and targeted management are essential. The strong association between frailty and depressive symptoms underscores the value of multidisciplinary care approaches that address both physical and psychological well-being.

Second, promoting walking as a simple and accessible form of physical activity may be particularly beneficial for individuals who are frail or pre-frail. Unlike structured exercise programmes, which may be burdensome for older adults with RA, walking requires minimal resources and can be easily adapted to individual functional capacities. Health professionals may encourage patients to incorporate regular walking into their daily routines, while emphasizing the mental and physical health benefits of consistent moderate activity.

Third, the observed moderating role of walking suggests that, even in the presence of significant frailty, regular walking may be associated with a buffering of depressive symptoms. This finding supports the inclusion of walking-based activities as part of personalized care plans. Nurses and allied health professionals play key roles in assessing patients' readiness to engage in physical activity, helping set realistic walking goals, and providing ongoing motivation and support.

Author Contributions

Conceptualization: Wonhee Baek, Ari Min, Minkyung Kang. Methodology: Wonhee Baek, Ji Yea Lee, Ari Min, Minkyung Kang. Formal analysis: Wonhee Baek, Chang Gi Park. Supervision: Wonhee Baek, Minkyung Kang. Project administration: Wonhee Baek. Funding acquisition: Wonhee Baek. Visualization: Wonhee Baek. Writing – original draft: Wonhee Baek, Ji Yea Lee, Ari Min, Minkyung Kang. Writing – review and editing: Wonhee Baek, Ji Yea Lee, Ari Min, Minkyung Kang. All authors read and approved the final manuscript.

Acknowledgments

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean Government (MSIT) (no. RS-2024-00350086).

Disclosure

The authors have nothing to report.

Ethics Statement

The Institutional Review Board of Ajou University approved this study (approval no. AJOUIRB-EX-2025-021), and the requirement for written informed consent was waived.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are openly available in Korea Disease Control and Prevention Agency at https://knhanes.kdca.go.kr/knhanes/.

References

American College of Rheumatology. 2025. Rheumatoid Arthritis. Retrieved October 30, 2025. https://rheumatology.org/patients/rheumatoid-arthritis.

Aprahamian, I., M. K. Borges, D. J. C. Hanssen, H. W. Jeuring, and R. C. Oude Voshaar. 2022. "The Frail Depressed Patient: A Narrative Review on Treatment Challenges." *Clinical Interventions in Aging* 17: 979–990. https://doi.org/10.2147/CIA.S328432.

Baek, W., J. W. Lee, H. S. Lee, et al. 2021. "Concurrent Smoking and Alcohol Consumers Had Higher Triglyceride Glucose Indices Than Either Only Smokers or Alcohol Consumers: A Cross-Sectional Study in Korea." *Lipids in Health and Disease* 20, no. 1: 49. https://doi.org/10.1186/s12944-021-01472-2.

Baek, W., and A. Min. 2022. "Frailty Index and Gender-Specific Mortality in Korean Adults: Findings from the Korean Longitudinal Study of Aging (2006–2018)." *Journal of Advanced Nursing* 78, no. 8: 2397–2407. https://doi.org/10.1111/jan.15168.

Bozzalla-Cassione, E., S. Grignaschi, B. Xoxi, et al. 2022. "Insights into the Concept of Rheumatoid Arthritis Flare." *Frontiers in Medicine* 9: 852220. https://doi.org/10.3389/fmed.2022.852220.

Brady, S. M., S. A. M. Fenton, G. S. Metsios, et al. 2021. "Different Types of Physical Activity Are Positively Associated with Indicators of Mental Health and Psychological Wellbeing in Rheumatoid Arthritis During COVID-19." *Rheumatology International* 41, no. 2: 335–344. https://doi.org/10.1007/s00296-020-04751-w.

Canning, J., S. Siebert, B. D. Jani, et al. 2022. "Examining the Relationship Between Rheumatoid Arthritis, Multimorbidity, and Adverse Health-Related Outcomes: A Systematic Review." *Arthritis Care & Research* 74, no. 9: 1500–1512. https://doi.org/10.1002/acr.24587.

Clegg, A., J. Young, S. Iliffe, M. O. Rikkert, and K. Rockwood. 2013. "Frailty in Elderly People." *Lancet* 381, no. 9868: 752–762. https://doi.org/10.1016/S0140-6736(12)62167-9.

Cooney, G. M., K. Dwan, C. A. Greig, et al. 2013. "Exercise for Depression." *Cochrane Database of Systematic Reviews* no. 9: CD004366. https://doi.org/10.1002/14651858.CD004366.pub6.

Doody, P., J. M. Lord, C. A. Greig, and A. C. Whittaker. 2023. "Frailty: Pathophysiology, Theoretical and Operational Definition(S), Impact, Prevalence, Management and Prevention, in an Increasingly Economically Developed and Ageing World." *Gerontology* 69, no. 8: 927–945. https://doi.org/10.1159/000528561.

England, B. R., B. J. Smith, N. A. Baker, et al. 2023. "2022 American College of Rheumatology Guideline for Exercise, Rehabilitation, Diet, and Additional Integrative Interventions for Rheumatoid Arthritis." *Arthritis & Rheumatology (Hoboken, N.J.)* 75, no. 8: 1299–1311. https://doi.org/10.1002/art.42507.

Englbrecht, M., R. Alten, M. Aringer, et al. 2019. "New Insights Into the Prevalence of Depressive Symptoms and Depression in Rheumatoid

1098240x, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/nur.70066 by MS HYEON - Chung-Ang University , Wiley Online Library on [29/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Arthritis – Implications From the Prospective Multicenter VADERA II Study." *PLoS One* 14, no. 5: e0217412. https://doi.org/10.1371/journal.pone.0217412.

Fenton, S. A. M., J. J. C. S. Veldhuijzen van Zanten, G. S. Metsios, et al. 2018. "Autonomy Support, Light Physical Activity and Psychological Well-Being in Rheumatoid Arthritis: A Cross-Sectional Study." *Mental Health and Physical Activity* 14: 11–18. https://doi.org/10.1016/j.mhpa.2017.12.002.

Fried, L. P., C. M. Tangen, J. Walston, et al. 2001. "Frailty in Older Adults: Evidence for a Phenotype." *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 56, no. 3: 146–156. https://doi.org/10.1093/gerona/56.3.m146.

Gao, R. C., Z. G. Wu, Z. Z. Wu, M. Hao, and G. C. Wu. 2022. "Frailty in Rheumatoid Arthritis: A Systematic Review and Meta-Analysis." *Joint, Bone, Spine* 89, no. 4: 105343. https://doi.org/10.1016/j.jbspin.2022.105343.

Germonpré, S., S. Mulier, L. Falzon, A. Boonen, and M. Van Onna. 2023. "Prevalence of Frailty and Pre-Frailty in Patients With Rheumatoid Arthritis: A Systematic Literature Review and Meta-Analysis." *Clinical and Experimental Rheumatology* 41, no. 7: 1443–1450. https://doi.org/10.55563/clinexprheumatol/1kr7bs.

Hayes, A. F. 2017. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach.* Guilford Publications.

Jeon, K. H., K. Han, J. Jung, et al. 2024. "Rheumatoid Arthritis and Risk of Depression in South Korea." *JAMA Network Open* 7, no. 3: e241139. https://doi.org/10.1001/jamanetworkopen.2024.1139.

Kang, M., O. S. Kim, E. O. Hoogendijk, and H. W. Jung. 2023. "Trends in Frailty Prevalence Among Older Adults in Korea: A Nationwide Study From 2008 to 2020." *Journal of Korean Medical Science* 38, no. 29: e157. https://doi.org/10.3346/jkms.2023.38.e157.

Kim, M., S. Jung, J. E. Park, et al. 2023. "Validation of the Patient Health Questionnaire–9 and Patient Health Questionnaire–2 in the General Korean Population." *Psychiatry Investigation* 20, no. 9: 853–860. https://doi.org/10.30773/pi.2023.0000.

Kojima, M., T. Kojima, Y. Waguri-Nagaya, et al. 2021. "Depression, Physical Function, and Disease Activity Associated with Frailty in Patients with Rheumatoid Arthritis." *Modern Rheumatology* 31, no. 5: 979–986. https://doi.org/10.1080/14397595.2020.1838402.

Kroenke, K., R. L. Spitzer, and J. B. W. Williams. 2001. "The PHQ-9: Validity of a Brief Depression Severity Measure." *Journal of General Internal Medicine* 16, no. 9: 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x.

Lee, D. Y. 2025. "Rheumatoid Arthritis Prevalence and Risk Factors in Korean Adults: A Focus on Age and Sex Differences." *Medical Sciences (Basel, Switzerland)* 13, no. 1: 17. https://doi.org/10.3390/medsci13010017.

Manning-Bennett, A. T., A. M. Hopkins, M. J. Sorich, et al. 2022. "The Association of Depression and Anxiety with Treatment Outcomes in Patients with Rheumatoid Arthritis: A Pooled Analysis of Five Randomised Controlled Trials." *Therapeutic Advances in Musculoskeletal Disease* 14: 1759720X221111613. https://doi.org/10.1177/1759720X221111613.

Matcham, F., L. Rayner, S. Steer, and M. Hotopf. 2013. "The Prevalence of Depression in Rheumatoid Arthritis: A Systematic Review and Meta-Analysis." *Rheumatology* 52, no. 12: 2136–2148. https://doi.org/10.1093/rheumatology/ket169.

Metsios, G. S., A. Stavropoulos-Kalinoglou, and G. D. Kitas. 2020. "Exercise and Physical Activity in Rheumatoid Arthritis: Implications for Cardiovascular Risk and Disease Outcomes." supplementary, *Rheumatology* 59, no. S5: v19–v26. https://doi.org/10.1093/rheumatology/keaa418.

Ng, C. H., J. Xiao, N. W. S. Chew, et al. 2022. "Depression in Non-Alcoholic Fatty Liver Disease is Associated with an Increased Risk of Complications and Mortality." *Frontiers in Medicine* 9: 985803. https://doi.org/10.3389/fmed.2022.985803.

Ng, C. Y. H., S. H. Tay, R. S. McIntyre, R. Ho, W. W. S. Tam, and C. S. H. Ho. 2022. "Elucidating a Bidirectional Association Between Rheumatoid Arthritis and Depression: A Systematic Review and Meta-Analysis." *Journal of Affective Disorders* 311: 407–415. https://doi.org/10.1016/j.jad.2022.05.108.

Sung, Y. K., S. K. Cho, C. B. Choi, and S. C. Bae. 2013. "Prevalence and Incidence of Rheumatoid Arthritis in South Korea." *Rheumatology International* 33, no. 6: 1525–1532. https://doi.org/10.1007/s00296-012-2590-2.

Venetsanopoulou, A. I., Y. Alamanos, P. V. Voulgari, and A. A. Drosos. 2023. "Epidemiology and Risk Factors for Rheumatoid Arthritis Development." *Mediterranean Journal of Rheumatology* 34, no. 4: 404. https://doi.org/10.31138/mjr.301223.eaf.

World Health Organization. Rheumatoid Arthritis. 2023. https://www.who.int/news-room/fact-sheets/detail/rheumatoid-arthritis.

Xu, Z., X. Zheng, H. Ding, et al. 2024. "The Effect of Walking on Depressive and Anxiety Symptoms: Systematic Review and Meta-Analysis." *JMIR Public Health and Surveillance* 10: e48355. https://doi.org/10.2196/48355.

Yeom, Y. H., and S. J. Lee. 2023. "Moderating Effect of Physical Activity on the Relationship Between Perceived Stress and Depression in Patients with Ischemic Heart Disease: A Cross-Sectional Study." *Korean Journal of Adult Nursing* 35, no. 3: 204–211. https://doi.org/10.7475/kjan.2023.35.3.204.

Zhang, L., P. Cai, and W. Zhu. 2020. "Depression has an Impact on Disease Activity and Health-Related Quality of Life in Rheumatoid Arthritis: A Systematic Review and Meta-Analysis." *International Journal of Rheumatic Diseases* 23, no. 3: 285–293. https://doi.org/10.1111/1756-185X.13774.

Zhou, J., H. Chen, and C. Lin. 2024. "Frailty in the Elderly is Associated with an Increased Risk of Depression: A Systematic Review and Meta-Analysis." *Alpha Psychiatry* 25, no. 2: 175–182. https://doi.org/10.5152/alphapsychiatry.2024.231362.

Supporting Information

Additional supporting information can be found online in the Supporting Information section.
Supplementary Table 1: Deficits included in the frailty index. **Supplementary Table 2:** Conditional effects of frailty index on depressive symptoms across levels of weekly walking days. **Supplementary Table 3:** Sensitivity analysis of moderation analysis with modified frailty index. **Supplementary Table 4:** Conditional effects of modified frailty index on depressive symptoms across levels of weekly walking days.

1098240x, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/nur.70066 by MS HYEON - Chung-Ang University , Wiley Online Library on [29/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License