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Predicting physical activity and sarcopenia-related health outcomes in women with rheumatoid arthritis: A test of the self-determination theory

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Abstract

Aim: This study aimed to examine a hypothetical model of physical activity (PA) and health outcomes related to sarcopenia in women with rheumatoid arthritis (RA) based on self-determination theory.

Design: Cross-sectional study.

Methods: This study included 214 women diagnosed with RA from the outpatient rheumatology department of a university-affiliated hospital in South Korea. Data were collected from September 2019 to August 2020 through structured questionnaires and anthropometric measurements and analysed using path analysis to test the hypothesized model. The primary health outcomes were perceived health status and sarcopenia-related health (thigh circumference, handgrip strength and sarcopenia risk).

Results: The final model's fit indices were adequate. Physical activity was directly affected by motivation for PA, while depression, self-efficacy for PA, health care provider's autonomy support and basic psychological needs satisfaction indirectly affected PA. Physical activity directly affected perceived health status and thigh circumference, while perceived sarcopenia risk and handgrip strength were directly affected by disease activity and age.

Patient or Public Contribution: Patients were involved in a questionnaire-based survey.

KEYWORDS
depression, nursing, physical activity, rheumatoid arthritis, sarcopenia, self-determination

1 | INTRODUCTION

Rheumatoid arthritis (RA) is an inflammatory chronic systemic disease that causes tissue damage and loss of function due to an inflammatory reaction (Arthritis Foundation, 2020; Sharif et al., 2018). The prevalence of RA is 0.5%–1% in the global population (Arthritis Foundation, 2020) and 1.85% in South Korea (Kim & Sung, 2021), with women experiencing RA three times more frequently than men (Mollard et al., 2018). The global prevalence of RA increased significantly between 1980 and 2019, with 460 cases per 100,000 people

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(Almutairi et al., 2021). Approximately 18 million people worldwide have RA (World Health Organization, 2022). Furthermore, patients with RA have a greater risk of falls during aging, increasing threefold when gait and balance weakness or impairments occur (Ontan et al., 2021). In addition, RA, an inflammatory disease, invades the joints and the amount of activity decreases because of pain. Inflammation in the joint causes damage to tissues such as the surrounding muscles or ligaments (Mochizuki et al., 2019).

Therefore, patients with RA are at a higher risk of developing sarcopenia owing to chronic inflammation, decreased physical activity (PA), and the use of glucocorticoids (Arai, 2021, p. 179). The prevalence of sarcopenia ranges from 10% to 27% in individuals aged ≥60 years (Petermann-Rocha et al., 2022). Moreover, RA has many symptoms, such as fatigue, depression and sleep disorders, which negatively impact quality of life (Dar et al., 2022; Kim et al., 2021; Lee et al., 2020; Tański et al., 2022; Zhang et al., 2021). Technological advancements have facilitated remote care (Marques et al., 2022) and the use of wearable devices (Ocagli et al., 2023), which have been useful in monitoring PA in rheumatic and musculoskeletal diseases (RMDs). The increasing demand for health services among patients with RA is a global concern (Cai et al., 2023; Safiri et al., 2019), particularly given the increasing aging population.

1.1 | Background

Sarcopenia is operationally defined as a gradual loss or reduction in muscle mass (Cruz-Jentoft et al., 2021, p. 1). Older adults with sarcopenia are 1.5 times more likely to develop diseases such as diabetes, arthritis, cancer and stroke, and more than twice as likely to develop physical damage and disability than normal older adults (Takanashi et al., 2021). Moreover, in previous studies, the mortality rate was higher in the sarcopenia group than in the non-sarcopenia group (Malmstrom et al., 2016; Xia et al., 2020). Along with aging, RA disease activity is correlated with sarcopenia (Arai, 2021). In a study of sarcopenia in RA, more skeletal muscle loss and abnormal fat accumulation were observed in Estonian patients with early RA than in the control group without RA (Müller et al., 2019). Moreover, according to the Korea National Health and Nutrition Examination Survey, sarcopenia status and higher body mass index were associated with a higher risk of RA in adults (Yoon et al., 2017), thus increasing the risk of sarcopenia resulting in decreased muscle mass and muscle function (Tournadre et al., 2019).

Although the international consensus regarding definitions of sarcopenia is still a work in progress, to date, the Asian Working Group for Sarcopenia modified criteria (Chen et al., 2020) are the most often used by the Korean population. The criteria for the diagnosis of sarcopenia include evaluations of muscle mass, strength and physical performance. Thigh muscle mass has been a good predictor of whole-body skeletal muscle mass (Cruz-Jentoft & Sayer, 2019; Hodgkiss & McCarthy, 2017), while handgrip strength has been a good indicator of muscle strength for sarcopenia risk (Auyeung et al., 2014; Chen et al., 2020). In addition, the Strength, Assistance with walking, Rising from a chair, Climbing stairs and Falls (SARC-F) questionnaire has been used to screen for sarcopenia quickly and obviate the measurement of muscle mass in the clinical setting (Cao et al., 2014; Chen et al., 2020).

To date, consistent with the guidelines of the American College of Sports Medicine and the American Heart Association, regular PA (over 600 MET-min/week or 150 min/week) has been associated with a decreased risk of all-cause mortality and improved disease-related health outcomes (Peterson & Serra, 2021). However, despite the many benefits of PA, people with rheumatoid disease face many barriers to PA and lack the motivation to engage in PA (Veldhuijzen van Zanten et al., 2015). Moreover, the model explaining the factors associated with PA and health outcomes in women with RA at risk of sarcopenia is lacking. These findings suggest the importance of increasing motivation for PA, preventing loss of physical function due to tissue destruction, and controlling inflammation to minimize pain and loss of function, maintain daily life, and improve the health outcomes of individuals (Arthritis Foundation, 2020).

1.2 | Conceptual framework

Self-determination theory (SDT) is commonly used to enhance understanding of the factors associated with motivation, health behaviour and outcomes (Ryan & Deci, 2017). The SDT fosters the support of patients' autonomy by healthcare providers (HCP), enhances patients' intrinsic motivation and competence, and maintains the health outcomes of patients with chronic diseases (Williams et al., 2004). Furthermore, a recent PA interventional study based on SDT reported significantly increased autonomous motivation linked to increased engagement in PA in RA patients (Fenton et al., 2021). According to Ryan et al. (2008), SDT posits that each element (i.e. autonomy, a supportive environment, basic needs and autonomous motivation) affects health behaviour and outcomes. In addition, disease-related characteristics (i.e. disease activity) and psychological indicators (i.e. depression and self-efficacy) may affect PA and health outcomes in patients with RA.

This study aimed to examine a hypothetical model of PA and health outcomes based on SDT in women with RA at risk for sarcopenia. The author hypothesized that SDT-based factors (i.e. HCPs' autonomy support, basic needs and motivation) and other factors based on the literature (i.e. age, disease activity, depression and self-efficacy) would be associated with PA, perceived health status and sarcopenia-related health, such as thigh circumference for muscle mass, and handgrip strength for muscle strength in women with RA (Figure 1).

2 | THE STUDY

2.1 | Study design

This cross-sectional study employed path analysis to explore the hypothesis that SDT-based factors and other factors are associated with PA and sarcopenia-related health outcomes.

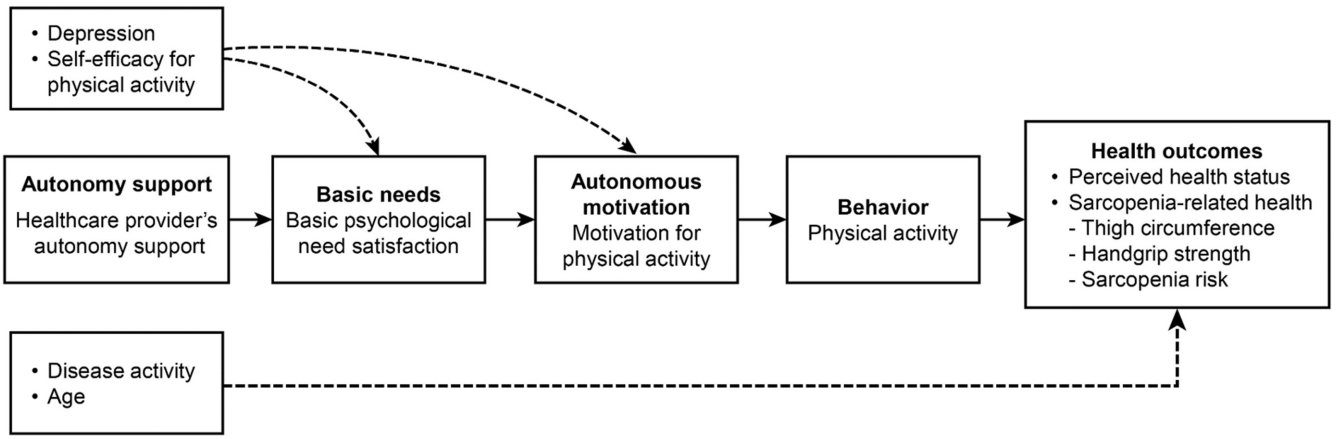

FIGURE 1 A hypothetical model of physical activity and sarcopenia-related health outcomes based on the self-determination theory in women with rheumatoid arthritis.

2.2 | Participants and setting

Participants were recruited from the outpatient department of rheumatology at a university-affiliated hospital, in South Korea. They were selected according to the following inclusion criteria: (1) adults (≥ 40 years), (2) women diagnosed with RA by a rheumatologist, according to the American College of Rheumatology Criteria 2010 and (3) participated voluntarily. In addition, participants were excluded if they had a history of a serious psychiatric disease (e.g. schizophrenia), terminal illness (e.g. cancer), or were taking oral steroids at a dosage of 2.5 mg or duration of 3 months or longer because chronic or continuous use of drugs may adversely affect bone calcium metabolism.

The sample size was determined based on the recommendation that a minimum sample size of 200 is required for studies using the structural equation model (Kline & Little, 2015).

2.3 | Data collection

Data were collected from September 2019 to August 2020 at the outpatient clinic during the participants' regular follow-ups using self-administered, structured questionnaires and clinical assessments by the physicians and the research nurse who was trained for this study. Laboratory data were collected from electronic medical records. The survey and anthropometric measurements required approximately 25–30 min to complete. A rheumatologist screened participants for eligibility, and a trained research nurse explained the study and obtained informed consent from each participant.

2.3.1 | Physical activity

The seven-item short form of the International Physical Activity Questionnaire (IPAQ) Korean version was used to assess PA levels (Oh et al., 2007). The IPAQ short form, developed by the International Consensus Group and adopted by the World Health Organization, assesses engagement in PA during the preceding 7 days and the duration of three types of intensity activities: (a) vigorous PA (8.0 METs), (b) moderate PA (4.0 METs) and (c) walking (3.3 METs). Based on the IPAQ score conversion method (Craig et al., 2003), the amount of total PA (metabolic equivalent of task minutes/week) was calculated by multiplying activity intensity by duration (minutes) and frequency of PA per week. The higher the metabolic equivalent of task minutes/week, the greater the amount of PA per week, with a score of over 600 classifying the participant as clinically physically active (Ainsworth et al., 2000). Spearman's rho clustered around 0.8, indicating acceptable stability (Craig et al., 2003).

2.3.2 | Health outcomes

Health outcomes were assessed based on (1) perceived health status and (2) sarcopenia-related health.

- Perceived health status
  Perceived health was measured with a single item, 'How is your health in general' on a five-point scale (ranging from 1 = very good to 5 = very bad).
- Sarcopenia-related health
  Sarcopenia-related health was measured by three aspects: thigh circumference (muscle mass), handgrip strength (muscle strength) and sarcopenia risk.
  - Thigh circumference: The degree of muscle mass was measured using thigh circumference. Participants' thigh circumference was measured perpendicular to the long axis of the thigh at the mid-point by a trained research nurse using a flexible inelastic fibreglass measuring tape about 0.7 cm wide (TANITA) marked in centimetres along one side.
  - Handgrip strength: Handgrip strength was measured by a trained researcher using a grip dynamometer (TKK5401®, Takei) while the participant was seated in a chair without lifting their arm from the chair's armrest. While the participant held the grip of the dynamometer and bent their elbow to 90°

so that the second joint of the finger was at a right angle, the researcher recorded the handgrip strength while encouraging them to apply maximum force for 4–5 s. With 60-s breaks between assessments, the researcher alternately measured the right and left hands twice and used the higher value of the two.

- Sarcopenia risk: Sarcopenia risk was measured using the self-administered questionnaire on sarcopenia (SARC-F). This scale consists of five questions about muscle strength, walking aids, getting up from a chair, climbing stairs and falling (Malmstrom et al., 2016). This scale consists of five items rated on a 3-point Likert scale (0 = not difficult at all, 1 = a little difficult, 2 = very difficult to perform). SARC-F scores ≥4 are defined as sarcopenia and are associated with poor functional outcomes (Malmstrom et al., 2016).

2.3.3 | Health care providers' autonomy support

Autonomy support was measured using the Korean version of the Health Care Climate Questionnaire (HCCQ) (Han & Shin, 2010) developed by Williams et al. (1996). The HCCQ comprises 15 items rated on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree), with total scores ranging from 7 to 105 points. Higher scores indicate a higher level of perceived HCP autonomy support. Cronbach's alpha coefficients were 0.94 in a previous study (Han & Shin, 2010) and 0.91 in the current study.

2.3.4 | Basic psychological need satisfaction

The Korean version of the Basic Psychological Needs Satisfaction (BPNS) scale (Lee & Kim, 2008) developed by Deci and Ryan (2000) was administered to measure the three basic psychological needs of participants. The BPNS scale has 18 items (six items on autonomy, six on competence and six on relationship) and uses a 7-point Likert scale (1 = not at all true to 7 = very true), with total scores ranging from 7 to 126 points. Higher scores represent greater satisfaction with basic psychological needs. Cronbach's alpha coefficients were 0.90 in a previous study and 0.86 in the current study.

2.3.5 | Motivation for physical activity

Motivation for PA was measured using the adapted Korean version of the Behavioural Regulation Exercise Questionnaire (BREQ)-2 (Cheon & Pyo, 2008) revised by Wilson and Rodgers (2004). This eight-item questionnaire measures identified and intrinsic exercise regulations and behavioural dimensions on a 5-point Likert scale (0 = not true for me to 4 = very true for me). The unidimensional index of the *degree* to which participants feel self-determination, known as the Relative Autonomy Index (Ryan & Connell, 1989), is a single-score index derived from the subscales where a higher score indicates greater relative autonomy. Cronbach's alpha reliabilities of identified and intrinsic regulation dimensions were 0.73 and 0.86 in a previous study (Wilson & Rodgers, 2004) and 0.82 and 0.93, respectively, in the current study.

2.3.6 | Depression

Depression was measured using the Geriatric Depression Scale (GDS) Short Form-Korean (Kee, 1996) developed by Sheikh and Yesavage (1986). This scale consists of 15 yes/no questions, with total scores ranging from 0 to 15 points. A higher score on the GDS indicates a more severe level of depression. Cronbach's α coefficient in a previous study (Kee, 1996) was 0.88. In this study, the reliability of the test, as measured by the Kuder Richardson (KR-20) was 0.82.

2.3.7 | Self-efficacy for physical activity

Self-efficacy for PA was measured using the Self-Efficacy for Exercise Scale-Korean (SEE-K) (Choi et al., 2015) developed by Resnick and Jenkins (2000). This 9-item scale measures self-efficacy in activity disorder and performance on a 10-point Likert scale (0 = not confident to 10 = very confident), with total scores ranging from 0 to 90 points. Higher scores indicate better self-efficacy for PA. Cronbach's alpha coefficients were 0.83 in a previous study (Choi et al., 2015) and 0.84 in the current study.

2.3.8 | Disease activity

RA disease activity was measured with the Disease Activity Score in 28 Joints (DAS28). DAS28 is a scoring system used to evaluate disease activity and response to treatment in patients with rheumatoid arthritis (Prevoo et al., 1995). The DAS28 considers tender 28-joint counts (TJC28) and swollen 28-joint counts (SJC28), general health (GH) patient assessment of disease activity using a 100 mm visual analog scale with 0 = best, 100 = worst, plus levels of an acute phase reactant Erythrocyte Sedimentation Rate (ESR, mm/h). DAS28-ESR values were calculated as DAS28 $\text{ESR} = 0.56 * \sqrt{\text{TJC28}} + 0.28 * \sqrt{\text{SJC28}} + 0.014 * \text{GH} + 0.70 * \ln(\text{ESR})$. A DAS28 score of <2.6 indicates remission according to the European League Against Rheumatism (EULAR) response criteria (Wells et al., 2009).

2.3.9 | Comorbidity

The Charlson Comorbidity Index (CCI) was used to evaluate comorbid conditions (Charlson et al., 1987). The CCI consists of 19 items corresponding to different medical comorbid conditions displaying

different clinical weights for each condition, ranging from 1, 2, 3 or 6. Higher total scores indicate a greater mortality risk and more severe comorbid conditions.

2.3.10 | Disability

Disability was measured using the Health Assessment Questionnaire–Disability Index (HAQ-DI) comprising 20 items distributed across 8 components (Fries et al., 1982). The scores for each dimension were corrected for the use of aids or devices, summated and transformed to give an overall disability index (DI) score between 0 (no disability) and 3 (high-dependency disability).

2.4 | Data analysis

The data were analysed using IBM SPSS and AMOS version 26.0. The subjects' general characteristics, disease-related characteristics, and the level of study variables were analysed with descriptive statistics. Cronbach's alpha coefficients were used to measure the reliability of the scales; Pearson correlation measured the relationships among study variables. The significance level was set at $p < 0.05$.

We tested the model using path analysis and assessed its fit by examining several indicators. In this study, acceptable model fit (Kline & Little, 2015) was defined by the following criteria: comparative fit index (CFI) and Tucker-Lewis index (TLI) ≥ 0.90, root mean square error of approximation (RMSEA) ≤0.06 and standardized root mean square residual (SRMR) <0.08. In addition, Bootstrapping (1000 times) was used to test the indirect effects; all path coefficients are reported as standardized estimates.

2.5 | Ethical consideration

This study was conducted in compliance with the principles of the Declaration of Helsinki. The Medical Ethics Committee of the first author's Institutional Review Board approved the study protocol (IRB No. AJIRB-BMR-SUR-19-324). All the patients agreed to participate in this study and provided written informed consent.

3 | RESULTS

3.1 | Participants' general and disease-related characteristics

The sociodemographic and disease-related characteristics of the 214 participants are shown in Table 1. The participants' mean age was 62.87 (SD = 7.61, range 41–82), and 76.6% of participants had completed six or more years of education. The mean duration of RA was 10.05 years (SD = 5.77, range 15.2–35.8). The mean counts of the tender joint count was 4.03 (SD = 4.29) and the swollen joint count was 1.31 (SD = 2.67), due to RA. The number of patients with non-inflammatory residual pain showing a difference equal or more than 7 between tender and swollen joints was 16 (7.5%). Over half of the women (53.3%, $n = 114$) were positive on the rheumatoid factor (RF), whereas 37.4% ($n = 80$) had a positive anti-citrullinated protein/peptide antibody (ACPA). Most patients (87.9%) were taking disease modifying antirheumatic drugs (DMARDs) and 8.9% were taking Biologic/Targeted synthetic DMARDs, and 3% had not used any DMARDs. The mean Charlson Comorbidity score was 1.22 (SD = 0.51, range 1–4). The common comorbidities were peptic ulcer disease (8.9%), diabetes (6.1%), mild liver disease (4.7%) and peripheral vascular disease (2.8%). The mean of HAQ-DI score was 0.29 (SD = 0.31, range 0–1), and 95.8% of participants had no disability; only 4.2% had a low-dependency disability. In addition, half of the participants (50.0%) currently use steroids, and the mean of total steroid use was 51.07 months (SD = 53.80). Moreover, 43.0% of participants had been diagnosed with osteoarthritis, and 53.7% had been diagnosed with sarcopenia.

3.2 | Descriptive statistics of study variables

Table 1 presents the descriptive statistics of the study variables. The mean (SD) scores were depression 6.00 (3.86) out of 15, self-efficacy for PA 46.85 (21.81) out of 90 and basic psychological need satisfaction 93.95 (16.04) out of 126. The mean (SD) score for motivation of PA was 27.49 (8.40) out of 40. The mean (SD) score for total PA level was 1882.82 (2390.92) MET-min/week, and 64.5% ($n = 138$) of the participants engaged in active (>600 MET-min/week) PA. The mean (SD) scores for disease activity were 3.01 (1.20) out of 9.74 and 38.3% ($n = 82$) of the participants were in DAS28 remission (<2.6 of DAS28). The mean (SD) score for perceived health status was 3.46 (0.77). Regarding sarcopenia-related health outcomes, the mean score for thigh circumferences (cm) was 41.73 (4.96), handgrip strength (kg) 18.48 (5.17) and sarcopenia risk 1.81 (1.77) out of 5, respectively.

3.3 | Multicollinearity between study variables

Table 2 shows the bivariate correlations between the study variables. There was no autocorrelation (Durbin–Watson statistic = 1.857–2.242) or multicollinearity between the measured variables. Tolerance ranged from 0.459 to 0.919, the variance inflation factor ranged from 1.088 to 2.178, and the correlation coefficient between variables ranged from 0.008 to 0.558.

3.4 | An empirical test of the hypothesized path model

The hypothesized model was tested and modified by removing the non-significant paths (from PA to sarcopenia risk and handgrip

TABLE 1 General characteristics and descriptive statistics of the variables ($n = 214$).

Variables	n (%) or mean ± SD
Age (years)	62.87 ± 7.61
Education	
≤Elementary school	50 (23.4)
Middle and high school	129 (60.2)
≥Graduate school	35 (16.4)
Marital status, yes	183 (84.3)
Job, yes	72 (33.2)
Post menopause, yes	202 (94.4)
Duration of RA (years)	10.05 ± 5.77
Morning stiffness, yes	129 (60.3)
Tender joint count	4.03 ± 4.29
Swollen joint count	1.31 ± 2.67
RF, positive	114 (53.3)
ACPA, positive	80 (37.4)
DMARDs, yes	188 (87.9)
Biologic/targeted synthetic DMARDs	19 (8.9)
NSAID use, yes	161 (75.2)
Glucocorticoids use, yes	107 (50.0)
Total steroid use (months)	51.07 ± 53.80
Disease activity (DAS28)	3.01 ± 1.20
Comorbidities	
Diabetes	13 (6.1)
Peptic ulcer disease	19 (8.9)
Mild liver disease	10 (4.7)
Peripheral vascular disease	6 (2.8)
Rheumatologic disease	214 (100.0)
CCI score	1.22 ± 0.51
HAQ-DI	0.29 ± 0.31
0	205 (95.8)
1	9 (4.2)
Depression	6.00 ± 3.86
Self-efficacy for PA	46.85 ± 21.81
HCP's autonomy support	80.14 ± 16.19
Basic psychological need satisfaction	93.95 ± 16.04
Motivation of PA	27.49 ± 8.40
Physical activity (MET-min/week)	1882.82 ± 2390.92
Perceived health status	3.46 ± 0.77
Thigh circumference (cm)	41.73 ± 4.96
Handgrip strength (kg)	18.48 ± 5.17
Sarcopenia risk	1.81 ± 1.77

Abbreviations: ACPA, anti-citrullinated protein/peptide antibody; CCI, Charlson Comorbity Index; DAS28, disease activity score; DMARDs, disease modifying antirheumatic drugs; HAQ-DI, Health Assessment Questionnaire Disability Index; HCP, health care providers; NSAID: non-steroid anti-inflammatory drugs; PA, physical activity; RA, rheumatoid arthritis; RF, rheumatoid factor; SD, standard deviation.

TABLE 2 Correlations of study variables ($n = 214$).

Variables	X_1	X_2	X_3	X_4	X_5	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
X_1. Age	1										
X_2. Disease activity	0.13	1									
X_3. Depression	−0.05	0.22**	1								
X_4. Self-efficacy for PA	0.14*	−0.19**	−0.22**	1							
X_5. HCPs' autonomy support	0.02	−0.08	−0.20**	0.07	1						
Y_1. Basic needs	−0.05	−0.09	−0.49***	0.24***	0.26***	1					
Y_2. Motivation of PA	−0.03	−0.16*	−0.31***	0.56***	0.40***	0.43***	1				
Y_3. Physical activity	−0.04	−0.13	−0.19**	0.26***	0.35***	0.30***	0.48***	1			
Y_4. Perceived health status	−0.06	0.29***	0.47***	−0.27***	−0.22***	−0.25***	−0.25***	−0.26***	1		
Y_5. Thigh circumference	−0.23**	−0.17*	−0.14*	−0.03	0.17*	0.15*	0.19**	0.23**	−0.09	1	
Y_6. Handgrip strength	−0.25***	−0.48***	−0.18*	0.05	0.08	0.13	0.10	0.07	−0.18**	0.15*	1
Y_7. Sarcopenia risk	0.31***	0.39***	0.18**	−0.12	−0.05	−0.18**	−0.20**	−0.16*	0.27***	−0.15*	−0.42***

Abbreviations: Basic needs, basic psychological need satisfaction; HCP, health care providers; PA, physical activity.

*$p < 0.05$;; **$p < 0.01$;; ***$p < 0.001$.

TABLE 3 Total, direct and indirect effects for study model ($n=214$).

Endogenous variables	Exogenous variables	SMC	Direct effect β (p)	Indirect effect β (p)	Total effect β (p)
Basic needs	HCP support	0.28	0.16 (0.003)		0.16 (0.003)
	Depression		−0.43 (0.002)		−0.43 (0.002)
	Self-efficacy		0.14 (0.010)		0.14 (0.010)
Motivation	Basic needs	0.50	0.23 (0.002)		0.23 (0.002)
	HCP support		0.31 (0.005)	0.04 (0.002)	0.35 (0.003)
	Depression			−0.10 (0.001)	−0.10 (0.001)
	Self-efficacy		0.48 (0.002)	0.03 (0.005)	0.51 (0.002)
Physical activity	Motivation	0.23	0.48 (0.001)		0.48 (0.001)
	Basic needs			0.11 (0.002)	0.11 (0.002)
	HCP support			0.17 (0.001)	0.17 (0.001)
	Depression			−0.05 (0.001)	−0.05 (0.001)
	Self-efficacy			0.25 (0.001)	0.25 (0.001)
Perceived health status	Depression	0.27	−0.40 (0.002)	−0.008 (0.017)	−0.41 (0.001)
	Physical activity		0.16 (0.038)		0.16 (0.038)
	Motivation			0.08 (0.028)	0.08 (0.028)
	Basic needs			0.02 (0.018)	0.02 (0.018)
	HCP support			0.03 (0.026)	0.03 (0.026)
	Self-efficacy			0.04 (0.025)	0.04 (0.025)
	Disease activity		−0.18 (0.003)		−0.18 (0.003)
Thigh circumference	Physical activity	0.09	0.22 (0.003)		0.22 (0.003)
	Motivation			0.11 (0.003)	0.11 (0.003)
	Basic needs			0.03 (0.002)	0.03 (0.002)
	HCP support			0.04 (0.003)	0.04 (0.003)
	Self-efficacy			0.06 (0.002)	0.06 (0.002)
	Depression			−0.01 (0.001)	−0.01 (0.001)
	Age		−0.22 (0.003)		−0.22 (0.003)
Handgrip strength	Disease activity	0.26	−0.45 (0.002)		−0.45 (0.002)
	Age		−0.19 (0.004)		−0.19 (0.004)
Sarcopenia risk	Disease activity	0.22	0.36 (0.003)		0.36 (0.003)
	Age		0.26 (0.003)		0.26 (0.003)

Abbreviations: Basic needs, basic psychological need satisfaction; HCP support, health care provider's autonomy support; Motivation, motivation for physical activity; Self-efficacy, self-efficacy for physical activity; SMC, squared multiple correlation; β, standardized coefficient.

strength; from depression to motivation for PA) and by adding two paths (from HCPs' support to motivation for PA; from depression to perceived health status). Overall, the fit indices demonstrated an acceptable fit between the data and the modified model: $\chi^2=69.83$, $df=40$, $p=0.002$, CMIN/DF = 1.75, CFI = 0.94, TLI = 0.91, RMSEA = 0.059 and SRMR = 0.068.

In Table 3, the path analysis indicated that depression, HCPs' autonomy support, and self-efficacy for PA directly affect basic psychological need satisfaction ($\beta=-0.43$, $p=0.002$; $\beta=0.16$, $p=0.003$; $\beta=0.14$, $p=0.010$, respectively). HCPs' autonomy support, self-efficacy for PA, and basic psychological need satisfaction directly affect motivation for PA ($\beta=0.31$, $p=0.005$; $\beta=0.48$, $p=0.002$; $\beta=0.23$, $p=0.002$). Motivation for PA directly affects PA ($\beta=0.48$, $p=0.001$). Perceived health status was directly affected by depression, PA, and disease activity ($\beta=-0.40$, $p=0.002$; $\beta=0.16$, $p=0.038$; $\beta=-0.18$, $p=0.003$). Sarcopenia-related health (thigh circumference, handgrip strength and sarcopenia risk) was directly affected by PA, disease activity and age. Table 3 reveals the total, direct and indirect effects of the study variables on PA and health outcomes. Overall, the modified model explained 23% of the variance in PA, 27% in perceived health status, and 9%, 26% and 22% in thigh circumference, handgrip strength and sarcopenia risk, respectively. The final path model with standardized coefficients R^2 is presented in Figure 2.

4 | DISCUSSION

We used a hypothesized model based on SDT to examine factors influencing PA and health outcomes, including perceived health status and sarcopenia-related health in women with RA at risk for sarcopenia. The present study confirmed previous findings and provided additional evidence of the association between PA with thigh circumference. However, this study did not include handgrip strength, which is associated with disease activity.

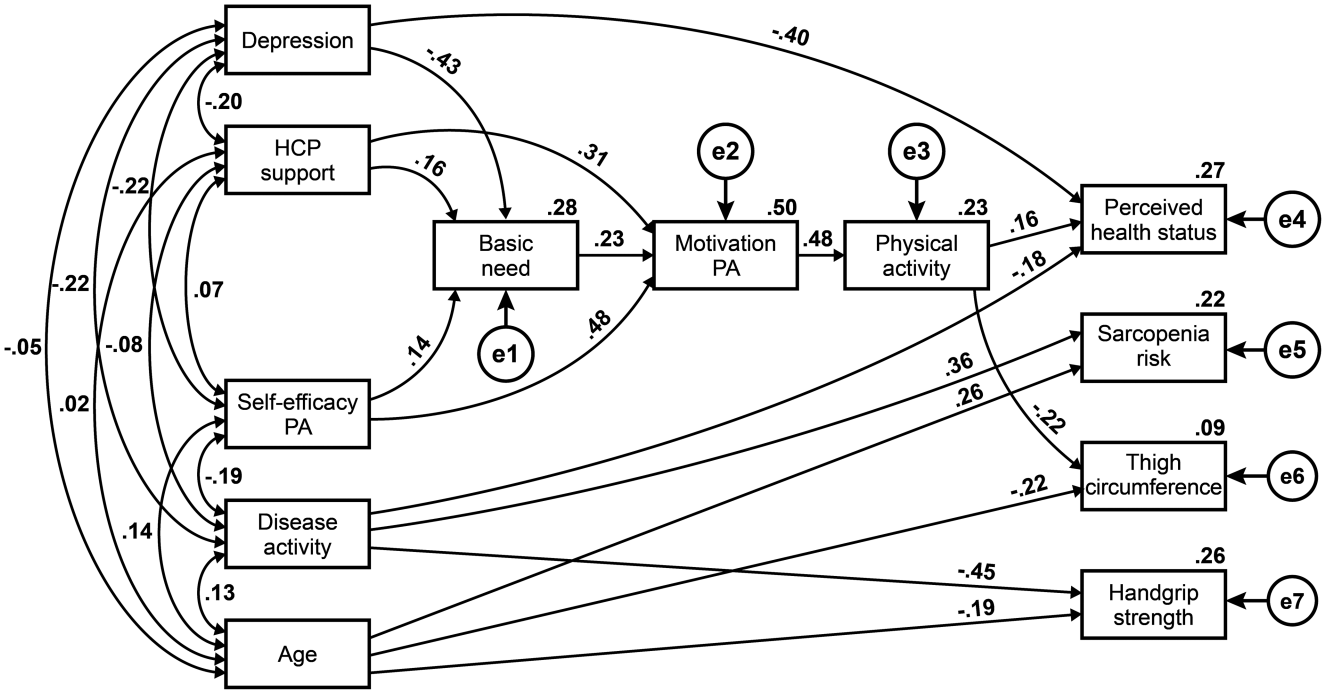

FIGURE 2 Final model of path analysis. HCP support, health care provider's support; Basic needs, Basic psychological need satisfaction; Self-efficacy PA, self-efficacy for physical activity; Motivation PA, Motivation for physical activity.

In line with SDT, the current results showed that PA motivation was directly associated with PA. Furthermore, previous studies have demonstrated that motivation promotes PA, and that low motivation is a barrier to PA in the RA population (Thomas et al., 2019; Verhoeven et al., 2016). These findings imply that preserving a high level of motivation is essential in PA. Moreover, motivation was directly or indirectly affected by several factors, such as depressive symptoms, HCPs' autonomy support, basic psychological need satisfaction and self-efficacy for PA. Therefore, early assessment of depressive symptoms and self-efficacy for PA, including supporting HCPs to meet individual needs, may help encourage motivation in women with RA who are at risk of sarcopenia.

This study showed that PA positively affected health outcomes. These results support previous studies that showed that PA improved positive perceptions of an individual's health status (Denche-Zamorano et al., 2022) and lowered sarcopenia risk (Lee et al., 2008; Oliveira et al., 2020; Steffl et al., 2017). Furthermore, a systematic review conducted to examine the effects of PA on sarcopenia in older individuals reported that PA was beneficial for preventing sarcopenia. Therefore, encouraging PA is vital for people with an inactive lifestyle to prevent or delay the risk of sarcopenia. Remote care and the use of wearable devices could be particularly beneficial for managing RMDs and potentially improving health outcomes for individuals with RA (Marques et al., 2022; Ocagli et al., 2023).

People with RA reportedly have a greater risk of developing sarcopenia (Li et al., 2021). Reduced muscle mass and strength, such as handgrip strength, are good indicators of sarcopenia risk (Auyeung et al., 2014; Chen et al., 2020). As indicated in a systematic review that reported PA as a beneficial factor for preventing sarcopenia (Steffl et al., 2017), we expected to find a significant association between PA and muscle mass measured as thigh circumference and muscle strength measured through handgrip strength. However, PA was only associated with thigh circumference and not handgrip strength.

In contrast, this study found that disease activity was associated with handgrip strength. Further studies are required to confirm these results. However, the current findings indicate that assessing women's thigh circumference and handgrip strength, particularly those with RA, and monitoring their changes for early recognition of possible sarcopenia risk is necessary. It also indicates that promoting handgrip strength exercises based on functional status could be helpful when promoting PA. Furthermore, it is advisable to promote awareness of sarcopenia-related health among women and their caregivers and disseminate information via multiple channels, including public media and social networking, to reduce the health disparity regarding sarcopenia-related health.

In our study, the mean DAS28 level ranged from low to remission, and the mean level of depressive symptoms was within the normal range. These findings may indicate that the study population could comprise a good responder to treatment cohort with higher psychological well-being. A study conducted with 379 adults (124 of whom had sustained remission) found that suboptimal psychosocial well-being and perceptions of negative illness predict a lower probability of sustained remission in RA (Doumen et al., 2023). Similarly, the present study revealed that depression was associated with disease activity and negatively affected perceived health status. Combined with the above finding, our study

emphasizes the importance of assessing and managing psychological well-being and illness perceptions to optimize the care and quality of life of individuals with RA. In addition, peripheral and central sensitization of pain is important in the long-term health outcome of RA patients. Although the number of current study patients with non-inflammatory residual pain was 7.5%, future research should assess residual pain using a central sensitization inventory (CSI) questionnaire or other tests.

As expected, age was associated with sarcopenia-related health in this study, confirming earlier studies that reported that sarcopenia risk was positively associated with increasing age (Chen et al., 2020; Cruz-Jentoft & Sayer, 2019; Ishii et al., 2014), implying that age is a biomedical barrier to sarcopenia. Thus, assessment of sarcopenia-related health should be included in regular check-ups of older adults.

HCPs' autonomy support was directly associated with basic psychological need satisfaction, consistent with SDT. In contrast to SDT, HCPs' autonomy support also directly correlated with motivation for PA. Furthermore, HCPs' autonomy support positively affected the motivation for PA in women with RA. Previous studies have demonstrated that people with HCPs' support for PA are more likely to engage in PA and that the lack of this support was a barrier to PA (Katz et al., 2020; Veldhuijzen van Zanten et al., 2015). Therefore, increased support from HCPs may be significant.

The findings of this study showed that women with higher levels of depressive symptoms had lower PA levels and perceived health status. Previous studies reported that depressive symptoms were prevalent in individuals with RA and sarcopenia (Chang et al., 2017; Fakra & Marotte, 2021). These findings demonstrate the importance of reducing the incidence of depressive symptoms. Furthermore, higher levels of PA and lower levels of depressive symptoms were significantly associated with increased perceived health status. By contrast, higher disease activity and age were significantly associated with an increased risk of sarcopenia. These findings underscore that an integrated approach tailored to individual needs by promoting motivation, self-efficacy, support from HCPs, and reducing depressive symptoms is vital for women with RA at risk of sarcopenia. To the best of our knowledge, this is the first study to examine the extended model based on SDT to explain health outcomes (perceived health status and sarcopenia-related health) in women with RA at risk of sarcopenia prevalent in the RA population. These findings would help HCPs implement evidence-based practice in sarcopenia-related health.

5 | LIMITATIONS

This study had some limitations. Data were obtained from adult women using a convenience sampling method from a single university hospital in South Korea, limiting the generalizability of these results. Nutrition, a predisposing factor for sarcopenia (Sieber, 2019), was not considered. We used the 'GDS' to assess participant depression (middle-aged and older adults), which could limit the generalizability of the findings. Disability was not included in the model because most patients had no disability. However, future studies assessing PA and health outcomes in people with RA need to use a model that includes disability. Another limitation of our study is that the DAS28, although an extremely useful tool to evaluate disease activity and treatment response in RA, does not allow for a complete assessment of lower limb strength because it does not consider the feet and ankles (Erdem & Kanar, 2023; Rutkowski et al., 2022). In addition, the path model used a cross-sectional design, which limits inferences regarding causality. Future research should include larger samples with a longitudinal design to increase generalizability and confirm the findings. Despite these limitations, this study fills the knowledge gap in exploring factors associated with PA and health outcomes in women with RA at risk of sarcopenia.

6 | CONCLUSION

The results confirmed that the expanded model based on SDT is suitable for predicting PA and sarcopenia-related health in women with RA. Factors such as disease activity, age and PA affect sarcopenia-related health. For example, PA was associated with thigh circumference, whereas disease activity and age were associated with handgrip strength and sarcopenia risk. Based on the study's results, recommendations for HCPs include educating patients and caregivers, such as family members, about the importance of PA in decreasing sarcopenia risk and promoting perceived health status. In addition, HCPs can incorporate assessments for depressive symptoms, self-efficacy, motivation for PA and disease activity (sarcopenia risk) into routine clinical practice to promote PA and health outcomes regarding sarcopenia.

AUTHOR CONTRIBUTIONS

Chun-Ja Kim, Hee Sun Kang and Elizabeth A Schlenk designed the study and wrote the first draft of the manuscript. Chun-Ja Kim, Hye-Won Yun, and Ju-Yang Jung contributed to acquisition of data. Hee Sun Kang and Chun-Ja Kim have made a substantial contribution to analysis and interpretation of data. All authors contributed to the writing or revision of the manuscript for important intellectual content. All authors approved the final version of the manuscript. All authors listed meet the authorship criteria according to the latest guidelines of the International Committee of Medical Journal Editors and are in agreement with the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to further analyses.

ETHICS STATEMENT

This study was conducted in compliance with the principles of the Declaration of Helsinki. The Institutional Review Board of Ajou University Hospital approved the study protocol (IRB No. AJIRB-BMR-SUR-19-324). All patients agreed to participate in this study and provided written informed consent.

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REFERENCES

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., O'Brien, W. L., Bassett, D. R., Jr., Schmitz, K. H., Emplaincourt, P. O., Jacobs, D. R., Jr., & Leon, A. S. (2000). Compendium of physical activities: An update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise*, *32*, S498–S504. https://doi.org/10.1097/00005768-200009001-00009

Almutairi, K., Nossent, J., Preen, D., Keen, H., & Inderjeeth, C. (2021). The global prevalence of rheumatoid arthritis: A meta-analysis based on a systematic review. *Rheumatology International*, *41*(5), 863–877. https://doi.org/10.1007/s00296-020-04731-0

Arai, H. (2021). Sarcopenia and other chronic organ diseases. In A. J. Cruz-Jentoft & J. E. Morley (Eds.), *Sarcopenia* (2nd ed., pp. 175–183). https://doi.org/10.1002/9781119597896.ch14

Arthritis Foundation. (2020). *Arthritis by the numbers*. Retrieved from https://www.arthritis.org/getmedia/73a9f02d-7f91-4084-91c3-0ed0b11c5814/abtn-2020-final.pdf

Auyeung, T. W., Lee, S. W., Leung, J., Kwok, T., & Woo, J. (2014). Age-associated decline of muscle mass, grip strength and gait speed: A 4-year longitudinal study of 3018 community-dwelling older Chinese. *Geriatrics & Gerontology International*, *14*, 76–84. https://doi.org/10.1111/ggi.12213

Cai, Y., Zhang, J., Liang, J., Xiao, M., Zhang, G., Jing, Z., Lv, L., Nan, K., & Dang, X. (2023). The burden of rheumatoid arthritis: Findings from the 2019 global burden of diseases study and forecasts for 2030 by Bayesian age-period-cohort analysis. *Journal of Clinical Medicine*, *12*(4), 1291. https://doi.org/10.3390/jcm12041291

Cao, L., Chen, S., Zou, C., Ding, X., Gao, L., Liao, Z., Liu, G., Malmstrom, T. K., Morley, J. H., Flaherty, J. E., An, Y., & Dong, B. (2014). A pilot study of the SARC-F scale on screening sarcopenia and physical disability in the Chinese older people. *The Journal of Nutrition, Health & Aging*, *18*, 277–283. https://doi.org/10.1007/s12603-013-0410-3

Chang, K. V., Hsu, T. H., Wu, W. T., Huang, K. C., & Han, D. S. (2017). Is sarcopenia associated with depression? A systematic review and meta-analysis of observational studies. *Age & Ageing*, *46*, 738–746. https://doi.org/10.1093/ageing/afx094

Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. *Journal of Chronic Diseases*, *40*(5), 373–383. https://doi.org/10.1016/0021-9681(87)90171-8

Chen, L. K., Woo, J., Assantachai, P., Auyeung, T. W., Chou, M. Y., Iijima, K., Jang, H. C., Kang, L., Kim, M., Kim, S., Kojima, T., Kuzuya, M., Lee, J., Lee, S. Y., Lee, W.-J., Lee, Y., Liang, C.-K., Lim, J.-Y., Lim, W. S., … Arai, H. (2020). Asian Working Group for sarcopenia: 2019 consensus update on sarcopenia diagnosis and treatment. *Journal of the American Medical Directors Association*, *21*, 300–307.e2. https://doi.org/10.1016/j.jamda.2019.12.012

Cheon, K. M., & Pyo, N. S. (2008). Predicting stage of change in exercise behavior through basic psychological needs and behavior regulation to exercise of adolescence. *Korean Society of Sport Psychology*, *19*, 33–44.

Choi, M., Ahn, S., & Jung, D. (2015). Psychometric evaluation of the Korean version of the self-efficacy for exercise scale for older adults. *Geriatric Nursing*, *36*, 301–305. https://doi.org/10.1016/j.gerinurse.2015.03.005

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*, 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Cruz-Jentoft, A. J., Montero-Errasquín, B., & Morley, J. E. (2021). Definitions of sarcopenia. In A. J. Cruz-Jentoft & J. E. Morley (Eds.), *Sarcopenia* (2nd ed., p. 19). John Wiley & Sons. https://doi.org/10.1002/9781119597896.ch1

Cruz-Jentoft, A. J., & Sayer, A. A. (2019). Sarcopenia. *Lancet (London, England)*, *393*, 2636–2646. https://doi.org/10.1016/S0140-6736(19)31138-9

Dar, W. R., Mir, I. A., Siddiq, S., Nadeem, M., & Singh, G. (2022). The assessment of fatigue in rheumatoid arthritis patients and its impact on their quality of life. *Clinics and Practice*, *12*(4), 591–598. https://doi.org/10.3390/clinpract12040062

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*, 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Denche-Zamorano, Á., Mendoza-Muñoz, M., Carlos-Vivas, J., Muñoz-Bermejo, L., Rojo-Ramos, J., Pastor-Cisneros, R., Giakoni-Ramírez, F., Godoy-Cumillaf, A., & Barrios-Fernandez, S. (2022). A cross-sectional study on self-perceived health and physical activity level in the Spanish population. *International Journal of Environmental Research and Public Health*, *19*, 5656. https://doi.org/10.3390/ijerph19095656

Doumen, M., De Cock, D., Pazmino, S., Bertrand, D., Joly, J., Westhovens, R., & Verschueren, P. (2023). Psychosocial burden predicts sustained remission in early rheumatoid arthritis: Unraveling the complex interplay of well-being and disease activity. *Arthritis Care & Research*, *75*(4), 758–767. https://doi.org/10.1002/acr.24847

Erdem, I. H., & Kanar, M. (2023). Foot deformities in rheumatoid arthritis patients and their effects on foot functions. *European Review for Medical and Pharmacological Sciences*, *27*(5), 1844–1851. https://doi.org/10.26355/eurrev_202303_31547

Fakra, E., & Marotte, H. (2021). Rheumatoid arthritis and depression. *Joint, Bone, Spine*, *88*(5), 105200. https://doi.org/10.1016/j.jbspin.2021.105200

Fenton, S. A. M., Veldhuijzen van Zanten, J. J., Metsios, G. S., Rouse, P. C., Yu, C. A., Ntoumanis, N., Kitas, G. D., & Duda, J. L. (2021). Testing a self-determination theory-based process model of physical activity behavior change in rheumatoid arthritis: Results of a randomized controlled trial. *Translational Behavioral Medicine*, *11*, 369–380. https://doi.org/10.1093/tbm/ibaa022

Fries, J. F., Spitz, P. W., & Young, D. Y. (1982). The dimensions of health outcomes: The health assessment questionnaire, disability and pain scales. *The Journal of Rheumatology*, *9*(5), 789–793.

Han, S., & Shin, H. (2010). Development and validation of the basic psychological needs satisfaction scale in therapeutic relationships. *The Korean Journal of Counselling and Psychology*, *22*, 993–1021.

Hodgkiss, A., & McCarthy, H. (2017). Thigh circumference measurement as a potential marker of leg skeletal muscle mass–cross sectional study in a US population age 39–69 years. *Proceedings of the Nutrition Society*, *76*, E14. https://doi.org/10.1017/S0029665117000143

Ishii, S., Tanaka, T., Shibasaki, K., Ouchi, Y., Kikutani, T., Higashiguchi, T., Obuchi, S. P., Ishikawa-Takata, K., Hirano, H., Kawai, H., Tsuji, T., & Iijima, K. (2014). Development of a simple screening test for sarcopenia in older adults. *Geriatrics & Gerontology International*, *14*, 93–101. https://doi.org/10.1111/ggi.12197

Katz, P., Andonian, B. J., & Huffman, K. M. (2020). Benefits and promotion of physical activity in rheumatoid arthritis. *Current Opinion in Rheumatology*, *32*, 307–314. https://doi.org/10.1097/BOR.0000000000000696

Kee, B. S. (1996). A preliminary study for the standardization of geriatric depression scale short form-Korea version. *Journal of Korean Neuropsychiatric Association*, *35*, 298–306.

Kim, H., & Sung, Y. K. (2021). Epidemiology of rheumatoid arthritis in Korea. *Journal of Rheumatic Diseases*, *28*(2), 60–67. https://doi.org/10.4078/jrd.2021.28.2.60

Kim, J. D., Choi, J. Y., Lee, D. W., & Oh, K. J. (2021). A clinical validity study on the Korean version of older adult behavior checklist. *Journal of Clinical Psychology*, *36*(2), 283–290. https://doi.org/10.15842/kjcp.2017.36.2.010

Kline, R. B., & Little, T. (2015). *Principles and practice of structural equation modeling* (4th ed.). Guilford Publications.

Lee, E. N., Kim, Y. H., Chung, W. T., & Lee, M. S. (2008). Tai chi for disease activity and flexibility in patients with ankylosing spondylitis—A controlled clinical trial. *Evidence-Based Complementary and Alternative Medicine*, *5*, 457–462. https://doi.org/10.1093/ecam/nem048

Lee, H. J., Pok, L. S. L., Ng, C. M., Yahya, F., Sockalingam, S., Tee, Y. C., & Raja, J. (2020). Fatigue and associated factors in a multiethnic cohort of rheumatoid arthritis patients. *International Journal of Rheumatic Diseases*, *23*(8), 1088–1093. https://doi.org/10.1111/1756-185X.13897

Lee, M. H., & Kim, A. Y. (2008). Development and construct validation of the basic psychological needs scale for Korean adolescents based on the self-determination theory. *Korean Journal of Social and Personality Psychology*, *22*, 157–174. https://doi.org/10.21193/kjspp.2008.22.4.010

Li, T. H., Chang, Y. S., Liu, C. W., Su, C. F., Tsai, H. C., Tsao, Y. P., Liao, H. T., Chen, M. H., Chuang, C. C., Yang, Y. Y., & Tsai, C. Y. (2021). The prevalence and risk factors of sarcopenia in rheumatoid arthritis patients: A systematic review and meta-regression analysis. *Seminars in Arthritis and Rheumatism*, *51*, 236–245. https://doi.org/10.1016/j.semarthrit.2020.10.002

Malmstrom, T. K., Miller, D. K., Simonsick, E. M., Ferrucci, L., & Morley, J. E. (2016). SARC-F: A symptom score to predict persons with sarcopenia at risk for poor functional outcomes. *Journal of Cachexia, Sarcopenia and Muscle*, *7*, 28–36. https://doi.org/10.1002/jcsm.12048

Marques, A., Bosch, P., de Thurah, A., Meissner, Y., Falzon, L., Mukhtyar, C., Bijlsma, J. W., Dejaco, C., Stamm, T. A., & EULAR task force on Points to Consider for the for remote care in rheumatic and musculoskeletal diseases. (2022). Effectiveness of remote care interventions: A systematic review informing the 2022 EULAR points to consider for remote care in rheumatic and musculoskeletal diseases. *RMD Open*, *8*(1), e002290. https://doi.org/10.1136/rmdopen-2022-002290

Mochizuki, T., Yano, K., Ikari, K., & Okazaki, K. (2019). Sarcopenia-associated factors in Japanese patients with rheumatoid arthritis: A cross-sectional study. *Geriatrics & Gerontology International*, *19*, 907–912. https://doi.org/10.1111/ggi.13747

Mollard, E., Pedro, S., Chakravarty, E., Clowse, M., Schumacher, R., & Michaud, K. (2018). The impact of menopause on functional status in women with rheumatoid arthritis. *Rheumatology*, *57*(5), 798–802. https://doi.org/10.1093/rheumatology/kex526

Müller, R., Kull, M., Põlluste, K., Valner, A., Lember, M., & Kallikorm, R. (2019). Factors associated with low lean mass in early rheumatoid arthritis: A cross- sectional study. *Medicina (Kaunas, Lithuania)*, *55*, 730. https://doi.org/10.3390/medicina55110730

Ocagli, H., Agarinis, R., Azzolina, D., Zabotti, A., Treppo, E., Francavilla, A., Bartolotta, P., Todino, F., Binutti, M., Gregori, D., & Quartuccio, L. (2023). Physical activity assessment with wearable devices in rheumatic diseases: A systematic review and meta-analysis. *Rheumatology (Oxford, England)*, *62*(3), 1031–1046. https://doi.org/10.1093/rheumatology/keac476

Oh, J. Y., Yang, Y. J., Kim, B. S., & Kang, J. H. (2007). Validity and reliability of Korean version of international physical activity questionnaire (IPAQ) short form. *Journal of Korean Academy of Family Medicine*, *28*, 532–541.

Oliveira, J. S., Pinheiro, M. B., Fairhall, N., Walsh, S., Chesterfield Franks, T., Kwok, W., Bauman, A., & Sherrington, C. (2020). Evidence on physical activity and the prevention of frailty and sarcopenia among older people: A systematic review to inform the World Health Organization physical activity guidelines. *Journal of Physical Activity & Health*, *17*(12), 1247–1258. https://doi.org/10.1123/jpah.2020-0323

Ontan, M. S., Dokuzlar, O., Ates Bulut, E., Soysal, P., & Isik, A. T. (2021). The relationship between osteoporosis and sarcopenia, according to EWGSOP-2 criteria, in outpatient elderly. *Journal of Bone and Mineral Metabolism*, *39*, 684–692. https://doi.org/10.1007/s00774-021-01213-6.pdf

Petermann-Rocha, F., Balntzi, V., Gray, S. R., Lara, J., Ho, F. K., Pell, J. P., & Celis-Morales, C. (2022). Global prevalence of sarcopenia and severe sarcopenia: A systematic review and meta-analysis. *Journal of Cachexia, Sarcopenia and Muscle*, *13*(1), 86–99. https://doi.org/10.1002/jcsm.12783

Peterson, M. D., & Serra, J. A. (2021). Exercise interventions to prevent and improve sarcopenia. In A. J. Cruz-Jentoft & J. E. Morley (Eds.), *Sarcopenia* (2nd ed., pp. 305–333). Wiley Blackwell Publishing. https://doi.org/10.1002/9781119597896.ch22

Prevoo, M. L., van't Hof, M. A., Kuper, H. H., van Leeuwen, M. A., van de Putte, L. B., & van Riel, P. L. (1995). Modified disease activity scores that include twenty-eight-joint counts. Development and validation in a prospective longitudinal study of patients with rheumatoid arthritis. *Arthritis and Rheumatism*, *38*, 44–48. https://doi.org/10.1002/art.1780380107

Resnick, B., & Jenkins, L. S. (2000). Testing the reliability and validity of the self-efficacy for exercise scale. *Nursing Research*, *49*, 154–159. https://doi.org/10.1097/00006199-200005000-00007

Rutkowski, R., Gizińska, M., Gałczyńska-Rusin, M., Kasprzak, M. P., & Budiman-Mak, E. (2022). The importance of foot function assessment using the foot function index-revised short form (FFI-RS) questionnaire in the comprehensive treatment of patients with rheumatoid arthritis. *Journal of Clinical Medicine*, *11*(9), 2298. https://doi.org/10.3390/jcm11092298

Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*, *57*, 749–761. https://doi.org/10.1037//0022-3514.57.5.749

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Publications.

Ryan, R. M., Patrick, H., Deci, E. L., & Williams, G. C. (2008). Facilitating health behavior change and its maintenance: Interventions based on self-determination theory. *The European Health Psychologist*, *10*, 2–5.

Safiri, S., Kolahi, A.-A., Hoy, D., Smith, E., Bettampadi, D., Mansournia, M. A., Almasi-Hashiani, A., Ashrafi-Asgarabad, A., Moradi-Lakeh, M., Qorbani, M., Collins, G., Woolf, A. D., March, L., & Cross, M. (2019). Global, regional and national burden of rheumatoid arthritis 1990–2017: A systematic analysis of the global burden of disease study

2017. *Annals of the Rheumatic Diseases*, *78*(11), 1463–1471. https://doi.org/10.1136/annrheumdis-2019-215920

Sharif, K., Sharif, A., Jumah, F., Oskouian, R., & Tubbs, R. S. (2018). Rheumatoid arthritis in review: Clinical, anatomical, cellular and molecular points of view. *Clinical Anatomy*, *31*, 216–223. https://doi.org/10.1002/ca.22980

Sheikh, J. I., & Yesavage, J. A. (1986). Geriatric depression scale (GDS): Recent evidence and development of a shorter version. *Clinical Gerontologist: The Journal of Aging and Mental Health*, *5*, 165–173. https://doi.org/10.1300/J018v05n01_09

Sieber, C. C. (2019). Malnutrition and sarcopenia. *Aging Clinical and Experimental Research*, *31*(6), 793–798. https://doi.org/10.1007/s40520-019-01170-1

Steffl, M., Bohannon, R. W., Sontakova, L., Tufano, J. J., Shiells, K., & Holmerova, I. (2017). Relationship between sarcopenia and physical activity in older people: A systematic review and meta-analysis. *Clinical Interventions in Aging*, *12*, 835–845. https://doi.org/10.2147/CIA.S132940

Takanashi, S., Kaneko, Y., & Takeuchi, T. (2021). Elderly patients with comorbidities in the definition of difficult-to-treat rheumatoid arthritis. *Annals of the Rheumatic Diseases*, *80*, 1491–1493. https://doi.org/10.1136/annrheumdis-2021-220315

Tański, W., Świątoniowska-Lonc, N., Tomasiewicz, A., Dudek, K., & Jankowska-Polańska, B. (2022). The impact of sleep disorders on the daily activity and quality of life in rheumatoid arthritis patients—a systematic review and meta-analysis. *European Review for Medical and Pharmacological Sciences*, *26*(9), 3212–3229. https://doi.org/10.26355/eurrev_202205_28740

Thomas, E., Battaglia, G., Patti, A., Brusa, J., Leonardi, V., Palma, A., & Bellafiore, M. (2019). Physical activity programs for balance and fall prevention in elderly: A systematic review. *Medicine*, *98*(27), e16218. https://doi.org/10.1097/MD.0000000000016218

Tournadre, A., Vial, G., Capel, F., Soubrier, M., & Boirie, Y. (2019). Sarcopenia. *Joint, Bone, Spine*, *86*, 309–314. https://doi.org/10.1016/j.jbspin.2018.08.001

Veldhuijzen van Zanten, J. J., Rouse, P. C., Hale, E. D., Ntoumanis, N., Metsios, G. S., Duda, J. L., & Kitas, G. D. (2015). Perceived barriers, facilitators and benefits for regular physical activity and exercise in patients with rheumatoid arthritis: A review of the literature. *Sports Medicine*, *45*, 1401–1412. https://doi.org/10.1007/s40279-015-0363-2

Verhoeven, F., Tordi, N., Prati, C., Demougeot, C., Mougin, F., & Wendling, D. (2016). Physical activity in patients with rheumatoid arthritis. *Joint, Bone, Spine*, *83*(3), 265–270. https://doi.org/10.1016/j.jbspin.2015.10.002

Wells, G., Becker, J. C., Teng, J., Dougados, M., Schiff, M., Smolen, J., Aletaha, D., & van Riel, P. L. C. M. (2009). Validation of the 28-joint Disease Activity Score (DAS28) and European League Against Rheumatism response criteria based on C-reactive protein against disease progression in patients with rheumatoid arthritis, and comparison with the DAS28 based on erythrocyte sedimentation rate. *Annals of the Rheumatic Diseases*, *68*, 954–960. https://doi.org/10.1136/ard.2007.084459

Williams, G. C., Grow, V. M., Freedman, Z. R., Ryan, R. M., & Deci, E. L. (1996). Motivational predictors of weight loss and weight-loss maintenance. *Journal of Personality and Social Psychology*, *70*, 115–126. https://doi.org/10.1037//0022-3514.70.1.115

Williams, G. C., McGregor, H. A., Zeldman, A., Freedman, Z. R., & Deci, E. L. (2004). Testing a self-determination theory process model for promoting glycemic control through diabetes self-management. *Health Psychology*, *23*, 58–66. https://doi.org/10.1037/0278-6133.23.1.58

Wilson, P. M., & Rodgers, W. M. (2004). The relationship between perceived autonomy support, exercise regulations and behavioral intentions in women. *Psychology of Sport and Exercise*, *5*(3), 229–242. https://doi.org/10.1016/S1469-0292(03)00003-7

World Health Organization. (2022). *Musculoskeletal health*. Retrieved April 25, 2023, from https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions

Xia, L., Zhao, R., Wan, Q., Wu, Y., Zhou, Y., Wang, Y., Cui, Y., Shen, X., & Wu, X. (2020). Sarcopenia and adverse health-related outcomes: An umbrella review of meta-analyses of observational studies. *Cancer Medicine*, *9*, 7964–7978. https://doi.org/10.1002/cam4.3428

Yoon, J., Kim, J., & Choi, Y. (2017). Associations of Sarcopenia with Rheumatoid Arthritis and Osteoarthritis in Korean adults: The Korea National Health and Nutrition Examination Survey 2008–2011. *The Journal of Kinesiology*, *19*, 61–70.

Zhang, L., Shen, B., & Liu, S. (2021). Rheumatoid arthritis is associated with negatively variable impacts on domains of sleep disturbances: Evidence from a systematic review and meta-analysis. *Psychology, Health & Medicine*, *26*(3), 267–277. https://doi.org/10.1080/13548506.2020.1764597

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