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*Research Article*

*Association of foot health and lower extremity function in older people with rheumatoid arthritis – a cross-sectional study*

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Short Title: Foot health and lower extremity function in RA

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Keywords: foot health, lower extremity function, older people, rheumatoid arthritis, survey

## Abstract

**Introduction:** Foot health and lower extremity function are important in older people with rheumatoid arthritis (RA), as they maintain and promote these individuals' independent living and functional health. RA is a long-term inflammatory health condition that alters foot structure and function. Relatively little is known about the association between foot health and lower extremity function in older people with RA. Therefore, the aim of the study was to analyse the levels of foot health and lower extremity function in older people with RA and to explore the associations between these factors.

**Methods:** A cross-sectional survey design study was conducted. The data were collected online in April 2023 from a national association of patients with rheumatic conditions in Finland using two instruments: the Self-administered Foot Health Assessment Instrument (S-FHAI) and the Lower Extremity Function Scale (LEFS). The data were analysed using descriptive and inferential statistics.

**Results:** Older people with RA (n = 270) reported many foot health problems, the most common of which were foot pain, dry skin and oedema. Lower extremity function in older people with RA was at the mild-to-moderate functional limitation level, and respondents reported major difficulties running or hopping, squatting, carrying out their usual hobbies, performing strenuous activities outside their homes or putting on shoes/socks. Poor levels of foot health were correlated with decreased lower extremity function.

**Conclusion:** Foot health is associated with lower extremity function in older people with RA. Therefore, it is essential that older people with RA be provided with systematic foot health assessments, care and rehabilitation to promote their lower extremity health and improve their functional health. Multiprofessional collaboration and seamless care chains at different levels of health care could benefit older people with RA looking to maintain their functional ability and – above all – promote their active ageing.

## Introduction

The World Health Organization has emphasised healthy ageing and functional ability in older people as key themes of the current decade [1]. Healthy ageing is described as a process that develops, maintains and promotes functional ability, which in turn enables wellbeing in advancing age [1]. Functional ability in this context refers to older people's capabilities to do what they perceive as important in their lives, including being mobile and active in society, are supported by the environment, such as through health care and services [1]. However, some long-term health conditions, such as rheumatoid arthritis (RA), pose several health-related threats that negatively affect safe and active ageing [2]. RA is more likely to affect women and is common with increasing age [3]. The age-specific prevalence rate of RA peaks in the age group of 59–75 years [4]. Therefore, to support the mobility and independence of older-age individuals, it is essential to determine how older people with rheumatoid arthritis perceive their lower extremity health. Lower extremity health in this study was defined as the structure and functions of the lower extremities from the hips to the toes.

Foot health in older people with rheumatoid arthritis (RA) is important to maintain and promote independent walking and functional ability. However, foot health problems are prevalent in RA [5,6]. These problems are often due to polyarthritis, with joint stiffness and pain caused by inflammation in the joints of the foot. It is estimated that almost 90% of patients with RA suffer from foot problems [7] or foot dysfunction [8]. Older people with RA report having foot problems that limit their ability to perform daily activities [6,9].

Lower extremity function is a precondition for safe ambulation. Lower extremity function, together with high physical activity and low levels of pain, is correlated with patients' perception of good health [10]. However, due to the inflammatory nature of RA, joint stiffness and pain often result in impairments in the lower extremities. Limited joint mobility and decreased muscle strength may lead to disabilities, causing significant problems, particularly for those engaging in dynamic activities such as walking or stair climbing [10]. Limited lower extremity function has been reported to result in high levels of kinesiophobia [11, 12] and decreased quality of life [13].

Previous evidence of the association between self-assessed foot health and perceived lower extremity function in older people with RA is scarce. There is evidence that foot deformities have an impact on foot function [14, 15]. In particular, foot structural deformities such as hallux valgus and lesser toe deformities alter gait and foot function, which may lead to unsteady walking and balance [14]. Moreover, problems in the midfoot and hindfoot affect functional disability and walking [16].

However, studies on this topic were focused on conducting mainly clinically objective foot and lower extremity assessments rather than investigating the subjective perceptions of older people with RA.

Given the importance of foot health and lower extremity function among people with RA, the aim of this study was to analyse the level of foot health and lower extremity function in older people with rheumatoid arthritis and to investigate their associations. Following research questions were set:

1. What is the average level of foot health in older people with rheumatoid arthritis?
2. What is the average lower extremity function in older people with rheumatoid arthritis?
3. What, if any, is the association between foot health and lower extremity function in older people with rheumatoid arthritis?

## Methods

A cross-sectional survey design was applied. The data were collected through online survey distributed through a national patient association of rheumatic conditions in Finland to people with RA (N = 2400). Webropol online survey tool was used to collect the data. The online survey was constructed to be as short as possible in order to minimize respondent burden and be simple in design to promote easy and quick administration [17]. The online survey was pilot-tested with 10 participants to ensure technical functionality and clarity of items and response instructions. After pilot-test only minor modifications to the layout of the survey was made.

All members of the national association who were adults (age 18 years and older), diagnosed with rheumatoid arthritis, had an email address in the member registry of the association and were voluntarily willing to participate in the study were invited. A contact person of the association distributed an invitation letter to all potential participants via email. The data were collected in April 2023. Two reminders to respond the survey were sent resulting to some increase in response rate. This study reported in this article is a part of a larger nationwide foot health in RA (n = 656) study. For the purposes of this article, a sub-data of older people (age 65 +) with RA (n = 270) was used as RA is relatively common in older people [4].

## *Instruments*

Foot health levels were measured using the Self-administered Foot Health Assessment Instrument (S-FHAI) [18]. The S-FHAI is a subjective self-assessment measure of current foot health with 22 items. Four subcategories were included: skin health (12 items), nail health (4 items), foot structure (5 items) and foot pain (1 item). The response options are dichotomous (no–yes). By summing up the

values, the S-FHAI produces a total foot health sum variable ranging from 22 to 44. The higher the values, the poorer the foot health. The S-FHAI has been used successfully in previous studies to collect data from nurses [18] and people with RA [6, 7] demonstrating satisfactory internal consistency (0.67, 0.72 respectively). Moreover, unidimensionality, with an acceptable item fit using Rasch analysis, have been reported acceptable in previous studies [19].

The Lower Extremity Function Scale (LEFS) [20] measures the functional impairment of a patient with a disorder of one or both lower extremities. It consists of 20 questions seeking to determine respondent's ability to perform everyday tasks, such as walking inside and outside the home, taking care of one's personal hygiene and engaging in recreational activities. The response scale is a five-point rating scale (0 = Extreme difficulty or inability to perform activity, 4 = No difficulty performing the activity). The values of each item are summed together, leading to a total score that ranges between 0 and 80. The lower the score, the greater the disability. The scores of the LEFS were categorised, and functional limitation can be interpreted as follows: 0–20: severe; 21–40: moderate; 41–60: mild to moderate; 61–80: minimal (normal function) functional limitation [21]. The internal consistency (Cronbach's alpha 0.96), test-retest reliability, sensitivity and responsiveness of the LEFS has been demonstrated to be acceptable [20,22,23]. Previously the LEFS has been used to measure functional decline caused by several lower extremity disorders such as osteoarthritis, knee or ankle injuries [22].

Our background questions covered age, gender, duration of RA, highest education, perception of how much foot health affects performance in daily activities in general and self-evaluated level of foot health (0 = poorest foot health, 10 = excellent foot health).

### *Data analysis*

The data were analysed statistically using SPSS 22.0 software (SPSS Inc., Chicago, Illinois). First, descriptive statistics (i.e. frequencies, percentages, means and standard deviations) were calculated to describe foot health, lower extremity function and respondents' background factors. Second, the sum variables of total foot health, skin health, nails, foot structure, foot pain and lower extremity function were formulated by counting the item scores and dividing the sum by the number of items. Third, the associations between foot health sum variables and lower extremity function sum variables were tested using the Pearson correlation coefficient. The statistical significance level was set to 0.05. The reliability of the S-FHAI and LEFS were analysed using Cronbach's alpha coefficient.

### *Ethical considerations*

The study followed good scientific practice in each phase [24]. The ethical approval was obtained (code: 35/2021) from the University's ethical committee and permission to collect the data according to standard procedures of the patient association. The participants received a cover letter together with a link to the survey distributed by the contact person of the national patient association. The cover letter included a description of data collection procedures, anonymity, confidentiality, the right to withdraw and reporting. After reading the cover letter, the participants indicated their informed consent electronically and then proceeded to answer the survey questions.

## Results

### *Description of participants*

A total of 270 persons with rheumatoid arthritis participated in the study (Table 1). Their mean age was 71.2 (range: 65–87, SD: 4.8). The duration of rheumatoid arthritis was 17.7 years (range: 1–70, SD: 14.5). The majority of the participants were female (n = 225, 85%). The educational background of participants was commonly university of applied sciences (n = 95, 35%), elementary school (n = 63, 23%), or university (n = 52, 19%). Most of the participants perceived that their foot health affected their performance in daily activities very much (n = 105, 39%) or much (n = 106, 39%). Their self-assessed level of foot health was 6.5 on average (range: 1–10, SD: 1.7).

<insert Table 1. about here>

### *Level of foot health in people with rheumatoid arthritis*

Older people with RA reported experiencing many foot health problems (Table 2). The mean total foot health sum variable was 30 (range: 15–40, SD: 3.3), indicating a great number of foot problems and thus decreased foot health levels. High percentages of foot problem occurrence were identified on the subscale level. In the area of foot skin, the most common problems were dry skin (n = 195, 73%), oedema (n = 177, 66%) and corns or calluses (n = 161, 60%). Thickened toenails (n = 173, 64%) were the most prevalent toenail problem, followed by colour changes in the nails (n = 126, 47%). Overall, foot structural deformities were common, hammer toes (n = 150, 57%), hallux valgus (n = 137, 51%) and low foot arch (n = 116, 44%) being the most prevalent. A total of 206 of older people with RA (78%) experienced foot pain over the last two weeks prior to the survey.

<insert Table 2. about here>

### *Lower extremity function in people with rheumatoid arthritis*

Lower extremity function in older people with RA was on at a mild-to-moderate functional limitation level (mean: 54.5, SD: 16.3, range: 13–80, Table 3). Older people with RA reported extreme

difficulties with or an inability to run, hop, squat, engage in their usual hobbies, perform strenuous activities outside the home or put on shoes and socks.

*<insert Table 3. about here>*

#### *Association between foot health and lower extremity function in people with rheumatoid arthritis*

The poor level of foot health correlated with poor lower extremity function ( $-0.255$ ,  $p < 0.001$ ). The same correlative association between foot health and lower extremity function was found on each foot health subscale: skin health ( $-0.191$ ,  $p = 0.002$ ), toenails ( $-0.132$ ,  $p = 0.031$ ), foot structure ( $-0.199$ ,  $p = 0.001$ ) and foot pain ( $-0.323$ ,  $p < 0.001$ ).

## Discussion

Foot health and lower extremity function in people with RA had a weak, but significant, association. This indicates that foot problems are correlated with functional disability. This study illuminates the lived experiences of people with RA in terms of their foot problems and lower extremity function. The results of this study support and build on previous knowledge that foot problems impact foot function [14,15].

Older people with RA reported many foot problems associated with their lower extremity function. Foot problems are common in older people [25]. RA is a long-term health problem, and its inflammatory nature may produce further problems. The level of foot health in older people with RA in this study seems to be lower compared to older people studied in previous studies [26]. In particular, the incidence of foot pain was high and correlated to lower extremity function. Foot pain is a common symptom in RA and can be caused by changes in joints and ligaments or by altered foot function. The study's results indicate the need for regular foot health assessments and individually tailored podiatric care. Nowadays, podiatric care for people with RA is organised in diverse ways despite the international care guidelines emphasising multidisciplinary care with access to adequate footcare [27]. In some countries, podiatry forms part of systematic multiprofessional care for people with RA [27]; in Finland, however, the country where the study was conducted, podiatric care for people with RA is fragmented and is not sufficiently part of routine RA care [28]. Therefore, it is essential that people with RA have access to podiatric care and their foot health is also assessed during routine consultations.

In addition to podiatric care, accurate lower extremity function assessment is central to providing an overall status of a patient's functional health. Lower extremity function is important in daily activities. Along with advancing age, lower extremity function may decrease, often suddenly, if muscle strength and joint mobility are not maintained. Even slight changes in lower extremity

function may have detrimental effects on individuals' daily lives, resulting in poorer physical performance [29]. Such physical performance can, for example, increase the risk of falls [30]. Paying attention to foot health in older people with RA is extremely important, as poor lower extremity function may lead to inactivity and a sedentary lifestyle [31]. These may in turn produce secondary effects such as decreased muscle strength and increased risk of falls [32]. To mitigate these secondary effects, preventative care and rehabilitation interventions are needed.

As the onset of RA commonly occurs at older ages, it is essential to pay attention to foot health and lower extremity function in order to maintain and promote functional activity for those advancing in age. The results of this study underline the need for proactive multiprofessional rehabilitation when caring for older people with RA with compromised lower extremity functions.

The results provided here have implications for both clinical practice and for the design of future clinical studies in people with RA. In clinical practice, older people with RA could benefit from regular foot health assessments and podiatric care. The systematic assessment and follow-up of foot health could provide information on changes in foot health and thus the need for podiatric care. A thorough lower extremity biomechanical assessment could reveal the need for individualized foot orthoses that could improve foot function [33]. In addition, foot self-care information delivered through, for example, patient associations or digital platforms [34] could help older people with RA advance their skills and knowledge in terms of caring for their own feet. Multiprofessional collaboration is much needed for the promotion of lower extremity function, as various professionals, such as podiatrists, physiotherapists, occupational therapists and physicians, could provide their combined expertise on treating older people with RA. Future clinical studies could focus on testing multiprofessional lower extremity health interventions in which evidence-based information is gathered for older people to maintain and promote their lower extremity health and in which clinical consultations to podiatry, physiotherapy and occupational therapy or medicine are provided. Overall, older people with RA need help and support with their foot health and lower extremity function. Therefore, it is essential to structure health care services to cover the multidimensional health needs of these individuals. Structuring the co-creation of services for other patients and public involvement methods [35] could boost the alignment of the services and allow them become even more patient-centred.

### *Limitations*

This study has some limitations that limit the generalisability of the results. The data were collected using self-assessments – older people with RA provided information about their current foot health and lower extremity function. This subjective approach might have led to some variations in the results, as individuals commonly underestimate their health status in their subjective evaluations

[36]. However, subjective perception of foot health and lower extremity function is important as they both may influence physical activity, particularly in people with long-term health conditions such as RA. The data were collected in electronic format in collaboration with a national patient association, which may have caused some selection bias as not all people with RA are members of the national patient association, and some may not use electronic devices to respond to surveys. The data in this study were collected using commonly used structured instruments with acceptable internal consistency reliability (Cronbach's alpha coefficient: S-FHAI 0.60, LEFS 0.96) providing psychometric evidence of their use among a sample of people with RA.

### Conclusions

This study demonstrated the existence of a weak but significant association between foot health and lower extremity function in older people with RA. The results indicate the need for systematic foot health assessment, care and rehabilitation for older people with RA. Multiprofessional collaboration could benefit the promotion of functional health in older people with RA. Future research could focus on testing multiprofessional rehabilitation interventions targeted toward improving older individuals' confidence and management of foot problems. Moreover, offering foot health services with easy access to older people with RA is important for promoting their active ageing.

## Statements

### Acknowledgement

None.

### Statement of Ethics

Study approval statement: *This study protocol was reviewed and approved by [University of Turku, the Health Care Division of the Ethics Committee for Human Sciences], approval number [35/2021].*

Consent to participate statement: Participants gave their written informed consent to participate the study.

### Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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### Author Contributions

Conception and design of the research: MS and RS; acquisition of data: MS; analysis and interpretation of the data: JK, NN and MS; statistical analysis: JK; writing of the manuscript: MS; and critical revision of the manuscript for intellectual content: NN, RS. All authors read and approved the final draft.

### Data Availability Statement

The data that support the findings of this study are not publicly available due to confidentiality as it containing information that could compromise the privacy of research participants but are available from the corresponding author on reasonable request [MS].

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Table 1. Participants' (n = 270) background characteristics.

Background variable	f	(%)	mean (SD)	range	median
<i>Age</i>			71.2 (4.8)	65–87	70
<i>Duration of RA</i>			17.7 (14.5)	1–70	12.5
<i>Gender</i>					
Female	225	85			
Male	39	15			
<i>Highest education</i>					
University of applied sciences	95	36			
Vocational school	63	24			
University	52	20			
Elementary school	48	18			
High school	9	3			
<i>Effect of foot health to daily activities</i>					
Very much	105	39			
Much	108	40			
Neither too much nor too little	37	19			
Little	13	5			
Very little	7	3			
<i>Self-evaluated level of foot health</i>			6.5 (1.7)	1–10	7

Table 2. Self-reported foot health in older people with RA (n = 270).

Variable	f	%
<i>Foot skin</i>		
Skin breaks or maceration between toes	48	18
Dry skin	195	73
Fissures in the heel	93	34
Corns or calluses	161	60
Verrucae	27	10
Blisters	8	3
Oedema	177	66
Sweating feet	70	26
Burning feet	89	34
Cold feet	152	57
Leg cramps	157	59
Foot ulcers	6	2
<i>Toenails</i>		
Ingrown nail	42	16
Thickened nail	173	64
Colour changes in the nails	126	47
Fungal infection of the nails	26	10
<i>Foot structure</i>		
Hallux valgus	137	51
Taylor's bunion	86	33
Hammer toe	150	57
Low foot arch	116	44
High foot arch	32	12
<i>Foot pain</i>	<i>206</i>	<i>78</i>

Footnote: - Self-administered Foot Health Assessment Instrument (S-FHAI, Stolt et al. 2017) © Stolt.

Table 3. Participants' (n = 270) self-reported lower extremity function.

Activity	n	Extreme difficult or unable to perform activity	Quite a bit of difficulty	Moderate difficulty	A little bit of difficulty	No difficulty
		f (%)	f (%)	f (%)	f (%)	f (%)
Work, housework or school activities	267	2 (1)	9 (3)	41 (15)	105 (39)	110 (41)
Usual hobbies, recreational or sporting activities	268	4 (2)	23 (9)	55 (20)	132 (49)	54 (20)
Getting into or out of the bath	254	23 (9)	17 (6)	23 (9)	59 (22)	132 (49)
Walking between the rooms	264	2 (1)	3 (1)	14 (5)	62 (24)	183 (69)
Putting on shoes or socks	268	4 (2)	6 (2)	32 (12)	109 (41)	117 (44)
Squatting	269	30 (11)	24 (9)	50 (19)	86 (32)	79 (29)
Lifting an object	269	3 (1)	13 (5)	23 (9)	88 (33)	142 (53)
Light activities	268	0 (0)	4 (2)	16 (6)	75 (28)	173 (64)
Heavy activities	269	18 (7)	39 (15)	63 (23)	99 (37)	50 (19)
Getting into or out of a car	269	4 (2)	14 (5)	24 (9)	116 (43)	111 (41)
Walking 2 blocks	269	7 (3)	13 (5)	26 (10)	63 (23)	160 (60)
Walking one kilometer	269	16 (6)	19 (7)	33 (12)	72 (27)	129 (48)
Going up or downs 10 stairs	268	10 (4)	29 (11)	46 (17)	72 (27)	111 (41)
Standing for 1 hour	269	30 (11)	43 (16)	51 (19)	75 (28)	70 (26)
Sitting for 1 hour	269	0 (0)	9 (3)	26 (10)	86 (32)	148 (55)
Running on even ground	265	94 (36)	40 (15)	51 (19)	45 (17)	35 (13)
Running on uneven ground	267	110 (41)	40 (15)	51 (19)	49 (18)	17 (6)
Making sharp turns while running fast	265	100 (38)	41 (16)	44 (17)	52 (20)	28 (11)
Hopping	264	101 (38)	40 (15)	54 (21)	48 (18)	21 (8)
Rolling over in bed	267	2 (1)	13 (5)	31 (11)	94 (35)	127 (48)

Footnote: The Lower Extremity Function Scale (LEFS, Bingley et al. 1999) © Bingley.