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Impact of foot functionality in patients with systemic sclerosis: Cross-sectional study

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ABSTRACT

Background: Progressive systemic sclerosis or systemic scleroderma (SS) is a chronic and rare autoimmune disease that mainly affects the skin and various internal organs. Raynaud's phenomenon and digital ulcers are some of the symptoms that affect the foot, causing a decrease in the quality of life of patients. The objective of this study is to determine the functionality of the feet in patients with SS and determine the impact on their daily lives.

Methods: A sample of 165 patients (154 women, 11 men) diagnosed with SS with a mean age of 46.29 ± 11.36 years and a mean body mass index (BMI) of 24.90 ± 5.77 was recruited. Each participant completed the Foot Function Index (FFI) questionnaire and the Systemic Sclerosis Questionnaire (SySQ). A multivariate analysis was performed to determine which factors were related to a higher score in both questionnaires.

Results: 32.1% of the participants (n = 53) had claw toe deformities, 79.4% (n = 131) Raynaud's disease and 20% (n = 33) a history of foot ulcers. 51.5% of the participants (n = 85) presented symptoms in their nails, the most frequent sign being thickening, hardening and yellow coloration. The final score of the FFI questionnaire was 3.51 ± 2.41 (0–9.9), the pain subscale being the highest, with a score of 5.06 ± 2.75, followed by foot disability (3.26 ± 2.91) and difficulty performing activities (1.55 ± 2.22). The final score of the SySQ questionnaire was 0.95 ± 0.45 (0.18–2.45), and the subscales with the highest score were symptom frequency (1.30 ± 0.47), symptom intensity (1.11 ± 0.55), and general skill limitation (0.47 ± 0.51). A high correlation was observed between the final FFI score and the final SySQ score (r = 0.712; p=<0.001). Also, between foot activity limitation and general skill limitation (r = 0.658; p=<0.001). A moderate correlation was observed between foot pain score and overall symptom intensity (r = 0.482; p=<0.001). Also, between foot disability and overall symptom frequency (r = 0.556; p=<0.001). The multivariate analysis (R^2 0.51) showed that the final FFI score had a significant relationship with the final SySQ score (p < 0.001). No significant correlation was found between age (p = 0.15), gender (p = 0.49), BMI (p = 0.74) or time of diagnosis (p = 0.57) and FFI.

Conclusion: SS is a disease that affects foot functionality in patients, with a greater impact on the pain scale. There is a correlation between the final FFI score and the final SySQ score, so improving foot functionality could help to improve the overall functionality of the patient with sclerosis.

1. Introduction

Progressive systemic sclerosis or systemic scleroderma (SS) is a chronic autoimmune disease that mainly affects the skin and various internal organs [1]. It is characterized by abnormal hardening and thickening of connective tissue in various parts of the body, which can lead to a variety of symptoms and complications.

It is a rare disease, with a global prevalence of 18.67 per 100,000 people with an overall incidence rate of 8.64 per 100,000 [2]. Important regional variations are observed, with higher rates in North America.

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Although SS can start at any age, it usually occurs more frequently in people between 30 and 50 years of age, with an incidence in women which is five times higher than in men [3].

The risk factors for the development of SS are not known, but it is believed that there is a combination of genetic predisposition and environmental factors [4]. Some studies suggest that certain genes and genetic variations may increase susceptibility to the disease [5]. In addition, exposure to certain environmental triggers, such as viral infections, toxins, and certain medications, could play a role in the onset or progression of the disease [6,7].

Clinical symptoms vary widely and can affect different body systems. One of the distinctive features is cutaneous fibrosis, which can manifest as thickening, hardening and changes in skin coloration, especially on limb, face and trunk. In addition to skin symptoms, SS can affect the blood vessels [8], heart [9], lungs [10], gastrointestinal system [4]and kidneys [11], among other organs.

One of the important points of this condition is its impact on feet, an essential body part for mobility and general well-being [12]. As connective tissue and blood vessels are affected by SS, the feet can experience a number of changes and symptoms ranging from mild discomfort to significant quality-of-life challenges [13]. Thickening and hardening of the skin can result in decreased joint flexibility and mobility. The skin around the ankles, the dorsal part of the foot, and toes may become tighter and less elastic, making it difficult to walk normally and wear proper footwear. Digital ulcers are a common complication of changes in blood vessels [14].

Raynaud's phenomenon, characterized by an exaggerated response to cold or stress caused by constriction of blood vessels in fingers and toes, is in many cases the first symptom in patients with systemic sclerosis [15]. This can lead to changes in the coloration of the skin of the feet, ranging from white to blue and then to red, accompanied by numbness, tingling and pain. Raynaud's flare ups can affect feet circulation and worsen circulatory problems [16].

Patients with SS may present emotional, social and functional challenges that influence various aspects of their daily lives [17]. Therefore, knowing the functionality of the foot could be a key aspect in improving their quality of life. Specialized medical care and focus on early and effective symptom management are critical to minimizing difficulties and improving patients' quality of life. The objective of this study is to determine the functionality of the feet in patients with SS and determine its impact on the patient's life.

2. Methodology

2.1. Study design

Observational study designed following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines Methodology [18]. The patients were recruited from January to May 2023 from the Spanish Association of Scleroderma.

Ethical statement

This study was approved by the Ethics Committee of the Miguel Hernández University (Code: DCC.ECL.01.23). All participants were informed of the study objective and agreed to participate in the study. Data were collected anonymously and the ethical principles proposed in the Declaration of Helsinki [19]were followed.

2.2. Participants

A total of 165 patients were recruited, through a convenience and consecutive sampling, selecting patients who met the following inclusion criteria: a) being over 18 years old, b) being diagnosed with SS by a specialist b) having signed the informed consent form. The exclusion criteria were subjects with surgical history of the lower limb or musculoskeletal injuries in the last 6 months.

The patients underwent a thorough investigation to determine their alignment with the American College of Rheumatology (ACR) classification criteria, formerly known as the ARA criteria [20]. Additionally, we classified the clinical subset based on the criteria outlined by LeRoy et al. [21]. This involved an assessment of the extent of skin sclerosis, distinguishing between limited disease (in cases where skin involvement was distal to the elbow/knees) and diffuse disease (in cases where the trunk was involved as well) [22].

Further characterization included an evaluation of the serologic subset through the examination of antinuclear antibodies (ANA) on Hep-2 cells, with a designated cutoff level of 1:40 using the clinical data of the participants. We also looked at anti-DNA-topoisomerase I antibodies (anti-Scl 70) using an enzyme-linked immunosorbent assay, with a specified cutoff level of 20 EU/mL [23].

2.3. Sample size

Taking into consideration the number of patients with this disease in Spain, estimated at 13,000 people [24], it was necessary to include 149 patients, with a confidence level of 95% and a margin of error of 8. However, due to possible losses, the sample consisted of 165 patients diagnosed with SS by a rheumatologist.

2.4. Procedure

Sociodemographic variables (age, gender, educational level, marital status, employment status), anthropometric variables (weight, height, body mass index (BMI)) and clinical variables (family history, time of diagnosis, type of treatment) were collected. The existence of clinical signs in the nail plate (coloration, thickening and weakness) was assessed, as well as hyperkeratosis in the foot and its location. Data were collected on the frequency at which they went to the podiatrist, the use of foot orthoses and the difficulty in finding suitable footwear. All variables were collected by foot experts, some of which had expertise in the management of rheumatic diseases.

Subsequently, the patient completed the Foot Function Index (FFI) questionnaire and the Systemic Sclerosis Questionnaire (SySQ). Both tests were originally written in English, however both were translated into Spanish, the FFI in 2013 [25] and the SySQ in 2019 [26].

The FFI quantitatively measures the impact of foot pathology on function in terms of pain, disability and activity restriction [27]. Test-retest reliability of the FFI and sub-scale scores ranged from 0.87 to 0.69. Internal consistency ranged from 0.96 to 0.73. With the exception of two items, factor analysis supported the construct validity of the total index and the sub-scales. The Test is divided into 3 domains: pain (9 items), disability (9 items) and activity limitation (5 items). Each item is rated with a score from 0 to 9 with a total of 23 questions. The final score is obtained by adding the score obtained in all items, dividing it by the maximum possible score (207) and multiplying it by 100 to know the percentage. Lower scores indicate lower levels of pain, difficulty, and activity limitations. It was validated in Spanish in 2013 [25].

The SySQ is a self-administered questionnaire designed by Ruof et al. [28], which assesses the ability to do activities of daily living, and the intensity and frequency of symptoms with greater functional impact on scleroderma. Internal consistency ranged from 0.93 ('complex functions') to 0.73 ('heartburn/regurgitation'); Spearman's correlation coefficient for test retest reliability ranged from 0.93 to 0.73. The test is divided into three domains with a total of 33 items*: ability* to perform activities due to scleroderma (11 items) being 0 = no difficulty, 1 = mild difficulty, 2 = severe difficulty and 3 = impossible; *symptom intensity* (12 items), 0 = no, 1 = slightly, 2 = moderate and 3 = strong; *and frequency* of symptoms (10 items), 0 = never, 1 = ever, 2 = often, and 3 = always. The final score is calculated with the average of the values obtained in the 3 domains.

2.5. Statistical analysis

All statistical analyses were conducted using SPSS v. 24.0 (SPSS Inc., Chicago, IL, USA). Quantitative variables were reported by using means and standard deviations. Categorical variables were reported by frequencies, cross-tabulations and descriptive analysis.

The Kolmogorov-Smirnov test was used to measure normality, considering a normal distribution with a p-value >0.01. The Mann-Withney *U* test was applied to assess differences. The Bivariate correlation test sample was applied to assess the relationship between the FFI score and the SySQ score. Linear regression was performed to determine factors influencing foot functionality (final IFF score).

3. Results

The sample consisted of 165 patients diagnosed with SS (154 women, 11 men), with a mean age of 46.29 ± 11.36 years and a mean BMI of 24.90 ± 5.77. Table 1.

Regarding the presence of concomitant pathologies, 32.7% (n = 54) presented pulmonary pathology; 60% digestive pathology (n = 99), 7.95% cardiac pathology (n = 13) and 1.8% renal failure (n = 3).

Also, some of the participants presented other rheumatic diseases, such as rheumatoid arthritis, which was present in 15.8% (n = 26) and Sjögren's syndrome in 6.7% (n = 11).

Regarding foot symptoms, 62.4% had never attended a podiatry consultation and 21.1% did so with a frequency of between one and three months per year, although 32.1% (n = 53) had deformities in their toes and 79.4% (n = 131) Raynaud's disease. 20% (n = 33) had a history of ulcers.

During the toenail assessment, it was observed that 51.5% (n = 85) of the participants had symptoms, the most frequent symptom being thickening, hardening and yellow coloration in 27.2% (n = 45). In addition, the presence of plantar hyperkeratosis was detected in 64.8% (n = 107). The most frequent location of dermal lesions was the forefoot (40%), followed by the toes (29.7%) and the heel (24.8%).

37% (n = 61) used foot orthoses prescribed by the podiatrist, orthopedic surgeon or rheumatologist. Participants used the foot orthoses for an average age of 8.25 ± 8.91 years. A mean of 2.16 ± 1.75 (0–5) patients had difficulty finding footwear that fit their feett.

In the FFI questionnaire, the "*pain*" subscale achieved a mean score of 5.06 ± 2.75 (0–10). Patients reported greater foot pain "at the end of the day" (mean score: 5.78 ± 3.13) and "when walking with shoes" (mean score: 5.45 ± 3.12). The lowest scoring item was foot pain in the morning, with a mean score of 4 ± 3.04. In relation to "*foot disability*," the mean score was 3.26 ± 2.91 (0–10), noting greater difficulty in "tiptoeing" (mean score: 4.44 ± 3.68) and "fast walking" (mean score: 4.37 ± 3.64). Finally, the subscale "activity limitation" obtained a mean score of 1.55 ± 2.22 (0–10), with a mean score of 3 ± 3.24 in the limitation of daily activities due to the feet. Table 2. The final score of the FFI questionnaire was 3.51 ± 2.41 (0–9.9). Patients with a history of ulcers and stiffness in the foot presented higher scores in the questionnaire, due to worse functionality (history of ulceration: FFI of 112.06 vs no FFI history of 75.73 $p < 0.001$; FFI stiffness of 101.64 vs no FFI rigidity of 61.70 $p < 0.001$).

In the SySQ questionnaire, the subscale "*ability to perform activities due to scleroderma*" had a mean score of 0.47 ± 0.51 (0–2.45). The activities with the highest difficulty (high difficulty or impossibility) were climbing stairs (17.6%; mean score: 0.73 ± 0.77), eating an apple (12.2%; mean score: 0.60 ± 0.86) and cutting meat with a knife (12.1%; mean score: 0.72 ± 0.68). The subscale "intensity of symptoms" had a mean score of 1.11 ± 0.55 (0.08–2.67), with the most intense symptoms (moderate and severe intensity) being pain due to cold hands (in 80%; mean score: 2.23 ± 0.86) and cold feet (in 73.4%; mean score: 2.03 ± 0.94). Finally, in the subscale of "*frequency of symptoms*" the score was 1.30 ± 0.47 (0.20–2.60). The most frequent symptoms (often or always) were cold hands (79.4%; mean score: 2.04 ± 0.75); followed by foot pain from having cold feet (60%; mean score: 1.76 ± 0.95) and heartburn (58.8%; mean score: 1.76 ± 0.86). Table 3. The final score of the SySQ questionnaire was 0.95 ± 0.45 (0.18–2.45).

We observed a high correlation between the final FFI score and the final SySQ score (r = 0.712). Also, between foot activity limitation and general skill limitation (r = 0.658). A moderate correlation between foot pain score and overall symptom intensity was found (r = 0.482). Also, between foot disability and overall symptom frequency (r = 0.556). Table 4.

The multivariate analysis (R^2 0.51) found that the final FFI score had a significant relationship with the final SySQ score ($p < 0.001$). No significant relationship was found between FFI and age (p = 0.15), gender (p = 0.49), BMI (p = 0.74) or time of evolution in years (p = 0.57). Table 5.

Table 1
Descriptive analysis of the sociodemographic and disease-related variables considered.

Variable	Total group n = 165 Mean ± SD
Age (years)	46.29 ± 11.36 (18–71)
Weight (kg)	66.09 ± 16.85 (34–128)
BMI (kg/cm^2)	24.90 ± 5.77 (18.79–45.4)
Duration of condition since diagnosis (years)	9.67 ± 8.78 (0–40)
Family history of Systemic Sclerosis (yes/no) %	3/97
Gender (male/female) %	93.3/6.7
Employment status (student/employed/retired/on sick leave/homemaker/unemployed) %	3.6/49.7/21.9/12.1/ 8.5/4.2
Currently receiving medication (yes/no) %	90.9/9.1

Abbreviations: BMI - Body mass index.

Table 2
Pain scores, foot disability, and foot activity limitation. FFI questionnaire.

Pain	Average review Mean ± SD
How has the foot pain been in the morning?	4 ± 3.04
How has the foot pain been when walking?	5.13 ± 3.08
How has the foot pain been while standing?	5.07 ± 3
Have you had foot pain when walking in shoes?	5.45 ± 3.12
How has the foot pain been when the foot is in shoes?	5.41 ± 3.06
How has the foot pain been when walking with foot orthoses*?	5.01 ± 3.19
How has foot pain been when standing with foot orthoses *?	4.96 ± 2.97
Level of foot pain at the end of the day.	5.78 ± 3.13
Disability	**Average review Mean ± SD**
Do you have difficulty walking at home?	2.30 ± 2.83
Do you have difficulty walking on the street?	3.33 ± 3.32
Do you have difficulty walking 500 m?	3.15 ± 3.14
Do you have difficulty climbing stairs?	3.78 ± 3.45
Do you have difficulty going down stairs?	3.22 ± 3.30
Do you have difficulty standing on tiptoe?	4.44 ± 3.68
Do you have difficulty getting out of your chair?	2.65 ± 3.02
Do you have difficulty climbing the curb?	2.12 ± 2.83
Do you have difficulty walking fast?	4.37 ± 3.64
Limitation of activity	**Average review Mean ± SD**
Did you stay home all day because of your feet?	1.96 ± 3.10
Did you stay in bed all day because of your feet?	1.04 ± 2.30
Did you limit your activities because of your feet?	3 ± 3.24
Did you use an assistive device (cane, walker, crutch, etc.) indoors?	0.68 ± 2.12
Did you use an assistive device (cane, walker, crutch, etc.) outside the home?	1.06 ± 2.75

Table 3
Degree of difficulty of skills, symptoms and their frequency in patients with Systemic Scleroderma. SySQ Questionnaire.

Ability	No difficulty %	Mild difficulty %	High difficulty %	Impossible %	Average review Mean ± SD
Cutting meat with a knife	41.2	46.7	11.5	0.6	0.72 ± 0.68
Bathing and drying without assistance	69.1	26.7	3.6	0.6	0.36 ± 0.58
Pull up your socks	66.1	26.7	5.5	1.8	0.43 ± 0.68
Put on cream	66.7	23.6	7.9	1.8	0.45 ± 0.72
Open and close the water outlet	63.6	26.7	8.5	1.2	0.47 ± 0.70
Getting up from a chair alone	67.3	25.5	4.8	2.4	0.42 ± 0.70
Going to bed and getting up on your own	78.2	19.4	1.8	0.6	0.25 ± 0.51
Walking alone on the street	75.8	19.4	3.6	1.2	0.30 ± 0.60
Climbing stairs	46.1	36.4	16.4	1.2	0.73 ± 0.77
Eating an apple	58.8	29.1	5.5	6.7	0.60 ± 0.86
Eating whole, uncrushed food	67.9	24.2	5.5	2.4	0.42 ± 0.71

Symptoms	No %	Slightly %	Moderate %	Strong %	Average review Mean ± SD
Pain in the fingers when touching or picking up things	15.2	43.6	32.1	9.1	1.35 ± 0.85
Stiffness in the hands	8.5	37	34.5	20	1.66 ± 0.89
Stiffness in the arms	39.4	32.1	21.2	7.2	0.96 ± 0.95
Stiffness in the legs	31.5	37.6	23	7.9	1.07 ± 0.92
Pain in the hands with the cold	4.2	5.8	32.7	47.3	2.23 ± 0.86
Pain in the feet with the cold	7.9	18.8	35.8	37.6	2.03 ± 0.94
Shortness of breath when going outside	50.3	29.7	16.4	3.6	0.73 ± 0.86
Shortness of breath when climbing two to ten steps	28.5	43	19.4	9.1	1.09 ± 0.91
Shortness of breath when dressing	72.7	17	9.1	1.2	0.39 ± 0.70
That	53.9	29.7	12.7	3.6	0.66 ± 0.83
Expectoration	72.1	19.4	7.3	1.2	0.38 ± 0.67
Tiredness when breathing deeply	46.1	37.6	10.3	6.1	0.76 ± 0.86

Frequency	Never %	Sometimes %	Often %	Always %	Average review Mean ± SD
Weakness in the hands when picking up things	8.5	55.8	26.1	9.7	1.37 ± 0.77
Things he holds fall out of his hands	16.4	6.8	18.8	3	1.08 ± 0.68
Pains in the hands	4.2	41.8	33.3	20.6	1.70 ± 0.84
Cold hands	3	17.6	52.1	27.3	2.04 ± 0.75

Table 3 (*continued*)

Frequency	Never %	Sometimes %	Often %	Always %	Average review Mean ± SD
Pain when swallowing saliva or food	44.2	43.6	10.3	1.8	0.70 ± 0.72
Tiredness when swallowing saliva or food	60	29.1	8.5	2.4	0.53 ± 0.75
Your food is choked	30.9	49.1	19.4	0.6	0.90 ± 0.72
Heartburn	5.5	35.8	35.8	23	1.76 ± 0.86
Belching	21.8	46.7	20	11.5	1.21 ± 0.91
Pain in the feet from the cold	9.7	30.3	33.9	26.1	1.76 ± 0.95

Table 4
Correlation between the FFI (pain, disability and activity limitation) and SySQ (general limitation of abilities, intensity and frequency of symptoms).

Foot Function Index (FFI)	Total Group n = 165 Mean ± SD (%)	Questionnaire SySQ	Total Group n = 165 Mean ± SD	Pearson's correlation
Pain	5.06 ± 2.75 (0–10)	Symptom intensity	1.11 ± 0.55 (0.08–2.67)	r = 0.482 p=<0.001
Disability	3.26 ± 2.91 (0–10)	Symptom frequency	1.30 ± 0.47 (0.20–2.60)	r = 0.556 p=<0.001
Activity limitation	1.55 ± 2.22 (0–10)	General limitation of skills	0.47 ± 0,51 (0–2,45)	r = 0.658 p=<0.001
Total FFI score	3.51 ± 2.41 (0–9.9)	Total SySQ score	0.95 ± 0.45 (0.18–2.45)	r = 0.712 p=<0.001

Pearson's correlation. In all analyses, $p<0.05$ (with a 95% confidence interval) was considered statistically significant. Correlation is perfect with $r = 1$; moderate with $0.4 < r < 0.6$, high with $0.6 < r < 0.8$ and very high with $0.8 < r < 1$.

4. Discussion

The aim of our study was to analyze foot health in patients with SS and determine its impact on the patient's life, and as in the studies by Sari-Kouzel et al. [12] and Patro et al. [29] showed, patients with SS have a high prevalence of nail lesions and calluses on the feet. However, the present study is the first study that shows a high prevalence of Raynaud's disease, reporting 79.4% of the participants.

Pain in the hands and feet due to cold were the most intense and frequent symptoms found in the present study, above stiffness or weakness, despite the fact that degenerative arthropathy in the foot is very frequent, also combined with arthralgia and contractures of the toes with flexion deformity [30]. This, along with the decreased thickness of the heel pad and head of the first metatarsal seen in patients with SS [31] can cause pain in the sole of the foot that requires specific treatments. However, in our study, despite the complications that can occur in the foot, only 37% used foot orthoses prescribed by a specialist.

The values of pain, disability and limitation of activities by the foot found in the present study were 5.06 ± 2.75, 3.26 ± 2.91 and 1.55 ± 2.22, respectively.

Our research within the cohort of scleroderma patients unveiled a distinctive pattern in the experience of pain throughout the day. The lower intensity observed in the early hours of the morning suggests a potential influence of circadian inflammatory responses in these patients. Conversely, the increased pain during the afternoon and physical activity may indicate a combination of factors, including disease progression and biomechanical impact during ambulation.

Table 5
Analysis of factors related to the final score of the FFI.

Model	Non-standardized coefficients		Standardized coefficients	t	Sig.	95.0% confidence interval for B	
	B	Dev. Error	Beta			Lower limit	Upper limit
(Constant)	−0.137	0.089		−1.539	0.126	−0.312	0.039
Age (years)	0.002	0.001	0.085	1.427	0.156	−0.001	0.004
Gender	0.037	0.054	0.038	0.687	0.493	−0.069	0.143
Time since diagnosis	0.001	0.002	0.033	0.570	0.570	−0.002	0.004
BMI	0.001	0.002	0.018	0.328	0.743	−0.004	0.005
SySQ Final Score	0.357	0.032	0.672	11.318	**<0.001**	0.295	0.419

BMI – Body mass index. SySQ - Systemic Sclerosis Questionnaire.

The link between scleroderma and foot functionality is intricate and multifactorial. Inflammation and fibrosis of connective tissue can lead to a loss of elasticity and mobility, affecting the normal biomechanics of the foot [32]. Purian et al. [31]studied the biomechanical properties of the heel pad and metatarsal head soft tissue, determining that the soft tissue thickness of the foot decreases in scleroderma patients. This is reflected in the heightened pain intensity during activities that exert pressure on the feet, such as walking or prolonged standing.

It is particularly noteworthy that the connection between foot pain in scleroderma patients and underlying circulatory dysfunction underscores the need to address not only symptomatic relief but also the root causes of dysfunction. The bidirectional relationship between pain and foot functionality may lead to a detrimental cycle, where the presence of pain negatively impacts mobility, thereby exacerbating disease progression.

The disability and limitation scores were lower than those presented in Bongi's study [33]where the scale with the highest score was observed in disability and not in pain, with a value of 5.1 ± 3.2. However, very few patients stayed in bed or at home due to pain, or had to use an assistive device. It should be noted that the worst score was obtained by patients with a history of ulceration and foot stiffness, so it would be essential to establish therapeutic and preventative measures especially in these types of patients.

The high correlation found between the final FFI score and the final SySQ score suggests that better foot health would contribute to better overall patient function. Constant attention to hygiene, hydration or choice of footwear is important to reduce complications. In our study, patients presented difficulty in finding footwear that adapted to their foot and there was evidence that therapeutic footwear is beneficial in reducing pain, improving foot health and mobility in rheumatic pathologies [34].

The study by LaMontagna et al. [35]shows a relationship between years of evolution of the disease andthe involvement of the hands. However, we have not found a significant relationship between foot involvement (FFI score) and years of evolution, age or gender.

Podiatry Rheumatic Care Association and Arthritis and Musculoskeletal Alliance Standards recommend that all people with SS should receive basic information about the health of their feet, and that those with detected problems should have access to self-care advice and care [36]. Patients with SS have a considerable prevalence of peripheral neuropathy of the foot, with loss of vibratory sensation and pressure [37]making them victims of devastating complications. However, few patients receive adequate podiatric care. Bongi's study [33] showed that only 28% of patients had specific foot treatment and none received foot care during the first 6 months of the disease. In our study, 62.4% had never visited a podiatrist and only 21.1% did so, with a frequency of 1–3 months per year, which determines that the attention paid to the feet is insufficient. Better information about foot health would help patients improve their care when they are at low risk of injury and identify high-risk problems that require specialized care.

This study emphasizes the importance of a comprehensive approach in managing scleroderma patients, with interventions targeting both pain management and the preservation of foot functionality. Early identification of contributing factors and the implementation of specific therapeutic strategies can be crucial in improving the quality of life and mitigating functional limitations associated with scleroderma in the podiatric context.

There are some limitations in the present study. The type of SS presented by the patient, diffuse or localized, was not considered in the assessment of the foot and general function. This could determine different results in terms of functionality, since localized sclerosis fundamentally affects only the skin. On the other hand, this observational study also presents some strengths because it is the first study in Spain where information has been collected on foot functionality in patients with scleroderma.

This study encourages others to continue with various studies in the same field. In pursuit of advancing the management of foot-related complications in patients with scleroderma and enhancing both pain relief and functionality, future research endeavors should focus on exploring innovative and personalized therapeutic interventions. Randomized clinical trials evaluating the efficacy of non-invasive treatments, such as physical therapy modalities, orthotic devices, and targeted pharmacological approaches, could provide valuable insights. Additionally, investigating the role of emerging technologies, including wearable devices and telehealth solutions, in remotely monitoring and managing foot-related symptoms could contribute to a more comprehensive and patient-centered care strategy. Moreover, longitudinal studies assessing the long-term impact of these interventions on the quality of life and daily functioning of individuals with scleroderma will be crucial for establishing evidence-based guidelines and optimizing patient outcomes.

5. Conclusions

SS is a disease that affects the functionality of the foot, with an even greater impact on pain. There is a correlation between the final FFI score and the final SySQ score, so improving foot health will help improve the overall functionality of the Sclerosis patient.

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