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Original Article

Evaluation of hand functional indices in association to clinical, laboratory, and radiologic data in patients with systemic sclerosis

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ABSTRACT

Objectives: This study aims to compare the clinical, radiological, and general health status of patients with systemic sclerosis (SSc) using the Duruöz Hand Index (DHI) and the modified Hand Mobility in Scleroderma (mHAMIS) test.

Patients and methods: This cross-sectional, single-center study included 71 patients (68 females, 3 males; mean age: 49.1±8.1 years; range, 31 to 69 years) with SSc between January 2024 and August 2024. We recorded sociodemographic data, disease-related parameters, laboratory parameters, medications, physical examination findings of the hand, direct radiographic changes, and the degree of skin stiffness with the modified Rodnan skin score (mRSS) in patients with SSc. Hand function was assessed with two hand indices: DHI and mHAMIS. Patients' general health status was evaluated with the Health Assessment Questionnaire-Disability Index (HAQ-DI).

Results: The mean DHI and the median total mHAMIS scores were 16.7±15.8 and 1 (4), respectively. Patients showed a moderate to strong positive correlation of both DHI and mHAMIS scores with since time to diagnosis, diffuse cutaneous SSc, mRSS, hand examination, radiography, and the HAQ-DI scores, and a negative correlation with body mass index ($p<0.05$). Digital ulcers and erosive changes were associated with DHI scores, while the since time to diagnosis, digital ulcers, and flexion contracture on radiographic examination affected mHAMIS scores in multiple regression analysis. The mHAMIS score showed a higher coefficient correlation value with disease-related parameters, hand examination, radiography, mRSS, and HAQ-DI scores compared to the DHI score.

Conclusion: The findings demonstrated that mHAMIS, a simple tool for assessing patient hand functionality, more accurately captured hand examination and radiography, disease-related parameters, mRSS, and HAQ-DI scores.

Keywords: Hand examination, hand indices, hand radiography, quality of life, systemic sclerosis.

Systemic sclerosis (SSc), meaning hardening of the skin, is an immune-mediated connective tissue disease that can lead to skin fibrosis and internal organ involvement.[1] It affects one in 10,000 individuals worldwide.[2] Cutaneous symptoms are crucial in determining the initial diagnosis. Early stages typically show skin involvement. Raynaud's phenomenon (RP), nonpitting edema, and sclerodactyly develop later. Vasculopathy-induced ischemia frequently results in the development of distal phalangeal tapering, digital ulcers, distal atrophies, and autoamputation.[3] The most prevalent forms of SSc are limited and diffuse cutaneous (dcSSc). Limited form affects the face skin and the skin distal to the elbows and knees. The diffuse form affects both the trunk, face skin, and the proximal extremities. A physical examination revealed that skin tightening can lead to flexion contractures, a limited range of motion in the hand, weakened grip strength, impaired hand function, and disability.[4] Direct radiography is used to identify pathologies of the soft tissues, joints, and bones. Abnormal hand radiographic examination reveal acro-osteolysis, calcinosis, flexion contracture, erosion of the joint, narrowing of the joint, subluxation, and juxta-articular osteopenia.[5,6] Examination of

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hand and evaluation of skin thickness are crucial for determining the functional level of the hand in SSc. Skin thickness is measured by modified Rodnan skin score (mRSS). Elevated mRSS is correlated with increased mortality and internal organ involvement.[7] It is also a disease that reduces the quality of daily life, negatively affects hand functionality, and leads to significant disability.[4,8-10] Therefore, it is important to evaluate the skin and hand in addition to visceral involvement in these patients. There are studies that examine systemic involvement, serology, mRSS, and radiographic abnormalities in SSc.[5,6,11]

It is crucial to evaluate hand function in patients with SSc since three out of four of their disability results from impaired hand function.[12] Numerous studies have examined hand function and related clinical characteristics in patients with SSc. The hand functionality was assessed in these studies using the Duruöz Hand Index (DHI), and a small number of studies utilized the modified hand mobility in scleroderma (mHAMIS) test.[8,13-15] However, research has not yet demonstrated the differences between the DHI and mHAMIS. The aim of this study was to assess the relationship between these two indices and several disease-related parameters (laboratory, physical, and radiographic findings) and general functional status in patients with SSc and to highlight distinctions.

PATIENTS AND METHODS

The cross-sectional study was conducted at the rheumatology outpatient clinic of the Çukurova University Faculty of Medicine, between January 2024 and August 2024. The study assessed 82 individuals diagnosed with SSc according to the 2013 American College of Rheumatology/European League Against Rheumatism classification criteria.[16] The exclusion criteria included *(i)* co-existing inflammatory rheumatic diseases; *(ii)* malignancy; *(iii)* concomitant neurological diseases/disabilities such as myelopathy and radiculopathy; *(iv)* acute or chronic infection; *(v)* major organ dysfunction; *(vi)* orthopedic disorders, such as fracture, ligament/nerve injury, and prothesis; and *(vii)* being pregnant. After applying the eligibility criteria, 71 patients (68 females, 3 males; mean age: 49.1±8.1 years; range, 31 to 69 years) were included in the study. Of the 11 excluded patients, seven had other rheumatic disease (rheumatoid arthritis, n=1; Sjogren syndrome, n=6), one had chronic osteomyelitis, one had malignancy, one was mentally retarded, and one was pregnant. Written informed consent was obtained from all participants. The study protocol was approved by the Çukurova University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (Date: 04.01.2024, No: 140/38). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Sociodemografic data [age, sex, body mass index (BMI), and years of education], smoking history, medicines, and disease-related parameters [since time to diagnosis (years), classification of SSc, autoantibodies for SSc, and systemic involvements] of the patients were recorded. The data, including the presence of RP, puffy finger, digital ulcer, digital pitting, nail fold bleeding, acro-osteolysis, surgical amputation, and flexion contracture obtained from the physical examination of the hand, were reported. Two rheumatologists assessed the hand's radiographic examination (anteroposterior and lateral images) to identify pathologies such as acro-osteolysis, calcinosis, flexion contracture, joint erosion, joint space narrowing, and juxta-articular osteopenia. The authors resolved all disagreements through reconsideration and consensus. Skin thickening was evaluated by mRSS as total, upper extremity, and hand. For a total of 17 areas, patients received mRSS scores ranging from 0 to 3 (total score ranging from 0 to 51). Higher scores indicated increased severity of skin involvement.[7,17,18]

The functionality of the hand was evaluated using the DHI and mHAMIS, which are reliable and valid tools for patients with SSc.[19-21]

The DHI, a self-reported questionnaire, was designed to evaluate daily activities, including cooking, dressing, maintaining personal hygiene, and performing office tasks, among others, using the fingers, hands, and wrists. Each of the 18 DHI questions received a score between 0 and 5, totaling 90 points. Higher total scores indicated deterioration of hand ability.

The mHAMIS is a functional test designed to evaluate the mobility of the hand. The mHAMIS enables the clinician to objectively evaluate the patient's hand function in a simple and efficient manner using basic equipment. Flexion, extension, and abduction of the fingers and dorsal extension of the hands were assessed using various objects. The mHAMIS consists of 4, with each scored from 0 to 3, resulting in a total score ranging from 0 to 12. For each item, a score of 0 indicated normal movement performance, while a score of 3 signified complete functional disability.

We assessed the patients' functional status (disability) with the Health Assessment Questionnaire-Disability Index (HAQ-DI), which includes 20 questions. The HAQ-DI score ranges from 0 (no disability) to 3 (severe disability), with higher scores representing worsening functionality.[22]

TABLE 1
Sociodemographic, clinic, laboratory, and other study parameters of patients with SSc (n=71)

Variables	n	%	Mean±SD	Median	IQR
Age (year)			49.1±8.1		
Sex					
Female	68	95.8			
Diagnosis age (year)			40.1±9.9		
Since time to diagnosis (year)				9	11
Body mass index (kg/m^2)				26.6	6.1
Education (year)				8	3
Current smoking (+)	12	16.9			
Cigarette box per a year				11.5	16
Classification of SSc					
Limited cutaneous SSc	39	54.9			
Diffuse cutaneous SSc	32	45.1			
ANA (+)	66	93			
SSc-related autoantibodies (+)					
Anti-Scl 70 antibody	46	67.8			
Anti-centromere antibody	21	29.6			
Organ involvement (+)					
Interstitial lung disease	53	74.6			
Pulmonary arterial hypertension	9	12.7			
Esophageal manifestation	45	63.4			
Modified Rodnan skin score					
Hand			7.8±2.5		
Upper extremity			11.3±4.8		
Total			17.6±10.2		
Hand examination findings (+)					
Raynaud phenomenon	59	83.1			
Puffy finger	6	8.5			
Digital ulcer	19	26.8			
Pitting in finger	31	43.7			
Nail fold bleeding	6	8.5			
Autoamputation	8	11.3			
Amputation	1	1.4			
Flexion contracture	24	33.8			
Duruöz Hand Index			16.7±15.8		
mHAMIS					
Finger flexion				0	0
Finger extension				0	1
Finger abduction				1	2
Wrist extension				0	2
Total				1	4
Hand radiographic abnormalities (+)					
Acro-osteolysis	22	31			
Calcinosis	9	12.7			
Flexion contracture	27	38			
Erosive change	44	62			
Joint space narrowing	59	83.1			
Juxta-articular osteopenia	64	90.1			
HAQ-DI			0.56±0.61		

SSc: Systemic sclerosis; SD: Standard deviation; IQR: Inter quartile range; ANA: Anti-nuclear antibody; mHAMIS: The modified Hand Mobility in Scleroderma; HAQ-DI: Health Assessment Questionnaire-Disability Index.

Statistical analysis

G*Power version 3.0.18 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) was used to determine the sample size. In the system, the parameter "Correlation: Binary Normal Model" was selected. We accepted the correlation coefficient (r) as 0.330, based on the study by Perrotta et al.,[23] which assumed a significant relationship between hand function and radiographic findings in the study group. The sample size was calculated as a minimum of 69 patients with SSc, with a correlation coefficient (r) of 0.330, statistical power of 0.80 (1-β=0.20), and an alpha level of 0.05 (type 1 error).

Statistical analyses were carried out using IBM SPSS version 27.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistics were shown as the number of patients (%) for categorical variables, mean ± standard deviation (SD) for parametric continuous variables, and median (interquartile range) for nonparametric continuous variables. Correlation analyses were performed to investigate the association of DHI and mHAMIS scores with other study parameters. All variables that were significantly associated with DHI and mHAMIS scores in the correlation analysis were entered into a multiple linear regression analysis. Prior to regression analysis, the assumptions of multiple linear regression were assessed. Multicollinearity was evaluated using variance inflation factor (<10) and tolerance values (>0.1). Linearity, homoscedasticity, and normality of residuals were examined visually using scatterplot and histogram analyses. Casewise diagnostics were also reviewed to identify potential outliers. Independence of residuals was assessed using the Durbin-Watson test. A p-value <0.05 was considered statistically significant.

RESULTS

The median since time to diagnosis was 9 (11) years. Thirty-two (45.1%) patients had dcSSc, and 39 (54.9%) had limited SSc. Detailed clinical and serological characteristics are described in Table 1. The number of patients receiving immunosuppressive therapy was 45 (mycophenolate mofetil, n=29; azathioprine, n=13; cyclophosphamide, n=1; and rituximab, n=2), and 22 of the patients used disease modifying anti-rheumatic drugs (hydroxychloroquine n=18; methotrexate, n=3; sulfasalazine, n=2; and leflunamide, n=1). Other medications were for RP (n=44), digital ulcer (bosentan, n=10), arterial hypertension (bosentan and macitentan, n=5), and antifibrotic (nintedanib, n=11).

Table 2 displays the results of the correlation analysis between the DHI and mHAMIS scores with the study variables. A significant positive correlation was found between the DHI score and HAQ-DI score, esophageal manifestation, classification of SSc (dcSSc), since time to diagnosis (years), mRSS, hand radiographic abnormalities, and examination of the hand, except for puffy finger and pitting in finger (r-value ranged from 0.236 to 0.569; p<0.05 for all), and the DHI scores showed a negative correlation with diagnosis age and BMI (r=−0.237 and −0.407, respectively; p<0.05). There was a significant positive correlation between mHAMIS and organ involvement (interstitial lung disease and esophageal manifestation), anti-Scl-70 antibody positivity, since time to diagnosis, classification of SSc, examination of the hand (except for puffy finger and amputation), hand radiographic abnormalities (except for juxta-articular osteopenia), HAQ-DI score, and mRSS (r-value ranged from 0.257 to 0.747; p<0.05 for all), and a negative correlation between mHAMIS and anti-centromere antibody positivitiy, diagnosis age, and BMI (r=−0.306, −0.351, and −0.437, respectively; p<0.05).

Clinical outcome variables, including BMI, since time to diagnosis, mRSS-total, dcSSc, examination of the hand (digital ulcer, autoamputation, and flexion contracture), and hand radiographic abnormalities (acro-osteolysis, calcinosis, flexion contracture, and erosive change), were significantly associated with DHI and mHAMIS scores in the correlation analysis and therefore included in a multiple regression analysis. Results of the multiple regression analysis revealed that digital ulcer (B=17.56) and erosive change (B=12.28) were significantly associated with DHI scores (p<0.05 for all). The presence of digital ulcers was associated with a 17.56-point increase in DHI scores, indicating better hand function in patients without ulcers. Similarly, the presence of erosive changes on radiographic examination was linked to a 12.28-point increase in DHI scores. The adjusted R-squared value was 0.43 for the model predicting DHI scores, indicating that approximately 43% (a moderate level of explanatory power) of the variance in hand function was explained by the included predictors. Furthermore, since time to

TABLE 2
Correlation of DHI and mHAMIS scores with sociodemographic and clinical variables

	DHI		mHAMIS	
	r	*p*	r	*p*
Age (years)	0.005	0.965	−0.046	0.705
Sex	−0.108	0.368	−0.075	0.532
Diagnosis age (year)	−0.237	**0.047**	−0.351	**0.003**
Since time to diagnosis (year)	0.371	**0.001**	0.481	**<0.001**
Body mass index (kg/m^2)	−0.407	**<0.001**	−0.437	**<0.001**
Education (year)	0.085	0.481	0.109	0.364
Current smoking (+)	−0.041	0.736	−0.120	0.317
Cigarette box per a year	0.149	0.644	−0.110	0.734
Classification of SSc (diffuse)	0.340	**0.004**	0.482	**<0.001**
Anti-nuclear antibody	0.367	0.109	0.228	0.055
SSc-related autoantibodies (+)				
Anti-Scl 70 antibody	0.154	0.200	0.457	**<0.001**
Anti-centromere antibody	−0.084	0.486	−0.306	**0.010**
Organ involvement				
Interstitial lung disease	0.082	0.499	0.257	**0.031**
Pulmonary arterial hypertension	−0.097	0.419	−0.084	0.488
Esophageal manifestation	0.306	**0.009**	0.326	**0.005**
Modified Rodnan skin score				
Hand	0.497	**<0.001**	0.727	**<0.001**
Upper extremity	0.550	**<0.001**	0.747	**<0.001**
Total	0.496	**<0.001**	0.689	**<0.001**
Hand examination findings				
Raynaud phenomenon	0.236	**0.047**	0.352	**0.003**
Puffy finger	−0.124	0.301	−0.231	0.053
Digital ulcer	0.569	**<0.001**	0.646	**<0.001**
Pitting in finger	0.176	0.142	0.340	**0.004**
Nail fold bleeding	0.323	**0.006**	0.346	**0.003**
Acro-osteolysis	0.376	**0.001**	0.375	**0.001**
Amputation	0.343	**0.003**	0.093	0.442
Flexion contracture	0.517	**<0.001**	0.720	**<0.001**
Hand radiographic abnormalities (+)				
Acro-osteolysis	0.496	**<0.001**	0.591	**<0.001**
Calcinosis	0.350	**0.003**	0.458	**<0.001**
Flexion contracture	0.515	**<0.001**	0.707	**<0.001**
Erosive change	0.519	**<0.001**	0.604	**<0.001**
Joint space narrowing	0.353	**0.003**	0.345	**0.003**
Juxta-articular osteopenia	0.240	**0.044**	0.114	0.346
HAQ-DI	0.280	**0.018**	0.617	**<0.001**

DHI: Duruöz Hand Index; mHAMIS: Modified hand mobility in scleroderma; r: Co-efficient correlation; SSc: Systemic sclerosis; HAQ-DI: Health Assessment Questionnaire-Disability Index. Bold p-values indicate statistical significance at the p<0.05 level.

diagnosis (B=0.09), digital ulcers (B=1.82), and flexion contractures (B=2.52) were significantly associated with mHAMIS scores (p<0.05 for all). In the model predicting mHAMIS scores, each additional year since diagnosis was associated with a 0.09-point increase in mHAMIS scores, reflecting worse hand mobility over time. The presence of digital ulcers was associated with a 1.82-point increase in mHAMIS scores, while the presence of a radiographic flexion contracture led to a 2.52-point increase in hand mobility score, both suggesting greater impairment in mobility. In addition, the adjusted R-squared value was 0.74, suggesting that 74% (a strong explanatory power) of the variance in hand mobility was accounted for by the same predictors (Table 3).

TABLE 3
Multiple regression analysis for the association between DHI and mHAMIS scores and clinical variables

	Duruöz Hand Index			mHAMIS		
	B (SE)	β	*p*	B (SE)	β	*p*
Body mass index	−0.38 (0.42)	−0.10	0.364	−0.09 (0.05)	−0.14	0.078
Since time to diagnosis (year)	0.25 (0.28)	0.10	0.372	0.09 (0.04)	0.18	**0.020**
mRSS-total	0.17 (0.30)	0.08	0.569	0.07 (0.04)	0.16	0.093
Subsets (dcSSc)	2.33 (4.79)	0.06	0.628	−0.21 (0.60)	−0.03	0.732
Hand examination						
Digital ulcer	17.56 (6.28)	0.38	**0.007**	1.82 (0.79)	0.22	**0.025**
Autoamputation	6.70 (7.30)	0.10	0.362	1.43 (0.92)	0.12	0.125
Flexion contracture	5.40 (10.47)	0.13	0.608	−0.50 (1.32)	−0.06	0.708
Radiographic examination						
Acro-osteolysis	5.23 (5.92)	0.12	0.381	0.29 (0.75)	0.04	0.701
Calcinosis	7.19 (7.48)	0.12	0.340	0.47 (0.94)	0.04	0.618
Flexion contracture	−5.35 (9.72)	−0.13	0.584	2.52 (1.22)	0.33	**0.044**
Erosive change	12.28 (4.82)	0.29	**0.013**	0.83 (0.61)	0.11	0.178
Note:	Durbin-Watson: 1.937 Constant (SE): 73.73 (23.53) R^2: 0.43 F: 5.88			Durbin-Watson: 1.997 Constant (SE): 15.44 (2.96) R^2: 0.74 F: 18.62		

DHI: Duruöz Hand Index; mHAMIS: Modified hand mobility in scleroderma; B: Unstandardized coefficients; SE: Standard error; β: Standardized coefficients; R^2: Adjusted R-squared; mRSS: Modified Rodnan skin score; dcSSc: Diffuse cutaneous systemic sclerosis. Bold p-values indicate statistical significance at the p<0.05 level.

DISCUSSION

This study assessed hand function indices (DHI and mHAMIS), clinical, laboratory, and radiological data, and general health status. Approximately one-third of the patients had digital ulcers and flexion contracture, while 83.1% had RP. Despite the strong correlation of DHI and mHAMIS scores with skin stiffness, digital ulcer or flexion contracture of the hand, and flexion contracture or erosion on radiographic examination, the results of the correlation analysis showed that mHAMIS scores had a higher correlation coefficient value with the length of the disease, BMI, dcSSc, SSc-related autoantibodies, organ involvement, skin stiffness, hand examination, radiographic abnormalities, and HAQ-DI than DHI scores. Multiple regression analysis confirmed that digital ulcers and erosive changes in radiographic examination were the parameters associated with DHI scores, and the factors that affected mHAMIS scores were the length of the disease, digital ulcer, and flexion contracture on radiographic examination.

Numerous studies have examined hand function, as well as clinical and functional parameters affecting daily life in SSc.[4,24-26] Alterations in the vascular and connective tissue architecture in SSc result in hand symptoms.[9] The most common symptoms that have a moderate to severe impact on daily activities related to the hand include RP, stiffness of the hand, and joint pain.[27] Common clinical disorders, such as RP and digital ulcers, have a significant influence on daily living by impairing hand function in SSc.[24,25] Digital ulcers are associated with increased care needs, pain, impairment, and psychological suffering, as well as reduced daily tasks and quality of life (QoL).[8,28] Hand span, grip strength, and mRSS all had a significant impact on hand function in SSc.[4] High skin stiffness predicted decreased hand extension, which was inversely correlated with general functional status.[26] A correlation was observed between HAQ-DI and higher mRSS scores and disability indices.[29] Lopes et al.[30] reported that difficulty in daily living was associated with hand grip strength and lung function. Our findings, based on the DHI correlation, indicate that the level of functional hand involvement deteriorates as the disease's duration and severity (stiffness of the skin, esophageal manifestation, and decrease in BMI) increase. During hand examination, the presence of flexion contracture, digital ulcer, amputation, or acro-osteolysis indicates an impairment in the

patient's hand functionality. The findings that should be considered when evaluating the hand radiograph, particularly in terms of increasing hand function impairment, are calcinosis, narrowing of the joint space, acro-osteolysis, flexion contracture, and erosive change, respectively. The mHAMIS, a measure of hand mobility, was assessed in our study and found to be able to show disease-related factors such as the length of the disease, dcSSc, anti-Scl-70 antibody positivity, lower BMI, and skin hardening in correlation analysis. Raynaud's phenomenon, digital ulcer, acro-osteolysis, or flexion deformity detected on hand examination are valuable in terms of reflecting decreased hand mobility. The detection of findings other than juxta-articular osteopenia (acro-osteolysis, calcinosis, flexion contracture, erosive change, or joint space narrowing) by hand radiography was associated with higher mHAMIS scores. Our study also found stronger correlation coefficient values between disease-related factors, organ involvement, skin stiffness level, hand symptoms, hand radiographic examination, and overall mHAMIS than DHI scores, which is a self-reported questionnaire.

In various studies, regression analyses have assessed clinical variables and radiographic changes as among the affected factors that influence hand disability and QoL. Sandqvist et al.[25] determined RP as the most important determinant of activities of daily living by regression analysis. Çevik et al.[8] reported that disease duration was associated with general QoL and DHI scores, and mRSS was associated with DHI. The strongest predictor of hand function and QoL was pain.[8] Mouthon et al.[31,32] reported that having a digital ulcer was associated with hand pain, reduced hand function, and increased disability. Increased skin thickness and fatigue, as well as decreased manual dexterity, worsen the overall QoL.[29] Acro-osteolysis was associated with digital ulcers, while flexion contractures were associated with dcSSc and high HAQ-DI scores in a study analyzing radiographic results.[11] In patients with SSc, malnutrition was associated with poor general health and functionality.[33] Zaghlol et al.[34] revealed strong associations between HAQ-DI and mHAMIS, mRSS, and tiredness. According to the results of the multiple regression analysis of our study, the factors most associated with DHI scores were digital ulcer and erosive changes on radiographic examination, and the factors most associated with mHAMIS scores were time to diagnosis, digital ulcer, and flexion contractures on radiographic examination.

Our study has some limitations and strengths. One of the limitations was its cross-sectional design, which included the current examination and radiographic findings of the patients. Another limitation was the inability to show the effect of examination and radiographic changes over time on hand functionality and mobility. The strength of our study was that it examined the factors affecting hand functionality and mobility in a comprehensive manner (sociodemographic factors, clinical parameters, and radiographic factors). Additionally, its prominent feature was that it revealed the differences between patient-based assessment and physician-based assessment through correlation analysis.

In conclusion, time to diagnosis (years), digital ulcer, radiographic erosive change, and flexion contracture were the factors most associated with hand function and mobility. Although organ involvement is prioritized in the treatment of patients with SSc, individuals with significant digital ulcers, time to diagnosis, erosions, and contractures on radiographic examination should be evaluated in terms of hand function. These findings suggest that using mHAMIS, which is easy and fast to apply in clinical practice, better reflects disease-related parameters and general health status in patients with SSc. Further studies are needed to evaluate the efficacy of mHAMIS in follow-up.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, references and fundings: A.Y., G.V., V.D., A.S., İ.T.; Design, materials, data collection and/or processing: A.Y., G.V., V.D., A.S., İ.T.; Control/supervision, critical review: A.S., İ.T.; Analysis and/or interpretation: A.Y., G.V., V.D.; Literature review: : A.Y., G.V., A.S., İ.T.; Writing the article: A.Y., V.D.

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REFERENCES

1. Rosendahl AH, Schönborn K, Krieg T. Pathophysiology of systemic sclerosis (scleroderma). Kaohsiung J Med Sci 2022;38:187-95. doi: 10.1002/kjm2.12505.
2. Denton CP, Khanna D. Systemic sclerosis. Lancet 2017;390:1685-99. doi: 10.1016/S0140-6736(17)30933-9.

3. Kucharz EJ, Kopeć-Mędrek M. Systemic sclerosis sine scleroderma. Adv Clin Exp Med 2017;26:875-80. doi: 10.17219/acem/64334.
4. Erol K, Gok K, Cengiz G, Ozgocmen S. Hand functions in systemic sclerosis and rheumatoid arthritis and influence on clinical variables. Int J Rheum Dis 2018;21:249-52. doi: 10.1111/1756-185X.13044.
5. Sakata K, Kaneko Y, Yasuoka H, Takeuchi T. Association of radiographic findings in hand X-ray with clinical features and autoantibodies in patients with systemic sclerosis. Clin Rheumatol 2020;39:113-8. doi: 10.1007/s10067-019-04639-6.
6. Wangkaew S, Sivasomboon C, Leungwatthananon W, Kasitanon N, Louthrenoo W. Prevalence and predictors of hand involvement in Thai patients with systemic sclerosis. Int J Rheum Dis 2018;21:240-8. doi: 10.1111/1756-185X.12919.
7. Khanna D, Furst DE, Clements PJ, Allanore Y, Baron M, Czirjak L, et al. Standardization of the modified Rodnan skin score for use in clinical trials of systemic sclerosis. J Scleroderma Relat Disord 2017;2:11-8. doi: 10.5301/jsrd.5000231.
8. Çevik R, Em S, Nas K, Toprak M, Cengiz G, Çalış M, et al. Association of pain and clinical factors on disability and quality of life in systemic sclerosis: A cross-sectional study from Turkish League Against Rheumatism Network. Arch Rheumatol 2022;38:9-21. doi: 10.46497/ArchRheumatol.2023.9243.
9. Krause D, Poole JL, Khanna D, Murphy SL. The association between hand disease severity and fatigue in individuals with systemic sclerosis: A scoping review. Disabil Rehabil 2022;44:5827-33. doi: 10.1080/09638288.2021.1958016.
10. Maddali-Bongi S, Del Rosso A, Mikhaylova S, Francini B, Branchi A, Baccini M, et al. Impact of hand and face disabilities on global disability and quality of life in systemic sclerosis patients. Clin Exp Rheumatol 2014;32:S-15-20.
11. Avouac J, Guerini H, Wipff J, Assous N, Chevrot A, Kahan A, et al. Radiological hand involvement in systemic sclerosis. Ann Rheum Dis 2006;65:1088-92. doi: 10.1136/ard.2005.044602.
12. Mouthon L. Hand involvement in systemic sclerosis. Presse Med 2013;42:1616-26. doi: 10.1016/j.lpm.2013.10.003.
13. Sandri G, Spinella A, Sartini S, Caselgrandi F, Schiavi M, Bettelli V, et al. Assessing hand grasp in patients with systemic sclerosis using the 16-grasp test: Preliminary results from a multidisciplinary study group. J Hand Ther 2024;37:458-64. doi: 10.1016/j.jht.2023.09.013.
14. Sandqvist G, Hesselstrand R, Eberhardt K. A longitudinal follow-up of hand involvement and activities of daily living in early systemic sclerosis. Scand J Rheumatol 2009;38:304-10. doi: 10.1080/03009740802695466.
15. Hesselstrand R, Carlestam J, Wildt M, Sandqvist G, Andréasson K. High frequency ultrasound of skin involvement in systemic sclerosis - a follow-up study. Arthritis Res Ther 2015;17:329. doi: 10.1186/s13075-015-0853-5.
16. van den Hoogen F, Khanna D, Fransen J, Johnson SR, Baron M, Tyndall A, et al. 2013 classification criteria for systemic sclerosis: An American college of rheumatology/European league against rheumatism collaborative initiative. Ann Rheum Dis 2013;72:1747-55. doi: 10.1136/annrheumdis-2013-204424.
17. Valentini G, D'Angelo S, Della Rossa A, Bencivelli W, Bombardieri S. European Scleroderma Study Group to define disease activity criteria for systemic sclerosis. IV. Assessment of skin thickening by modified Rodnan skin score. Ann Rheum Dis 2003;62:904-5. doi: 10.1136/ard.62.9.904.
18. Amjadi S, Maranian P, Furst DE, Clements PJ, Wong WK, Postlethwaite AE, et al. Course of the modified Rodnan skin thickness score in systemic sclerosis clinical trials: Analysis of three large multicenter, double-blind, randomized controlled trials. Arthritis Rheum 2009;60:2490-8. doi: 10.1002/art.24681.
19. Duruöz MT, Poiraudeau S, Fermanian J, Menkes CJ, Amor B, Dougados M, et al. Development and validation of a rheumatoid hand functional disability scale that assesses functional handicap. J Rheumatol 1996;23:1167-72.
20. Brower LM, Poole JL. Reliability and validity of the Duruoz Hand Index in persons with systemic sclerosis (scleroderma). Arthritis Rheum 2004;51:805-9. doi: 10.1002/art.20701.
21. Kaymaz S, Karasu U, Alkan H, Cobankara V. Turkish version of modified Hand Mobility in Scleroderma test: A translation and validation study. Int J Rheum Dis 2021;24:1040-6. doi: 10.1111/1756-185X.14162.
22. Khanna D, Hays RD, Furst DE. Functional disability and other health-related quality-of-life domains: Points to consider for clinical trials in systemic sclerosis. Rheumatology (Oxford) 2017;56:v17-22. doi: 10.1093/rheumatology/kex193.
23. Perrotta FM, Scriffignano S, De Socio A, Lubrano E. An assessment of hand erosive osteoarthritis: Correlation of radiographic severity with clinical, functional and laboratory findings. Rheumatol Ther 2019;6:125-33. doi: 10.1007/s40744-019-0145-7.
24. Merkel PA, Herlyn K, Martin RW, Anderson JJ, Mayes MD, Bell P, et al. Measuring disease activity and functional status in patients with scleroderma and Raynaud's phenomenon. Arthritis Rheum 2002;46:2410-20. doi: 10.1002/art.10486.
25. Sandqvist G, Eklund M, Akesson A, Nordenskiöld U. Daily activities and hand function in women with scleroderma. Scand J Rheumatol 2004;33:102-7. doi: 10.1080/03009740410006060.
26. Buni M, Joseph J, Pedroza C, Theodore S, Nair D, McNearney TA, et al. Predictors of hand contracture in early systemic sclerosis and the effect on function: A prospective study of the GENISOS Cohort. J Rheumatol 2019;46:1597-604. doi: 10.3899/jrheum.180093.
27. Bassel M, Hudson M, Taillefer SS, Schieir O, Baron M, Thombs BD. Frequency and impact of symptoms experienced by patients with systemic sclerosis: Results from a Canadian National Survey. Rheumatology (Oxford) 2011;50:762-7. doi: 10.1093/rheumatology/keq310.
28. Hughes M, Pauling JD. Exploring the patient experience of digital ulcers in systemic sclerosis. Semin Arthritis Rheum 2019;48:888-94. doi: 10.1016/j.semarthrit.2018.08.001.
29. Peytrignet S, Denton CP, Lunt M, Hesselstrand R, Mouthon L, Silman A, et al. Disability, fatigue, pain

and their associates in early diffuse cutaneous systemic sclerosis: The European Scleroderma Observational Study. Rheumatology (Oxford) 2018;57:370-81. doi: 10.1093/rheumatology/kex410.

30. Lopes AJ, Justo AC, Ferreira AS, Guimaraes FS. Systemic sclerosis: Association between physical function, handgrip strength and pulmonary function. J Bodyw Mov Ther 2017;21:972-7. doi: 10.1016/j.jbmt.2017.03.018.
31. Mouthon L, Carpentier PH, Lok C, Clerson P, Gressin V, Hachulla E, et al. Ischemic digital ulcers affect hand disability and pain in systemic sclerosis. J Rheumatol 2014;41:1317-23. doi: 10.3899/jrheum.130900.
32. Mouthon L, Mestre-Stanislas C, Bérezné A, Rannou F, Guilpain P, Revel M, et al. Impact of digital ulcers on disability and health-related quality of life in systemic sclerosis. Ann Rheum Dis 2010;69:214-7. doi: 10.1136/ard.2008.094193.
33. Fairley JL, Hansen D, Quinlivan A, Proudman S, Sahhar J, Ngian GS, et al. Frequency and implications of malnutrition in systemic sclerosis. Rheumatology (Oxford) 2025;64:1251-60. doi: 10.1093/rheumatology/keae209.
34. Zaghlol RS, Dawa GA, Makarm WK. Functional disability among systemic sclerosis patients: Relation to disease characteristics and quality of life parameters. Curr Rheumatol Rev 2022;18:257-65. doi: 10.2174/1573397117666211130150241.