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Uwe Lange, Bad Nauheim

Effects of a telerehabilitation-based exercise program in patients with systemic sclerosis

Fulden Sari[1] · Deran Oskay[2] · Abdurrahman Tufan[3]

[1] Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Bingol University, Bingol, Turkey

[2] Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Gazi University, Ankara, Turkey

[3] Inflamatuar Disease Section, National Human Genome Research Institute, Rockville Pike, USA

Abstract

Background: This study aimed to evaluate the effect of telerehabilitation-based exercise programs in systemic sclerosis (SSc) patients.
Methods: Forty-six SSc patients were randomly separated into two groups as telerehabilitation and control. Videos comprising clinical Pilates-based exercises were designed and uploaded to YouTube™ for the telerehabilitation group by physiotherapists. A video interview was conducted with the SSc patients once a week and an exercise program was performed twice daily for 8 weeks in the telerehabilitation group. The same exercise programs were printed on paper brochures and patients were instructed on their application in the form of a home exercise program to be continued for 8 weeks in the control group. Pain, fatigue, quality of life, sleep, physical activity, anxiety, and depression were assessed in all patients at the beginning and end of the study.
Results: The clinical and demographic characteristics were similar in both groups ($p > 0.05$). Fatigue, pain, anxiety, and depression decreased in both groups, while quality of life and sleep quality increased after the exercise program ($p < 0.05$). However, the improvements in the telerehabilitation group were statistically more significant than in the control group for all studied parameters ($p < 0.05$).
Conclusion: The results of our study demonstrate the superior efficacy of telerehabilitation-based treatment programs over home exercise programs, hence, we suggest widespread use of this innovative treatment program in SSc patients.

Keywords
Fatigue · Telemedicine · YouTube · Rehabilitation · Physiotherapy

Supplementary Information

The online version of this article (https://doi.org/10.1007/s00393-023-01346-1) contains supplementary material, which is available to authorized users.

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Introduction

Systemic sclerosis (SSc) is a heterogeneous and systemic autoimmune disease. SSc affects multiple organs, including musculoskeletal, gastrointestinal, pulmonary, and cardiac systems, in addition to skin involvement. Patients experience many symptoms (fatigue, pain, dry mouth, impaired hand function, and difficulty in sleeping) [1]. These patients experience a decrease in quality of life and physical activity, while anxiety and depression levels increase due to these symptoms. In order to reduce or eliminate these symptoms, an exercise program is an essential part of the treatment [2, 3]. Recent studies have shown that exercise has beneficial effects in SSc, including increased aerobic capacity, muscle strength, hand mobility, and quality of life [4, 5].

Telerehabilitation may increase treatment adherence, satisfaction, and overall health awareness by enabling participants to take an active role in disease management and decision-making. Telerehabilita-

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Table 1 Eligibility criteria

Inclusion criteria	Exclusion criteria	Withdrawals
Age 18–65 years	Uncooperative with the assessment	Patients who want to leave from study
Literate	Orthopedic problems or neurological diseases that prevent patients from doing the exercises	Patients who participated in less than 70% of the exercise program
Patients who received standard medical treatment and whose general condition had been stable for the last 6 months	Prior treatment in a physiotherapy and rehabilitation program	
Minimal smartphone or computer usage knowledge or an acquaintance with this information who can help in this regard	Presence of another inflammatory disease	
Having a computer and active internet connection at home	Pregnancy	
Disease duration between 1 and 10 years	COVID-19 positivity	
Agreed to participate in the study	A diagnosis of pulmonary arterial hypertension	
	Heart disease where exercise is contraindicated	

tion may replace the traditional treatment approach, allowing individuals to access treatment remotely. It was emphasized that the telerehabilitation-based exercise program overcomes many access barriers, including time and travel restrictions, provides access even for patients with more severe disabilities, and that treating patients at home is a practical, cost-effective, and widely available option for fatigue management [6, 7].

Telerehabilitation-based exercise programs are promising treatment approaches that enable management of patients remotely without bearing caveats of traditional in-person healthcare facility visits such as severe disability, transportation limitations, and risk of acquiring infection. Moreover, the videoconferencing method is historically one of the oldest methods in telerehabilitation applications. However, the efficacy of telerehabilitation programs and videoconferencing needs to be demonstrated, and if found beneficial, development of more efficacious programs must be fostered in various chronic health conditions. Herein, we aimed to research on the effect of telerehabilitation-based exercise programs applied for the first time in SSc patients on pain, fatigue, physical activity, sleep, quality of life, anxiety, and depression.

Materials and methods

Study design and ethics

This study was designed as a randomized controlled trial to evaluate the effects of a telerehabilitation-based exercise program in SSc patients and was registered on ClinicalTrials.gov (NCT number: NCT05078749). SSc patients who were diagnosed according to the ACR/EULAR criteria [8] and routine follow-ups in the university rheumatology department were included. Patients eligible for the study were randomized according to the predefined criteria (**Table 1**). The institutional ethics committee approved the study protocol and the study complied with the Declaration of Helsinki (01.03.2021-208). Written informed consent was obtained from patients to participate in the study.

Fifty patients were included in the study. Patients were randomized using the free Research Randomizer computer program and separated into two groups: telerehabilitation group (TG; $n = 25$) and control group (CG; $n = 25$). The patients did not know which group they belonged to. The study was completed with 24 patients in the TG and 22 patients in the CG, with a total of 46 patients (45 women, 1 man). The workflow is shown in **Fig. 1**.

Measurements

Demographic information (sex, age, body mass index, education), disease characteristics (disease duration, disease form, skin, and organ involvement), and current treatment of all the SSc patients were documented. The disability levels of patients were assessed by the Scleroderma Health Assessment Questionnaire (SHAQ). Outcome measures were measured on the same day. The outcome measures were pain, fatigue, physical activity, anxiety and depression, quality of life, and sleep. The first measurement and the second measurement at the end of the treatment were evaluated.

Disability level

The scleroderma modification of the SHAQ is mostly quality of life and functional measures. It consists of the five SSc symptoms and signs of the original five domains of the Health Assessment Questionnaire. There are five items evaluating patient global assessment, Raynaud's symptoms, digital ulcers, lung, and gastrointestinal involvement in the scale. The SHAQ ranges from 0 to 3 and is categorized into mild to moderate difficulty with a score between 0 and 1, moderate to severe disability between 1 and 2, and severe to very severe disability between 2 and 3 [9].

Pain

Resting, activity, and night pain were assessed with the numerical pain scale (NPS). The NPS is the scale that patients are asked to score by marking the number that best reflects the severity of pain between 0 and 10. A value of 0 means "no pain" and a value of 10 means "worst pain imaginable." Patients are asked to note pain intensity or average pain intensity in the last 24 h [10].

Fatigue

Fatigue was evaluated by the Multidimensional Assessment of Fatigue Scale (MAF). The MAF questionnaire evaluates fatigue in the last 7 days in four dimensions: 1) degree of fatigue, 2) severity of fatigue, 3) effect on activities of daily living, and 4) frequency of fatigue. A minimum of 1 point

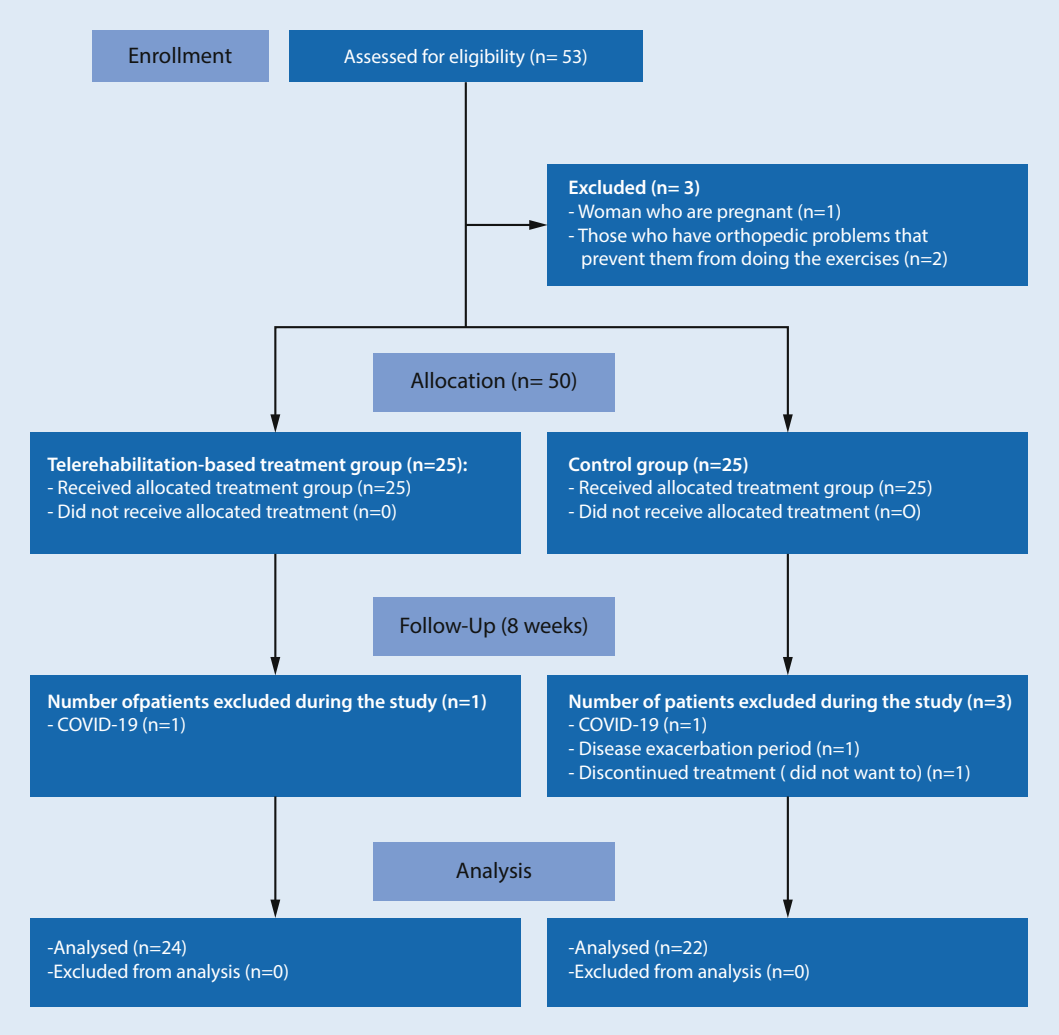


Fig. 1 ◀ Flow diagram of the patients

(no fatigue) and a maximum of 50 points (severe fatigue) are taken from the scale [11].

Physical activity

Physical activity was evaluated with the International Physical Activity Questionnaire (IPAQ). The questionnaire comprises seven questions and collects information about walking and moderate and vigorous activities [12].

Anxiety and depression

Anxiety and depression were assessed by the Hospital Anxiety and Depression Scale (HADS). HADS has two subscales, HADS-depression (HADS-D) and HADS-anxiety (HADS-A), and each subscale contains seven items. For each subscale, a cutoff score of 8 was applied [13].

Quality of life

The Nottingham Health Profile (NHP) was used to assess quality of life. It consists of two dimensions. The first dimension of the scale consists of items that examine experienced problems such as psychological, social, and physical functioning associated with health. It has six dimensions and 38 items which are associated with pain, vital energy, physical fitness, sleep disorders, social isolation, and emotional reaction. The second dimension of NHP has seven items that are related to housework, work, family, social and sexual life, hobbies, and leisure time. A higher score shows greater severity of health problems [14].

Sleep

Sleep was examined using the Pittsburgh Sleep Quality Index (PSQI). This comprises 24 questions. The first 19 questions are replied to by the individual themselves, and the last 5 questions are replied to by a roommate or family member. The questionnaire consists of questions about the frequency of sleep problems, quality, and duration. The scoring of the questions ranges from 0 (no problem) to 3 (severe distress). The questionnaire consists of a total of seven sub-components, and the sum of the sub-components indicates sleep quality [15].

Exercise intervention

Telerehabilitation group

A YouTube™ channel (YouTube Inc, San Bruno, CA, USA) was created that patients in the treatment group could follow regularly, every day, whenever they desired. Zoom Meeting™ (Zoom by Zoom Video Communications Inc, San Jose, CA, USA) and WhatsApp™ (WhatsApp Inc, Menlo

Park, CA, USA) video communication software was installed on computers and smartphones to share the exercise link and communicate.

Based on evidence from previous studies, we planned a clinical Pilates-based exercise program, which was mainly used in rheumatologic diseases [16–18]. The treatment program included thoracic expansion, centering, one-leg stretching, shoulder bridge, clam, and upper thoracic rotation between weeks 0 and 2; seated side stretch, shoulder bridge, strengthening, clam, and upper thoracic rotation between weeks 2 and 4; seated side stretch, shoulder bridge, hip abduction and adduction in the side-lying position, strengthening, single knee to chest, and side stretching between weeks 4 and 6; lying trunk rotation, shoulder bridge, abdominal strengthening, hip abduction and adduction in the side-lying position, and stretching to gluteals between weeks 6 and 8. Exercise training was regularly updated by increasing the difficulty level every 2 weeks. Clinical Pilates-based exercises were given to the telerehabilitation-based treatment group for 8 weeks, every day, 2 sessions a day, each session an average of 10 min. The YouTube™ videos created were uploaded to the YouTube™ platform so that only the patient could see them, and were sent as copy-links via WhatsApp™. Patients were asked to do these exercises regularly, every day. One day a week, the patient was interviewed via Zoom Meeting™ or WhatsApp Messenger™ (according to the patient's preference). During the video interview, the patient's exercises were checked and their questions about the exercises were answered. In addition, a weekly exercise diary was sent to the patients. Patients were asked to fill in their weekly exercise diaries and resend them via WhatsApp™. In the interviews, patients were encouraged to continue their participation in exercise training, motivated, and followed up regularly.

Control group

The importance of exercise was explained to the control group. The exercises in the home program were taught to the patients in this group. Then, brochures describing the exercises in written and visual form were sent to the patients regularly via WhatsApp Messenger™ by increasing the difficulty level of the exercises every 2 weeks (electronic supplementary material). The exercises given to the patients in a home program were the same as those in the telerehabilitation-based exercise program. The patients were asked to do the exercises regularly for 8 weeks, every day, 2 sessions a day in the control group. Moreover, the patients were asked to keep a regular exercise diary. In order to ensure the continuation of exercise, patients were called once a week and the exercise diaries were assessed. The final patient evaluations were conducted after an 8-week exercise training program.

Statistical analysis

The data were analyzed using the SPSS 15.0 (SPSS, Chicago, IL, USA) statistical software. Visual and analytical methods were used to assess the conformity of continuous variables to parametric data. Parametric data were given using mean and standard deviation (M ± SD), and non-parametric data were presented as median and interquartile range (IQR 25–75%) values. The chi-squared test or Fisher's exact chi-squared test was used to compare the counted variables. A comparison of continuous variables was analyzed either by the Student *t*-test or the Mann–Whitney U test, according to the normality distribution. Treatment effects within groups were assessed by paired-samples *t*-test or Wilcoxon test for parametric and non-parametric data, respectively. A post hoc power analysis was performed using the effect size of the between-group differences in quality of life outcomes (d = 1.16) and assuming a type I error of 5% in G*Power 3.0.10 software, which was reported. The study had sufficient statistical power (> 95%) to demonstrate differences between the groups. The significance level for all analyzes was $p < 0.05$.

Results

A total of 53 patients with SSc were screened, 3 patients were excluded as per the exclusion criteria, and 50 patients with SSc were randomly and equally assigned to TG ($n = 25$) and CG ($n = 25$) groups. One patient in the TG and 3 patients in the CG were lost to follow-up and excluded from the analyses. Therefore, the data of 46 patients that were complete at the end of the treatment were analyzed (**Fig. 1**).

There was similarity between TG and CG with regard to clinical features at study entry. The mean age of patients in the TG was 42.46 ± 14.99 years and 41.96 ± 10.62 years in the CG. In addition, while there was 33.3% limited cutaneous systemic sclerosis (LcSSc) and 66.7% diffuse cutaneous systemic sclerosis (DcSSc) patients in TG according to the type of disease, there was 31.8% LcSSc and 68.2% DcSSc patients in CG. The education levels of the patients in the TG and CG were high (45.8% of the patients in the TG and 68.2% of the patients in CG were university graduates) and similar. Disease duration, current treatments, and skin and organ involvement were similar for patients in both groups. The SHAQ scores (Raynaud's phenomenon, digital ulcer, and digestive, pulmonary, overall disease severity) showed mild to moderate difficulty and were similar in both groups ($p > 0.05$, **Table 2**).

Comparison of changes between baseline and end-of-study outcomes in the TG and CG are shown in **Table 3**. After 8 weeks, within-group changes demonstrated that the IPAQ score ($p < 0.05$) significantly increased and NPS (resting, activity, and night), MAF score, PSQI score, NHP score, HAD-A, HAD-D, and HAD total score decreased in TG ($p < 0.001$). On the other hand, the IPAQ score ($p < 0.05$) significantly increased and NPS (resting, activity, and night), MAF score, PSQI score, NHP score, and HAD total score decreased in TG ($p < 0.001$), whereas HAD-A and HAD-D did not change in CG ($p > 0.05$). Likewise, the NPS (activity; $p < 0.05$), the MAF ($p < 0.001$), the PSQI ($p < 0.05$), the HADS-A ($p < 0.05$), HADS-D ($p < 0.001$), HAD total ($p < 0.001$), and the NHP ($p < 0.001$) scores showed a significant improvement in the TG compared to the CG, while no significant changes were shown in the NPS (resting and night) and IPAQ scores between the groups ($p > 0.05$, **Table 3**).

Discussion

A review of the literature has shown that exercise is beneficial in patients with SSc [2, 3]. Due to the small study populations,

Table 2 Patient characteristics at baseline		
	Telerehabilitation group ($n = 24$)	**Control group ($n = 22$)**
Sex (F/M)	23/1	22/0
Age (years)	42.46 ± 14.99	41.96 ± 10.62
BMI (kg/m²)	23.55 ± 5.86	22.46 ± 4.54
Education (n/%)		
Elementary school	9 (37.5)	5 (22.7)
High school	4 (16.7)	2 (9.1)
University	11 (45.8)	15 (68.2)
Disease duration (years)	7.75 ± 6.81	8.13 ± 7.50
Disease form (n, %)		
Diffuse	16 (66.7)	15 (68.2)
Limited	8 (33.3)	7 (31.8)
Skin involvement (n, %)		
Sclerodactyly	14 (58.3)	15 (68.2)
Telangiectasia	9 (37.5)	7 (31.8)
Raynaud	23 (95.8)	22 (100)
Calcinosis	3 (12.5)	5 (22.7)
Digital ischemia	3 (12.5)	7 (31.8)
Organ involvement (n, %)		
Esophagus	2 (14.3)	4 (28.6)
Lung involvement	9 (64.3)	9 (64.3)
Cardiac involvement	1 (7.1)	0 (0)
Current treatment (n, %)		
Mycophenolate mofetil	9 (52.9)	7 (43.8)
Corticosteroids	1 (5.9)	4 (25.0)
Acetylsalicylic acid	3 (17.6)	2 (12.5)
Hydroxychloroquine	4 (23.5)	3 (18.8)
SHAQ VAS median (IQR25th/75th)[a]		
Raynaud's phenomenon	0.13 (0–0.38)	0.20 (0.06–0.33)
Digital ulcer	0 (0–0)	0.16 (0–0.41)
Digestive	0 (0–0.13)	0.13 (0–0.33)
Pulmonary	0 (0–0.26)	0.26 (0.05–0.40)
Overall disease severity	0.23 (0.08–0.33)	0.26 (0.11–0.40)

BMI body mass index, ***kg*** kilogram, ***m*** meter, ***n*** number, ***SHAQ*** Scleroderma Health Assessment Questionnaire, ***VAS*** visual analog scale, ***IQR25th/75th*** interquartile range 25–75
[a]Mann–Whitney U test

methodological shortcomings, and differences in exercise programs (frequency, intensity, duration, and type of exercise), a standardized exercise program could not be established. In addition, studies on education level in SSc patients have found that a low education level increases functional disability and decreases psychosocial adjustment [19]. In our study, the education levels of the patients in the TG and CG were high and similar. We thought that the high level of education of the patients would have positive effects on their perception of the disease, evaluation of their complaints, doing the exercises regularly, and correctly answering the scales used in the study. Our study is the first to study the effects of telerehabilitation-based exercise training, a new method in physiotherapy and rehabilitation, in individuals with an SSc diagnosis. The results of our study demonstrate that telerehabilitation-based exercise training programs reduced fatigue, pain, anxiety, and depression levels in SSc patients, while improving quality of life and sleep. The observed benefits were more robust in the telerehabilitation group than for a home exercise program.

Pain is a common feature in rheumatologic diseases, and many studies have shown that exercise training has positive effects on pain perception in these diseases [20, 21]. Studies on multimodal rheumatologic complex treatment, which is a significant concept of treatment for rheumatic disease, have found a decrease in pain parameters of patients after patient physical treatment [22–24]. There is no study investigating the effects of telerehabilitation-based exercise programs in SSc patients in the literature; however, a small numbers of studies have evaluated the effect of telerehabilitation-based exercise programs on pain in other rheumatic diseases [25, 26]. In a recent telerehabilitation study conducted by Hernando-Garijo et al. in fibromyalgia patients, a telerehabilitation-based exercise program was shown to be an effective method to reduce mechanical pain sensitivity, pain intensity, and psychological symptoms during quarantine caused by the COVID-19 pandemic [26]. Our study indicated that the TG and CG programs can reduce the severity of pain (resting, activity, and night) in SSc patients. Moreover, especially the severity of pain during activity was reduced more in TG compared to CG. Exercise training improves inflammation in rheumatic diseases, thereby reducing pain intensity and fostering mobility in daily living activities [27]. According to our study results, telerehabilitation programs can be used for regular exercise follow-up of SSc patients by overcoming barriers such as lack of energy, motivation, or support compared to home exercise programs. Therefore, the severity of pain (especially during activity) may have decreased more in TG. However, there is a need for more telerehabilitation studies.

Fatigue is a multidimensional symptom seen in approximately 60% of patients with chronic diseases [28]. Disease severity, functional limitation, pain, sleep disturbance, anxiety, and depression contribute to fatigue. Fatigue in SSc has been found to have a similar prevalence to other rheumatologic diseases and is reported to be one of the most common symptoms experienced. Exercise has been found to reduce fatigue in SSc patients [29–31]. In the literature, we could not find any study investigating the efficiency of the telerehabilitation program on fatigue in SSc; however, in individuals with multiple sclerosis, fatigue

Table 3 Before and after treatment changes within and between groups

	Telerehabilitation group ($n = 24$)			Control group ($n = 22$)			Telerehabilitation group	Control group	
	Before	After	Group difference	Before	After	Group difference	Change (Δ)	Change (Δ)	Treatment effect (Δ)
	Mean ± SD	Mean ± SD	*P*-value[a]	Mean ± SD	Mean ± SD	*P*-value[a]	Mean ± SD	Mean ± SD	*P*-value[b]
NPS (cm)									
Resting	4.12 ± 3.24	1.83 ± 1.97	< 0.001*	4.90 ± 2.87	1.86 ± 1.88	< 0.001*	−2.17 ± 2.63	−3.05 ± 2.63	0.264
Activity	5.45 ± 3.20	3.29 ± 2.36	< 0.001*	4.90 ± 3.00	4.22 ± 3.33	< 0.05*	−2.75 ± 2.33	−0.68 ± 1.56	< 0.05*
Night	3.33 ± 3.39	0.95 ± 1.57	< 0.001*	4.00 ± 3.05	2.77 ± 2.87	< 0.05*	−2.45 ± 2.55	−1.23 ± 1.77	0.063
MAF	32.12 ± 9.78	15.49 ± 9.96	< 0.001*	33.50 ± 9.42	27.43 ± 9.62	< 0.001*	−16.63 ± 6.46	−6.07 ± 4.79	< 0.001*
IPAQ	169.08 ± 262.50	857.35 ± 1032.97	< 0.05*	229.45 ± 371.00	887.81 ± 945.24	< 0.05*	688.27 ± 1011.65	658.36 ± 953.18	0.918
PSQI	8.00 ± 3.17	3.66 ± 1.94	< 0.001*	8.86 ± 4.31	7.22 ± 3.63	< 0.001*	−4.33 ± 3.03	−1.64 ± 1.65	< 0.05*
HADS									
HADS-A	9.62 ± 4.67	5.12 ± 2.99	< 0.001*	10.19 ± 3.42	9.09 ± 2.90	0.054	−4.50 ± 4.12	−1.46 ± 1.81	0.003*
HADS-D	9.41 ± 4.45	3.95 ± 2.57	< 0.001*	8.77 ± 4.66	7.72 ± 3.66	0.057	−5.46 ± 3.55	−1.05 ± 2.44	< 0.001*
Total score	19.04 ± 8.10	9.08 ± 4.84	< 0.001*	19.40 ± 6.89	16.81 ± 5.66	< 0.001*	−9.71 ± 6.91	−2.50 ± 4.72	< 0.001*
NHP	256.90 ± 142.99	94.33 ± 66.68	< 0.001*	273.32 ± 150.27	213.31 ± 151.49	< 0.001*	−162.57 ± 101.48	−60.00 ± 72.82	< 0.001*

NPS numerical pain scale, ***MAF*** Multidimensional Assessment of Fatigue, ***IPAQ*** International Physical Activity Questionnaire, ***PSQI*** Pittsburgh Sleep Quality Index, ***HADS*** Hospital Anxiety and Depression Scale, ***HADS-A*** Hospital Anxiety and Depression Scale—Anxiety, ***HADS-D*** Hospital Anxiety and Depression Scale—Depression, ***NHP*** Nottingham Health Profile

[a]Paired-samples t-test, mean ± standard deviation (SD)

[b]Independent-samples ***t***-test

*$p < 0.05$

was significantly reduced with a telerehabilitation-based exercise program [32, 33]. In our study, TG and CG could reduce fatigue in SSc patients; in fact, TG was more effective. The level of fatigue may have been reduced due to the decrease in the severity of pain (especially during activity), decreased level of anxiety and depression, and increase in sleep quality. Nevertheless, our study is the first to study the effect of telerehabilitation programs on fatigue levels in SSc patients. Hence, there is a need to research telerehabilitation programs and the effects in long-term prospective studies.

Physical activity is important for improving health in all people, including rheumatic patients [34]. Liem et al. [36] found that the physical activity of SSc patients was lower compared to healthy individuals. The international SSc patient cohort emphasized that only 50% of SSc patients were physically active and that these active patients did not engage in any activity other than walking [35]. For patients diagnosed with SSc, regular physical activity not only benefits overall health but also benefits disease-related outcomes such as pain, fatigue, and stiffness [36]. In our study, a statistically significant difference was not determined between the groups; however, it was observed that the number of SSc patients with a physical activity level of 0 MET-min/week decreased significantly in both groups. This decrease may be due to the fact that patients learn the importance of physical activity. There is a need for research that will demonstrate the effects of telerehabilitation and home exercise programs on physical activity.

It has been found that sleep quality is impaired in SSc patients and that sleep quality is reduced compared to healthy individuals. Exercise has been demonstrated to improve sleep in controlled trials [37, 38]. However, there is no research in the literature investigating the effects of telerehabilitation-based or different exercise methods on sleep in SSc patients. In two studies conducted in individuals with traumatic brain injury, it was reported that the telerehabilitation-based treatment was more effective in improving sleep quality than the control treatment [39, 40]. In our study, in the TG group, 21 patients (87.5%) had poor sleep quality before exercise training, whereas only 4 patients (16.7%) in the same group had poor sleep quality after exercise training. A significant decrease was found in the total PSQI score in the TG compared to the CG. In our study, the improvement in sleep quality may have affected the benefits of telerehabilitation programs on regular exercise habits and decreased anxiety and depression levels, similar to other telerehabilitation studies. Nevertheless, studies that address the effectiveness of telerehabilitation programs on sleep quality and physiological mechanisms in SSc patients are needed.

Anxiety and depression have been investigated more in SSc patients compared to other symptoms. Chronic pain, sleep problems, fatigue, changes in physical appearance, and disability due to illness cause negative psychological problems. Studies have demonstrated that there are moderate to high levels of anxiety and depression among SSc patients [41, 42]. In the literature, only a randomized controlled study by Thombs et al. evaluated the effect of videoconferencing programs on anxiety symptoms in SSc patients. It

has been emphasized that videoconferencing-based applications can be useful tools to reduce anxiety and depression in chronic diseases such as SSc, especially during the COVID-19 pandemic. Regular exercise increases endorphin levels and reduces levels of the stress hormone cortisol. As a result, it has been shown that regular exercise reduces the level of anxiety and depression in individuals. Our results demonstrated that TG and CG can decrease anxiety and depression in SSc patients; however, TG was more effective. It was observed that the patients in the TG were better able to adapt and follow the exercise program for 8 weeks. Therefore, we think that the TG treatment is more effective than the CG treatment. Moreover, our study is one of the first studies demonstrating that a telerehabilitation-based treatment program reduces the level of anxiety and depression in these patients.

In SSc patients, symptoms such as high morbidity, irreversible organ damage, skin involvement, pain, anxiety, and depression are related to poor quality of life [43]. Recent studies have demonstrated that regular exercise improves quality of life significantly [5, 44]. In the literature, we could not find any study investigating the effects of telerehabilitation programs on the quality of life in SSc patients; however, there are studies investigating the effects of telerehabilitation exercise training on quality of life in other patient groups [45, 46]. In our study, quality of life improved in both groups after exercise programs; however, TG was more effective. The difference might be because the TG had more interaction with the physiotherapist during the 8 weeks. These results demonstrate that telerehabilitation programs in these patients could improve motivation and social and functional activities. We think that telerehabilitation programs are also efficient for coping with the negative effects of the disease in these patients. Our study documented the necessity of using telerehabilitation programs generally in treatment programs to improve quality of life in SSc patients.

There are some limitations to our study. First, the lack of a supervised exercise group in our study and not comparing our study results with the supervised exercise group are limitations. According to our research, the telerehabilitation program is more effective than the home program; however, we cannot compare it to a supervised exercise group. Randomized controlled studies are required. Second, we did not have a third control group that did not have a rehabilitation program for ethical reasons, Third, our study was not blinded because the same physiotherapist was responsible for the evaluation and treatment.

In conclusion, pain, fatigue, physical activity, quality of life, sleep, anxiety, and depression were improved by telerehabilitation in SSc patients. Telerehabilitation is an effective method as it removes the obstacles to accessing the exercise program such as resource and time constraints, transportation problems, geographical, economic, or physical inadequacies, social distance, and global pandemics.

Corresponding address

Fulden Sari
Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Bingol University
12000 Bingol, Turkey
fuldensari@hotmail.com

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Declarations

Conflict of interest. F. Sari, D. Oskay and A. Tufan declare that they have no competing interests.

All procedures performed in studies involving human participants or on human tissue were in accordance with the ethical standards of the institutional and/or national research committee and with the 1975 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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Zusammenfassung

Auswirkungen eines auf Telerehabilitation basierenden Trainingsprogramms bei Patienten mit systemischer Sklerose

Hintergrund: Ziel dieser Studie war es, die Wirkung telerehabilitationsbasierter Übungsprogramme bei Patienten mit systemischer Sklerose (SSc) zu bewerten.
Methoden: Nach dem Zufallsprinzip wurden 46 SSc-Patienten in 2 Gruppen, die Telerehabilitations- und die Kontrollgruppe, aufgeteilt. Physiotherapeuten entwarfen Videos mit klinischen Pilates-Übungen und luden sie für die Telerehabilitationsgruppe auf YouTube™ (YouTube Inc, San Bruno, CA, USA) hoch. Mit den SSc-Patienten wurde einmal pro Woche ein Videointerview geführt, und in der Telerehabilitationsgruppe wurde 8 Wochen lang 2-mal täglich ein Übungsprogramm durchgeführt. Dieselben Übungsprogramme wurden auf Papierbroschüren gedruckt, und die Patienten wurden von denselben Untersuchern in Form eines 8-wöchigen Heimübungsprogramms in der Kontrollgruppe zur Anwendung angeleitet. Schmerzen, Müdigkeit, Lebensqualität, Schlaf, körperliche Aktivität, Angst und Depression wurden bei allen Patienten zu Beginn und am Ende der Studie bewertet.
Ergebnisse: Die klinischen und demografischen Merkmale waren in beiden Gruppen ähnlich ($p > 0{,}05$). Müdigkeit, Schmerzen, Angst und Depression nahmen in beiden Gruppen ab, während die Lebensqualität und Schlafqualität nach dem Trainingsprogramm zunahmen ($p < 0{,}05$). Jedoch waren die Verbesserungen in der Telerehabilitationsgruppe bei allen untersuchten Parametern statistisch signifikanter als in der Kontrollgruppe ($p < 0{,}05$).
Schlussfolgerung: Die Ergebnisse der vorliegenden Studie zeigten eine überlegene Wirksamkeit von auf Telerehabilitation basierenden Behandlungsprogrammen gegenüber Heimübungsprogrammen, daher schlagen die Autoren eine breite Anwendung dieses innovativen Behandlungsprogramms bei SSc-Patienten vor.

Schlüsselwörter
Müdigkeit · Telemedizin · YouTube · Rehabilitation · Physiotherapie