DOI: 10.4274/tod.galenos.2025.26504
Turk J Osteoporos 2026;32(1):54-63

Investigating the Effects of Face-to-face Rehabilitation and Telerehabilitation on Muscle Strength, Balance, and Quality of Life in Postmenopausal Osteoporosis Patients: Randomized Controlled Trial

Postmenopozal Osteoporoz Hastalarında Yüz Yüze Rehabilitasyon ve Telerehabilitasyonun Kas Gücü, Denge ve Yaşam Kalitesi Üzerine Etkilerinin Araştırılması: Randomize Kontrollü Çalışma

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Abstract

Objective: Exercise is an important parameter in osteoporosis (OP). However, there are significant difficulties in patients following exercise programs in the long term. We aimed to compare the effectiveness of the exercise program applied with face-to-face and telerehabilitation methods in postmenopausal OP.

Materials and Methods: The study included 50 patients aged 55-75 years, diagnosed with postmenopausal OP and able to use technology. Patients were randomly divided into 2 groups (group 1: Face-to-face, group 2: Telerehabilitation). The exercise program was applied 3 days a week for 12 weeks. Assessments were made before treatment and at 6th and 12th weeks. Primary outcome measures, muscle strength, were assessed with a hand-held dynamometer, balance was assessed with the Tinetti balance-walking test. Kinesiophobia was assessed with the TAMPA kinesiophobia scale, quality of life with the short form-36 (SF-36), health anxiety with the health anxiety scale (HAS).

Results: In group 1, a significant change was found in knee extensor muscle strength after treatment (p=0.032, 0.004). No change was detected in kinesiophobia levels (p>0.05). There was a significant difference in balance before and after treatment in group 1 (p=0.001), but not in group 2 (p>0.05). In the HAS, a significant difference was seen in favor of group1 in anxiety and total scores (p=0.025; 0.023). A significant difference was seen between SF-36 general health (p=0.034) and emotional role limitation delta change values in favor of group 1 (p=0.011).

Conclusion: Although both face-to-face and telerehabilitation were found to be effective in postmenopausal OP, this effect was greater in face-to-face. We think that telerehabilitation would be a good option for those who have obstacles to participating in face-to-face rehabilitation.

Keywords: Postmenopausal osteoporosis, exercise therapy, telerehabilitation, muscle strength, postural balance

Öz

Amaç: Egzersiz, osteoporoz (OP) tedavisinin ana bileşenlerinden olmasına rağmen, hastaların uzun vadede egzersiz programlarını takip etmelerinde önemli zorluklar yaşanmaktadır. Bu çalışmada, postmenopozal OP'de yüz yüze ve telerehabilitasyon yöntemleriyle uygulanan egzersiz programının etkinliğini karşılaştırmayı amaçladık.

Gereç ve Yöntem: Çalışmaya, 55-75 yaşları arasında, postmenopozal OP tanısı almış ve teknolojiyi kullanabilen 50 hasta dahil edildi. Hastalar rastgele 2 gruba ayrıldı (grup 1: Yüz yüze, grup 2: Telerehabilitasyon). Egzersiz programı haftada 3 gün, 12 hafta boyunca uygulandı. Değerlendirmeler tedavi öncesi, 6. ve 12. haftalarda yapıldı. Birincil sonuç ölçütleri olan kas kuvveti elde taşınan bir dinamometre ile, denge Tinetti denge-yürüme testi ile, kinezyofobi TAMPA kinezyofobi ölçeği ile, yaşam kalitesi kısa form-36 (SF-36) ile, sağlık kaygısı ise sağlık kaygısı ölçeği (HAS) ile değerlendirildi.

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Received/Geliş Tarihi: 24.09.2025 **Accepted/Kabul Tarihi:** 22.10.2025 **Epub:** 28.10.2025 **Publication Date/Yayınlanma Tarihi:** 24.03.2026

Cite this article as/Atıf: Altaş EU, Uçurum SG, Aka T. Investigating the effects of face-to-face rehabilitation and telerehabilitation on muscle strength, balance, and quality of life in postmenopausal osteoporosis patients: randomized controlled trial. Turk J Osteoporos. 2026;32(1):54-63

Bulgular: Grup 1'de tedavi sonrası diz ekstansör kas kuvvetinde anlamlı bir değişiklik bulundu (p=0,032, 0,004). Kinezyofobi düzeylerinde bir değişiklik saptanmadı (p>0,05). Grup 1'de tedavi öncesi ve sonrası dengede anlamlı bir fark vardı (p=0,001), ancak grup 2'de böyle bir fark yoktu (p>0,05). HAS'de kaygı ve toplam puanlarda grup 1 lehine anlamlı bir fark görüldü (p=0,025; 0,023). SF-36 genel sağlık (p=0,034) ve duygusal rol kısıtlaması delta değişim değerleri arasında grup 1 lehine anlamlı bir fark görüldü (p=0,011).

Sonuç: Hem yüz yüze hem de telerehabilitasyonun postmenopozal OP'de etkili olduğu bulunmuş olsa da, bu etki yüz yüze tedavide daha fazlaydı. Yüz yüze rehabilitasyona katılımda engeli olan kişiler için telerehabilitasyonun iyi bir seçenek olacağını düşünmekteyiz.

Anahtar kelimeler: Postmenopozal osteoporoz, egzersiz tedavisi, telerehabilitasyon, kas gücü, duruş dengesi

Introduction

Osteoporosis (OP) is an osteometabolic disorder marked by bone tissue deterioration that compromises bone quality and strength, raising fracture risk and potentially leading to chronic pain, functional capacity loss, and reduced quality of life (1). OP is increasingly prevalent due to population aging, leading to serious secondary health problems, including fractures that may result in mortality (2). Each year, OP-related fractures affect an estimated 9 million people worldwide, with women constituting the majority (3). For those who experience fractures, mortality risk increases by 2.7 times (4). Ranking as the fourth most severe chronic disease, OP-related fractures place a substantial burden on healthcare systems, largely due to associated issues such as depression, pain, and functional impairments (5).

Physical activity is recommended as a cost-effective strategy for slowing bone loss and improving bone mineral density (BMD) (6). Systematic reviews indicate that different types of exercise positively impact BMD in postmenopausal women (7,8). While walking has been recommended in a systematic review, progressive resistance exercise training has also been cited as an effective strategy for maintaining or increasing BMD (9). Studies on chronic painful musculoskeletal disorders, including OP, reveal that these conditions contribute to pain, kinesiophobia, physical dysfunction, dissatisfaction with daily life, and low quality of life (10). Due to OP's prevalence, an aging population, and limited access to treatment, few patients participate in structured, professional exercise programs.

Telerehabilitation is under study as a potentially innovative solution for patients with limited access to healthcare. A study evaluating telerehabilitation-based physical therapy reported that 94% of patients and 100% of treating physiotherapists were satisfied with the application and outcomes, highlighting the feasibility of delivering physical therapy via telehealth (11). Another randomized controlled study comparing telerehabilitation and face-to-face rehabilitation after total hip replacement surgery found comparable physical and functional outcomes between the two approaches (12).

The current study aimed to compare the effectiveness of a 12-week face-to-face rehabilitation and telerehabilitation on muscle strength, balance, and quality of life in postmenopausal OP patients. Since this is the first study on this topic in the literature, it holds unique value. The findings obtained will shed light on identifying a more accessible, cost-effective, and efficient treatment tool to reach a broader range of individuals for OP rehabilitation.

Materials and Methods

Desing and Setting

This randomized, controlled single blind study was conducted between January-September 2022 in the physical medicine and rehabilitation outpatient clinic. The study was conducted as a single-blind study with blinding of the physiotherapist performing the assessments. This research has been approved by the authors' affiliated institutions and all procedures were conducted according to the Declaration of Helsinki. Prior to the commencement of the study, approval was obtained from the Non-Interventional Clinical Research Ethics Committee of İzmir Bakırçay University (decision no: 459, date: December 22, 2021). The study was supported by the Scientific Research Projects Coordination Unit at İzmir Bakırçay University (KBP.2021.002). All participants provided written informed consent before the participation in the study.

Participants

The study included 50 postmenopausal OP patients and they were randomly divided into two groups using a web-based randomization tool (random.org). The inclusion criteria were: (1) being between 55-75 years of age, (2) those with a DEXA score of -2.5 and above and diagnosed with OP, (3) required to have the necessary skills and access to participate in telerehabilitation as well as possess and be proficient in using a smartphone or computer. Patients with severe cardiovascular or respiratory problems or those with neurological, metabolic, vestibular, or orthopedic issues that could impact gait, balance, or mobility (such as prior spinal surgery, or the presence of rheumatologic diseases or central or peripheral nervous system disorders), acute compression fractures, or spinal pain restricting exercise were excluded. The study flowchart is presented in Figure 1.

Procedure

Fifty adults with OP was randomized into two groups to either a control group (face-to-face rehabilitation) or an experimental group (telerehabilitation). Socio-demographic data (age, gender, occupation, medical history, etc.), height, body mass index, and DXA scores were recorded for all patients, followed by the assessment of their muscle strength, balance, fear of movement, quality of life, and health anxiety levels. All evaluations of the participants were performed face-to-face at the physical medicine and rehabilitation outpatient clinic by a physiotherapist who was blind to the study. Patients received exercise therapy three times weekly over a 12-week period, with the program updated every

three weeks to gradually increase intensity. Interim assessments were conducted at the end of the six week of exercise therapy, with final assessments following the full 12-week program.

Intervention

Patients received exercise therapy three times weekly over a 12-week period, with the program updated every three weeks to gradually increase intensity. The rehabilitation program content was consistent across groups, differing only in the delivery method (face-to-face versus telerehabilitation). The face-to-face group attended sessions at the treatment unit under a physiotherapist's supervision. For the telerehabilitation group, exercises were taught one-on-one by a physiotherapist during the initial assessment. Exercise videos were provided via telephone as a reference in case patients forgot the instructions. The telerehabilitation group was managed by a physiotherapist and sent reminders before each session and provided live session support.

The exercise program was structured across four levels, with progressions every three weeks. Warm-up and cool-down involved three to five minutes of marching in place, with stretching exercises performed as self-administered at each joint's end range of motion for 10-15 seconds, repeated 3-5 times. Strengthening exercises followed, maintaining a modified Borg scale intensity of 13-15, with repetitions per set varying from 8-12 based on individual capacity. Strengthening exercises were performed in lying, sitting and standing positions. Started from the easy and made more difficult according to the patient's tolerance. Although lower extremity and trunk exercises are predominant, exercises that include the whole body have been selected. All exercises were performed as calisthenic exercises. Balance exercises were performed in standing position, double-leg, tandem and single-leg positions. Starting with a wide support surface, the support surface was gradually narrowed.

The exercise session lasted 45 minutes in total, with a 5-minute warm-up and cool-down period. Patients were asked to walk for 30 minutes on days when they did not exercise.

Outcome Measures

For strength measurements, a handheld dynamometer was used. Patients were seated with hips and knees at 90° flexion, with the dynamometer positioned at the distal two-thirds of the calves, anteriorly for knee extension measurements and posteriorly for knee flexor assessments. An isometric "make

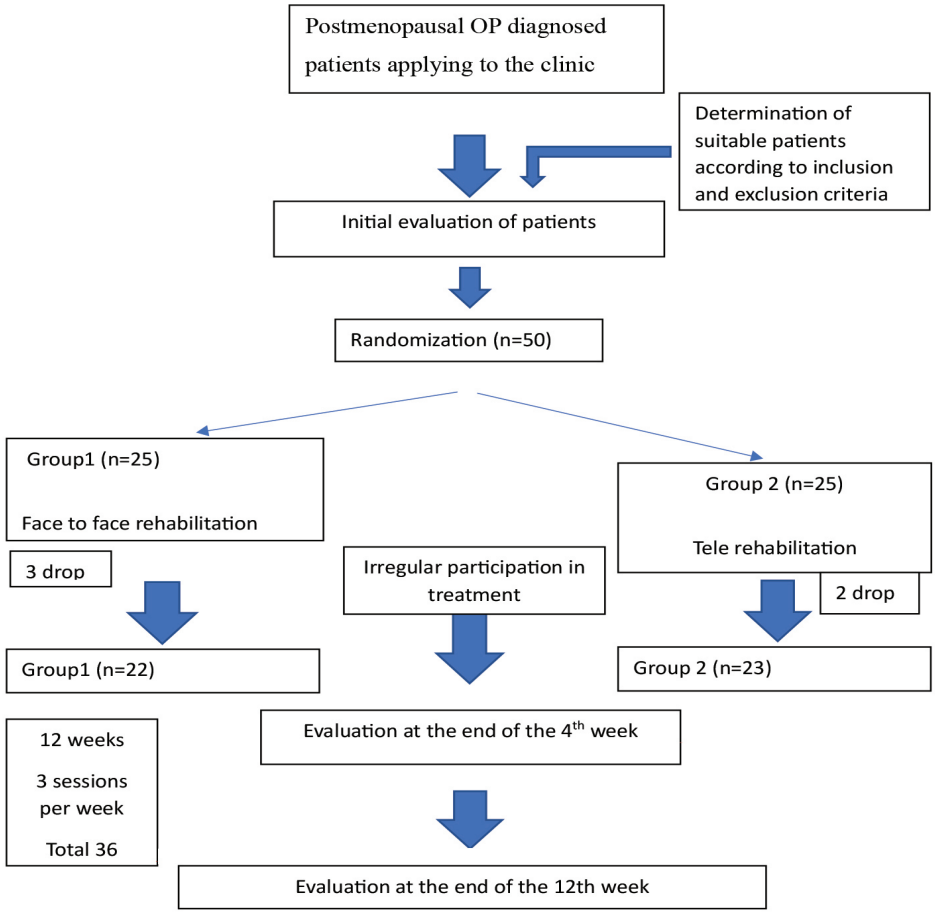

Figure 1. Study flow diagram
OP: Osteoporosis

test" was employed, with patients instructed to apply maximum force against the fixed device for three seconds. Each trial was followed by a 30-second rest period, and two measurements were averaged and recorded in kilograms (13).

The Tinetti test assesses balance through the first nine items and gait through the following seven, categorized into two sections. Scores below 18 indicate a high fall risk, scores of 19-23 suggest moderate risk, and scores of 24 or higher reflect a low fall risk (14).

Kinesiophobia was evaluated with the 17-item tampa scale of kinesiophobia. The scale uses a 4-point Likert scoring system (1: Strongly disagree, 4: Strongly agree), with total scores ranging from 17 to 68, where higher scores represent greater fear of movement (15).

Quality of life was assessed using the SF-36, evaluating eight domains of functional health (physical functioning, physical role, bodily pain, general health, vitality, social functioning, role-emotional, and mental health). Scores range from 0 (worst quality of life) to 100 (best quality of life) (16).

The short health anxiety inventory was used to measure health anxiety levels. Fourteen items assess patients' psychological states in relation to their health, while the remaining four evaluate concerns about possible serious illnesses. Each item is scored from 0-3, with higher scores indicating greater health anxiety (17).

Statistical Analysis

Sample size determination

The primary objective of this study was to compare the effects of face-to-face rehabilitation versus telerehabilitation on muscle strength, balance, and quality of life in postmenopausal OP patients at 12 weeks. Based on the study by Moffet et al. (18) on knee osteoarthritis patients and changes in knee extensor strength, a sample size calculation was performed using a t-test to compare the differences between the two groups. This calculation determined that a total of 40 patients (20 per group) would be needed, with an α of 0.05, power of 0.85, and effect size of 0.97. To account for an estimated 10% potential attrition rate during follow-up, 50 patients were included.

Statistical Methods

All data analyses were performed using IBM SPSS Statistics v.25. Normal distribution was assessed with the Kolmogorov-Smirnov test (for analyses involving all participants) and the Shapiro-Wilk test (for analyses within treatment groups), as well as by examining Skewness, Kurtosis, graphs, and histograms. Descriptive statistics were reported as medians and interquartile ranges for non-normally distributed variables. For repeated measures comparisons (baseline, week 4, and week 8), the Friedman test was applied for non-normally distributed data. Statistical significance was set at $p<0.05$ for all analyses. Post-hoc Wilcoxon tests identified specific differences in variables with significant Friedman test results, with statistical significance set at $p<0.17$. Intergroup comparisons involved calculating differences from baseline to second and third measurements, analyzed using the Mann-Whitney U test, with a significance level set at $p<0.17$.

Results

Our study included 50 females who presented at the Physical Medicine and Rehabilitation Clinic at İzmir Bakırçay University and were diagnosed with OP. The average ages of the randomly assigned face-to-face exercise and telerehabilitation groups were 60.5±4.47 and 61.0±7.1 years, respectively. The demographic characteristics of the participants and intergroup comparisons are presented in Table 1. Statistical analysis revealed no significant differences in demographic characteristics between the groups, indicating homogeneity ($p>0.05$).

Muscle Strength

Significant changes were observed within the face-to-face exercise group in both dominant and non-dominant knee extensor muscle strength post-treatment compared to pre-treatment ($p=0.032$ and $p=0.004$). In the telerehabilitation group, an increase was noted only in non-dominant flexor muscle strength ($p=0.008$). No significant differences were found in other parameters ($p>0.05$) (Table 2). When comparing the groups, a significant difference was observed only in the delta values for non-dominant knee flexion between mid-treatment and post-treatment, with no significant differences noted in the other parameters ($p>0.05$) (Table 3).

Kinesiophobia

Face-to-face exercise and telerehabilitation groups exhibited high pre-treatment kinesiophobia scores [47.00 (39.00-53.00) and 42.00 (36.00-46.00)]. However, there were no significant changes in kinesiophobia scores either within or between the groups ($p>0.05$) (Table 2, Table 3).

Balance/Gait

When evaluating the balance and gait scores, a significant improvement in gait was observed within the face-to-face exercise group from pre-treatment to post-treatment ($p=0.001$). In contrast, no significant changes were noted in the telerehabilitation group ($p>0.05$). Comparisons between the groups revealed significant differences in favor of the face-to-face exercise group regarding balance scores at both mid-treatment and post-treatment. However, no significant differences were found in gait within or between the groups ($p>0.05$) (Table 2, Table 3).

Anxiety Levels

In comparing intragroup anxiety levels before, during, and after treatment, the face-to-face exercise group exhibited significant differences across all parameters ($p=0.016$, $p=0.001$, and $p=0.005$, respectively), while no differences were noted in the telerehabilitation group ($p>0.05$) (Table 4). When comparing the

Table 1. Demographic and clinical characteristics of the study population			
	Face-to-face X±SD/n (%)*	**Telerehabilitation X±SD/n (%)***	**p**
Age (year)	60.5±4.47	61.0±7.1	0.76
Body mass index (kg/m²)	26.0±3.6	25.7±4.2	0.78
Lomber T-score	-2.6±0.6	-2.6±0.8	0.96
Femur neck T-score	-2.0±0.5	-2.0±0.7	0.98
Duration of symptoms (month)	71.3±53.4	88.0±63.9	0.34
Age of menopause (month)	46.5±3.9	45.6±5.4	0.53
Number of falls (year)	1.9±2.6	0.4±0.9	**0.02**
Education level*			
Not literate	1	1	
Primary-secondary education	11	9	
High school	3	6	0.75
University	7	7	
Marital status*			
Married	12	14	
Not married	6	4	0.72
Widow	4	5	
Occupation*			
Retired	8	13	0.17
Housewife	14	10	
Fracture history*			
Yes	8	11	0.43
No	14	12	

TSK: Tampa scale of kinesiophobia, TGBT: Tinetti gait and balance test, SD: Standard deviation, *: Number of participants

Table 2. Comparison of muscle strength, TSK and TGBT values within the group before and after treatment						
	Face-to-face			**Telerehabilitation**		
	Median (25-75%)	**Chi-square**	**p**	**Median (25-75%)**	**Chi-square**	**p**
Left knee flexion 1 **Left knee flexion 2** **Left knee flexion 3**	15.42 (13.46-19.02) 17.67 (15.92-19.86) 18.62 (16.63-19.90)	1.402	0.496	21.05 (18.90-21.90) 23.25 (19.95-26.45) 20.95 (18.15-22.65)	9.648	**0.008**
Right knee flexion 1 **Right knee flexion 2** **Right knee flexion 3**	16.32 (14.58-20.47) 16.35 (15.47-18.63) 16.95 (15.70-17.86)	0.023	0.989	20.00 (18.10-22.05) 20.65 (18.50-22.75) 20.95 (17.90-22.70)	3.130	0.209
Left knee extension 1 **Left knee extension 2** **Left knee extension 3**	20.85 (18.11-23.47) 21.72 (17.83-23.98) 23.07 (19.77-27.08)	11.000	**0.004**	24.50 (19.15-28.65) 24.20 (22.00-29.50) 23.95 (22.30-32.25)	2.696	0.260
Right knee extension 1 **Right knee extension 2** **Right knee extension 3**	19.70 (14.03-22.76) 22.22 (17.70-24.81) 22.92 (19.12-25.78)	6.909	**0.032**	23.45 (18.80-25.35) 23.25 (19.00-28.70) 25.60 (21.90-28.70)	3.739	0.154
TSK 1 **TSK 2** **TSK 3**	47.00 (39.00-53.00) 46.00 (38.50-49.25) 41.00 (38.00-44.50)	2.424	0.289	42.00 (36.00-46.00) 40.00 (36.00-44.00) 40.00 (38.00-45.00)	0.483	0.786
TGBT gait 1 **TGBT gait 2** **TGBT gait 3**	9.00 (9.00-9.00) 9.00 (9.00-9.00) 9.00 (9.00-9.00)	2.000	0.368	9.00 (9.00-9.00) 9.00 (9.00-9.00) 9.00 (9.00-9.00)	2.000	0.368
TGBT balance 1 **TGBT balance 2** **TGBT balance 3**	25.50 (23.75-26.00) 25.00 (26.00-26.00) 26.00 (26.00-26.00)	16.233	**0.001**	26.00 (25.00-26.00) 26.00 (26.00-26.00) 26.00 (26.00-26.00)	4.909	0.086

TSK: Tampa scale of kinesiophobia, TGBT: Tinetti gait and balance test

groups, significant differences favoring the face-to-face exercise group were observed in the negative delta values for the HAI between pre-treatment and mid-treatment (p=0.021), as well as in the HAI anxiety and total HAI delta values between mid-treatment and post-treatment (p=0.025 and p=0.023). No significant differences were found among other data (p>0.05).

Quality of Life

In the intra-group comparisons of quality of life, significant differences were noted in the face-to-face exercise group for physical and emotional role limitations, energy/fatigue, emotional well-being, and pain subparameters (p=0.044, p=0.050, p=0.001, p=0.001, and p=0.0189, respectively). In contrast, the telerehabilitation group exhibited significant differences only in the energy/fatigue and pain subparameters (p=0.009 and p=0.050) (Table 5). Intergroup comparisons revealed a significant difference favoring the face-to-face exercise group in SF-36 energy/fatigue delta values between pre-treatment and mid-treatment (p=0.034) and in SF-36 emotional role limitation delta values between mid-treatment and post-treatment (p=0.011). No significant differences were found among other data (p>0.05).

Discussion

Exercise has been recommended as a low-cost and effective non-pharmacological strategy for improving bone strength. However, due to disparities in medical accessibility, many patients remain unidentified and have limited access to regular professional exercise programs. To enable more patients to receive professional rehabilitation guidance, numerous studies have begun exploring telerehabilitation, which is considered a potential innovative treatment approach and has demonstrated positive physical and functional outcomes. Nevertheless, there is insufficient literature and data on the effectiveness of telerehabilitation for patients with OP (19). Therefore, our study

Table 3. Comparison of changes in result scores in muscle strength, TSK and TGBT evaluations at baseline, 2nd and 3rd controls

	Face-to-face	Telerehabilitation	z	p
Δ Left knee flexion 1-2	1.35 (4.18-1.35)	2.05 (5.85-0.2)	0.772	0.440
Δ Left knee flexion 2-3	0.22 (2.37-1.42)	2.55 (0-4.95)	1.987	**0.047**
Δ Left knee extension 1-2	1.2 (4.62-1.56)	3.3 (4.6-6.05)	0.136	0.892
Δ Left knee extension 2-3	2.15 (4.18-0.73)	1.2 (2.75-4.3)	0.488	0.625
Δ Right knee flexion 1-2	0.05 (3.1-2.4)	0.55 (1.55-3.55)	0.749	0.454
Δ Right knee flexion 2-3	0.05 (1.23-1.42)	0.4 (1.15-3.3)	0.227	0.820
Δ Right knee extension 1-2	2.6 (4.87-1.53)	1.35 (3.15-4.4)	0.693	0.489
Δ Right knee extension 2-3	0.65 (5.18-2.2)	1.75 (3.5-6.2)	0.420	0.674
Δ TSK 1-2	0.5 (3.5-4.5)	0 (2-6)	0.057	0.955
Δ TSK 2-3	3.5 (3-8.25)	1 (2-3)	1.174	0.240
Δ TGBT gait 1-2	0 (0-0)	0 (0-0)	0.333	0.739
Δ TGBT gait 2-3	0 (0-0)	0 (0-0)	1.399	0.162
Δ TGBT balance 1-2	0.5 (2-0)	0 (0-0)	0.970	0.332
Δ TGBT balance 2-3	0 (0-1)	0 (0-1)	2.314	**0.019**

TSK: Tampa scale of kinesiophobia, TGBT: Tinetti gait and balance test

Table 4. Comparison of SHAI values within the group before and after treatment

	Face-to-face			Telerehabilitation		
	Median (25-75%)	**Chi-square**	**p**	**Median (25-75%)**	**Chi-square**	**p**
Anxiety 1 **Anxiety 2** **Anxiety 3**	15.50 (9.75-20.00) 14.50 (10.00-17.50) 11.00 (10.00-15.75)	8.32	**0.016**	21.05 (18.90-21.90) 23.25 (19.95-26.45) 20.95 (18.15-22.65)	2.02	0.363
Negative result 1 **Negative result 2** **Negative result 3**	6.00 (2.75-9.00) 4.00 (2.00-6.00) 2.00 (1.00-4.00)	18.65	**0.001**	20.00 (18.10-22.05) 20.65 (18.50-22.75) 20.95 (17.90-22.70)	1.23	0.538
Total 1 **Total 2** **Total 3**	21.50 (14.00-27.25) 19.00 (14.00-21.50) 13.50 (11.00-19.25)	10.41	**0.005**	24.50 (19.15-28.65) 24.20 (22.00-29.50) 23.95 (22.30-32.25)	1.19	0.550

SHAI: Short health anxiety inventory

Table 5. Comparison of SF-36 values within the group before and after treatment

	Face-to-face			Telerehabilitation		
	Median (25-75%)	**Chi-square**	**p**	**Median (25-75%)**	**Chi-square**	**p**
Physical function 1 **Physical function 2** **Physical function 3**	70.00 (55.00-85.00) 70.00 (58.75-95.00) 75.00 (60.00-90.00)	3.675	0.159	75.00 (60.00-90.00) 80.00 (65.00-95.00) 75.00 (60.00-95.00)	0.538	0.764
Role physical 1 **Role physical 2** **Role physical 3**	50.00 (0.00-100.00) 62.50 (25.00-100.00) 87.50 (25.00-100.00)	6.241	**0.044**	75.00 (25.00-100.00) 100.00 (50.00-100.00) 100.00 (75.00-100.00)	4.633	0.099
Role emotion 1 **Role emotion 2** **Role emotion 2**	50.00 (0.00-100.00) 83.35 (58.35-100.00) 50.00 (0.00-100.00)	5.607	**0.050**	66.70 (0.00-100.00) 66.70 (33.30-100.00) 100.00 (33.30-100.00)	3.640	0.162
Vitality 1 **Vitality 2** **Vitality 3**	35.00 (15.00-71.25) 60.00 (33.75-75.00) 62.50 (45.00-81.25)	26.554	**0.001**	50.00 (40.00-65.00) 60.00 (45.00-70.00) 65.00 (50.00-80.00)	9.349	**0.009**
Mental health 1 **Mental health 2** **Mental health 3**	50.00 (31.00-80.00) 72.00 (52.00-80.00) 70.00 (59.00-81.00)	17.446	**0.001**	60.00 (52.00-76.00) 72.00 (52.00-80.00) 68.00 (60.00-84.00)	3.791	0.150
Social function 1 **Social function 2** **Social function 3**	62.50 (50.00-87.50) 68.75 (50.00-87.50) 75.00 (59.37-100.00)	1.365	0.505	87.50 (50.00-100.00) 87.50 (62.50-100.00) 75.00 (62.50-100.00)	0.427	0.808
Pain 1 **Pain 2** **Pain 3**	45.00 (35.00-77.50) 61.25 (45.00-78.12) 57.50 (45.00-90.00)	8.026	**0.018**	55.00 (35.00-67.50) 67.50 (45.00-77.50) 77.50 (45.00-90.00)	5.951	**0.050**
General health 1 **General health 2** **General health 3**	52.50 (35.00-70.00) 70.00 (38.75-75.00) 52.50 (42.50-70.00)	4.741	0.093	50.00 (50.00-70.00) 65.00 (45.00-80.00) 70.00 (50.00-80.00)	4.959	0.084

SF-36: Short form-36

aimed to investigate and compare the effectiveness of face-to-face rehabilitation and telerehabilitation on muscle strength, balance, and quality of life in postmenopausal patients with OP. We found significant changes in both the face-to-face exercise group and the telerehabilitation group after treatment compared to pre-treatment, with the changes being more pronounced in the face-to-face exercise group.

Individuals with OP often experience muscle strength reduction and muscle atrophy due to various reasons. Muscle strength is a critical parameter, as its reduction is associated with decreased physical function, loss of balance, and falls (20). Studies have shown that exercise interventions are effective in increasing muscle strength. Gibbs et al. (21) demonstrated that home exercise programs could lead to increased muscle strength in individuals with OP. Similarly, Zhang et al. (20) found that exercise programs resulted in improvements in muscle strength and function. While there are variations in the literature regarding the duration of exercises, it is generally suggested that a minimum of 12 weeks of exercise programs should be implemented for individuals with OP (22). The length of exercise programs poses challenges for patients in accessing facilities, prompting the consideration of telerehabilitation as a viable option. Chen et al. (23) compared the effectiveness of face-to-face rehabilitation and telerehabilitation in stroke patients, implementing interventions for 12 weeks and following up for an additional 12 weeks. The authors reported that telerehabilitation was as effective as face-to-face rehabilitation in terms of functional improvement and muscle strength. Nelson et al. (12) divided 69 patients who had undergone total hip arthroplasty into two groups, providing face-to-face rehabilitation and a technology-based home exercise program using an iPad. Their 6-week follow-up indicated no differences in muscle strength and balance between the two groups. Zou et al. (24) concluded in their meta-analysis that the use of telerehabilitation is beneficial, particularly in reducing pain intensity and improving disability in patients with non-specific neck pain. On the other hand, Xiang et al. (25) reported in their meta-analysis of patients with knee osteoarthritis that telerehabilitation programs may help alleviate pain but do not improve physical function; however, they are beneficial for facilitating the implementation of home-based rehabilitation exercises for patients. In our study, which examined the effectiveness of both face-to-face rehabilitation and telerehabilitation, we found changes in muscle strength and balance before and after treatment in both groups; however, there was no superiority in muscle strength between the groups, whereas the face-to-face exercise group had better outcomes in terms of balance. The necessity for the face-to-face exercise group to leave their homes and attend a facility on specific days of the week may

have contributed to an increase in their physical activity levels, leading to this observed difference. While the face-to-face exercise program was found to be more effective functionally than telerehabilitation, we believe that telerehabilitation could be a useful option for patients with barriers to participating in face-to-face exercise programs, particularly for those who have difficulty in transportation or who are at high risk of fractures, balance loss, and falls.

A decrease in bone density, an increase in fragility, and the possibility of falling and related fractures, especially during physical activity, can lead to kinesiophobia in individuals with OP, particularly those living a sedentary lifestyle (5). Osteoporotic fractures, recognized as the fourth most burdensome chronic disease, can lead to significant economic and social costs, increased disability, and a reduced quality of life (26,27). Research has shown that exercise interventions improve parameters such as muscle strength and balance, helping to prevent falls, reduce kinesiophobia, and enhance quality of life (28). In our study, we observed a reduction in kinesiophobia levels post-treatment; however, this decrease was not statistically significant. Conversely, the anxiety levels in the face-to-face exercise group significantly decreased. Additionally, improvements in certain quality of life parameters were noted in both groups, though neither group showed a clear advantage over the other. The participation of patients in the face-to-face exercise group in group interactions and their direct communication with a physiotherapist may have contributed to a reduction in anxiety levels, resulting in a more substantial improvement in their quality of life compared to the telerehabilitation group. Therefore, we believe that telerehabilitation may be an appropriate method for improving the quality of life of patients who lack access to professional face-to-face exercise programs or who face barriers due to high risks of fractures, balance loss, and falls. Supporting our results, Wicks et al. (29) concluded in their meta-analysis that exercise-based telerehabilitation is not superior to face-to-face rehabilitation for older adults with musculoskeletal and cardiopulmonary conditions, but it is more effective than no intervention.

It is well known that resistance exercises, especially those involving moderate to heavy weights, effectively improve bone density and microarchitecture in OP (30). However, long-term, clinically supervised exercise programs are typically required to realize these benefits (31). Unfortunately, patients with OP and low bone density may struggle to participate in these exercise programs due to the high demands on the healthcare system, time constraints, and transportation challenges (32). Therefore, enabling patients to engage in supervised and safe exercise programs from home is crucial for mitigating OP and its secondary problems (33). A meta-analysis investigating the effectiveness and cost-effectiveness of telerehabilitation in musculoskeletal disorders reported that telerehabilitation should be considered as a cost- and time-efficient option in the rehabilitation process of musculoskeletal conditions, particularly when face-to-face rehabilitation is not optimally feasible (34). In a study involving 50 patients with chronic low back pain (35), participants were randomized into two groups: One group received telerehabilitation while the other followed a home exercise program. After eight weeks, telerehabilitation was found to be more effective than the home program in reducing pain and improving quality of life. In their meta-analysis of 13 articles (36), Cottrell et al. (36) emphasized that telerehabilitation appears to be effective in improving physical function and pain in various musculoskeletal disorders, comparable to traditional healthcare delivery methods. However, the researchers concluded that there is insufficient research to demonstrate whether telerehabilitation is an effective approach. Although there are studies examining the efficacy of telerehabilitation, these are limited, and further research is needed (37,38). Moreover, studies focusing on OP are particularly scarce. Our research, which compares telerehabilitation with face-to-face exercise in individuals with OP, is one of the first in this field, highlighting its strengths.

Study Limitations

Our study had some limitations. The lack of assessment of patient satisfaction and perspectives on telerehabilitation can be considered a limitation. Additionally, not conducting long-term follow-ups to ascertain the enduring effects of exercise programs may also be viewed as a limitation. Therefore, future studies should explore the feasibility of long-term telerehabilitation programs, patient compliance, and the effects during chronic phases.

Conclusion

In postmenopausal patients with OP, both face-to-face rehabilitation and telerehabilitation programs resulted in improvements; however, the enhancements observed in the face-to-face exercise group were greater than those in the telerehabilitation group. These improvements were particularly noted in anxiety and quality of life parameters. We believe that the reasons for this may include the interaction of patients in the face-to-face exercise group with their external environment, the confidence and comfort derived from direct communication with physiotherapists, and the supervised nature of their exercises. The integration of telehealth technologies into rehabilitation can facilitate the delivery of personalized interventions, monitoring, and support in individuals' homes or local communities, regardless of geographic location, socio-economic status, or mental capacity. We propose that telerehabilitation exercise programs be implemented to reduce risks such as falls, kinesiophobia, and fractures in individuals with OP, particularly those with barriers to participating in any face-to-face treatment programs. This could help mitigate the risks of falls and fractures, thereby preventing secondary issues arising from these problems. Since the effectiveness of telerehabilitation in patients diagnosed with OP has not been previously researched, we believe our study will contribute significantly to the existing literature.

Ethics

Ethics Committee Approval: Prior to the commencement of the study, approval was obtained from the Non-Interventional Clinical Research Ethics Committee of İzmir Bakırçay University (decision no: 459, date: December 22, 2021).

Informed Consent: All participants provided written informed consent before the participation in the study.

Acknowledgments

The authors would like to acknowledge the Scientific Research Projects Coordination Unit at İzmir Bakırçay University.

Footnotes

Authorship Contributions

Concept: E.U.A., Design: E.U.A., T.A., Data Collection or Processing: E.U.A., T.A., Analysis or Interpretation: E.U.A., S.G.U., Literature Search: E.U.A., S.G.U., Writing: E.U.A., S.G.U.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The study was supported by the Scientific Research Projects Coordination Unit at İzmir Bakırçay University (KBP.2021.002).

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