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The Effect of Progressive Muscle Relaxation Exercises on Sleep Quality in Patients Receiving Hemodialysis Treatment: A Randomized Controlled Study

Hemodiyaliz Tedavisi Alan Hastalarda Progresif Kas Gevşeme Egzersizlerinin Uyku Kalitesi Üzerine Etkisi: Randomize Kontrollü Çalışma

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Abstract

Objective: This study evaluated the effect of progressive muscle relaxation exercises (PMRE) applied to patients undergoing hemodialysis (HD) treatment due to chronic kidney disease on sleep quality.

Materials and Methods: The research was conducted between March 1 and September 30, 2022, with 76 participants in a private dialysis center in Konya Province, Turkey. Using a randomized controlled research design, we divided the participants into 38 experimental and 38 control groups. We collected data using the "personal information form" and the "Pittsburgh sleep quality index (PSQI)". IBM SPSS 26 software performed the statistical analysis of the obtained data. When the parametric test assumptions were met, the ""Student's t-test" was used to evaluate differences between the two independent groups; otherwise, the "Mann-Whitney U test" was employed. The relationship between categorical variables was assessed using Fisher's exact test and chi-square tests.

Results: In the intervention group undergoing PMRE, it was determined that the PSQI total sleep score and its subdimensions, including subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, and daytime dysfunction (except for the sleep medication use subdimension), had a significantly positive effect compared to the control group at the eighth week ($p<0.001$).

Conclusion: In line with these findings, it has been determined that PMRE improve sleep quality in patients undergoing HD treatment. It is recommended that HD patients be educated about PMRE and that the exercises be taught.

Keywords: Hemodialysis, sleep quality, progressive muscle relaxation exercise

Öz

Amaç: Bu çalışma kronik böbrek hastalığı nedeniyle hemodiyaliz tedavisi alan hastalara uygulanan progresif kas gevşeme egzersizlerinin (PKGE) uyku kalitesi üzerine etkisini değerlendirmek amacıyla yapıldı.

Gereç ve Yöntem: Araştırma 01 Mart-30 Eylül 2022 tarihleri arasında Konya ilinde özel bir diyaliz merkezinde hemodiyaliz tedavisi alan hastalar ile randomize kontrollü araştırma şeklinde 38 deney, 38 kontrol grubu olmak üzere toplam 76 hasta ile tamamlandı. Veriler "kişisel bilgi formu" ve "Pittsburgh uyku kalitesi indeksi (PUKİ) ile toplandı. Elde edilen verilerin istatistiksel analizi IBM SPSS 26 programında, iki bağımsız grup arasındaki farklılıkların değerlendirilmesinde, parametrik test ön şartlarını sağladığı durumda "Student's t-test"; sağlanamadığında ise "Mann Whitney-U testi" kullanıldı. Kategorik değişkenler arasındaki ilişkiye Fisher's exact testi ve ki-kare testleri kullanılarak yapıldı.

Bulgular: PKGE yapılan deney grubunda PUKİ toplam uyku puanı ve PUKİ öznel uyku kalitesi, uyku latansı, uyku süresi, uyku etkinliği, uyku bozukluğu, gündüz işlev bozukluğu alt boyutlarının puanının (uyku ilacı kullanımı alt boyutu hariç) kontrol grubuna göre sekizinci haftada olumlu yönde etkili olduğu belirlendi ($p<0,001$).

Sonuç: Bu sonuçlar doğrultusunda hemodiyaliz tedavisi alan hastalarda PKGE'nin uyku kalitesini artırdığı saptanmış olup PKGE hakkında hemodiyaliz tedavisi alan hastalara eğitim verilerek egzersizlerin öğretilmesi önerilir.

Anahtar Kelimeler: Hemodiyaliz, uyku kalitesi, progresif kas gevşeme egzersizi

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Clinical Trial Registration: The Clinical Trials protocol of this study was registered (NCT05604833).

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Introduction

Chronic kidney disease (CKD) is a severe health condition that adversely affects individuals' physical, social, and psychological well-being, reducing their overall quality of life. Renal replacement therapy (RRT) becomes necessary when diet and medication fail to manage CKD. RRT includes hemodialysis (HD), peritoneal dialysis, and renal transplantation.[1,2] In patients undergoing HD, side effects such as fatigue, muscle cramps, insomnia, and restless legs syndrome can be seen due to the HD process, which can negatively affect the patient's quality of life.[3,4]

Patients undergoing HD may experience sleep problems that could negatively impact their sleep quality, including issues with falling or waking up from sleep, frequent nighttime awakenings, restless wakefulness, daytime sleepiness, and impaired daytime functioning. Studies have indicated that sleep problems are observed in 40-83% of patients in HD treatment. Studies have shown that the sleep quality of patients with HD is poor, which negatively affects their quality of life.[3-9] Non-pharmacological practices such as cognitive therapy, sleep hygiene, music therapy, and relaxation exercises can reduce insomnia and improve sleep quality.[10,11]

Relaxation exercises include techniques like deep breathing exercises, meditation, reflexology, and progressive muscle relaxation exercises (PMRE). PMRE is a type of relaxation exercise involving individual contraction and muscle group relaxation from the face to the feet.[12-14] PMRE is easily learned, has no adverse effects, and can be practiced anywhere. However, limited studies have been found in the literature showing the benefits of relaxation exercises for improving sleep quality in HD patients.[15-18] This research aimed to assess the impact of PMRE on sleep quality in patients receiving HD treatment.

Materials and Methods

This study was conducted as a randomized controlled trial (Figure 1). The study took place at a private dialysis center in Konya between March 1 and September 30, 2022.

Study Participant

During the study period, a total of 218 patients received HD at a private dialysis center. The study's sample size was calculated with α =0.05, 90% power, and 0.746 effect size based on the results of a similar study. It used G*Power 3.1 software. As a result of the analysis, a total of 64 patients, 32 of whom were experimental and 32 were control, formed the sample for this study.[16] We included 80 samples, with 40 patients in the intervention group and 40 in the control group, to account for potential losses during the study. Throughout the study, we excluded a total of four patients: two from the intervention group (one patient left the dialysis center, another couldn't allocate time for the study), and two from the control group (both patients stated they couldn't allocate time for the study). We completed the study with 76 patients, 38 in the intervention group and 38 in the control group.

Inclusion for the study: Patients aged eighteen years or older, with a Pittsburgh sleep quality index (PSQI) global sleep score of ≥5 points, who had undergone HD for at least three months, who had a mobile phone suitable for downloading PMRE video, and who volunteered to participate in the study were included in the study.

Exclusion criteria for the study: We identified exclusion criteria as hearing impairment, physical barriers to performing relaxation exercises, psychiatric disorders like depression and schizophrenia, and participation in relaxation exercises like yoga, breathing exercises, and meditation for the previous six months.

Randomization and blinding: A computer-based program (www.random.org) randomly and equally assigned patients meeting the inclusion criteria to both groups. An independent statistician assigned participants to the experimental and control groups to ensure privacy and prevent bias. We carried out this process using a blind technique, which included random assignment and concealed randomization to control selection bias. Due to the intervention, blinding the researcher was impossible. The researcher coded the data as "A" and "B" before transferring them to the computer.

Additionally, an independent statistical expert analyzed the coded data to prevent bias in data analysis. We allocated the participants to groups based on this list after obtaining their consent and completing the pre-tests. The study's nature precluded the application of blinding to the participants. To remove any potential prejudice, a neutral researcher who had no prior knowledge of the trained groups collected and recorded the information for the study. Additionally, an independent statistician, unaware of the assigned groups, conducted the statistical analysis of the data. This approach ensured the prevention of bias during the data analysis phase.

Data Collection Tools

Personal information form: The form included 12 questions that assessed participants' age, gender, education, marital status, occupation, and information about their HD treatment.[17-19]

PSQI: In the last month, Buysse et al.[20] developed the PSQI to provide information about sleep quality, as well as the type and severity of sleep disorders. The Turkish validity and reliability of the scale were made by Agargun et al.[21] The PSQI consists of seven components and 19 questions that assess overall sleep quality, subjective sleep quality, sleep duration, sleep latency, habitual sleep efficiency, sleep disturbances, sleep medication use, and daytime dysfunction. Based on symptom frequency, a scale of 0 to 3 scores each subdimension's response. Scoring is as follows: 0 for "not during the past month", 1 for "less than once a week", 2 for "once or twice a week", and 3 for "three or more times a week". The global sleep score ranges from 0 to 21, with higher values indicating poorer sleep quality and higher levels of sleep disorders. A PSQI global sleep score of ≥5 points indicates poor sleep quality.[20,21] In this study, Cronbach's alpha coefficient calculated for the seven components of the PSQI scale was found to be 0.73.

Patient Inclusion and Assignment to the Study

Before their dialysis sessions, the HD center conducted individual interviews with HD patients in a private room. We verbally

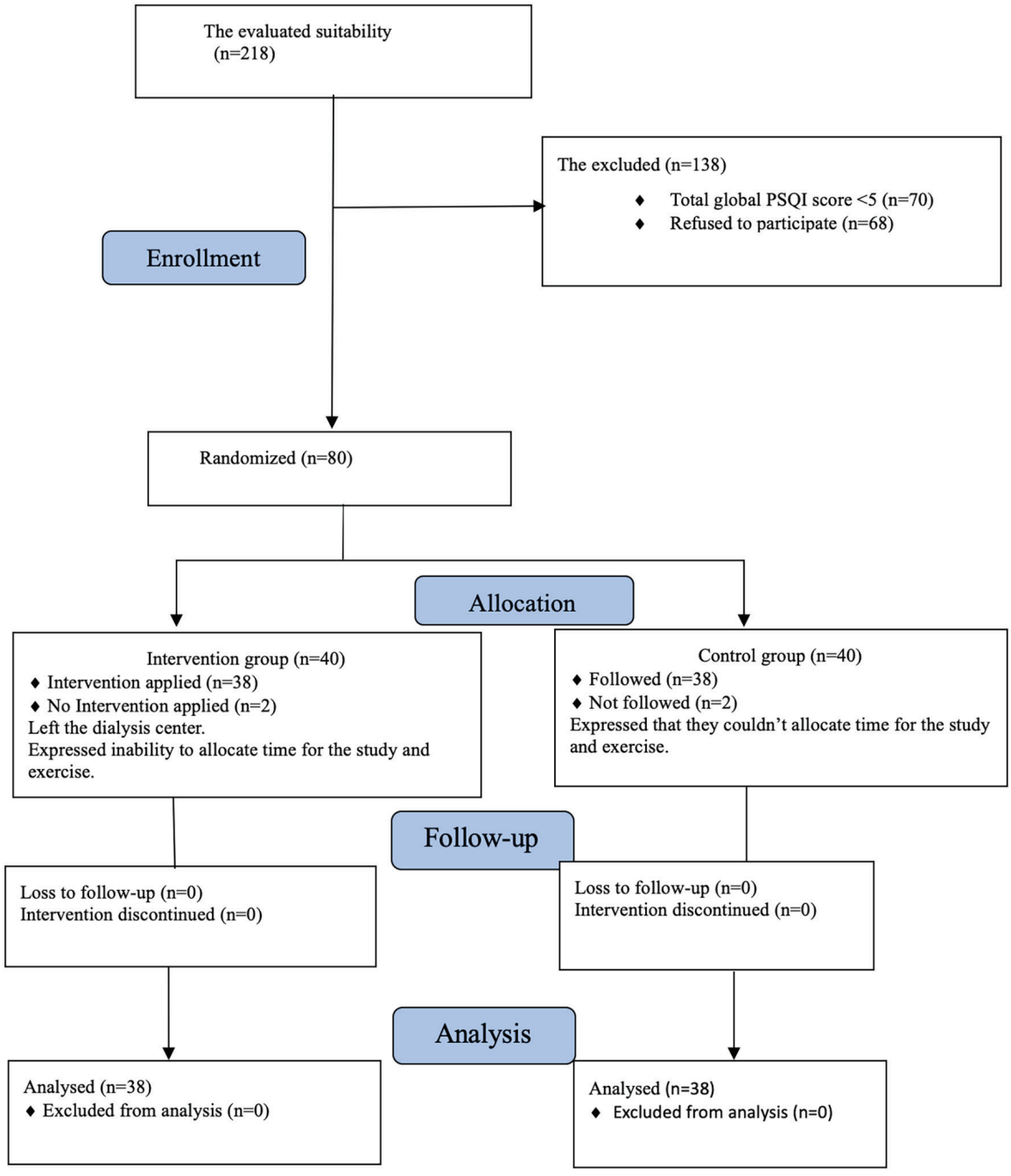

Figure 1. Consort flow diagram
PSQI: Pittsburgh sleep quality index

informed the patients about the study and invited them to participate. Those agreeing to participate had their eligibility assessed based on the inclusion criteria. We obtained written consent from eligible participants. Before allocating to groups, the researcher completed the "personal information form" and PSQI as pre-tests. The randomization process involved opening sealed envelopes and assigning patients to either the experimental or control groups.

Implementation of the Intervention Group

In a separate room within the HD unit, patients assigned to the intervention group received information about PMRE. The Turkish Psychologists Association granted permission to upload the exercise video to the patient's phone. We then provided the patient with headphones, enabling them to perform the exercise while listening to the video. We monitored the patient's correct execution of the exercise throughout this process. We

instructed the patient to perform the exercise twice daily for 8 weeks, once during the day and once before bed. We sent a daily reminder message to ensure regular exercise. We asked them to record their home workouts in the daily exercise form. We evaluated sleep quality using PSQI during the fourth and eighth weeks.

Control Group

Patients in the control group received only routine care, without any interventions. We evaluated sleep quality with PSQI in the fourth and eighth weeks. We offered the control group the option to learn PMRE at the end of the eighth week. Of these, we taught PMRE to 25 patients who expressed interest.

PMRE

PMRE is a cognitive-behavioral technique developed by Jacobson in the 1920s. It involves voluntary contraction and subsequent relaxation of muscles, aiming to induce sensations of relaxation, comfort, and rest.[12,13] Regular relaxation exercises activate the parasympathetic nervous system, promoting relaxation.[11] Various muscle groups, including hands, arms, neck, shoulders, face, chest, hips, thighs, feet, and fingers, tense and then relax during PMRE (Figure 2). The exercise is typically conducted in a calm environment while listening to audio recordings lasting around 30 minutes.[22,23]

Statistical Analysis

We analyzed the collected data using the IBM SPSS Statistics Standard Concurrent User V 26 software package (IBM Corp., Armonk, New York, USA). We assessed the normal data distribution for numerical variables using the Shapiro-Wilk normality test. We evaluated the homogeneity of variances using the Levene test. When examining differences between two independent groups, the parametric "Student's t-test" was employed if the prerequisites were met; otherwise, the "Mann Whitney-U test" was utilized. We assessed the relationships between categorical variables using the Fisher's exact and chi-square tests. The Mauchly test verified the assumption of sphericity for repeated measures analyses. We selected the appropriate test (Huynh-Feldt or Greenhouse-Geisser) depending on whether the epsilon value was greater than 0.75 or not. Repeated measures (clinical parameters) and an overall assessment between patient groups were conducted using a mixed-design analysis of variance and the Bonferroni-Dunn post-hoc test for multiple comparisons. We also performed within-timepoint comparisons using the Bonferroni-Dunn test. Initial values exhibited a statistically significant difference between the two groups.

Consequently, we conducted a mixed-design ANCOVA, considering the initial values as covariates, and carried out within-group and between-group multiple comparisons using the Bonferroni-Dunn test. A significance level of $p<0.05$ was considered statistically significant.

Ethical Consideration

To conduct the research, ethical approval was obtained from the KTO Karatay University Faculty of Medicine, Pharmaceutical and Non-Medical Device Research Ethics Committee under the decision number 2022/006 (date: 14.01.2022), and permission was obtained from the institution where the research would be conducted. Participation in the study was entirely voluntary, and written consent was obtained from the participants. The Clinical Trials protocol of this study was registered (NCT05604833).

Results

This study was completed with 76 patients (intervention group; 38, control group; 38). The demographic characteristics of the patients in the study groups (Table 1) and their disease and HD treatment processes (Table 2) were statistically similar ($p>0.05$). Table 3 shows the comparison of PSQI global sleep scores and PSQI subscale mean scores between the experimental and control groups.

PSQI Global Sleep

There was no difference in PSQI global sleep scores between the two groups before the intervention ($p>0.05$). It was determined that the mean PSQI global sleep scores measured in the fourth and eighth weeks were significantly lower in the intervention group than in the control group ($p<0.001$) (Table 3).

PSQI Subjective Sleep Quality Subscale

Before the intervention, measurements taken in both groups showed no difference in the average PSQI subjective sleep quality subscale scores. However, it was determined that in the intervention group, the average scores of the PSQI subjective sleep quality subscale in the fourth and eighth weeks were significantly lower compared to the control group's scores in the fourth and eighth weeks ($p<0.05$) (Table 3).

PSQI Sleep Latency Subscale

There was no significant difference in the mean scores of the PSQI sleep latency subscale between the groups in the measurements performed before the intervention and in the fourth week. However, the mean sleep latency scores in the eighth week were significantly lower in the intervention group than in the control group (Table 3).

PSQI Sleep Duration Subscale

In the eighth week of the study, the average score of the "sleep duration" subscale in the intervention group was significantly lower compared to the average score in the eighth week of the control group ($p<0.001$) (Table 3).

PSQI Habitual Sleep Efficiency Subscale

While there was no significant difference in the pre-intervention and fourth-week measurements between the study groups, the average score of the "habitual sleep efficiency" subscale in the intervention group was found to be significantly lower than that of the control group in the eighth week ($p<0.001$) (Table 3).

PSQI Sleep Disturbance Subscale

While there was no significant difference in the pre-intervention measurements between the study groups, the average scores of the "sleep disturbance" subscale in the intervention group during the fourth and eighth weeks were found to be

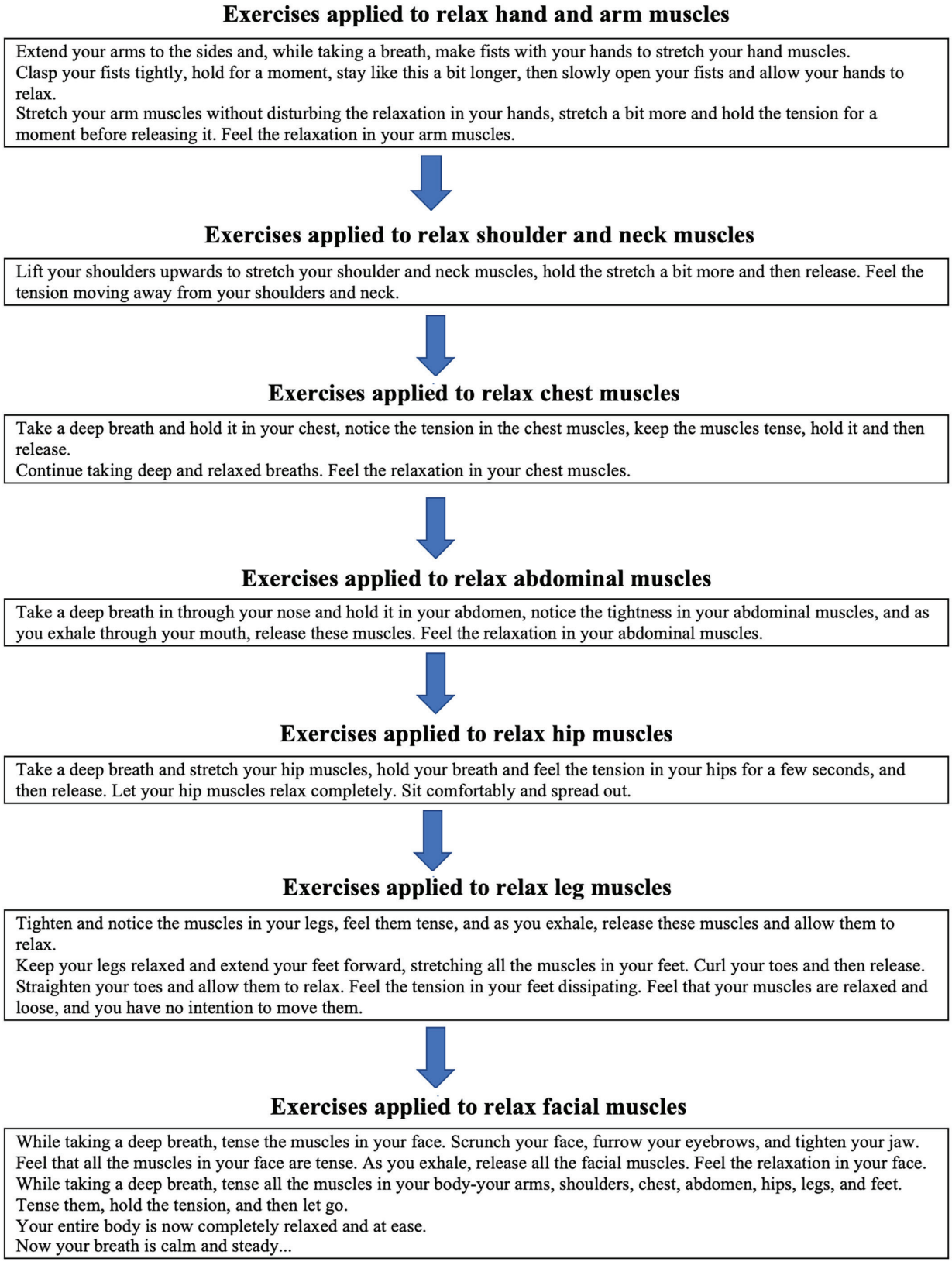

Figure 2. PMRE stages
PMRE: Progressive muscle relaxation exercises

Table 1. Comparison of participants' demographic characteristics according to study groups

	Group		Test statistics	
	Experiment n=38	Control n=38	Test value	p
Age, (year)				
Mean ± SD	54.71±12.11	58.82±9.31	-1.804‡	0.071
M (min-max)	53.5 (35-86)	58 (37-78)		
Gender, n (%)				
Woman	21 (55.3)	20 (52.6)	0.053†	0.818
Male	17 (44.7)	18 (47.4)		
Marital status, n (%)				
Married	32 (84.2)	34 (89.5)	0.461†	0.497
Single	6 (15.8)	4 (10.5)		
Education status, n (%)				
Literate	0 (0)	4 (10.5)	6.640†	0.084
Primary school	28 (73.6)	30 (78.9)		
High school	5 (13.2)	2 (5.3)		
College	5 (13.2)	2 (5.3)		
Working status, n (%)				
Working	4 (10.5)	1 (2.6)	1.927†	0.165
Not working	34 (89.5)	37 (97.4)		
Occupation status, n (%)				
Housewife	18 (47.4)	20 (52.6)	1.848†	0.384
Retired	13 (34.2)	15 (39.5)		
Other (6 self-employed, 1 civil servant)	7 (18.4)	3 (7.9)		

†: Chi-square test (χ^2), ‡: Mann-Whitney U test (z)
SD: Standard deviation, M: Median, min-max: Minimum-maximum

significantly lower than those of the control group during the corresponding weeks (p<0.05) (Table 3).

PSQI Daytime Dysfunction Subscale

In the eighth-week measurement of the intervention group, the average score of the "daytime dysfunction" subscale was found to be significantly lower than that of the control group in the eighth week (p<0.001) (Table 3).

PSQI Sleep Medication Use Subscale

There was no statistically significant difference in PSQI sleep medication use subscale scores between the experimental and control groups (p>0.05). In the within-group comparison, it was observed that the intervention group's PSQI sleep medication use score in the fourth and eighth weeks was significantly lower than before the intervention (p<0.05) (Table 3).

Discussion

This study provides evidence that PMRE positively impacts sleep quality in patients undergoing HD during the fourth and eighth weeks.

Table 2. Comparison of participants' disease characteristics according to study groups

	Group		Test statistics	
	Experiment n=38	Control n=38	Test value	p
Chronic disease, n (%)				
Yes	26 (68.4)	29 (76.3)	0.592†	0.442
No	12 (31.6)	9 (23.7)		
Hemodialysis time, n (%)				
3 months-1 year	7 (18.4)	5 (13.2)	2.273†	0.518
1-5 years	12 (31.6)	18 (47.3)		
5-10 years	11 (28.9)	10 (26.3)		
10 years and above	8 (21.1)	5 (13.2)		
Number of hemodialysis per week, n (%)				
2 times a week	1 (2.6)	2 (5.3)	0.347†	0.556
3 times a week	37 (97.4)	36 (94.7)		

†: Chi-square test (χ^2)
SD: Standard deviation

According to the PSQI scale, a global sleep score of 5 or above indicates that sleep quality is negatively affected in at least two areas. As the score increases, the negative impact on sleep quality becomes more pronounced. However, in this study, the intervention group's PSQI global sleep score fell below 5 during the eighth week. Similarly, in a study by Saeedi et al.[15], the PSQI global sleep score decreased, but the indicator of poor sleep quality, represented by a score above 5, remained. Yang et al.[11] conducted a meta-analysis on the effects of PMRE on HD patients, noting an improvement in sleep quality among patients who engaged in PMRE. Similarly, Akgül and Kelleci's[18] study, in which they administered PMRE daily for eight weeks, revealed an improvement in sleep quality by the eighth week. However, the PSQI global sleep score had decreased compared to the baseline; it remained above the threshold associated with poor sleep quality.[18] It has been determined that PMRE also improves sleep quality in coronavirus disease-2019 patients.[24,25] Researchers have also found that PMRE enhances sleep quality in burn patients[26], lung resection patients[27], and chronic obstructive pulmonary disease patients.[28] Amini et al.[17] study, involving nightly PMRE sessions for eight weeks, demonstrated that the global sleep score fell below 5 (indicative of poor sleep quality).

In contrast, in a study by Rambod et al.[16], HD patients in the intervention group practiced the Benson relaxation technique twice a day for 20 minutes each over eight weeks, and the Benson relaxation exercises positively impacted sleep quality. However, Rambod et al. [16] determined that the global sleep score remained above 5 points. Based on the findings of previous studies and this research, we observed that PMRE started to improve global sleep quality from the fourth week, and by the eighth week, the improvement was more pronounced, surpassing the threshold of 5 points in the PSQI global sleep score. This outcome suggests that increasing the duration

Table 3. Comparison of PSQI and subscale mean scores between experimental and control groups					
		Pre-enterprise	**Fourth week**	**Eighth week**	**Test statistics**
PSQI global total score	Experiment	9.67±0.00[a]	7.53±0.23[b]	3.40±0.34[d]	**F=194.440 p<0.001 η^2=0.844;** **Group effect**: F=385.419 p<0.001 η^2=0.841; **Time effect:** F=24.179 p<0.001 η^2=0.249; **Group x time interaction:** F=195.466 p<0.001 η^2=0.728
	Control	9.67±0.00[a]	10.08±0.23[a]	11.04±0.34[b]	
	Test statistics	F=0.001 p=0.999 η^2=0.001	F=57.532 p<0.001 η^2=0.441	F=240.789 p<0.001 η^2=0.767	
Subjective sleep quality	Experiment	1.66±0.00[a]	1.30±0.10[b]	0.45±0.10[c]	**F=82.535 p<0.001 η^2=0.696;** **Group effect:** F=225.321 p<0.001 η^2=0.755; **Time effect:** F=10.200 p<0.001 η^2=0.123; **Group x time interaction:** F=59.131 p<0.001 η^2=0.448
	Control	1.66±0.00[a]	1.72±0.10[ab]	1.89±0.10[a]	
	Test statistics	F=0.001 p=0.999 η^2=0.001	F=9.219 p=0.003 η^2=0.112	F=99.542 p<0.001 η^2=0.577	
Sleep latency	Experiment	2.29±0.73[a]	2.03±0.75[b]	1.26±0.60[c]	**F=41.572 p<0.001 η^2=0.532;** **Group effect:** F=6.470 p=0.013 η^2=0.080; **Time effect:** F=14.804 p<0.001 η^2=0.167; **Group x time interaction:** F=43.759 p<0.001 η^2=0.372
	Control	2.05±0.77[a]	2.26±0.76[b]	2.37±0.75	
	Test statistics	F=1.891 p=0.173 η^2=0.025	F=1.863 p=0.176 η^2=0.025	F=50.206 p<0.001 η^2=0.404	
Sleep duration	Experiment	1.95±0.98[a]	1.53±0.83[b]	0.87±0.58[c]	**F=39.753 p<0.001 η^2=0.521;** **Group effect:** F=1.447 p=0.233 η^2=0.019; **Time effect:** F=15.278 p<0.001 η^2=0.171; **Group x time interaction:** F=42.409 p<0.001 η^2=0.364
	Control	1.55±0.92[a]	1.61±0.89[a]	1.82±0.83[a]	
	Test statistics	F=3.256 p=0.075 η^2=0.042	F=0.161 p=0.690 η^2=0.002	F=33.162 p<0.001 η^2=0.309	
Usual sleep efficiency	Experiment	1.42±1.08[a]	1.03±1.08[b]	0.24±0.54[c]	**F=32.236 p<0.001 η^2=0.469;** **Group effect:** F=3.385 p=0.070 η^2=0.044; **Time effect:** F=10.994 p<0.001 η^2=0.129; **Group x time interaction:** F=38.873 p<0.001 η^2=0.344
	Control	1.16±1.10[a]	1.16±1.00[a]	1.50±1.08[a]	
	Test statistics	F=1.103 p=0.297 η^2=0.015	F=0.304 p=0.583 η^2=0.004	F=41.262 p<0.001 η^2=0.358	
Sleep disturbance	Experiment	1.43±0.00[a]	1.15±0.07[b]	0.83±0.09[c]	**F=23.325 p<0.001 η^2=0.393;** **Group effect:** F=121.237 p<0.001 η^2=0.624; **Time effect:** F=33.980 p<0.001 η^2=0.318; **Group x time interaction:** F=15.617 p<0.001 η^2=0.176
	Control	1.43±0.00[a]	1.38±0.07[ab]	1.49±0.09[a]	
	Test statistics	F=0.001 p=0.999 η^2=0.001	F=5.052 p=0.028 η^2=0.065	F=25.978 p<0.001 η^2=0.262	
Daytime dysfunction	Experiment	1.21±0.96[a]	0.97±0.79[ab]	0.24±0.49[b]	**F= 28.194 p<0.001 η^2=0.436;** **Group effect:** F=13.248 p=0.001 η^2=0.152; **Time effect:** F=6.426 p=0.002 η^2=0.080; **Group x time interaction:** F=29.270 p<0.001 η^2=0.283
	Control	1.08±0.71[ab]	1.29±0.61[ab]	1.47±0.73[a]	
	Test statistics	F=0.459 p=0.500 η^2=0.006	F=3.811 p=0.055 η^2=0.049	F=75.890 p<0.001 η^2=0.506	
Sleep medication usage	Experiment	0.39±0.92[a]	0.16±0.49[b]	0.03±0.16[c]	F=6.862 p=0.002 η^2=0.158; **Group effect:** F=0.750 p=0.389 η^2=0.010; **Time effect:** F=5.024 p=0.008 η^2=0.064; **Group x time interaction:** F=6.816 p=0.001 η^2=0.084
	Control	0.08±0.49[abc]	0.11±0.51[abc]	0.11±0.51[abc]	
	Test statistics	F=3.519 p=0.065 η^2=0.045	F=0.209 p=0.649 η^2=0.003	F=0.830 p=0.365 η^2=0.011	
a>b>c>d: Different letter on the same line or letter combinations indicate a statistically significant difference p<0.05, PSQI: Pittsburgh sleep quality index					

and frequency of PMRE sessions might be more effective in enhancing sleep quality. Therefore, we recommend comparing PMRE interventions with varying durations and frequencies.

This study determined that the PSQI subjective sleep quality scores of the intervention group significantly decreased in the fourth and eighth weeks compared to the control group. The findings of Sayed and Younis's[14] study, which applied relaxation techniques once a day for thirty days, align with this result. A study by Amini et al.[17] demonstrated that PMRE administered once a day for sixty days improved sleep quality on the 60th day for HD patients compared to aerobic exercises and the control group. In contrast to the prior studies involving PMRE interventions administered once a day for thirty days[14] and sixty days[17], this current research implemented PMRE twice a

day, leading to a more pronounced reduction in sleep scores between the fourth and eighth weeks. Based on the study's outcomes, it is believed that exercises performed twice daily and for an extended period could yield more effective results.

Sleep latency is a sub-dimension of PSQI that indicates the time it takes for patients to fall asleep. It is negatively affected in patients who experience difficulty falling asleep.[20] In a study by Sayed and Younis[14], sleep latency decreased from 1.70 to 0.95. In contrast, in a study by Demiralp et al.[29] on patients who underwent breast cancer chemotherapy and received PMRE eight times during four chemotherapy cycles, PMRE reduced sleep latency from 1.21 to 1.07. The results of this study are consistent with the findings of other studies, indicating the effectiveness of PMRE on sleep latency; considering that the shorter the time to fall asleep, the better the sleep quality, it is believed that performing PMRE before falling asleep could be beneficial.

Sleep duration is defined as the amount of time patients spend asleep. In HD patients, factors such as uremia-related itching, restless leg syndrome-associated night awakenings, fatigue, cramps, and emotional problems can lead to a decrease in sleep duration and disrupted sleep quality. Sayed and Younis[14] conducted a PMRE intervention once daily for 30 days in HD patients and compared pre- and post-relaxation measurements, finding a significant decrease in sleep duration. They reported a decrease from 2.22 to 1.96 in sleep duration scores before and after relaxation, respectively, indicating a significant improvement. This study exhibits similarities to existing literature, suggesting that longer daily exercise sessions may lead to more effective outcomes.

Unusual sleep efficiency is an indicator that patients are not sleeping enough. Similar to this study's findings, Sayed and Younis[14] compared pre- and post-relaxation sleep levels in HD patients who received PMRE once daily for 30 days and found a significant decrease in sleep duration. The results of these studies are consistent with the literature.

Sleep disturbance is defined as a decrease in mental activity, excessive sleep need, and the inability of the patient to sleep.[20] Like this study, Sayed and Younis[14] compared pre- and post-relaxation sleep levels in HD patients who received PMRE once daily for 30 days and found a significant decrease in sleep disturbance. Daytime dysfunction is daytime napping and the inability to perform daytime functions due to inadequate sleep in HD patients.[20] HD patients participate in the HD program two or three times a week. During the HD procedure, they lie down, and each session lasts at least four hours, allowing them to sleep. However, this can disrupt the circadian rhythm, which significantly affects sleep quality. The resulting disruption in circadian rhythm can lead to daytime dysfunction. By addressing these issues, PMRE is believed to be beneficial for improving the daytime dysfunction subdomain.

Sleep medications can be used for short-term treatment of insomnia. Similarly, Saeedi et al.[15] looked at how PMRE affected the quality of sleep in HD patients and found results similar to this study. The only area where the groups did not differ significantly was the use of sleep medications.[15] Similarly, Sayed and Younis[14] found no significant difference in the sleep medication usage score between the groups. The lack of difference in PSQI sleep medication usage may be due to the participants who used sleep medication needing to take the medication regularly, even if their sleep quality improved. Therefore, we might suggest conducting studies that assess sleep quality over a longer period to better understand the effects.

Study Limitations

Only patients undergoing HD treatment participated in this study, which took place at a single healthcare center. The study used subjective self-report scales to assess sleep quality, and patients may have experienced fatigue during the questionnaire filling process. Additionally, the researcher's increased interaction with the intervention group for teaching and reminders about the exercises might have created a subjective sense of well-being.

Conclusion

We investigated the impact of PMRE on sleep quality in patients undergoing HD treatment. PMRE was effective in improving sleep quality by reducing both the PSQI global sleep score and PSQI sub-dimension scores (except for sleep medication usage). The study evaluated the effectiveness after an eight-week intervention period. We recommend further studies to assess the longer-term effects of exercises. Patients easily learned and adapted to the PMRE exercises. Integrating PMRE into patient education programs and implementing it within HD units could enhance its utilization among patients.

Ethics

Ethics Committee Approval: To conduct the research, ethical approval was obtained from the KTO Karatay University Faculty of Medicine, Pharmaceutical and Non-Medical Device Research Ethics Committee under the decision number 2022/006 (date: 14.01.2022), and permission was obtained from the institution where the research would be conducted.

Informed Consent: Participation in the study was entirely voluntary, and written consent was obtained from the participants.

Authorship Contributions

Surgical and Medical Practices: H.G.H., F.G., Concept: H.G.H., F.G., Design: H.G.H., F.G., Data Collection or Processing: H.G.H., F.G., Analysis or Interpretation: H.G.H., F.G., Literature Search: H.G.H., F.G., Writing: H.G.H., F.G.

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