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Effect of Pilates Exercises on Balance, Fatigue and Quality of Life in Patients with Renal Transplantation: Randomized Controlled Trial

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ABSTRACT: **Introduction:** For patients with end-stage kidney disease, kidney transplantation enhances longevity and overall well-being, yet fatigue remains a common complication that impairs recovery and life quality. Pilates, focusing on controlled motion, breathing, and core strength, can alleviate fatigue and enhance quality of life (QoL).

Material and methods: This research comprised fifty patients, who had functional and physical difficulties following kidney transplantion. The participants were divided into two equal groups. Group A (n = 25) practiced Pilates exercises in three sessions weekly along with a 12-week standard physiotherapy protocol and medical therapy, while Group B (n = 25) was a control group that received a 12-week standard physiotherapy protocol and medical therapy. The Borg Balance Scale, the Modified Fatigue Impact Scale, and the Kidney Disease Quality of Life self-report (KDQOL-SF) were used to measure balance, fatigue, and QoL pre- and post-intervention.

Results: All 50 participants completed the study, and the groups' baseline clinical and demographic features were similar ($p > 0.05$). Balance (BBS; MD = 5.2, 95% CI: 3.17–7.23; $p = 0.001$), fatigue (MFIS; MD = −8.9, 95% CI: −12.8 to −5.0; $p = 0.007$), and KDQOL-SF; MD = 8.11, 95% CI: 3.70–12.53; $p = 0.001$. All end measures revealed substantial improvements from baseline in the two groups (all $p < 0.001$), although the Pilates group exhibited a considerably greater improvement.

Conclusion: Incorporating Pilates exercises into conventional physical therapy is an effective rehabilitation strategy for improving balance, reducing fatigue, and improving kidney transplant recipients' QoL in relation to renal disease

INTRODUCTION

Kidney transplantation is a crucial component of managing end-stage kidney disease (ESKD) regarding health-related quality of life (HRQoL), survival and cost-efficiency. It considerably reduces the death rates linked to alternative therapies [1]. Kidney transplant recipients (KTRs) are more likely to develop comorbid diseases, including diabetes, cancer, infections, and cardiovascular illnesses that have a detrimental effect on HRQoL. Furthermore, reduced HRQoL is associated with frequent hospital admissions for malnutrition, poor diet, and inadequate protein intake [2].

Fatigue was usual in KTRs and had been influenced by environmental, psychological, and physical factors [3]. Recent data indicate that between 35 and 40 percent of individuals undergoing kidney transplants exhibit weakness or are deemed susceptible to frailty due to a persistent, age-related decline in physiological reserve. The progression of underlying illnesses, associated comorbidities, and unfavorable dialysis side effects all worsen this situation among kidney transplant candidates [4].

Even though KTRs' quality of life has improved when compared to other dialysis methods, chronic fatigue is still a difficult and persistent complaint [5]. A growing number of individuals are surviving kidney transplants for longer periods of time. As a result, the topic of HRQoL following transplantation continues to gain significance and needs more scientific study. Unfortunately, there is a lack of research about Pilates exercises to improve balance and HRQoL among KTRs [6].

Pilates is a form of training that improves spinal stability, flexibility, and endurance by focusing on postural muscles through regulated body motions and multi-muscle synergy. A 12-week Pilates exercise program provides enhanced QOL by lowering fatigue, depression, and restless nights [7].

The neurological and musculoskeletal systems needed for dynamic stability are utilized in the Pilates exercise method. It helps improve trunk muscles and restore muscular balance through breathing, stretching, and strengthening. Additionally, Pilates exercises enhance physical function (cardiorespiratory fitness, muscular power, endurance, and flexibility) and motor control (static and dynamic stability, superb motion, and trunk control) [8].

There is still limited data about the effectiveness of Pilates training for KTRs, despite the established advantages of exercise-based rehabilitation. So, this research sought to determine whether, in comparison to conventional physical therapy alone, a 12-week Pilates exercise program would improve balance, lessen fatigue, and enhance kidney disease-specific HRQoL in renal transplant recipients.

MATERIALS AND METHODS

Study design

In a double-blind, randomized controlled trial, the effectiveness of Pilates training on balance, fatigue, and life quality was assessed in patients receiving renal transplants. The patients were allocated to groups via a computer-generated block randomization technique. Between January and June of 2026, the study was conducted at the Damanhour Medical National Institute in El-Beheira, Egypt.

Ethical Considerations

The ethical principles delineated in the Declaration of Helsinki were adhered to throughout the study. The Research Ethics Committee at the Faculty of Physical Therapy, Cairo University, Egypt, has authorized the research's methods (No. P.T. REC/012/006251). ClinicalTrials.gov registered the study (Registration No.: NCT07626086). Every participant was made aware of the objectives, methodology, and benefits of the research, and their freedom to withdraw from the trial at any moment without justification. Following ethical approval, each patient who took part in the trial signed an informed consent form before data collection.

Randomization and Recruitment

This study included sixty individuals who experienced functional and physical impairments following kidney transplantation. Following RT, fifty patients were selected from Damanhour Medical National Institute to participate in this study; 10 of them were unable to do so, including six who didn't fulfil the eligibility criteria and four who rejected taking part (Figure 1).

Fifty patients were randomized and equally split into two groups utilizing SPSS software for Windows, version 25 (SPSS Inc., Chicago, USA). To obscure the distribution, the randomization codes were securely preserved in opaque, enclosed envelopes with consecutive numbers. An evaluator who was not involved in the evaluation or the treatment interventions conducted the randomization.

The study comprised patients who fulfilled the following requirements: (1) Every patient was in the 20–50 age range; (2) both sexes took part in the study; (3) none of the patients had any neurological conditions; and (4) none of the patients had any genitourinary infections. (5) Every patient began the treatment program three to twelve months after receiving a kidney transplant; (6) At the time, none of the patients were following any other consistent exercise routine; (7) Individuals who could

understand instructions and were willing to take part in the study; and (8) Every patient who was enrolled in the trial gave their informed consent. The following criteria were used to exclude participants: (1) neuropathic disorders; (2) rheumatic or orthopedic problems; (3) surgeries of the upper or lower abdomen; (4) individuals necessitating immediate respiratory treatment; (5) patients admitted to the intensive care unit; (6) current smokers; (7) diabetes; (8) uncontrolled hypertensive patients; (9) chronic hepatitis; (10) patients with cardiac pacemakers; and (11) identification of diminished exercise capacity, encompassing tachycardia, dyspnea, or fatigue.

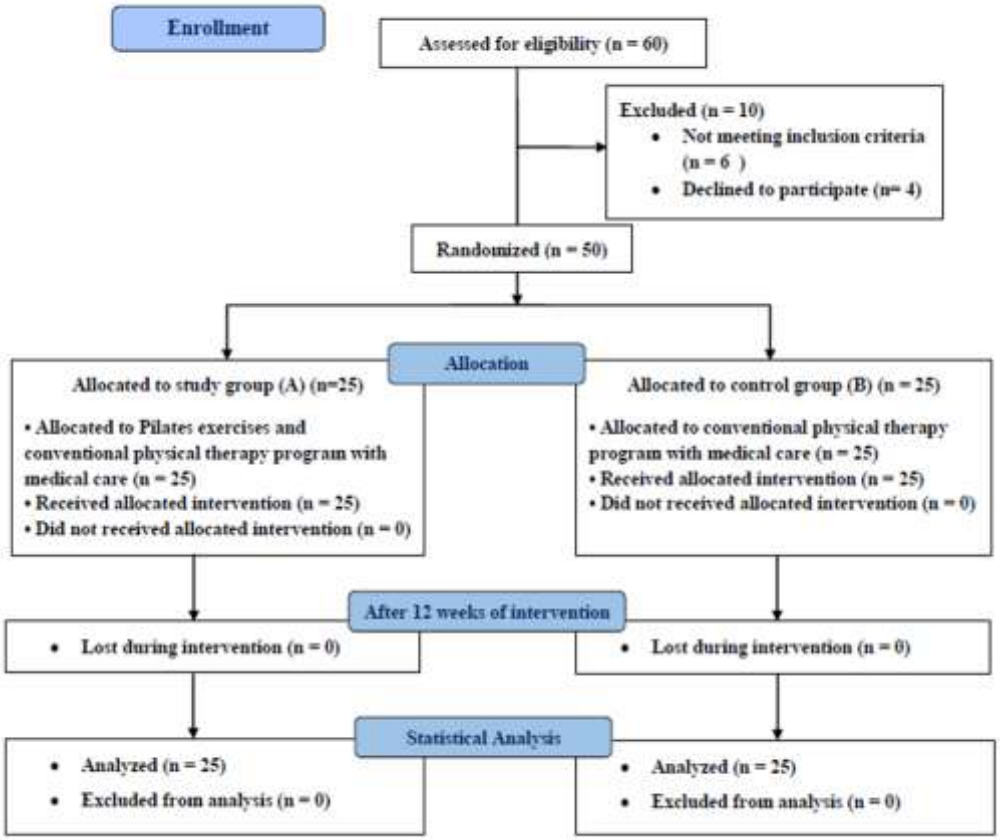


Figure (1): CONSORT flow chart of the study.

Outcomes measures

Balance, fatigue, and quality of life were assessed via the Berg Balance Scale, the Modified Fatigue Impact Scale (MFIS), and the Kidney Disease Quality of Life Short Form (KDQOL-SF) before and following the intervention.

Berg Balance Scale (BBS)

In clinical research, the BBS—possibly the frequently utilized balance-related metric—has become more well-known. It can be used to determine whether a patient's ability to balance has improved or deteriorated as a result of physical therapy. The BBS is a scale with values ranging from 0 (not applicable) to 4 (normal performance) for 14 different tasks. A loss of balance is determined by scores between 0 and 20 on this 56-point scale; an adequate level of balance is indicated by scores between 21 and 40, and excellent balance is determined by scores between 41 and 56 [9].

Modified Fatigue Impact Scale (MFIS)

The self-report MFIS, which has three components (MFIS Physical, MFIS Cognitive, and MFIS Psychosocial) and a total score (MFIS Total), was used to gauge the effects of exhaustion. Higher values indicate that weariness has a bigger effect. To divide participants into two groups—fatigued and non-fatigued—the MFIS overall score (0–84) was dichotomized at 38 [10].

The Kidney Disease Quality of Life self-report (KDQOL_SF)

This scale, which consists of 24 items that address several aspects of subject functions in everyday, vocational, and social life, is utilized to evaluate the QoL of patients with renal illness. This self-report measure is based on a person's subjective assessment of their functionality, health, and QoL in relation to having renal illness. A certain number of points are awarded for each questionnaire response. Responses to the KDQoL-SFTM questionnaire are scored on a 0–100 point scale. The QOL increases with a higher value and decreases with a lower number [11].

Intervention

The experimental group (Group A; n=25) practiced supervised mat-based Pilates training three sessions weekly, along with a conventional aerobic exercise regimen and standard medical therapy for 12 weeks, while the control group (Group B; n=25) underwent the same supervised conventional aerobic exercise regimen and standard medical therapy for 12 weeks.

Pilates exercises

Participants in the experimental group practiced a supervised mat-based Pilates exercise program immediately following the aerobic exercise session for twelve weeks, three times a week. Before starting the program, participants received a comprehensive explanation of the treatment protocol and the potential benefits of Pilates exercises to enhance adherence and motivation. Before the initial session, the physiotherapist demonstrated every exercise and explained the fundamental principles of Pilates to ensure correct technique. Participants were instructed to coordinate breathing with movement, emphasizing forced exhalation and natural inhalation throughout the exercises. The Pilates session initially lasted 25 minutes and was progressively increased to 30 minutes over the course of the intervention. Participants learned how to properly activate the transversus abdominis, multifidus, and pelvic floor muscles through diaphragmatic breathing and isometric contraction prior to each session. Exercise performance emphasized movement quality, precision, appropriate intensity, and correct breathing patterns. The number of repetitions was progressively increased from 4 to 12 according to participants' tolerance and exercise progression. Each Pilates session was structured into three sequential phases. The first phase included a warm-up consisting of breathing techniques and range-of-motion exercises to prepare the body for activity. The second phase involved a core training component featuring thirteen mat-based Pilates exercises: Bridging, One-Leg Circle (performed in both directions), Roll-Up, Rocker with Closed Legs, The Hundred, Single Straight Leg Stretch, Single Leg Kick, Double Leg Stretch, Side Kick (up and down), Side Kick Circles, Forward Spinal Stretch, Curling, and Rest Position (incorporating stretching and relaxation). These exercises are designed to enhance trunk stability, flexibility, balance, and muscular strength. The final phase included a cool-down (stretching, breathing, and relaxation exercises). The Pilates intervention was adapted from the protocol developed by Lendraitiene et al. [12].

Because Pilates was performed immediately following aerobic exercise, the duration of the Pilates session was reduced from that of the original protocol to maintain an appropriate total exercise volume, minimize excessive fatigue, and enhance participant adherence, while preserving the original exercise sequence and progression in accordance with established exercise prescription principles [13].

The conventional physical therapy program

Participants allocated to the control group underwent a supervised traditional aerobic exercise program along with standard medical therapy for 12 weeks. The exercise intervention was practiced in three sessions weekly, with every session lasting for about 45–50 minutes. Sessions initiated with a 5–10 minute warm-up, then 30 minutes of treadmill walking at an intensity corresponding to 60–70% of heart rate reserve (HRR), equivalent to 60–80% of maximum heart rate or a Borg Rating of Perceived Exertion (RPE) of 11–13. Each session ended with a 5–10 minute cool-down in the form of slow walking and stretching exercises. In order to maintain steady hemodynamic responses, exercise intensity was gradually increased in accordance with the participant's tolerance. Exercise safety was ensured by monitoring heart rate, blood pressure, oxygen saturation, and subjective effort prior to, during, and following each session. The results of a comprehensive analysis that showed the safety and effectiveness of moderate-intensity aerobic exercise in renal transplant patients are in line with the evidence from a recent randomized controlled study [14–15].

Statistical analysis

Statistical analyses were employed utilizing SPSS for Windows version 23 (SPSS, Inc., Chicago, IL) to analyze the evaluated variables, with a significant level established at $p < 0.05$Data were evaluated for the existence of outliers, homogeneity of variance, and adherence to the normality assumption. The assessed variables exhibited a normal distribution ($p > 0.5$) as determined by the Shapiro-Wilks normality test. Excluding gender and comorbidities (counts), the data are displayed as mean and standard deviation for every outcome. MANOVA was utilized to assess the cumulative effect of all outcomes and compare them across groups. When the MANOVA yielded statistically substantial results, subsequent univariate analyses of variance (ANOVAs) with Bonferroni-adjusted post hoc tests were performed for every assessed outcome to control for type I error.

RESULTS

The participants' demographic characteristics were comparable across both groups, with no significant variations detected, as presented in Tables [1&2] ($p > 0.5$).

To determine how participants in the two groups differed in how much their scores on outcome measures changed, MANOVA was employed. A statistically significant variation was noted across groups as Wilk's $\Lambda = 0.29$, $F(3, 46) = 38.47$, P-value < 0.001, and Partial Eta Squared (η^2) = 0.72. While there was a statistically substantial impact on time (before-after treatment) as Wilk's $\Lambda = 0.003$, $F(3, 46) = 4882.59$, p-value < 0.001, and $\eta^2 = 0.99$, and for the interaction between groups and time as Wilk's $\Lambda = 0.02$, $F(3, 46) = 749.84$, p-value < 0.001, and $\eta^2 = 0.98$.

Between-groups comparison:

After 12 weeks of intervention: Following a 12-week intervention, both groups exhibited statistically substantial variations ($P < 0.05$) regarding BBS, MFIS, and KDQOL-SF, where mean differences (MD) and 95 percent confidence intervals (CI) were 5.2 (3.17, 7.23), -8.9 (-12.8, -5.001), and 8.11 (3.7, 12.53), respectively, with a more favorable outcome for the study group, as in table 2.

Within-group comparison: A statistically significant variation was noted in both groups between pre- and post-treatments in all outcome measures, favoring the study group, as displayed in Table 2.

Tab 1. Participants' Demographic Characteristics (N=50)

Characteristics	Study group (n=25)	Control group (n=25)	t- value	P Value
Age (years)	35.96±6.3	34.56±5.1	-0.24	0.81
BMI (kg/m²)	26.84±3.16	26.4±3.89	0.45	0.66
Duration since transplantation (months)	6.92±1.2	6.28±1.37	0.99	0.33
Gender, n (%)				
Females	12 (48%)	13 (52%)	$\chi 2=0.08$	0.78
Males	13 (52%)	12 (48%)		
Comorbidities, n (%)				
Hypertension	15 (60%)	16 (64%)	$\chi 2=1.63$	0.8
Diabetes mellitus	2 (8%)	3 (12%)		
Dyslipidemia	3 (12%)	1 (4%)		
Mixed comorbidities	2 (8%)	3 (12%)		
No comorbidities	3 (12%)	2 (8%)		

BMI, body mass index; Data are mean± SD for all demographics with the exception of gender; X2, Chi Square; P-Value < 0.05 is a significant value.

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Table 2. Within and between group comparison regarding BBS, MFIS, and KDQOL-SF (N=50)

Outcomes	Time	Study group (n=25)	Control group (n=25)	MD(95% CI)	P Value
BBS (score)	***Baseline***	41.8±4.11	42.3±4.19	-0.5 (-2.86,1.86)	0.67
	After 12 weeks	52.1±3.29	46.9±3.82	5.2 (3.17,7.23)	0.001
	p-value (within)	0.001	0.001		
	MD(95% CI)	-10.3 (-10.84,-9.76)	-4.6 (-5.14,-4.06)		
	Cohen's d	2.73	1.14		
MFIS (score)	***Baseline***	51.2±7.39	50.6±7.08	0.6 (-3.52,4.72)	0.77
	After 12 weeks	33.9±4.8	42.8±6.91	-8.9 (-12.8, -5.001)	0.007
	p-value (within)	0.001	0.001		
	MD(95% CI)	17.3 (16.59,18.01)	7.8 (7.09,8.51)		
	Cohen's d	2.66	1.11		
KDQOL-SF (score)	***Baseline***	58.4±8.7	59.09±7.97	-0.69 (-5.44,4.05)	0.77
	After 12 weeks	73.9±7.6	65.79±7.92	8.11 (3.7,12.53)	0.001
	p-value (within)	0.001	0.001		
	MD(95% CI)	-15.5 (-15.82,-15.18)	-6.7 (-7.01,-6.38)		
	Cohen's d	1.89	0.84		

* Data are mean± SD, P-Value < 0.05 is a significant value, BBS: Berge balance scale, MFIS: modified fatigue impact scale, KDQOL-SF: kidney disease quality of life- short form, MD; mean difference, CI; confidence interval; Cohen's d: small 0.2, medium 0.5, large > 0.8.

DISCUSSION

Contrary to the control group that received the standard physiotherapy program alone, our key findings show that Pilates exercises significantly enhanced balance, decreased fatigue, and raised QOL in renal transplant recipients.

In addition to a substantial decrease in fatigue and higher QOL scores ($p < 0.05$), comparisons made after the intervention showed noticeably greater gains in balance scores in the experimental group. These findings imply that Pilates-based rehabilitation improves both physical and psychosocial outcomes in this population more successfully than conventional physical therapy programs.

Improved proprioceptive input, improved neuromuscular control, and increased core stability could all contribute to the noted improvements in balance. The diaphragm, multifidus, transversus abdominis, and pelvic floor muscles are among the deep stabilizing muscles that are used during Pilates exercises, which place an emphasis on regulated movements, trunk stabilization, and postural alignment. Maintaining balance requires better postural control and spinal stability, both of which are enhanced by strengthening these muscle groups [16]. Pilates also incorporates somatosensory, vestibular, and visual signals that improve

posture corrections and motor coordination. Frequent stimulation of these systems enhances functional stability in daily activities by reducing postural sway and increasing the effectiveness of balance responses [17].

By enhancing breathing control, neuromuscular coordination, cardiorespiratory efficiency, and psychological well-being, Pilates exercise can reduce fatigue. Despite not being a conventional aerobic workout, it improves ventilatory efficiency and VO_2-related parameters, which lowers the relative energy cost of physical activity and increases exercise tolerance. Its focus on diaphragmatic breathing encourages parasympathetic activation, which supports rest and recuperation, and enhances posture and movement efficiency to minimize unnecessary muscle strain. Furthermore, clinical patients' QoL is enhanced, and reported weariness is reduced when stress and anxiety levels are reduced [18].

The present findings were in line with those of Rahimimoghadam et al. [19], who looked at the effects of Pilates exercises over a 12-week period on the QOL of fifty patients with chronic renal disease. Following the intervention, the study group's QOL dimension ratings significantly improved ($p < 0.05$). Pilates exercises can enhance QoL, according to a comparison of the MD across both groups at the study onset and after two months. The experimental group's QOL dimensions scores were markedly superior to those of the control group ($p \leq 0.05$).

Waked et al. [20], who evaluated the impact of a three-week Pilates training in improving the QOL for forty KT patients, supported the results of this study. Three weeks following surgery, there were significantly different QOL scores ($p < 0.05$), according to the data. Pilates exercises have been demonstrated to integrate the body and mind while improving flexibility, strength, and posture. It includes deep breathing exercises, muscle control, and an emphasis on the core musculatures.

The study's findings were consistent with those of Kılınç et al. [21], who looked at how Pilates affected thirty patients' posture, exhaustion, balance, and quality of life. Participants' balance and all sub-dimensions of QOL demonstrated statistically substantial improvements ($p < 0.05$) after Pilates training. Fatigue was significantly reduced ($p < 0.05$). The study's outcomes demonstrated that twice-weekly Pilates exercises improved balance, fatigue, posture, and QOL for people with postural problems.

The current findings are corroborated by Miri et al. [22], who examined the effects of an eight-week Pilates training on fatigue, balance, muscle endurance, and QoL. Pilates training considerably decreased the individuals' level of weariness in the experimental group ($P=0.000$). Furthermore, Pilates workouts significantly improved both the physical and mental elements of QOL ($P=0.000$ and $P=0.042$), according to the QOL result. These results demonstrate that Pilates training has a significant beneficial impact on reducing fatigue and improving balance.

The research's findings were corroborated by Ruiz-Ariza et al. [23], who illustrated that a 12-week Pilates-focused training regimen markedly enhanced nutritional well-being and HRQoL. Enhancements in overall health, vitality, social interaction, and psychological well-being were among the mental and physical advantages of the intervention. The study suggests that Pilates may enhance psychosocial outcomes, such as reduced anxiety and sadness symptoms and increased self-perceived health and QoL.

STRENGTHS AND LIMITATIONS

Pilates exercises are a safe modality for kidney transplant recipients, according to the current study, which found no negative effects associated with the intervention. However, some limitations should be noted, including the comparatively small sample size and lack of extended follow-up, which restricts the capacity to evaluate long-term effects. In addition, variability in participants' baseline characteristics, differences in skill levels, potential measurement errors, psychological status during treatment, and participant adherence may have influenced the results.

CONCLUSION

Incorporating Pilates exercises into conventional physical therapy is an effective and safe rehabilitation strategy for improving balance, reducing fatigue, and enhancing the kidney disease-specific QoL in renal transplant recipients.

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CONFLICT OF INTEREST

No conflicts of interest.

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