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Effectiveness of low to moderate intensity aerobic exercises along with Jacobson's relaxation on quality of life and physical performance in chronic kidney disease patient with frailty: Randomized controlled trial

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Abstract

Background: Chronic kidney disease (CKD) with frailty is associated with reduced physical performance and poor quality of life (QOL). This study evaluated the effectiveness of low-to-moderate intensity aerobic exercise combined with Jacobson's Progressive Muscle Relaxation (JPMR) in patients with CKD and frailty.
Methods: 40 clinically diagnosed CKD patients with frailty were randomly allocated into two groups (n=20 each). Group A received aerobic exercise with JPMR, while Group B received aerobic exercise alone, three times weekly for 12 weeks. QOL was assessed using the Kidney Disease Quality of Life-36 (KDQOL-36) questionnaire, and physical performance was assessed using estimated VO_2max.
Results: Both groups showed significant improvements after the intervention ($p<0.05$). However, Group A demonstrated significantly greater improvements in QOL (50.55 ± 4.00 vs. 44.35 ± 2.75) and VO_2max (26.60 ± 2.90 vs. 22.50 ± 2.72) than Group B.
Conclusion: Aerobic exercise combined with JPMR is more effective than aerobic exercise alone in improving physical performance and QOL in frail CKD patients.

➢ INTRODUCTION

Chronic kidney disease (CKD) is a progressive disorder characterized by abnormalities of kidney structure or function that persist for more than three months and have important implications for health. CKD affects approximately 10% of the global

population and is a major contributor to morbidity, mortality, and healthcare expenditure. As kidney function declines, patients commonly experience reduced exercise tolerance, skeletal muscle dysfunction, fatigue, impaired physical performance, and poor health-related quality of life (HRQOL), which adversely affect functional independence and clinical outcomes[1,2].

Frailty is a common geriatric syndrome that is increasingly recognized among individuals with CKD. It is characterized by decreased physiological reserve, weakness, exhaustion, slow gait speed, low physical activity, and increased vulnerability to stressors. The prevalence of frailty is substantially higher in patients with CKD than in the general population and is associated with increased risks of hospitalization, falls, disability, cardiovascular events, and mortality[3,4]. Therefore, improving physical performance and quality of life has become an important goal in the rehabilitation of patients with CKD and frailty.

Exercise therapy is considered a cornerstone of non-pharmacological management in CKD. Regular aerobic exercise has been shown to improve cardiovascular fitness, muscle strength, functional capacity, exercise tolerance, and HRQOL while reducing fatigue and physical inactivity. Current evidence supports the safety and effectiveness of moderate-intensity aerobic exercise in clinically stable patients with CKD, making it an integral component of multidisciplinary rehabilitation programmes[2,5,6].

In addition to physical impairments, patients with CKD frequently experience psychological distress, anxiety, depression, sleep disturbances, and emotional stress, which further compromise their quality of life and adherence to treatment. Jacobson's Progressive Muscle Relaxation (JPMR) is a simple, non-pharmacological relaxation technique that involves the systematic contraction and relaxation of major muscle groups. Previous studies have demonstrated that JPMR reduces anxiety, fatigue, and stress while improving sleep quality and psychological well-being among patients undergoing haemodialysis[7,8].

Although aerobic exercise and JPMR have individually demonstrated beneficial effects in CKD, evidence regarding their combined effect on physical performance and quality of life among frail CKD patients remains limited. Since frailty has both physical and psychological components, combining aerobic exercise with relaxation therapy may provide additive benefits by simultaneously improving functional capacity and emotional well-being.

Therefore, the present study aimed to evaluate the effectiveness of low-to-moderate intensity aerobic exercise combined with Jacobson's Progressive Muscle Relaxation on quality of life and physical performance in patients with chronic kidney disease and frailty.

➢ MATERIALS AND METHODS

❖ Study Design

Randomized controlled trial.

❖ Study Setting

The study was conducted in the Department of cardiovascular and respiratory physiotherapy in collaboration with the Department of Nephrology after obtaining approval from the Institutional Ethics Committee. Written informed consent was

obtained from all participants before enrollment.

❖ Participants

A total of 40 clinically diagnosed CKD patients with frailty were recruited using simple random sampling and were randomly allocated into two equal groups (n = 20 each).

- **Group A:** Low-to-moderate intensity aerobic exercise combined with Jacobson's Progressive Muscle Relaxation.
- **Group B:** Low-to-moderate intensity aerobic exercise alone.

❖ Eligibility criteria

Inclusion Criteria

- Clinically diagnosed chronic kidney disease patients with frailty.
- Patient should able to complete 6 min walk test
- Resting SPO2 ≥ 90%
- Chronicity of disease (more than 3 months)
- Age between 18 to 60 years of both the genders.
- Medically stable and able to participate in an exercise program.
- Willing to provide written informed consent.

Exclusion Criteria

- Patients with unstable cardiovascular or respiratory conditions.
- Severe musculoskeletal or neurological disorders limiting exercise participation.
- Cognitive impairment affecting understanding of instructions.

❖ Outcome measures

Outcome measures included:

- Physical Performance: Estimated maximal oxygen consumption (VO_2max).
- Quality of Life: Kidney Disease Quality of Life-36 (KDQOL-36) questionnaire.

Outcome measures were assessed at baseline and after completion of the 12-week intervention.

❖ Intervention

Both groups underwent supervised exercise sessions 3 times per week for 12 weeks.

Each session consisted of:

- Warm-up (5–10 minutes): Stretching exercises for major muscle groups.
- Aerobic conditioning programme (20-60 min): Following warm up participants engaged in main aerobic conditioning programme lasted for 20 to 60 minutes.

  - It included following activities Static cycling for approximately (3 minutes)
  - Stepping activity for approximately (3 minutes)
  - Walking for (3 minutes)
  - Spot jumping for (3 minutes)
  - [2 min of passive interval after each session]

- **Cool-down (5–10 minutes):** Stretching exercises combined with active range-of-motion exercises.

Participants in Group A additionally performed Jacobson's Progressive Muscle Relaxation for approximately 20 minutes after aerobic exercise. The relaxation protocol involved systematic contraction and relaxation of major muscle groups with controlled breathing under therapist supervision.

➢ STATISTICAL ANALYSIS

Data were entered into Microsoft Excel and analyzed using JAMOVI software. Descriptive statistics were expressed as mean ± standard deviation. The confidence interval was set at 99%, with an alpha level of 0.01 and study power of 90%. Within-group comparisons were performed using the paired *t*-test, while repeated-measures ANOVA and independent *t*-tests were used for between-group comparisons. A *p*-value <0.05 was considered statistically significant.

➢ RESULTS

A total of 40 patients with chronic kidney disease (CKD) and frailty completed the study. Participants were randomly allocated into two groups: Group A (aerobic exercise + Jacobson's Progressive Muscle Relaxation; n = 20) and Group B (aerobic exercise alone; n = 20). There were no dropouts during the intervention period.

Baseline Characteristics

The age of the participants ranged from 18 to 60 years. In Group A, 65% were male and 35% were female, whereas Group B comprised 60% males and 40% females. The demographic characteristics of both groups were comparable at baseline.

Quality of Life

Both groups demonstrated improvement in Kidney Disease Quality of Life (KDQOL-36) scores following the 12-week intervention. In Group A, the mean KDQOL-36 score increased from 44.65 ± 3.52 at baseline to 50.55 ± 4.00 after intervention. In Group B, the mean score increased from 42.95 ± 1.82 to 44.35 ± 2.75.

Within-group analysis using the paired *t*-test showed statistically significant improvements in quality of life in both groups ($p < 0.05$). The improvement was greater in Group A (mean difference = 5.90) than in Group B (mean difference = 1.40).

Between-group comparison after the intervention demonstrated significantly higher post-treatment KDQOL-36 scores in Group A than in Group B (mean difference = 6.20; independent $t = 5.701$, $p < 0.05$).

Physical Performance

Physical performance, assessed using estimated VO_2max, improved significantly in both groups after 12 weeks. In Group A, the mean VO_2max increased from 21.70 ± 2.27 mL/kg/min to 26.60 ± 2.90 mL/kg/min, whereas in Group B it increased from 20.75 ± 2.24 mL/kg/min to 22.50 ± 2.72 mL/kg/min.

Within-group analysis demonstrated statistically significant improvements in physical performance in both groups ($p < 0.05$). The mean improvement was 4.90 in Group A compared with 1.75 in Group B.

Post-intervention comparison between the groups revealed significantly greater improvement in Group A than in Group B (mean difference = 4.10; independent $t = 4.601$, $p < 0.05$).

Overall, participants who received low-to-moderate intensity aerobic exercise combined with Jacobson's Progressive Muscle Relaxation demonstrated

significantly greater improvements in both quality of life and physical performance than those who received aerobic exercise alone.

TABLE - 1

Frequency and Percentage distribution of Samples according to their Age

N=20+20

Sr.no	Demographic Variables	Group - A		Group - B	
		Frequency	Percentage	Frequency	Percentage
1.	Age				
	a. 25-35 yrs	05	25	06	30
	b. 36-45 yrs	04	20	03	15
	c. 46-55 yrs	10	50	07	35
	d. 56-65 yrs	01	05	04	20

Age: The data presented in the Table 1 shows that, the age of Samples varied from 25-65 years, in Group-A, most (50%) were 46-55 yrs, 25% were 25-35 yrs, and 5% were 56-65 yrs . In group B, most (35%) were 46-55 yrs, 30% were25-35 yrs, and 20% were 56-65 yrs.

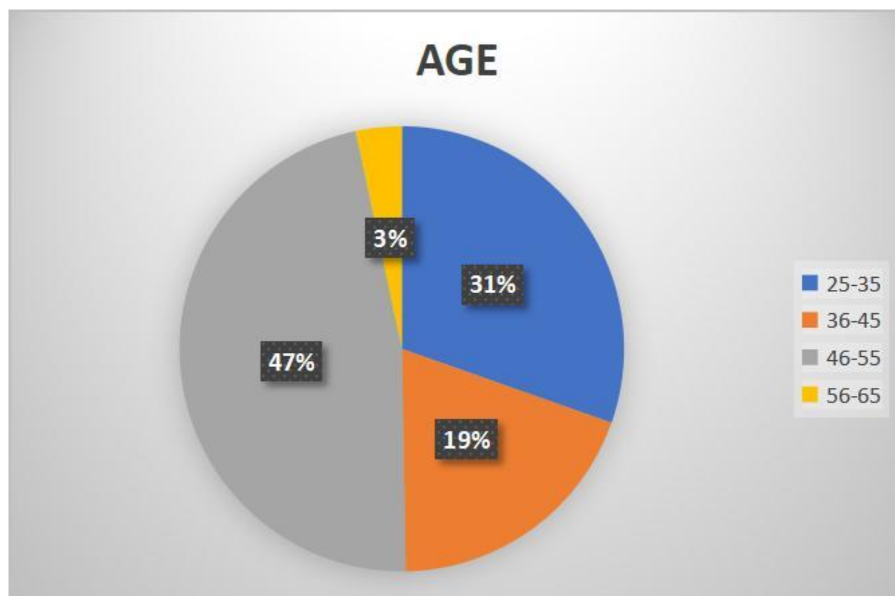

Figure no. 01 : distribution of Samples according to their Age.

TABLE - 2

Frequency and Percentage distribution of Samples according to their Gender

N=20+20

Sr.no	Demographic variables	Group A		Group B	
		Frequency	Percentage	Frequency	Percentage
1.	Gender				
	a. Male	13	65	12	60
	b. Female	07	35	08	40

Gender: -

The data presented in the Table no-02 revels distribution of samples according to their gender, In case of Group-A, Majority of the samples 13 (65 %) belonged to Male gender and 07 (35 %) belonged to Female gender, while in case of Group-B, Majority of the samples 12 (60 %) belonged to Male gender and 08 (40 %) belonged to female gender.

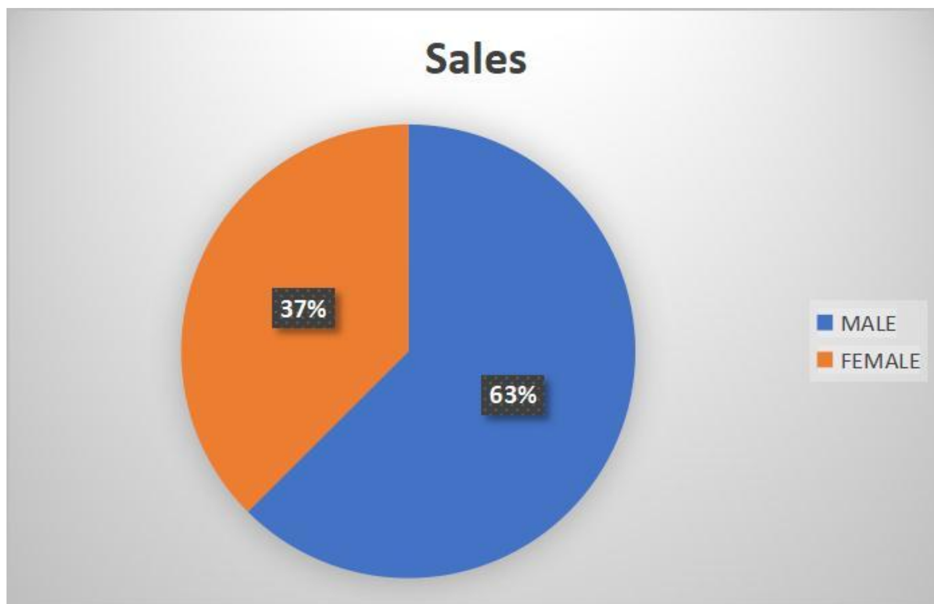

Figure no.2: Distribution of samples according to their Gender

a). Description of Mean Physical performance and Quality of Life before and after Interventions among CKD patients with Frailty.

40 CKD patients with frailty were divided into two groups (20 each).Group-A received aerobic exercise with Jacobson's relaxation; Group B received only Aerobic exercise. Interventions assessed physical performance and quality of life.

TABLE - 3

Group A - Mean and Standard Deviations of pre and post values of Quality Of Life

N = 20

parameters		Pre - test		Post - test	
		Mean	**S.D**	**Mean**	**S.D**
Quality Of Life	**Group A**	44.65	±03.52	50.55	±04.00

The data presented in Table – 3 and reveals the effect of Interventions on Quality of Life among CKD patients with Fraility, In Group A, mean Quality of life score improved from 44.65 ± 3.52 (pre-test) to 50.55 ± 4.00 (post-test)

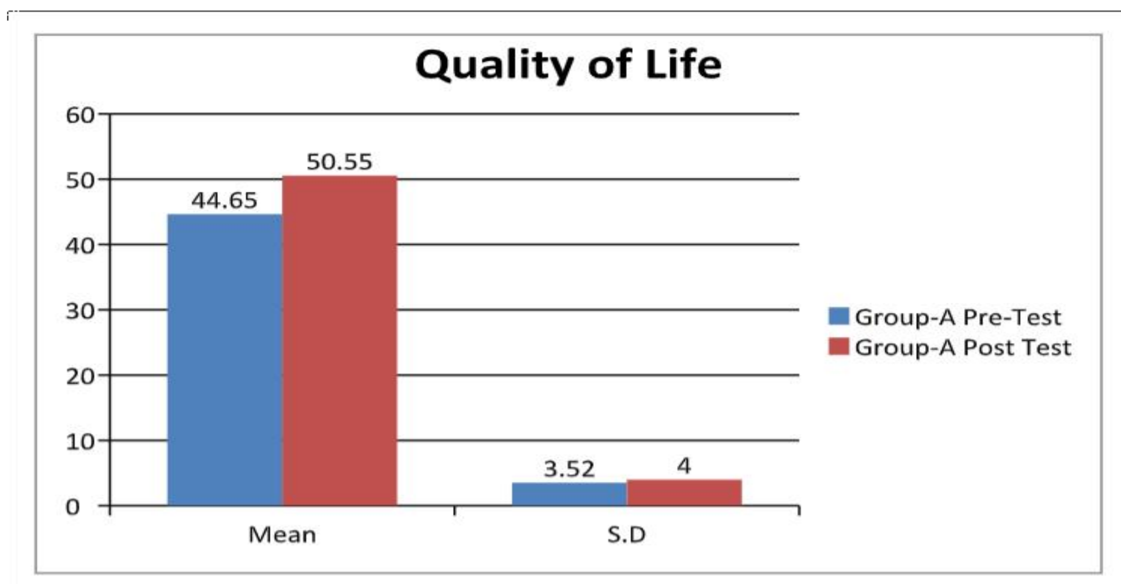

Figure no. 03: Intervention on Quality of life among CKD patients,group A

TABLE - 4

Group B - Mean and Standard Deviations of pre and post values of Quality Of Life

N = 20

Parameters		Pre - test		Post test	
		Mean	S.D	Mean	S.D
Quality Of Life	Group B	42.95	±01.820	44.35	±02.75

The data presented in Table – 4 and reveals the effect of Interventions on Quality of Life among CKD patients with Fraility, in case of Group –B pre-test, Mean Quality of life scores was 42.95 with Standard deviation ±01.820 while at Post –test the Mean Quality of life score was 44.35 with standard deviation ±02.75.

Figure no. 04: Intervention on Quality of life among CKD patients,group B

TABLE - 5

Group A - Mean and Standard Deviations of pre and post values of Physical Performance

N = 20

Parameters		Pre - test		Post - test	
		Mean	S.D	Mean	S.D
Physical performance	Group A	21.70	±02.27	26.60	±02.90

The data presented in Table – 5 reveals the effect of Interventions on Physical Performance among s patients, In case of Group –A pre-test the Mean Physical performance scores was 21.70 with Standard deviation ±02.27 while at Post – test the Mean Physical performance score was 26.6 with standard deviation ±02.90.

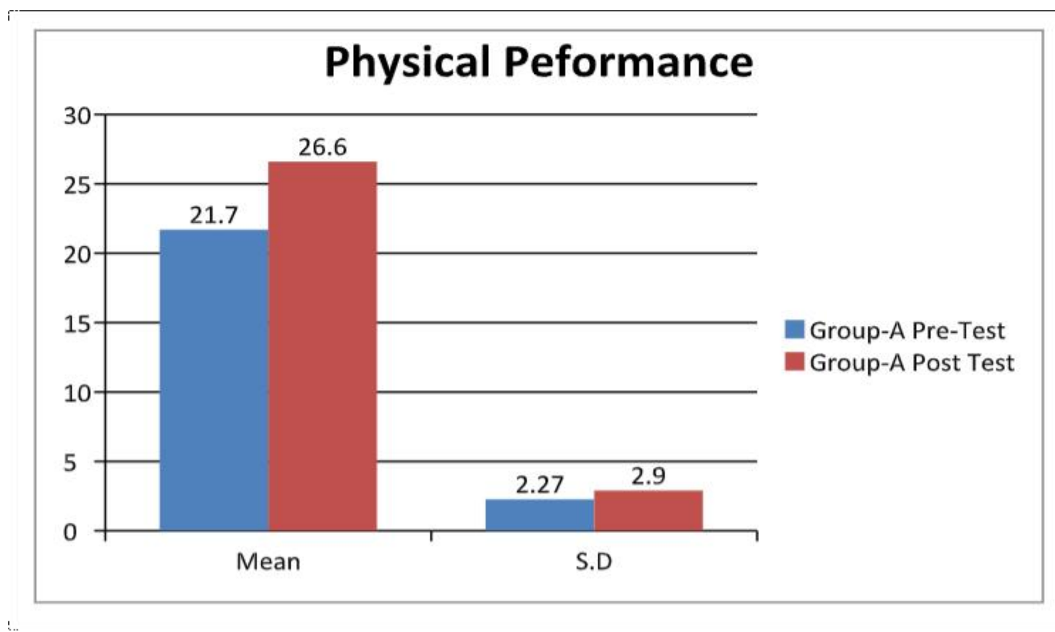

Figure no. 05: Intervention on Physical performance among CKD patients, group A

TABLE - 06

Group B - Mean and Standard Deviations of pre and post values of Physical Performance

N = 20

Parameters		Pre - test		Post - test	
		Mean	S.D	Mean	S.D
Physical performance	Group B	20.75	±02.24	22.50	±02.72

The data presented in Table – 5 reveals the effect of Interventions on Physical Performance among s patients, in case of Group –B pre-test, Mean Physical performance scores was 20.75 with Standard deviation ± 02.24 while at Post – test the Mean Physical performance score was 22.5 with standard deviation ±02.72.

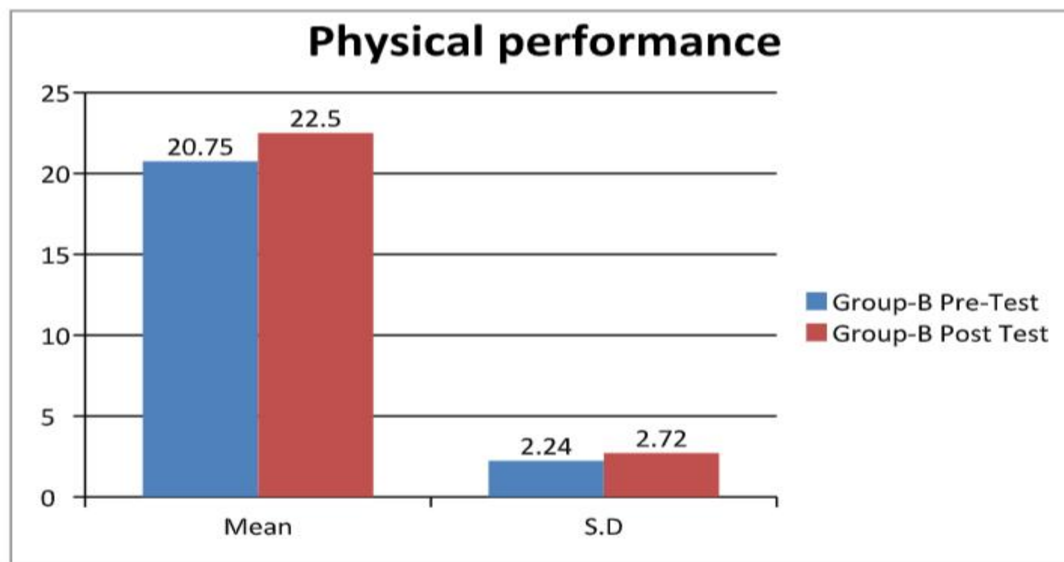

Figure no. 06 : Intervention on Physical performance among CKD patients, group A

Section 2:

a). Findings related to the effect of Aerobic exercise with Jacobson's muscle relaxation on Physical performance and Quality of life among CKD patients with fraility.

In order to find the significant difference in Physical performance and Quality of life among CKD patients with Frailty before and after Aerobic exercise with Jacobson's Progressive muscle relaxation. Paired t-test computed, the findings are as follows.

TABLE - 07

Aerobic exercise with jacobson's progressive muscle relaxation	Mean	Std. Deviation	Std. Error mean	t	df	P-value
Pre-test - post-test on Quality of life of CKD patients with frailty	05.90	± 02.807	0.6278	09.397	19	0.00
Pre-test- post-test on physical performanc e of CKD patients with frailty	04.90	± 01.80	0.403	12.150	19	0.00

t' (19) = 1.729, P<0.05

N = 20

The data in table.no-07 shows the impact of Aerobic exercise with Jacobson's progressive muscle relaxation technique on Physical performance and Quality of life among CKD patients with Fraility, for Quality of life the Mean score was 05.90 (SD±02.807, SE 0.6278). paired t-test value(t=09.397) exceeded the table value ($t_{(19)}$ =1.729), with $p<0.05$, indicating a significant improvement after intervention. Similarly for physical performance, the mean score was 04.90(SD± 01.80, SE 0.403), and paired t-test value (t=12.150) was higher than table value($t_{(19)}$=1.729), with $p<0.05$, confirming that intervention effectively improved physical performance among participants.

b). Findings related to the effect of Aerobic exercise on Physical performance and Quality of life among CKD patients with fraility.

In order to find the significant difference in Physical performance and Quality of life among CKD patients with Fraility before and after Aerobic exercise with Jacobson's Progressive muscle relaxation. Paired t-test computed, the findings are as follows.

TABLE - 08

N=20

Aerobic Exercise	**Mean**	**Std. Deviation**	**Std. Error mean**	**t**	**df**	**P-value**
Pre-test - post-test on Quality of life of CKD patients with frailty	01.40	±01.535	0.3433	04.077	19	0.001
Pre-test - post-test on physical performance of CKD patients with frailty	01.75	±01.482	0.331	05.280	19	0.001

The data presented in table.no-08 shows the impact of Aerobic exercise on Physical performance and Quality of life among CKD patients with Fraility, in case of Quality of life the Mean score was 01.40 with standard deviation ±01.535 and standard error of 0.3433, paired t-test was computed in order to find significant difference in mean scores before and after intervention, the calculated 't' was 04.077 which was higher than the table value ($t_{(19)}$ =1.729) and the P-value was lower than 0.05 indicating Aerobic exercise was successful in improving the Quality of Life, while in case of Physical performance the Mean score was 01.75 with standard deviation ±01.482 and standard error of 0.331, paired t-test was computed in order to find significant difference in mean scores before and after intervention, the calculated 't' was 05.280 which was higher than the table value ($t_{(19)}$ =1.729) and the P-value was lower than 0.05 indicating Aerobic exercise was successful in improving the Physical performance among the samples.

c). Finds related to comparison between Aerobic exercise with Jacobson's Muscle relaxation and Aerobic exercise on Physical performance and Quality of Life among CKD patients with frailty.

In order find significant difference on Physical performance and Quality of life between Aerobic exercise with Jacobson's progressive relaxation and Aerobic exercise, Independent 't' – test was computed and the findings are tabulated below in table - 9

TABLE - 09

n 1 +n 2 =40

Quality of life	Mean	Mean difference	Std. error difference	Independent 't' test	P-value
Aerobic exercise with Jacobson's muscle relaxation	50.55	06.200	01.0876	05.701	0.001
Aerobic Exercise	44.35				

't' (38) = 1.684, p & lt;0.05

The data presented in table.no – 9 shows the Mean difference between Aerobic exercise with Jacobson's progressive muscle relaxation and Aerobic exercise is 06.200, To find significant Mean difference for Quality of Life, Independent `t`-test was computed and obtained `t` (38) = 05.701 is found to be significant at 0.05 level of significance, as computed `t` value is higher than table Value (01.684) indicating Null Hypothesis is rejected implying there is significant difference between two interventions. As the Mean of Aerobic exercise with Jacobson's muscle relaxation has higher mean than Aerobic exercise. Hence Aerobic exercise with Jacobson's relaxation has pronounced effect than Aerobic exercise in enhancing Quality of Life among CKD patients with Fraility.

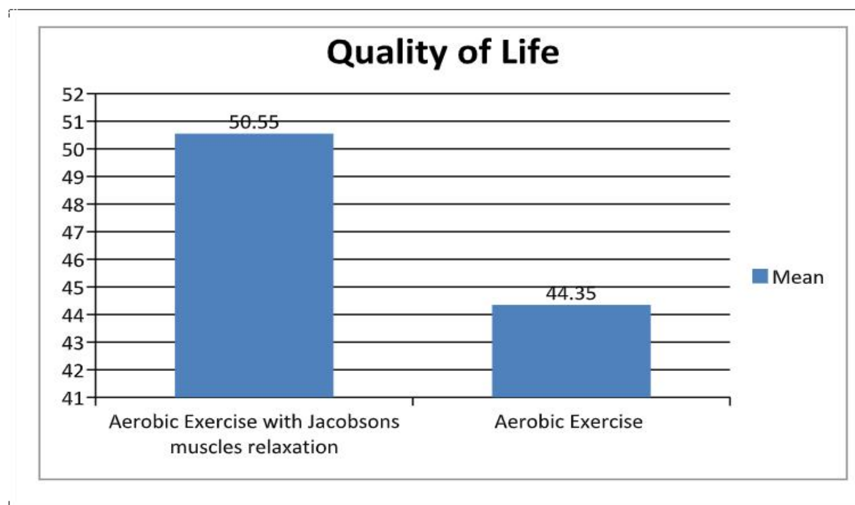

Figure no. 07: Intervention on Quality of life in CKD patients with frailty-comparison between group A and group B

TABLE - 10

n 1 +n 2 =40

Physical Performance	Mean	Mean difference	Std.error difference	Independent 't' test	P-value
Aerobic exercise with Jacobson'smuscle relaxation	26.60	04.100	0.891	04.601	0.001
Aerobic Exercise	22.50				

't' (38) = 1.684 , p<0.05

Data presented in Table No. 10 shows a mean difference of 04.100 in physical performance between aerobic exercise with Jacobson's progressive muscle relaxation and aerobic exercise alone. The independent t-test 't'(38) = 04.601, p
< 0.05) exceeded the table value (01.684), indicating a significant difference. Thus, the null hypothesis was rejected, showing that aerobic exercise combined with Jacobson's relaxation produced greater improvement in physical performance and quality of life among CKD patients with frailty.

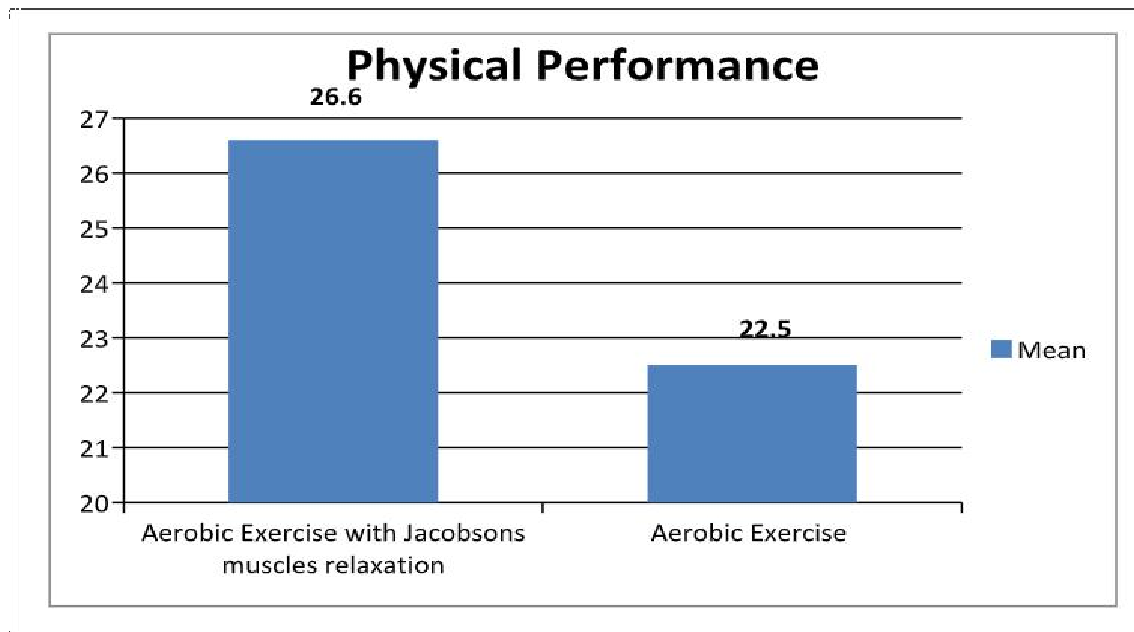

Figure no. 07: Intervention on physical preformance in CKD patients with frailty- comparison between group A and group B

DISCUSSION

The present randomized controlled trial evaluated the effectiveness of low-to-moderate intensity aerobic exercise combined with Jacobson's Progressive Muscle Relaxation (JPMR) on physical performance and quality of life (QOL) in patients with chronic kidney disease (CKD) and frailty. The findings demonstrated that both intervention groups showed significant improvements after the 12-week intervention. However, participants receiving aerobic exercise combined with JPMR exhibited significantly greater improvements in estimated VO_2max and KDQOL-36 scores than those receiving aerobic exercise alone, indicating that the addition of relaxation therapy enhances the benefits of conventional aerobic exercise.

The improvement in physical performance observed in the present study is consistent with previous evidence demonstrating that regular aerobic exercise improves exercise capacity, cardiovascular fitness, muscle function, and functional independence in patients with CKD. Johansen and Painter reported that structured exercise programmes improve physical functioning and reduce physical deconditioning in individuals with CKD[2]. Similarly, Abdelbasset et al. demonstrated that a 12-week programme of concurrent aerobic and resistance exercise significantly improved functional capacity and health-related quality of life among non-dialysis CKD patients.[5] A systematic review by Gomes Neto et al. further concluded that exercise training significantly improves cardiorespiratory fitness, walking capacity, and physical functioning in individuals with CKD.[9] These findings support the improvements in estimated VO_2max observed in the present study.

The superior improvement in physical performance in the experimental group may be explained by the additional effects of JPMR. Progressive muscle relaxation reduces excessive muscle tension, decreases sympathetic nervous system activity, and promotes relaxation, thereby reducing perceived exertion and improving exercise participation. Kusnanto et al. reported that progressive muscle relaxation effectively reduces anxiety and physiological stress responses in patients undergoing haemodialysis, creating favourable conditions for rehabilitation[7].

Quality of life improved significantly in both groups, with greater improvement observed in participants receiving the combined intervention. CKD is associated with fatigue, anxiety, depression, sleep disturbances, and reduced participation in daily activities, all of which negatively affect health-related quality of life. Aerobic exercise improves physical functioning, whereas JPMR primarily targets psychological well-being by reducing stress and promoting relaxation. Consequently, combining these interventions addresses both the physical and psychological dimensions of frailty. Similar findings were reported by Boughdady et al., who demonstrated significant improvements in fatigue and sleep quality following JPMR among

haemodialysis patients[8]. In addition, Barcellos et al. reported that regular exercise interventions improve quality of life and functional capacity in patients with CKD, supporting the findings of the present study[10].

Frailty is recognized as an important predictor of disability, hospitalization, and mortality in CKD. Zhang et al. reported that physical frailty is highly prevalent among CKD patients and is associated with poorer survival and adverse clinical outcomes[3]. Likewise, Johansen et al. identified frailty as a strong predictor of hospitalization and mortality among dialysis patients[4]. These findings emphasize the importance of early rehabilitation interventions aimed at improving both physical performance and quality of life. The greater improvements observed with the combined intervention suggest that integrating physical exercise with relaxation techniques may provide a more comprehensive rehabilitation strategy for frail CKD patients.

The findings of the present study have important clinical implications. Low-to-moderate intensity aerobic exercise combined with JPMR is a safe, inexpensive, and non-pharmacological intervention that can be easily incorporated into routine physiotherapy and nephrology rehabilitation programmes. Because both interventions require minimal equipment and can be adapted for supervised home-based rehabilitation, they may improve accessibility and long-term adherence among patients with CKD. Similar recommendations have been made by the kidney disease: Improving Global Outcomes (KDIGO) guideline, which emphasizes physical activity as an essential component of CKD management[1].

The present study has certain limitations. The relatively small sample size, single-center design, and short intervention duration may limit the generalizability of the findings. Furthermore, physical performance was assessed using estimated VO_2max rather than direct cardiopulmonary exercise testing. Future multicenter randomized controlled trials with larger sample sizes and longer follow-up periods are warranted to determine the long-term effectiveness of combining aerobic exercise with relaxation therapy and to evaluate its impact on hospitalization, disease progression, and survival.

Overall, the findings indicate that combining low-to-moderate intensity aerobic exercise with Jacobson's Progressive Muscle Relaxation provides greater improvements in physical performance and quality of life than aerobic exercise alone in patients with CKD and frailty, supporting its incorporation into comprehensive rehabilitation programmes.

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