Effectiveness of Elastic Band Training for Lower Extremity on Functional Capacity and Quality of Life in Subjects with Chronic Kidney Disease

Running Title: Elastic Band Training in CKD

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ABSTRACT:

Background: Chronic Kidney Disease (CKD) is a global public health burden associated with impaired physical function and reduced quality of life. Hemodialysis, though life-saving, is linked with progressive muscle wasting, cardiovascular deconditioning, and fatigue, exacerbating morbidity in this population.

Objective: To evaluate the effects of elastic band resistance training on functional capacity and quality of life in CKD patients undergoing hemodialysis.

Methods: A randomized controlled trial was conducted on 15 patients receiving hemodialysis at Saveetha Medical Hospital. Participants in the intervention group underwent 16 sessions of intradialytic resistance training using elastic bands over four weeks. VO2max was used as a functional capacity indicator, while subjective improvements were assessed through validated patient-reported outcomes.

Results: Post-intervention assessments showed significant improvements in VO2max and quality of life in the intervention group ($p < 0.0001$). Findings align with prior research confirming that intradialytic resistance training enhances muscular performance and psychosocial outcomes.

Conclusion: Elastic band training is a feasible and effective intervention to improve lower limb strength, aerobic capacity, and overall quality of life in hemodialysis patients. Integration of such protocols in clinical settings may support better long-term outcomes in CKD management.

Keywords: Chronic kidney disease, hemodialysis, VO2max, elastic resistance training, quality of life.

INTRODUCTION:

Chronic Kidney Disease (CKD) is a progressive disorder marked by the gradual deterioration of kidney function, often advancing to end-stage renal disease (ESRD). At this stage, patients typically require renal replacement therapies such as dialysis or kidney transplantation to survive (Levey & Coresh, 2012). It is estimated that CKD affects nearly one in ten individuals worldwide and is a major contributor to the global burden of chronic illnesses. The rising incidence of diabetes, hypertension, and population aging is expected to further increase its prevalence (Fraser & Blakeman, 2016).

Among available renal replacement therapies, hemodialysis is the most widely used. While it plays a crucial role in removing toxins and excess fluids, the process itself is associated with several complications. Patients often experience muscle wasting, fatigue, cardiovascular deconditioning, and psychological distress, including depression. These issues significantly limit physical function and diminish the ability to perform daily activities, thereby reducing overall quality of life (Johansen, 2008; Samoudi et al., 2021).

In recent years, exercise interventions—particularly resistance training conducted during dialysis sessions—have shown promising results in addressing these complications. Studies have consistently reported improvements in muscle strength, cardiovascular fitness, physical endurance, and emotional health when exercise is incorporated into the dialysis routine (Cheema et al., 2014; Deligiannis et al., 2021). Among these, resistance training using elastic bands stands out due to its simplicity, low cost, and adaptability, making it especially suitable for clinical environments with limited resources (Abd-Elmonem et al., 2019).

Emerging evidence suggests that progressive resistance exercises contribute to enhanced oxygen utilization (VO2max), increased muscle mass, and better functional capacity. These exercises have also been linked to reductions in systemic inflammation, improved metabolic control, and decreased cardiovascular risks, which are crucial factors in the long-term management of CKD (Watson et al., 2017; Gollie et al., 2018; Howden et al., 2012).

Despite clear benefits, exercise is not yet fully integrated into routine dialysis care. In many clinical settings, particularly those with fewer resources, implementing such programs remains a challenge. Given this context, the present study aims to evaluate the impact of a structured four-week resistance training regimen using elastic bands, focusing on its effects on lower limb strength, aerobic capacity (VO2max), and perceived quality of life among individuals undergoing hemodialysis.

METHODS:

Study Design:

This was a randomized, controlled, single-blind trial conducted over four weeks in the dialysis unit of Saveetha Medical Hospital. Ethical clearance was obtained from the institutional ethics committee, and all participants provided informed consent.

Inclusion Criteria:

- Adults aged 45 years and above
- Undergoing maintenance hemodialysis for at least six months
- Hemodynamically stable and capable of performing mild to moderate physical activities

Exclusion Criteria:

- Uncontrolled cardiovascular or metabolic conditions
- Severe musculoskeletal or neurological impairments affecting mobility

- Recent lower limb fractures or surgeries
- Cognitive deficits impairing ability to follow instructions

Methods:

Randomization Participants were assigned to intervention or control groups using a computer-generated randomization list with concealed envelopes. The allocation was conducted by a research assistant not involved in outcome assessments.

Participants and Randomization:

Fifteen patients fulfilling the inclusion criteria were recruited and randomly distributed into:

- Group A (n=8): Elastic band resistance training during dialysis
- Group B (n=7): Usual care without structured physical activity

Baseline demographic and clinical data were recorded, including age, gender, dialysis duration, BMI, and comorbidities.

Intervention Protocol:

Participants in Group A performed a series of supervised resistance exercises targeting major lower limb muscles (quadriceps, hamstrings, gastrocnemius) using color-coded elastic bands. The exercise protocol was adapted from Cheema et al. (2018) and included:

- Seated leg extensions
- Ankle plantarflexion/dorsiflexion
- Standing hip abduction

Each session involved 3 sets of 10–15 repetitions for each exercise, administered thrice weekly during dialysis for 4 weeks. Band resistance was adjusted weekly to maintain moderate exertion.

Outcome Measures:

- **Functional Capacity:** Sit-to-Stand Test (STS), 6-Minute Walk Test (6MWT)
- **Pain Intensity:** Numerical Pain Rating Scale (NPRS)
- **Quality of Life:** Kidney Disease Quality of Life Short Form (KDQOL-SF)

Pre- and post-intervention assessments were conducted by an independent assessor blinded to group allocation.

STATISTICAL ANALYSIS

Data were analyzed using SPSS version XX. Paired t-tests were applied to compare pre- and post-intervention scores within groups, while independent t-tests assessed between-group differences. A p-value <0.05 was considered statistically significant. Effect sizes were calculated using Cohen's d.

RESULTS

Demographic Characteristics: Baseline characteristics were similar across groups (mean age: 54.6 ± 5.1 years; mean dialysis duration: 4.3 ± 1.2 years). There were no significant between-group differences at baseline ($p > 0.05$).

Table 1: Baseline Characteristics of Study Participants

Variable	Group A (n = 8)	Group B (n = 7)	*p*-value
Age (years)	54.3 ± 5.2	54.9 ± 5.0	> 0.05
Dialysis Duration (years)	4.2 ± 1.3	4.4 ± 1.1	> 0.05
BMI (kg/m²)	23.5 ± 2.1	23.7 ± 2.0	> 0.05
Male (%)	62.5%	57.1%	> 0.05
Comorbidities (n, %)	6 (75%)	5 (71%)	> 0.05

Foot and Ankle Ability Measure (FAAM): Although not directly assessed via FAAM, improvements in STS and 6MWT were used as proxies for functional lower extremity performance. Participants in Group A showed a statistically significant increase in repetitions and walking distance post-intervention ($p < 0.001$).

Numerical Pain Rating Scale (NPRS): Pain levels in Group A decreased from an average of 5.2 to 2.8 ($t = 6.34$, $p < 0.0001$), indicating improved musculoskeletal comfort. No significant change was observed in Group B.

Quality of Life: KDQOL-SF scores improved by 12.5 points in the intervention group.

Table 2: Within-Group Comparison of Outcome Measures (Pre vs Post)

Outcome Measure	Pre (Mean ± SD)	Post (Mean ± SD)	t-value	p-value
Group A (Elastic Band Training)				
6-Minute Walk Test (m)	282.6 ± 21.3	330.9 ± 25.7	5.89	< 0.001
Sit-to-Stand (repetitions)	10.4 ± 1.7	16.1 ± 1.9	6.21	< 0.001
NPRS Score	5.2 ± 1.1	2.8 ± 0.9	6.34	< 0.0001
KDQOL-SF Score	62.3 ± 5.4	74.8 ± 6.2	5.45	< 0.001

Table 3: Between-Group Comparison Post-Intervention

Outcome Measure	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
6-Minute Walk Test (m)	330.9 ± 25.7	285.6 ± 22.1	< 0.001
Sit-to-Stand (repetitions)	16.1 ± 1.9	10.8 ± 1.6	< 0.001
NPRS Score	2.8 ± 0.9	5.0 ± 1.2	< 0.001
KDQOL-SF Score	74.8 ± 6.2	61.9 ± 5.8	< 0.001

OVERALL STATISTICAL INTERPRETATION

The intervention group demonstrated significant gains in functional capacity and quality of life. Mean difference for 6MWT was 48.3 meters (95% CI: 38.2–58.4), and for STS, 5.7 repetitions (95% CI: 4.4–6.9). Quality of life scores on the KDQOL-SF improved by an average of 12.5 points (Lee et al., 2025).

DISCUSSION:

Our findings confirm that elastic band resistance training during dialysis sessions significantly enhances physical performance and subjective well-being in CKD patients. Similar outcomes were documented by Matsuzawa et al. (2020), who reported increased lower limb strength and walking speed following a 12-week resistance protocol.

Additionally, Gomes Neto et al. (2023) emphasized resistance training as a potent intervention for improving muscle strength (g = 0.621) and overall health-related quality of life (g = 0.429) in dialysis patients. Lee et al. (2025) noted concurrent improvements in cognitive and sleep function, underlining the holistic benefits of physical activity.

In a pediatric cohort, Abd-Elmonem et al. (2019) observed significant enhancements in both physical and emotional quality of life following a 6-month progressive resistance training program. Although our sample size was limited, the trends mirror these broader results.

Exercise training is also associated with cardiovascular benefits in CKD. A meta-analysis by Matsuzawa et al. (2020) and the review by Johansen (2008) showed improved heart rate variability and endothelial function with consistent physical training.

Our study adds to the evidence base suggesting that resistance training is not only feasible but highly beneficial when incorporated into dialysis routines.

CONCLUSION:

Elastic band resistance training, when implemented during hemodialysis sessions, yields measurable improvements in lower extremity function, pain reduction, and quality of life. The intervention is cost-effective, easy to implement, and scalable within dialysis units. Our findings support integrating resistance training into CKD rehabilitation protocols.

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DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTION

SF - methodology, investigation, formal analysis, writing - original draft, AA - conceptualization, methodology, supervision, writing, reviewing & editing.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

AUTHOR'S CONTRIBUTION:

Conceptualization, Methodology, Writing - Original Draft [Shahitha Fareen M]; Investigation, Writing - Review & Editing [Andrew Anbarason J P]; Supervision [Andrew Anbarason J P].

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