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CASE REPORT

Effects of Multimodal Exercise Program Combined with Inspiratory Muscle Training on Cardio-renal-muscle Axis and Clinical Outcomes in a Patient with Chronic Kidney Disease

Naik Minaz* and Pawadshetty Vishvnath

Department of Cardiovascular and Respiratory Physiotherapy, Maharashtra Institute of Physiotherapy, Latur - 413531, Maharashtra, India; minaznaik786@gmail.c-om

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Abstract

Background: Chronic Kidney Disease (CKD) disrupts the cardio-renal-muscle axis, causing reduced functional capacity, muscle weakness, and poor quality of life. **Methods:** A 52-year-old male with Stage 3 CKD (eGFR 30-59 mL/min/1.73m^2) underwent a 12-week multimodal exercise program with Inspiratory Muscle Training (IMT): aerobic training (40-60% target heart rate), resistance training (60-70% 1RM), box breathing, and IMT (30-60% MIP), thrice weekly, with outcomes assessed at baseline and post-intervention. **Results:** Following intervention, 6-MWD elevated from 320 to 405 m (+26.6%), Sit-to-Stand repetitions from 10 to 16 (+60.0%), MIP from 55 to 80 cm H_2O (+45.5%), hs-CRP fell from 7.8 to 3.9 mg/L (−50.0%), IL-6 from 10.5 to 5.8 pg/mL (-44.8%), eGFR elevated from 42 to 48 mL/min/1.73m^2 (+14.3%), serum creatinine (-14.29%) and KDQOL-36 from 50 to 72 (+44.0%). **Conclusion:** As a single-case design (n=1), results reflect clinical rather than statistical significance. Multimodal exercise combined with IMT safely improved cardio-renal-muscle axis function in Stage 3 CKD.

INTRODUCTION

Chronic Kidney Disease (CKD) is defined by persistent structural or functional kidney abnormalities lasting beyond three months[1]. It affects an estimated 10-13% of adults globally, producing systemic effects that extend into cardiovascular, respiratory, and musculoskeletal function as nephron loss progresses[2,3].

Central to these effects is the cardio-renal-muscle axis, in which uremic toxin accumulation and chronic inflammation drive skeletal muscle catabolism and progressive sarcopenia[4], compounding cardiovascular strain and creating a cycle of deconditioning that is difficult to interrupt without targeted intervention[5]. Patients with Stage 3 CKD often show reduced aerobic capacity and inspiratory muscle weakness well before dialysis becomes necessary[6], and IMT have been shown to benefit strength and functional tolerance in CKD populations[7,8].

This report evaluates functional, respiratory, inflammatory, renal, and quality-of-life outcomes following a 12-week combined program in one such patient.

METHODS

This pre-post single-case design evaluated a multimodal exercise program combined with IMT in a patient with Stage 3 CKD (eGFR 30-59 mL/min/1.73m²), selected by purposive sampling. The study was conducted over 12 weeks supervised program at the Cardiovascular and Respiratory Physiotherapy Outpatient Department, with ethical clearance from the Institutional Ethics Committee (Approval No. IEC/PG-2024-25/2026) and written informed consent obtained prior to enrolment; patient confidentiality was maintained throughout.

A 52-year-old male with Stage 3 CKD, presenting with fatigue, reduced functional capacity, dyspnea on exertion, and decreased exercise tolerance, was screened and found eligible. Following baseline and post-intervention assessment of all outcome measures, the patient completed a 12-week supervised program.

Outcome Measures

Primary outcomes were functional capacity: 6-Minute Walk Distance, lower-limb strength (30-Second Sit-to-Stand Test), and inspiratory muscle strength (Maximum Inspiratory Pressure).

Secondary outcomes included renal parameters (serum creatinine, eGFR), inflammatory markers (hs-CRP, IL-6), quality of life (KDQOL-36), cardiovascular parameters (HR, BP, SpO_2), and dyspnea (Modified Borg Scale).

Intervention Protocol

The supervised program was conducted 3 times/week for 12 weeks; each session included aerobic training, resistance exercise, breathing retraining, and IMT.

- Aerobic training: cycle ergometer, 40-60% target heart rate, 20-30 min/session
- Resistance training: major upper- and lower-limb muscle groups, 60-70% 1RM, 2-3 sets of 10-15 repetitions.
- IMT: threshold device, initiated at 30% MIP and progressed to 60% MIP, 15-20 min/session.
- Box breathing: 5 to 10 repetitions, 2-3 sets/session.

Vitals were monitored before, during, and after every session, with intensity modified or discontinued for adverse symptoms such as excessive fatigue, dizziness, or abnormal vital responses.

Figure 1. Patient performing supervised aerobic, resistance, and inspiratory muscle training sessions.

Study Instruments

Cycle ergometer, Resistance training equipment, Threshold IMT device, Pulse oximeter, Sphygmomanometer, Stopwatch

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA). Outcome measures were summarised descriptively, comparing baseline and post-intervention values, with absolute and percentage change calculated for each. Findings were interpreted based on clinical rather than statistical significance and are presented in tabular format.

RESULTS

A 52-year-old male with Stage 3 CKD completed the 12-week multimodal exercise program without adverse events. All outcome measures improved from baseline to post-intervention.

The most clinically notable changes were the gains in 6MWD (+26.6%) and STS repetitions (+60.0%), reflecting improved functional capacity and lower-limb strength, and the rise in MIP (+45.5%), reflecting improved respiratory muscle strength. Inflammatory markers fell substantially (hs-CRP −50.0%, IL-6 −44.8%), renal parameters showed mild stabilisation (eGFR +14.3%), cardiovascular and symptom measures improved (reduced resting HR, BP, and dyspnea score), and QOL rose markedly (KDQOL-36 +44.0%).

DISCUSSION

This case demonstrates clinically meaningful gains across functional, respiratory, inflammatory, renal, and quality-of-life domains in a patient with Stage 3 CKD, supporting exercise-based rehabilitation as an adjunct in CKD care[6]. The gains in 6MWD, STS performance, and MIP likely reflect improved peripheral and respiratory muscle conditioning: exercise appears to partially reverse the uremic muscle catabolism and mitochondrial decline characteristic of CKD[4,5], while IMT strengthens the diaphragm and reduces dyspnea independent of dialysis status[7], a pattern also reported in hemodialysis cohorts[8].

The reduction in hs-CRP and IL-6 is consistent with exercise's anti-inflammatory effects through cytokine modulation, given that chronic low-grade inflammation drives both muscle wasting and cardiovascular risk in CKD[4]; comparable gains have been reported after structured intradialytic training[9]. Mild stabilisation in renal parameters, alongside reduced HR and BP, likely reflects improved hemodynamic and autonomic regulation rather than reversal of nephron loss[3], while

Table 1. Baseline and post-intervention outcome measures

Outcome Measure	Baseline	Post-intervention	Absolute change	% Change
6-Minute Walk Distance (m)	320	405	+85	+26.56
30-Second Sit-to-Stand (reps)	10	16	+6	+60.00
Maximum Inspiratory Pressure (cmH_2O)	55	80	+25	+45.45
Serum Creatinine (mg/dL)	2.1	1.8	−0.3	−14.29
eGFR (mL/min/1.73 m^2)	42	48	+6	+14.29
hs-CRP (mg/L)	7.8	3.9	−3.9	−50.00
IL-6 (pg/mL)	10.5	5.8	−4.7	−44.76
Resting Heart Rate (bpm)	90	80	−10	−11.11
Systolic BP (mmHg)	150	138	−12	−8.00
Diastolic BP (mmHg)	92	86	−6	−6.52
SpO_2 (%)	96	98	+2	+2.08
Modified Borg Dyspnea Score	5	2	−3	−60.00
KDQOL-36 Score	50	72	+22	+44.00

the rise in KDQOL-36 mirrors QOL gains reported in exercise trials among dialysis populations[10]. Collectively, multimodal programs appear to act on multiple interacting components of the cardio-renal-muscle axis simultaneously[5], explaining why gains occurred concurrently rather than in isolation.

CONCLUSION

This case report demonstrates that a 12-week multimodal exercise program combined with IMT is a safe and effective intervention for improvement in all outcome measures, supporting an integrated rehabilitation approach targeting the cardio-renal-muscle axis.

This study contributes to the growing evidence base by highlighting the combined effect of multimodal exercise and IMT in non-dialysis CKD, an area that remains relatively underexplored.

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Conflict of Interest

The authors declare that there are no financial or personal conflicts of interest that could have influenced the conduct or reporting of this study.

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