International Journal of Health Sciences and Research
[Indexed, Peer-Reviewed Journal]
Volume 16; Issue: 1; January 2026
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

The Effect of Intradialytic Exercise on Functional Capacity, Efficacy of Dialysis and Quality of Life in Pediatrics Maintenance Haemodialysis Individual - An Interventional Study

Dipika Pulpati[1], Bharat Tiwari[2], Harda Shah[3]

[1]Assistant Professor Department of Physiotherapy, C M Patel College of Physiotherapy, KSV University Gandhinagar, Gujarat India
[2]Principal and Senior Lecturer, IKDRC-ITS College of physiotherapy, Civil hospital Campus, Asarwa, Ahmedabad, Gujarat, India
[3]Senior Lecturer, Ph.D., IKDRC- ITS College of Physiotherapy, Civil Hospital Campus, Asarwa, Ahmedabad, Gujarat, India

Corresponding Author: Dr. Dipika Pulpati (PT)

DOI: https://doi.org/10.52403/ijhsr.20260110

ABSTRACT

Background: Chronic Kidney Disease (CKD) is a Serious Public Health Problem Worldwide That Substantially Reduces Quality of Life and Significantly Affects Patient's Short Term and Long-Term Survival. End stage renal disease (ESRD) patients on dialysis are at high risk of low exercise capacity and reduce muscle strength which can have significant consequence on their health-related quality of life (HRQL).
Objective: Study was to determine the effect intradialytic exercise on functional capacity, efficacy of dialysis and quality of life in pediatric maintenance haemodialysis.
Materials and Methods: Population of study was ESRD Haemodialysis 12 Pediatric Patients. In which 10 weeks protocol 2 weeks were observation period later Exercise would be started for remaining 8 weeks were Intervention Periods. In this Phase Patients were performed the Progressive Aerobic exercise with the use of Pedocycle and Resistance exercise with TheraBand during starting 1-2 hours of Haemodialysis treatment. Outcomes were 6-minute walk distance (SMWT), Hand Grip Strength (HGS), Dialysis efficacy and Peds scale in ESRD modules.
Result: A total 12 Patients were analyzed. Result showed significant Improvement in Functional Capacity, and Quality of Life but no significant improvement in Dialysis Efficacy.
Conclusion: The Study was Concluded that two months Interventional Intradialytic Exercise protocol is Effective for Improve Functional Capacity and Quality of Life.
Keywords: Intradialytic exercise, paediatric end stage renal disease rehabilitation. Dialysis efficacy, Quality of life paediatric CKD

INTRODUCTION

The Human Body Comprises Multiple Organ Systems That Work in Coordination to Maintain Physiological Balance. The Kidneys Play a Vital Role in Regulating Electrolytes, Hormones and Fluid Balance, Making Them Essential for Overall Body Function [1]. End-Stage Renal Disease (ESRD) Can Result from Chronic Renal Failure (CRF), An Irreversible, Progressive

Illness. According to Imaging, Urine Analysis, or Laboratory Testing, Structural or Functional Kidney Abnormalities That Persist for More Than Three Months Are Referred to as Chronic Kidney Disease (CKD) [2].

CKD is a non-communicable and often asymptomatic disease, frequently diagnosed at advanced stages. In adults, CKD commonly results from hypertension or diabetes, whereas in children, it often stems from chronic glomerulonephritis, obstructive uropathy, or congenital anomalies such as aplasia, hypoplasia, or dysplasia. Paediatric CKD is associated with complications including growth retardation, anaemia, cardiovascular disorders, renal osteodystrophy, malnutrition, and metabolic acidosis[3]. It also presents unique medical and psychosocial challenges compared to adult CKD[4].

Globally, ESRD affects 8–16% of the population 1. Following the diagnosis of end-stage renal disease (ESRD), renal replacement therapy (RRT) through haemodialysis (HD), peritoneal dialysis (PD), or Transplantation becomes essential. Depending on the patient's condition, HD is usually given two to three times a week for approximately four hours each session [5]. Children on dialysis often exhibit reduced physical function and quality of life (QOL) compared to their healthy peers [6]

Exercise during dialysis, particularly aerobic (e.g., Intradialytic cycling) and resistance training, has shown promising results in adults [7] Dialysis adequacy, a key clinical parameter, is commonly assessed using Kt/V and urea reduction ratio (URR), with the recommended targets being Kt/V >1.2 and URR >65% [8,9]. Exercise enhances dialysis efficiency by increasing muscle blood flow and facilitating urea clearance [23].

Functional capacity and QoL can be assessed using the 6-Minute Walk Test (6MWT), handgrip strength (HGS), and PedsQL (ESRD Module) scale, alongside dialysis adequacy through single-pool Kt/V(spkt/v). While intradialytic exercise is well-studied in adults [7], limited data exist for the paediatric population. Therefore, this study aims to evaluate the effects of intradialytic exercise on physical capacity, dialysis efficacy, and quality of life in Indian children undergoing maintenance haemodialysis.

AIM AND OBJECTIVE OF STUDY - To Determine Effect of Intradialytic Exercise on Functional Capacity, Efficacy of Dialysis and Quality of Life in Paediatric Population.

MATERIALS & METHODS

Ethical Approval - The study was conducted after approval by the Ethical committee of Institute of Kidney Diseases and Research Center and Institute of Transplantation Sciences (IKDRC-ITS).

Study Design - An Experimental study

Study Setting - Pediatric Haemodialysis Department, Institute of Kidney Disease and Research Centre and Institute of Transplantation (IKDRC-ITS) Civil Campus Ahmedabad Gujarat.

Sampling Method - Convenient sampling method.

Study Duration - Data was collected over a period of 1 year (2020-2021)

Sample Size - Total 12 number of haemodialysis (8-18 year) paediatric patient

Selection Criteria

Inclusion Criteria

- Age: 8–18 years
- Maintenance HD: 2–3 times/week
- Clinically stable during HD
- Able to perform/understand fitness tests
- Dialysis vintage ≥3 months

Exclusion Criteria

- Recent fractures or history of frequent falls**.**
- Unstable cardiac status and Pulmonary conditions (e.g., CHF, severe valvular disease, arrhythmias, pericarditis, Uncontrolled hypertension, pleural effusion, pneumonia).
- Recent injury, infection, or physical limitations.

- Dysfunctional arteriovenous (A-V) fistula and Haemoglobin level <9 g/dl
- Neurological disorders affecting participation.

PROCEDURE:

A total Twelve participants were enrolled based on inclusion criteria after informed consent was obtained from their parents. The 10-week study included the same subjects in both phases: A 2-week observational (control) phase followed by an 8-week interventional (experimental) phase. Two patients dropped out due to transplantation.

The evaluated Outcomes included the 6-Minute Walk Test (6MWT), Handgrip Strength (HGS) and Quality of Life (QOL). Blood urea samples were collected weekly before and after dialysis. Assessments were conducted at baseline, end of week 2, and end of week 8.

EVALUATION OF FUCTIONAL CAPACITY AND STRENGHT

6-Minute Walk Test: A conducted on a 30-meter straight corridor free of obstacles. Participants were instructed to walk back and forth along the corridor, covering as much distance as possible within six minutes, they were allowed to slow down, stop and rest, if necessary, but were encouraged to resume walking as soon as they were able. The total distance walked was recorded in meters at the end of the 6-minute period. Vital signs and modified borg scale were measured immediately before and after the test[10,11].

Hand grip strength: Grip strength of the upper extremities was measured at normal hand using a Jamar handheld dynamometer, with results expressed in kilograms. Participants in high sitting position with back support held the device at their normal hand side and avoid A-V fistula side with the arm straight and stationary to prevent activation of accessory muscles, adhering to standardized testing procedures. Three attempts were performed, and the highest reading was documented. This technique is widely used for both initial assessment and follow-up evaluation of grip strength[12].

Quality of life: assessed using the PedsQL™ ESRD Module Version 3.0 for children (2–12 years) and young adults (13–24 years). The questionnaire includes seven domains: fatigue, physical health, school functioning, treatment problems, social interaction, and communication. Responses are rated on a 5-point scale (0 = never to 4 = always), with higher scores indicating better quality of life. [13]

Dialysis Efficacy (Single-Pool Kt/V):

Dialysis adequacy is vital for patient survival and quality of life. The single-pool Kt/V (spKt/V) model assumes urea is distributed in one body compartment, predicting a linear decline in urea and immediate post-dialysis equilibration. A minimum spKt/V of 1.2 is recommended, with a target dose of 1.4[14].

Thus, the single pooled kt/v is calculated – as follows

$$SP\ kt/v = -\ln (R - 0.008 \times t) + (4 - 3.5 \times R) \times UF/W$$

Where, - ln - natural logarithm,

R – Post dialysis / Pre dialysis serum urea ratio

T – Time (hours)

UF – Ultra filtration volume (litters)

W – Post dialysis body weight

Blood Urea Sample: During both phases, pre- and post-dialysis blood samples (serum urea) were collected weekly during the same session with zero dialysis blood flow, blood sample were collected by nursing staff[12].

Intervention Exercise: Exercises were performed during the first 1-2 hours of dialysis sessions. during exercise Vitals (HR, BP, RR, SpO_2) were monitored and incase of chest pain, dyspnea, dizziness, uncontrolled blood pressure or other any abnormal sing stops the exercise immediately. Progression of exercise depends on rate of perceive exertion. Exercise was structured according to the FITT principle. It was scheduled 2 to 3 times per week on the days patients

underwent dialysis. The intensity level was maintained between mild to moderate, aligning with a Borg Rating of Perceived Exertion (RPE) of 9 to 12. Circuit interval training was used as the exercise method, with each session lasting around 40 to 50 minutes and avoid the movement of fistula limb.

TABLE 1: Components of Exercise Programme

Phase	Time	Activities
Warm-up	5 min	Deep breathing, calf and hamstring stretches, and ankle pump exercises (10 repetitions; 3 sets).
Cycling	15 – 20 min	Performed in seated or supine position using a stationary cycle.
Resistance Band Exercises	10-15 min	Upper limb: Shoulder joint (flexion-extension, abduction adduction), elbow joint (flexion-extension) Lower limb: Hip joint (flexion-extension, abduction-adduction), knee joint (flexion-extension) All movements were performed within the available range of motion (10 repetition, 2 sets)
Cool-down	5 min	Deep breathing exercises (5-10 repetition)

ACSM guidelines [17]

Statistical Analysis: Data analysis was conducted using SPSS version 25.0 and Microsoft Excel for a total of 12 subjects. Descriptive statistics were expressed as mean ± SD, and the Shapiro-Wilk test confirmed normal data distribution. A paired t-test was used for comparison with a 95% confidence interval and significance set at $p < 0.05$.

RESULT

TABLE 2: DEMOGRAPHIC DETAILS

AGE	13.3 ± 3.093
GENDER	Female 3 and Male 9
HEIGHT	134.75 ± 16.92
DRY WEIGHT	28.5± 10.11

Above table (2) showed demographic details of 12 paediatric patients average heigh and dry weight.

TABLE 3: Mean difference between pre and post observational phase

Outcomes	Baseline data Pre Observation Phase (MEAN ± SD)	Post Observation Phase (MEAN ± SD)	P value
6 MWT	411.1 ± 63.58	389.9 ± 97.396	0.025
HGS	14.05 ± 4.33	13.12± 4.88	0.153
PEDS QL Scale (ESRD Module)	58.844±13.035	62.570±15.062	0.387

Above table (3) showed the pre and post observational phase 6MWT, HGS, PEDs QL scale scores data. Represented in the form of MEAN ± SD and showed no statistical significance difference.

TABLE 4: Mean difference between pre and post Interventional phase

Outcomes	Pre Interventional Phase (MEAN ± SD)	Post Interventional Phase (MEAN ± SD)	P value
6 MWT	389.9±97.396	469.60 ± 22.97	0.006
HGS	13.12 ± 4.88	16.06 ± 4.72	0.0004
PEDS QL Scale (ESRD Module)	62.57±15.06	72.71±10.81	0.019

In table (4) the pre and post Interventional phase 6MWT, HGS, PEDs QL scale scores data. Represented in the form of MEAN ± SD and showed statistical significance difference.

TABLE 5: Mean difference of SP KT/V between Observational and Intervention Phase

SP kt/v	Observational Phase	Interventional Phase	P value
MEAN ± SD	1.2258 ± 0.0476	1.226813 ± 0.033726	0.9105

Table 5 demonstrates the comparison of dialysis (SP KT/V) between observational and interventional phase data. Represented in the form of MEAN ± SD and table also demonstrate no statistical significance difference.

DISCUSSION

This study aimed to evaluate the effects of combined aerobic and resistance exercise during dialysis sessions on physical fitness, muscle strength, quality of life, and dialysis adequacy in paediatric patients with end-stage renal disease (ESRD) undergoing maintenance haemodialysis.

The results demonstrated significant improvements in exercise capacity as measured by the 6-minute walk test (6MWT), muscle strength via hand grip strength (HGS) and quality of life through the PedsQL 3.0 ESRD scale during the interventional phase. These findings reinforce the positive role of intradialytic exercise in improving physical outcomes in children with ESRD.

Van Visitler et al. [15] previously reported that cycling during dialysis combined with a pre-dialysis strengthening program improved physical fitness, behavioural outcomes, physiological status, and overall health in dialysis patients. In line with this, our study observed a 78.6-meter improvement in 6MWT distance during the interventional phase, while no significant changes were noted during the observational phase. Stuart L. Goldstein et al. [16] similarly reported a significant 38-yard improvement after a 3-month exercise regimen in pediatric hemodialysis patients.

Skeletal muscle wasting is a common manifestation in ESRD, driven by protein-energy malnutrition, acidosis, comorbid conditions, and inactivity [5]. HGS, a reliable marker of muscle function, showed no significant changes during the observational phase, but improved significantly following the intervention. MA Guadalupeoveral Soto et al. [18] observed similar improvements, with HGS increasing from 19.6 kg to 21.6 kg after a 12-week exercise program in adult hemodialysis patients.

Chronic kidney disease negatively impacts not just physical health but also emotional and social well-being, often leading to reduced quality of life [1,20]. Our findings showed no significant changes in PedsQL scores during the observational phase but noted significant improvement during the interventional phase. This aligns with findings from Magdo Mohammad et al. [21], who demonstrated a significant improvement in KDQOL-SF™ scores following intradialytic exercise in adult ESRD patients.

Dialysis adequacy, assessed through single-pool Kt/V (spKt/V), did not significantly improve, consistent with the findings of Fabio Paglialonga et al. [22], who observed no significant change in pediatric patients after a 3-month intradialytic exercise regimen. However, Raheleh Mohseni et al. [23] reported a 38% improvement in spKt/V after 8 weeks of aerobic intradialytic training in adults. This discrepancy may be due to pediatric-specific factors, such as difficulty maintaining dry weight, physiological variability, and possible limitations of the spKt/V formula in accurately reflecting dialysis efficacy in children.

From a physiological standpoint, intradialytic exercise enhances dialysis efficacy by increasing muscle blood flow, capillary surface area, and urea diffusion, thereby potentially improving toxin clearance[24,13]. Static cycling, for instance,

promotes vasodilation and increases solute exchange via elevated core body temperature and vascular dilation [13,21]. Although this may not have translated into measurable improvements in spKt/V in this study, it likely contributed to the observed functional and quality-of-life benefits.

Moreover, ESRD patients are at high risk for fractures due to osteoporosis and mineral bone disorders, resulting in reduced bone density and structural integrity. Mechanical loading through resistance training has been shown to stimulate bone remodelling, suggesting a positive correlation between muscle strength and bone mineral density [19]. Thus, incorporating both aerobic and resistance exercise may help mitigate bone loss while promoting skeletal health.

Limitation of study: The single-centre dialysis study had an incomplete sample size due to the COVID-19 pandemic and unequal durations between the observation and intervention phases.

Future Perspectives: the study need more sample size and participant will be enrolled from multiple centers.

Clinical Implication: Intradialytic exercise programs to be integrated as a standard adjunct therapy in pediatric dialysis care.

CONCLUSION

The findings of the present study reveal that the prescribed intradialytic exercise resulted in significant improvement in physical functional capacity, quality of life and hand grip strength, but no significant improvement in dialysis efficacy. It also found that this exercise program is quite enjoyable, safe and complementary intervention and participant paediatric patient spend quality of time during dialysis.

Declaration by Authors

Ethical Approval: Approved

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Shiny PT. Effectiveness of Intra-dialytic Stretching Exercises on Painful Muscle Cramps among Patients Undergoing Haemodialysis' in Selected Hospitals, Hyderabad, Telangana. Practical Nursing.2018;6(3):129.
2. KDIGO 2017 Clinical Practice Guideline Update for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease–Mineral and Bone Disorder (CKD-MBD), volume 7 | issue 1 | July 2017
3. Kanitkar M. Chronic kidney disease in children: an Indian perspective. Medical Journal, Armed Forces India. 2009 Jan;65(1):45.
4. Agarwal SK. Chronic kidney disease and its prevention in India. Kidney international. 2005 Sep 1;68:S41-5.
5. Ellis D. Avner William E. Pediatric Nephrology, seventh edition
6. Ferreira GD, Bohlke M, Correa CM, Dias EC, Orcy RB. Does intradialytic exercise improve removal of solutes by hemodialysis? A systematic review and meta-analysis. Archives of physical medicine and rehabilitation. 2019 Dec 1;100(12):2371-80.
7. Mallamaci F, Pisano A, Tripepi G. Physical activity in chronic kidney disease and the exercise Introduction to Enhance trial. Nephrology Dialysis Transplantation. 2020 Mar 1;35(Supplement_2):ii18-22.
8. Safa J, Noshad H, Ansarin K, Nikzad A, Saleh P, Ranjbar A. Effect of hemodialysis on pulmonary function tests and plasma endothelin levels Saudi Journal of Kidney Diseases and Transplantation. 2014 Jul 1;25(4):781.
9. Paluchamy T, Vaidyanathan R. Effectiveness of intradialytic exercise on dialysis adequacy, physiological parameters, biochemical markers and quality of life–a pilot study. Saudi Journal of Kidney Diseases and Transplantation. 2018 Jul 1;29(4):902.
10. ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. ATS statement: guidelines for the six-minute walk test. AmJRespirCritCareMed.2002;166:111
11. Watanabe FT, Koch VH, Juliani RC, Cunha MT. Six-minute Walk test in children and adolescents with renal diseases: tolerance reproducibility and

comparison with healthy subjects. Clinics.2016Jan;71(1):22
12. Bakramae, Hasaneen B, Bassiouni D. Assessment of nutritional status in children with chronic kidney disease using hand grip strength tool. J Ren Nutr.2018;28(4):265-269. doi:10.1053/ j.jrn.2017.12.007
13. Maheshwari V, Samavedham L, Rangaiah GP. A Regional Blood Flow Model for B 2-Microglobulin Kinetics and for Simulating Intra-Dialytic Exercise Effect. Annals of biomedical Engineering.2011 Dec1;39(12):2879-90.
14. Afshar R, Shegarfy L, Shavandi N, Sanavi S. Effects of aerobic exercise and resistance training on lipid profiles and inflammation status in patients on maintenance hemodialysis. Indian J Nephrol. 2010 Oct;20(4):185–9. doi: 10.4103/0971-4065.73442
15. Van Bergen M, Takken T, Engelbert R, Groothoff J, Nauta J, van Hoeck K, Helders P, Lilien M. Exercise training in pediatric patients with end-stage renal disease. Pediatric nephrology. 2009 Mar;24(3):619-22.
16. Goldstein SL, Montgomery LR. A pilot study of twice-weekly exercise during hemodialysis in children. Pediatric Nephrology. 2009 Apr;24(4):833-9.
17. ACSM guidelines for exercise testing and prescription 10th edition.
18. Ma guadalupe olvera – soto. The effect of resistance exercise on the indicator of muscle reserve and handgrip strength in adult patient on hemodialysis. Journal of renal nutrition, vol 26 no 1, 2016 :53-60
19. Marinho SM, Moraes C, Barbosa JE, Carraro Eduardo JC, Fouque D, Pelletier S, Mafra D. Exercise Training Alters the Bone Mineral Density of Hemodialysis Patients. J Strength Cond Res. 2016 Oct;30(10):2918-23. doi: 10.1519/JSC. 0000000000001374. PMID: 26863587.
20. Bradley A. Warady, Md, Optimal Care of the Infant, Child, And Adolescent on Dialysis: 2014 Update. Am J Kidney Dis. 2014;64(1):128-142
21. Magda M Bayoumi, Jamal Alwakeel. Impact of exercise programs on hemodialysis patient's quality of life and physical fitness. Quality In Primary Care (2015) 23(4): 192-200.
22. Paglialonga F, Lopopolo A, Scarfia RV, Consolo S, Galli MA, Salera S, Grassi MR, Brivio A, Edefonti A. Intradialytic Cycling in Children and Young Adults on Chronic Hemodialysis. Pediatric Nephrology. 2014 Mar;29(3):431-8.
23. Rahelen Mohesin. The effect of intradialytic aerobic exercise on dialysis efficacy in hemodialysis patient- a randomised controlled trial. Oman Med Journal 2013 Sept;28(5):34
24. Brown PDS, Rowed K, Shearer J, MacRae JM, Parker K. Impact of intradialytic exercise intensity on urea clearance in hemodialysis patients. Appl Physiol Nutr Metab. 2018 Jan;43(1):101-104. doi: 10.1139/apnm-2017-0460. Epub 2017 Sep 29. PMID: 28961405.
25. Maheshwari V, Samavedham L, Rangaiah GP, Loy Y, Ling LH, Sethi S, Lau TW. Comparison of toxin removal outcomes in online hemodiafiltration and intra-dialytic exercise in high-flux hemodialysis: a prospective randomized open-label clinical study protocol. BMC Nephrology. 2012;13:156. Published 23 November 2012. doi:10.1186/1471-2369-13-156.

How to cite this article: Dipika Pulpati, Bharat Tiwari, Harda Shah. The Effect of Intradialytic Exercise on Functional Capacity, Efficacy of Dialysis and Quality of Life in Pediatrics Maintenance Haemodialysis Individual - An Interventional Study. Int J Health Sci Res. 2026; 16(1):76-82. DOI: *10.52403/ijhsr.20260110*

******