

The Impact of Renal Rehabilitation Programs on Clinical Outcomes in Hemodialysis Patients: A Systematic Review

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Abstract

Introduction: Chronic kidney disease (CKD) is a global health challenge, with rising numbers of patients requiring hemodialysis. Optimizing dialysis adequacy, fluid control, and cognitive function is essential for improving quality of life. This systematic review evaluates the impact of renal rehabilitation programs on these outcomes.

Methods: We systematically searched PubMed, Scopus, Web of Science, and SID for studies (2015–2025) assessing nutritional counseling, physical exercise, or cognitive training in hemodialysis patients. Irrelevant papers and non-systematic reviews were excluded. Twenty-three eligible articles were analyzed.

Results: Out of 1,246 records initially retrieved, 23 studies met the inclusion criteria. Renal rehabilitation interventions consistently improved dialysis adequacy (Kt/V, urea reduction ratio), enhanced fluid control (reduced interdialytic weight gain, improved blood pressure stability), and ameliorated cognitive function (measured by validated neuropsychological scales). Nutritional counseling was particularly effective in reducing fluid overload, while structured exercise programs demonstrated the most robust impact on overall physical performance and dialysis efficiency. Cognitive training showed promising but less consistent results due to limited sample sizes and methodological heterogeneity.

Conclusion: Multifaceted renal rehabilitation programs significantly improve clinical outcomes in hemodialysis patients, with physical activity providing the strongest evidence of benefit. In resource-constrained settings, prioritizing exercise-based interventions may yield the greatest clinical impact. Further large-scale, multicenter trials are required to optimize intervention protocols and confirm long-term benefits.

Keywords: Renal Rehabilitation, Hemodialysis, Dialysis Adequacy, Fluid Overload, Cognitive Dysfunction

Introduction

Chronic kidney disease (CKD) is a major public health challenge worldwide, characterized by a gradual decline in kidney function, which in advanced stages necessitates renal replacement therapies such as hemodialysis.¹ Although hemodialysis plays a crucial role in maintaining patient survival and effectively removes metabolic waste and excess fluids, patients undergoing dialysis often encounter numerous complications that can profoundly impair their quality of life. Among these, dialysis adequacy, fluid overload, and cognitive dysfunction are highly prevalent and clinically significant outcomes, given their direct association with patient morbidity and mortality.² These challenges not only affect patient survival but also have long-term implications for healthcare utilization, treatment costs, and the burden on caregivers.

Evidence suggests that these variables can be improved through renal rehabilitation interventions.³ Accordingly, the present systematic review focuses on these three key indicators to evaluate the effectiveness of rehabilitation programs in hemodialysis patients. Renal rehabilitation—by combining structured physical activity, nutritional optimization, and psychosocial support—offers a multidimensional strategy that directly targets these prevalent complications, potentially translating into improved survival and reduced hospitalization rates.

Dialysis adequacy, often assessed using indices such as Kt/V and URR, is a fundamental criterion in evaluating the efficacy of hemodialysis.⁴ Research has demonstrated that renal rehabilitation interventions, especially exercise programs, can improve these

indices.⁵⁻⁷ For instance, intra-dialytic exercise has been shown to increase Kt/V and reduce fatigue in patients.⁵ Furthermore, combining aerobic and resistance training exerts a positive effect on dialysis adequacy and enhances patients' quality of life.⁷

Fluid overload is also a prevalent and serious complication in hemodialysis patients, contributing to an increased risk of cardiovascular events and even mortality.⁸ Multiple studies have shown that educational and counseling programs effectively improve fluid control and patients' adherence to fluid restriction.^{8,9} For example, regular educational interventions have been associated with increased awareness, improved adherence to treatment regimens, and reduced fluid overload in dialysis patients.⁸

Cognitive dysfunction is a significant challenge among dialysis patients, likely caused by metabolic changes, uremic toxins, and reduced cerebral oxygenation.¹⁰ Such impairments can hinder patients' ability to comply with treatment regimens, resulting in increased complications and mortality. Thus, addressing cognitive issues is especially important in the management of dialysis patients.¹¹ Psychological and cognitive rehabilitation interventions can improve cognitive function and reduce symptoms of anxiety and depression in hemodialysis patients.¹⁰⁻¹² There is evidence that cognitive-behavioral interventions directly reduce depression and anxiety levels and promote patients' quality of life.^{10,12} Therefore, addressing and improving cognitive disorders is vital not only for enhancing quality of life but also for better treatment adherence and reduced morbidity and mortality. Despite this evidence, cognitive outcomes have been underrepresented in most prior reviews, limiting the understanding of how rehabilitation may interact with neurocognitive health.

Renal rehabilitation is a comprehensive approach that encompasses a set of therapeutic, educational, psychological, and social interventions, aiming to improve the quality of life of patients with kidney disease.^{3,13} This approach, by enhancing dialysis effectiveness, reducing disease complications, improving physical and psychological functioning, and increasing patients' self-care abilities, plays a crucial role in disease management and clinical outcomes. Renal rehabilitation programs include patient education, psychological counseling and support, exercise therapy, and self-care promotion, each of which can effectively improve

patient outcomes.

One important component of renal rehabilitation is patient education, which assists individuals in better understanding their condition and improving their quality of life. Numerous studies have shown that education related to dietary adherence, medication management, and health monitoring can increase treatment compliance and precise adherence to medical instructions.^{14,15}

Similarly, psychological interventions form an essential part of renal rehabilitation, effectively reducing anxiety, depression, and stress in patients. Counseling and psychological support help patients better cope with the potential difficulties associated with their disease.¹¹

Exercise therapy is a fundamental pillar of renal rehabilitation, whether provided in the clinical setting or at home, and plays a significant role in improving physical function, dialysis efficiency, and decreasing patient fatigue, all of which considerably enhance quality of life. Self-care is another crucial component, empowering patients to manage their health status; education and patient empowerment regarding medication and treatment regimens positively impact their quality of life and clinical outcomes.¹⁶⁻¹⁸

Studies show that renal rehabilitation is a multidimensional concept, sometimes addressed in a limited fashion,¹⁷ while in other research it is presented as a comprehensive approach.³ Therefore, accurately describing these dimensions and their impact on clinical improvement is essential.

Despite notable advances in the treatment and care of patients with kidney failure, many hemodialysis patients still struggle with issues such as fluid overload, cognitive impairment, and inadequate dialysis adequacy, all of which can significantly impact their quality of life and clinical outcomes. Although renal rehabilitation has been introduced as a novel and multidisciplinary approach to improve these outcomes, existing evidence remains scattered and unintegrated, and so far, no comprehensive systematic review has specifically evaluated the effects of these programs on these three key outcomes. Earlier systematic reviews have often been limited to single interventions, such as exercise training, without fully considering the combined and potentially synergistic effects of nutrition, physical activity, and cognitive support. This gap in the literature limits the ability of clinicians and policymakers to implement integrated, evidence-based protocols.

Addressing this research gap can provide valuable guidance for improving patient care and evidence-based policy-making in renal rehabilitation. Therefore, the present study aims to systematically review the effects of renal rehabilitation programs on dialysis adequacy, fluid overload, and cognitive function in hemodialysis patients.

Materials and Methods

This qualitative systematic review was conducted in accordance with the PRISMA guidelines, aiming to evaluate the effects of dietary and rehabilitation interventions on reducing fluid overload and improving health outcomes in patients with chronic kidney disease (CKD).

The review process was conducted in six major stages:

Stage 1: Research questions based on the PICO framework

The PICO framework is a structured model widely used in evidence-based medicine for formulating clinical research questions by defining four key components:

- P (Population): the specific patient group under study.
- I (Intervention): the treatment, program, or approach being investigated.
- C (Comparison): an alternative intervention or standard care against which the main intervention is compared.
- O (Outcome): the desired or expected measurable effects of the intervention.

In this review, the Population (P) comprised patients with CKD at various stages, receiving dialysis or other management modalities. Interventions (I) included rehabilitation programs such as aerobic and resistance exercises, nutritional education, lifestyle modification, and psychological or psychosocial support. The Comparison (C) group consisted of patients either receiving standard care (hemodialysis alone and/or routine drug therapy) or not exposed to rehabilitation interventions. Outcomes (O) of interest were the reduction of fluid overload, improvement of cognitive function, enhancement of dialysis adequacy indices (URR, Kt/V), reduction of cardiovascular complications, and improvement in quality of life measured by standardized tools (e.g., KDQOL, SF-36).

Stage 2: Systematic literature search was performed using keywords selected based on MeSH terms and

commonly used scientific expressions, including chronic kidney disease, dialysis, fluid overload, diet, rehabilitation, cognitive impairment, nutrition, exercise therapy, and quality of life.

Stage 3: Inclusion and exclusion criteria

A structured set of inclusion and exclusion criteria, along with the rationale for each, was applied to maintain methodological rigor and ensure that the studies selected were both relevant and of sufficient quality.

Inclusion criteria (with rationale):

1. Publication date: January 2015 to March 2025 — to capture the latest evidence reflecting current standards in renal rehabilitation.
2. Population: Patients with CKD (any stage) undergoing hemodialysis or other management modalities — to focus on the intended patient group.
3. Intervention: One or more components of dietary and/or rehabilitation programs (exercise, education, psychological support, lifestyle modification, or combinations) — consistent with the multidimensional nature of rehabilitation.
4. Outcomes: Measured impact on at least one of the predefined outcomes (fluid overload, cognitive impairment, dialysis adequacy, cardiovascular complications, quality of life) — to preserve relevance to the study objectives.
5. Language: English or Persian full-text articles — ensuring accuracy in data extraction and appraisal.
6. Study design: Qualitative, quantitative, or mixed-methods studies with extractable and valid data — ensuring sufficient methodological detail for analysis.

Exclusion criteria (with rationale):

7. Irrelevance to CKD or absence of rehabilitation-focused interventions — to maintain focus on the specific patient and intervention scope.
8. Non-systematic reviews, letters to the editor, conference abstracts, and study protocols — due to insufficient methodological detail.
9. Insufficient or unclear data — to safeguard the validity of extracted results.
10. Low methodological quality — as determined by CASP, JBI, or Cochrane quality tools, excluding studies with high bias risk or inadequate reporting.
11. Duplicate publications — retaining only the most complete and updated version to avoid data duplication.

Selection was conservative: studies partially meeting criteria were subjected to full-text review, and only those fulfilling all key requirements (population, intervention, outcomes, and methodological clarity) were retained.

Stage 4: Systematic searches were conducted in the following electronic databases: Cochrane Library, PubMed/Medline, Embase, Web of Science, Scopus, ProQuest, Ovid, SID, and Google Scholar. In total, 1,655 records were identified. After removing 674 duplicates, the titles and abstracts of the remaining 981 articles were screened, and 110 articles were selected for full-text review.

Stage 5: Upon full-text review, 87 articles were excluded due to misalignment with study objectives, low quality, incomplete data, or being presented only as a poster or oral presentation. Ultimately, 23 eligible studies were included for final analysis. Data from these studies were extracted and analyzed according to the thematic framework of the review in order to obtain precise and reliable results.

Stage 6: The quality of the included studies was assessed using standard tools: the CASP checklist for qualitative studies, the JBI framework, and the Cochrane criteria for quantitative studies. The CASP tool examines clarity of research aims, methodological rigor, and generalizability; the JBI framework evaluates methodological accuracy, data transparency, and applicability; and the Cochrane criteria assess methodological rigor, risk of bias, randomization, and quality of data analysis in randomized controlled trials. These tools ensure that the selected studies provide valid and reliable data for the final conclusions. Data were analyzed both qualitatively (via deductive content analysis) and quantitatively (using descriptive and inferential statistical methods). Results were categorized and reported according to the impact of rehabilitation interventions on fluid overload reduction, cognitive function improvement, and dialysis adequacy enhancement in CKD patients

Stage 7: Quality appraisal and data analysis

The quality of included studies was assessed using:

- CASP checklist for qualitative studies (clarity of aims, methodological rigor, transferability)
- JBI framework (methodological accuracy, transparency of data, applicability)
- Cochrane criteria for quantitative studies (risk of bias, randomization, data analysis quality)

Data analysis was conducted qualitatively (deductive content analysis) and quantitatively (descriptive and inferential statistical methods). Results were synthesized according to their impact on fluid overload reduction, cognitive function improvement, and dialysis adequacy enhancement in CKD patients.^{19–21}

All included studies were directly associated with one or more of the following clinical outcomes in hemodialysis patients: dialysis adequacy, fluid overload, cognitive function, and/or quality of life. The interventions assessed (rehabilitation, education, nutrition, exercise, and psychological support) align closely with the main focus of this systematic review and the current best practices for CKD patient care.

Limitations and Potential Biases

This systematic review may be subject to certain limitations and potential biases. First, publication bias cannot be ruled out, as studies with positive or significant results are more likely to be published and included. Second, language bias may have occurred due to the inclusion of only English and Persian language articles, potentially excluding relevant studies in other languages. Furthermore, the included studies varied in methodological quality, intervention types, sample sizes, and outcome measures, which may affect the consistency and generalizability of the findings. These limitations were considered in the interpretation of results and highlight the need for cautious extrapolation of conclusions.

Study Selection and Dual Review

In the study selection phase, the titles and abstracts of all retrieved articles were independently screened by two members of the research team. If any discrepancies arose between the two reviewers, efforts were first made to resolve disagreements through discussion and consensus. In cases where consensus was not reached, a third member of the research team was consulted to make the final decision. This dual-review process minimized selection errors and enhanced the credibility of the systematic review.

Data Extraction

Data extraction was also carried out independently by two researchers. Key information extracted included authors' names, year of publication, country of study, study design, sample size, type and characteristics of

intervention, reported outcomes, and criteria for assessing effectiveness. A standardized data extraction form, based on the study objectives, was used to ensure consistency and comparability of the data. In cases of unclear or incomplete information, study authors were contacted or ambiguities were addressed through consultation with other members of the research team.

Data Synthesis

For data synthesis, the findings from the included

studies were initially categorized thematically according to the main variables (dialysis adequacy, fluid overload, and cognitive impairment). Qualitative data were analyzed using deductive content analysis, and quantitative data were summarized descriptively whenever possible. Where sufficient homogeneity existed among studies, comparative and aggregated analyses were conducted to support more robust conclusions. All steps of data synthesis were performed transparently and in accordance with PRISMA standards.

Round	Search
1	("Renal Rehabilitation"[Title/Abstract] OR "Kidney Rehabilitation"[Title/Abstract]) AND ("Dialysis Adequacy"[Title/Abstract] OR "Fluid Overload"[Title/Abstract] OR "Cognitive Dysfunction"[Title/Abstract])
2	("Exercise Therapy"[Title/Abstract] OR "Physical Rehabilitation"[Title/Abstract]) AND ("Dialysis Patients"[Title/Abstract] OR "End-Stage Renal Disease"[Title/Abstract])
3	1+2
4	("Cognitive Impairment"[Title/Abstract] OR "Memory Dysfunction"[Title/Abstract]) AND ("Chronic Kidney Disease"[Title/Abstract])
5	3+4
6	("Hydration Status"[Title/Abstract] OR "Fluid Retention"[Title/Abstract]) AND ("Dialysis"[Title/Abstract])
7	5+6
8	("Rehabilitation Programs"[Title/Abstract] OR "Therapeutic Interventions"[Title/Abstract]) AND ("Kidney Function"[Title/Abstract])
9	7+8
10	("Barriers"[Title/Abstract] OR "Facilitators"[Title/Abstract]) AND ("Renal Rehabilitation"[Title/Abstract])
11	9+10
12	("Patient Outcomes"[Title/Abstract] OR "Quality of Life"[Title/Abstract]) AND ("Chronic Kidney Disease"[Title/Abstract])
13	11+12
14	("Qualitative Research"[Title/Abstract] OR "Clinical Trials"[Title/Abstract]) AND ("Renal Rehabilitation"[Title/Abstract])
15	13+14

Cochrane Library	PubMed/Medline	Embase	Web of Science	Scopus	ProQuest	Ovid	SID	Google Scholar	Total
95	245	210	195	230	160	110	90	320	1655

Results

A total of 23 studies met the inclusion criteria (Figure 1; PRISMA flow diagram), comprising ten studies on dialysis adequacy, three on fluid overload, four on cognitive and psychological outcomes, and six on rehabilitation, nutrition, and/or quality of life in hemodialysis patients. Detailed characteristics of the included studies are presented in Table 1 (dialysis adequacy), Table 2 (fluid overload), Table 3 (psychological and cognitive outcomes), and Table 4 (rehabilitation, nutrition, and quality of life).

Effect of Exercise Interventions on Dialysis Adequacy and Physical Performance

As summarized in Table 1, most included exercise-based studies demonstrated statistically significant improvements in dialysis adequacy indices (e.g., Kt/V, URR) and physical performance. For example, Malini

et al. reported that intra-dialytic range-of-motion exercise resulted in a mean Kt/V increase of 0.22 ($p = 0.03$) and a significant reduction in fatigue scores.⁵ Almasi and Ghodrati found that an eight-week aerobic program improved dialysis adequacy and blood flow rates ($p < 0.05$).²² Zhao et al. showed that combined aerobic and resistance training led to higher gains in both adequacy and quality of life compared with single-modality programs ($p < 0.01$).⁷ Hataf et al. observed that simple walking interventions improved physical function metrics and slightly increased dialysis adequacy indices, although the latter did not reach statistical significance.¹⁶ Wilkinson et al. emphasized that muscle power, rather than muscle mass, was the primary predictor of functional capacity.¹⁷ Basiri Moghaddam et al. found that intra-dialytic isotonic and isometric exercises significantly enhanced adequacy ($p = 0.04$) and other markers of renal function.²⁵

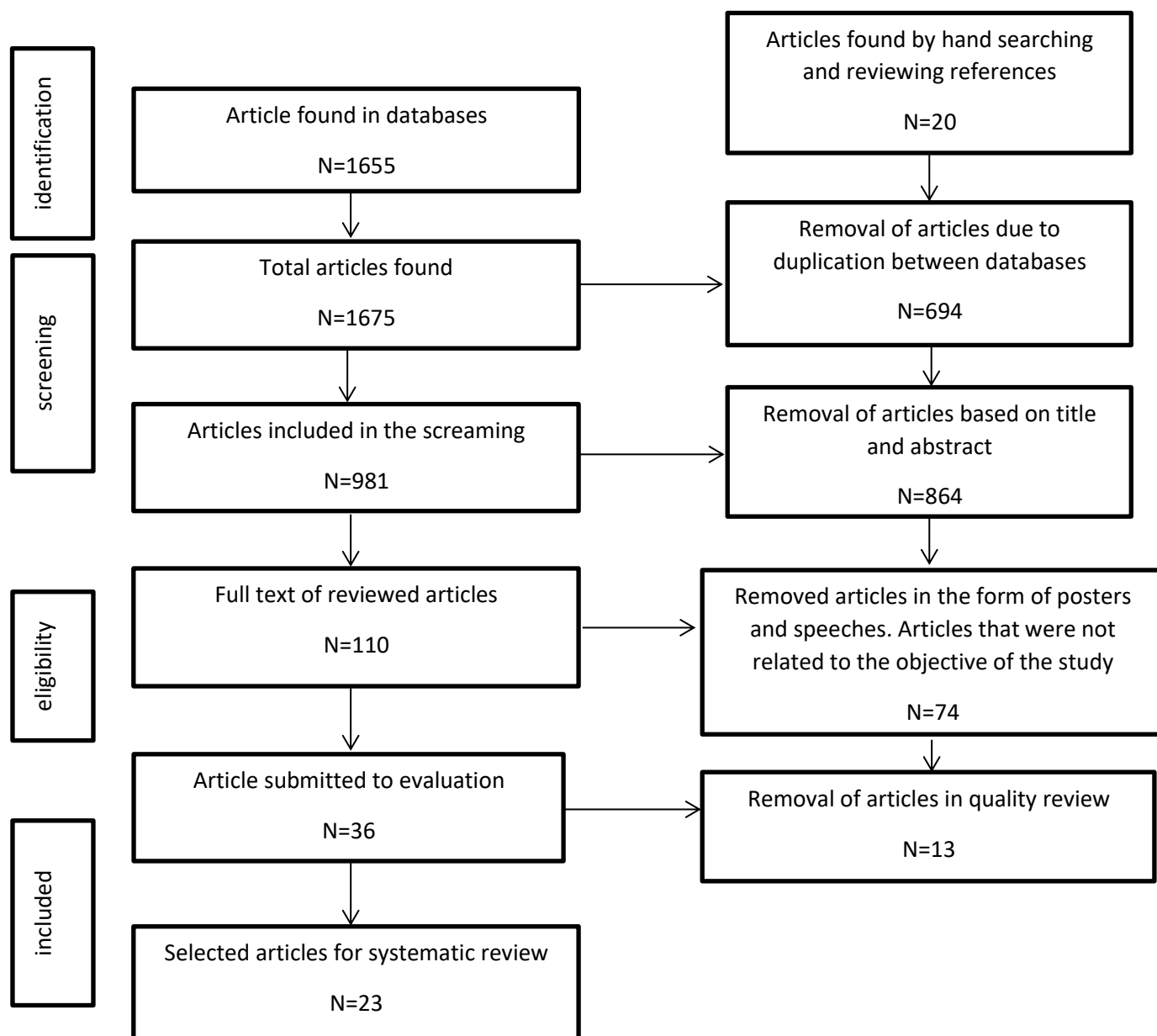


Figure 1. Prisma Flow Diagram

Role of Educational Interventions in Fluid Overload Management and Treatment Adherence

As shown in Table 2, educational interventions were consistently associated with improved fluid control and adherence. Jianfar et al. reported that a multifaceted educational program reduced interdialytic weight gain (IDWG) by a mean of 0.6 kg ($p < 0.05$) and improved depression scores.¹⁴ Başer and Mollaoğlu found that targeted diet/fluid education reduced IDWG and systolic blood pressure while improving self-reported adherence ($p < 0.01$).⁸ Alikari et al. confirmed that structured education increased adherence scores and quality of life.¹⁵ Salimi Ezzat et al. demonstrated that

telephone counseling combined with follow-up improved treatment adherence, understanding, and adequacy.⁹

Effect of Psychological and Supportive Interventions on Cognitive and Mental Health

Data summarized in Table 3 indicate strong psychological benefits. Lerma et al. and Valsaraj et al. found that CBT-based interventions significantly reduced Hospital Anxiety and Depression Scale (HADS) scores by 4–6 points ($p < 0.001$).^{10,12} Bargiel-Matusiewicz et al. reported that group support sessions produced meaningful reductions in anxiety and depression

Table 1. Articles Related to Dialysis Adequacy

Title	Authors	Year	Country	Study Type	Sample Size	Result
Relationship between the Level of Health Literacy, Diet Adherence and Dialysis Adequacy in Patients Undergoing Dialysis ⁴	Musavi Ghahfarokhi et al.	2024	Iran	Descriptive cross-sectional	207 patients	Significant link between health literacy and diet adherence; no link with dialysis adequacy
The Relationship between Dialysis Adequacy and Quality of Life: The Mediating Effect of Sleep Quality in Hemodialysis Patients in Medical Education Centers ²²	Khoshhal et al.	2023	Iran	Correlational (SEM)	208 patients	Dialysis adequacy indirectly improved QoL via sleep quality
The Effect of Intradialytic Range of Motion Exercise on Dialysis Adequacy and Fatigue in Hemodialysis Patients ⁵	Malini et al.	2022	Indonesia	Two-arm experimental study	50 patients	Increased Kt/V and URR; reduced fatigue in intervention group
Effect of Eight-Week Aerobic Exercise on Dialysis Adequacy of Patients Undergoing Hemodialysis ⁶	Almasi & Ghodrati	2022	Iran	Controlled clinical trial	20 patients	Improved adequacy and blood flow
Combined Aerobic Resistance Exercise Improves Dialysis Adequacy and Quality of Life in Patients on Maintenance Hemodialysis ⁷	Zhao et al.	2020	China	Interventional	45 patients	Both exercises improved adequacy and QoL; combined was superior
Effect of Intradialytic and Home-based Walking Exercises on Physical Function and Dialysis Adequacy in Hemodialysis Patients ¹⁶	Hatef et al.	2017	Iran	Clinical trial	60 patients	Improved function; slight, non-significant adequacy increase
Assessment of Hemodialysis Adequacy and Its Relationship with Individual and Personal Factors ²³	Rezaiee et al.	2016	Iran	Cross-sectional	202 patients	Personal factors influenced adequacy
Influence of Physical Exercise on the Dialytic Adequacy Parameters of Patients on Hemodialysis ²⁴	García Testal et al.	2019	Spain	RCT	69 patients	No significant difference between home vs intradialytic exercise
The effect of isometric and isotonic exercises during hemodialysis on dialysis adequacy ²⁵	Basiri Moghaddam et al.	2016	Iran	Clinical trial	50 patients	Improved adequacy through intradialytic exercise
The effect of telephone counseling and treatment follow-up on adherence and dialysis adequacy ⁹	Salimi Ezzat et al.	2018	Iran	Quasi-experimental	86 patients	Improved adherence, understanding, and adequacy

levels ($p < 0.05$).¹¹ Khoshhal et al. observed that physical activity indirectly improved quality of life through better sleep quality (mediation model, $p < 0.05$).²⁴ García Testal et al. reported that improved physical performance was associated with reduced perceived disability and higher self-confidence.²⁸

Rehabilitation, Nutritional, and Multidomain Interventions for Quality of Life and Clinical

Outcomes

As outlined in Table 4, specialized rehabilitation programs such as inspiratory muscle training (IMT) improved inspiratory strength and health-related quality of life, even if changes in laboratory parameters (urea, creatinine) were non-significant.²⁷ Resistance and velocity-based exercises were strongly linked to reduced functional disability and greater independence.¹⁷ In elderly hemodialysis patients, structured exercise

Table 2. Articles Related to Fluid Overload

Title	Authors	Year	Country	Study Type	Sample Size	Results
The Effect of a Hemodialysis Patient Education Program on Fluid Control and Dietary Compliance ⁸	Başer & Mollaoğlu	2019	Turkey	Quasi-experimental	78 patients	Reduced IDWG, BP, and improved fluid/diet adherence
Effectiveness of a Multifaceted Educational Intervention to Enhance Therapeutic Regimen Adherence and Quality of Life Amongst Iranian Hemodialysis Patients ¹⁴	Zhianfar et al.	2020	Iran	RCT	70 patients	Improved IDWG, depression, adherence, and QoL
The Impact of Education on Knowledge, Adherence and Quality of Life among Patients on Hemodialysis ¹⁵	Alikari et al.	2019	Greece	Quasi-experimental	50 patients	Improved adherence to diet/fluid and QoL

Table 3. Articles Related to Cognitive Impairment & Psychological Interventions

Title	Authors	Year	Country	Study Type	Sample Size	Results
The positive influence of psychological intervention on the level of anxiety and depression in dialysis patients: A pilot study ¹¹	Bargiel-Matusiewicz et al.	2019	Poland	Experimental	139 patients	Reduced anxiety and depression; narrative therapy most effective
Brief cognitive behavioral intervention for depression and anxiety symptoms improves quality of life in chronic hemodialysis patients ¹²	Jerma et al.	2017	Mexico	RCT	60 patients	Significant reduction in depression, anxiety, and distortions
Cognitive behavior therapy for anxiety and depression among people undergoing hemodialysis: a randomized controlled trial ¹⁰	Valsaraj et al.	2016	India	RCT	80 patients	Reduced anxiety/depression; improved psychological coping
Effect of psychoeducation on depression and anxiety symptoms in patients on hemodialysis ²⁶	Espahbodi et al.	2015	Iran	Experimental	60 patients	Decrease in depression and anxiety symptoms

improved sleep and reduced anxiety.²⁸ Nutritional studies revealed that poor nutritional status significantly predicted 10-year mortality; better dietary intake and lower Malnutrition Inflammation Score (MIS) were protective factors.²⁹ Greenwood et al. found that full completion of rehabilitation and improved exercise capacity led to a 40% reduction in adverse events over follow-up.³⁰ Finally, Lazarus demonstrated that integrating exercise with educational interventions produced simultaneous improvements in physical function, mental health, and quality of life ($p < 0.01$).¹⁸

Overall Trends

The majority of studies addressed dialysis adequacy and physical function, while fewer examined fluid overload management or psychological-cognitive outcomes. Due to the considerable heterogeneity in intervention types, durations, and outcome metrics, a meta-analysis was not feasible. Instead, a narrative synthesis was conducted, emphasizing statistically significant findings where available.

A total of 23 studies were included in this systematic

review: ten studies focused on dialysis adequacy, three on fluid overload, four on cognitive and psychological disorders, and six on rehabilitation and quality of life in hemodialysis patients.

Effect of Exercise Interventions on Dialysis Adequacy and Physical Performance

Most studies demonstrated that exercise during or outside dialysis sessions led to significant improvements in dialysis adequacy indices (e.g., Kt/V, URR) and patients' physical capacity.

For example, Malini et al. reported that intra-dialytic exercise increased Kt/V and reduced fatigue.⁵ Almasi and Ghodrati found that an eight-week aerobic program improved blood flow, physical capacity, and dialysis adequacy.²²

Zhao et al. indicated that combined aerobic and resistance training had greater benefits on dialysis markers and quality of life compared to single-modality interventions.⁷ Hataf et al. highlighted that even simple walking improved both physical performance and dialysis adequacy indices.¹⁶

Table 4. Articles Related to Rehabilitation, Nutrition, and QoL in Hemodialysis

Article Title	Authors	Year	Location	Sample Size	Study Type	Results
Feasibility of Inspiratory Muscle Training as a Rehabilitation Program for Chronic Kidney Disease Patients in a Developing Country ²⁷	I.R. Defi, M.V. Otafirda, N. Novitri, A. Rachmi	2023	Indonesia	32 patients (16 in the intervention group, 16 in the control group)	Randomized Controlled Trial (RCT)	IMT improved inspiratory muscle strength and significantly enhanced quality of life in CKD patients, though changes in urea, creatinine, and IL-6 were not statistically significant.
Muscle Power and Physical Dysfunction: A Model for Tailoring Rehabilitation in Chronic Kidney Disease ¹⁷	T.J. Wilkinson, E.F. Gore, L.A. Baker, E.L. Watson, A.C. Smith	2021	USA	102 non-dialysis CKD patients	Observational/clinical study with functional assessments	Mechanical muscle power was a strong predictor of physical function (e.g., ADLs, gait speed, TUAG), whereas skeletal muscle mass was not. The study highlights the importance of velocity-based power training for improving functional outcomes in CKD patients.
The Effect of Exercise on Sleep Quality in the Elderly Undergoing Hemodialysis ²⁸	Mansour AM, Ali S, Maryam JM	2021	Iran	30 elderly hemodialysis patients (15 intervention, 15 control)	Experimental study (pre-test/post-test design)	Exercise during dialysis improved sleep quality in elderly patients and is a safe, low-cost, and effective approach.
Nutritional Status Predicts 10-Year Mortality in Patients with End-Stage Renal Disease on Hemodialysis ²⁹	Shin Sook Kang, Jai Won Chang, Yongsoon Park	2017	South Korea	144 maintenance hemodialysis patients	Retrospective observational study	Poor nutritional status, particularly low energy intake and high MIS, strongly predicts mortality in hemodialysis patients. Adequate nutrition may enhance long-term outcomes.
Mortality and morbidity following exercise-based renal rehabilitation in patients with chronic kidney disease: the effect of programme completion and change in exercise capacity ³⁰	Greenwood SA, Castle E, Lindup H, Mayes J, Waite I, Grant D, et al.	2019	UK	757 patients	Retrospective longitudinal analysis	Completion of renal rehabilitation and improved exercise capacity were linked to better event-free survival. Non-completers faced higher risk, while improvers had a 40% lower risk of adverse events, suggesting RR may reduce morbidity and mortality in CKD patients.
Effectiveness of education and exercise on quality of life among patients undergoing hemodialysis ¹⁸	Eilean Rathinasamy Lazarus	2019	India	150 patients with ESRD	Randomized Controlled Trial (RCT)	Education combined with exercise significantly improved QoL in hemodialysis patients. Early interventions support physical and mental well-being, leading to better overall outcomes in ESRD care.

Moreover, Wilkinson et al. emphasized the role of muscle strengthening in reducing physical disability and increasing patients' independence.¹⁷ Moghaddam et al. also reported that intra-dialytic isotonic and isometric exercises improved both dialysis adequacy and overall renal function.²⁵

Role of Educational Interventions in Fluid Overload Management and Treatment Adherence

Jianfar et al. showed that a multifaceted educational program enhanced awareness, improved fluid restriction compliance, and led to better clinical outcomes.¹⁴

Basar and Mollaoglu reported that targeted education increased adherence to dietary and fluid restrictions among hemodialysis patients.⁸ Kari et al. confirmed the effectiveness of educational strategies for improving knowledge of nutrition and fluid management.¹⁵

Additionally, Salimi Ezzat et al. found that telephone counseling and regular follow-up significantly improved patient adherence and treatment outcomes.⁹

Effect of Psychological and Supportive Interventions on Cognitive and Mental Health

Studies by Lerma et al. and Valsaraj et al. showed that cognitive-behavioral intervention programs led to significant reductions in anxiety and depression symptoms among hemodialysis patients.^{10,12}

Bargiel-Matusiewicz et al. highlighted the positive impact of group support sessions on mental health.¹¹

Furthermore, Khoshhal et al. indicated that regular physical activity improved sleep quality and reduced anxiety and depression,²⁴ while Garcia Testal et al. demonstrated that increased physical capacity led to reduced perceived disability and improved self-confidence.²⁸

Rehabilitation, Nutritional, and Combined Interventions for Quality of Life and Clinical Outcomes

Several studies reported positive effects of rehabilitation interventions, such as respiratory exercises (e.g., IMT), on inspiratory muscle strength and quality of life, though without direct impact on laboratory markers.²⁷

Resistance exercises and muscle strengthening were also associated with decreased disability and greater independence.¹⁷ Additionally, regular exercise in elderly patients led to better sleep, reduced anxiety, and improved daily function.²⁸

Nutritional studies showed that poor nutritional status was associated with higher mortality, while effective nutritional interventions improved outcomes.²⁹

Longitudinal studies demonstrated that participation in rehabilitation programs, especially those enhancing physical function, reduced complications and mortality in hemodialysis patients.³⁰

Finally, studies examining combined educational and exercise interventions reported simultaneous improvement in physical, psychological, and quality of life outcomes.¹⁸

Overall, the majority of recent studies focused on improving dialysis adequacy and physical function, while fewer addressed fluid overload management or psychological-cognitive outcomes in hemodialysis patients.

Discussion

Chronic kidney disease (CKD) is a major global health challenge, resulting in renal dysfunction and dependency on interventions such as hemodialysis.^{1,2} Renal rehabilitation, as a multidimensional approach, including physical activity, cognitive-behavioral interventions, nutritional education, and behavioral counseling, plays a prominent role in improving clinical outcomes and enhancing the quality of life for patients undergoing hemodialysis.¹³ However, the focus and effectiveness of each component of rehabilitation have varied across studies, highlighting the need for more comprehensive and targeted evaluations.

The present review revealed that the majority of studies (10 out of 17) focused predominantly on physical activity interventions. These studies consistently demonstrated that exercise (both intra- and interdialytic) leads to improvements in dialysis adequacy indicators (such as Kt/V), reduction in fatigue, and enhancement of patients' physical function.⁴⁻⁶ Notably, combined endurance and resistance exercises were more effective not only in improving dialysis adequacy but also in enhancing quality of life. Regular aerobic exercise, even over a short period (eight weeks), was associated with improved dialysis efficacy and physical activity in patients. These results confirm and extend prior literature by reinforcing that structured, supervised exercise interventions are not merely adjunctive but can be considered essential therapeutic components for hemodialysis patients, with tangible benefits in both physiological and patient-reported outcomes.

In contrast to the physical activity domain, studies on cognitive and psychological aspects were fewer in number, with only four studies addressing these outcomes. Nonetheless, despite their smaller number, these studies highlighted the importance of this domain, reporting that psychological interventions—especially cognitive-behavioral therapy and group support—significantly reduced anxiety and depression in patients and improved their mental quality of life.^{9,11} This aligns with and adds to existing evidence that mental health directly influences adherence to treatment regimens, fluid restriction practices, and engagement in physical rehabilitation, indicating that underestimating this domain can undermine the total effectiveness of care.

Only three studies focused specifically on educational

interventions and fluid management, indicating that this area remains relatively underexplored. However, these few studies confirmed the effectiveness of educational measures in improving patients' adherence to dietary and fluid restrictions, reducing fluid overload, and enhancing dialysis adequacy.^{7,8} The importance of regular follow-up and counseling (including telephone-based counseling) in supporting patients and improving treatment outcomes was also evident. From a clinical standpoint, these findings suggest that even low-cost, low-resource educational programs, when structured and consistently delivered, can produce clinically meaningful improvements, making them feasible within diverse healthcare settings.

Importantly, among all the included studies, only one (study number 13) evaluated all domains simultaneously by implementing multidimensional interventions (physical, nutritional, and cognitive-psychological). This comprehensive study found that combined multidimensional interventions yielded significantly greater improvements in physical function, psychological status, and quality of life compared to single-domain interventions. This underscores the critical value of integrated rehabilitation strategies.

Reviewing the included studies showed that, although recent research has predominantly focused on dialysis adequacy, other domains—such as fluid overload management, multidimensional rehabilitation, and especially cognitive-psychological dimensions—have received less attention. This reflects a clear research gap in the current literature and emphasizes the need for future studies to focus on the long-term outcomes of multidisciplinary interventions as well as expand educational and psychological support content for hemodialysis patients.²⁸

Practical implications for healthcare providers: Based on the synthesized evidence, renal rehabilitation programs should be incorporated as a structured component of standard hemodialysis care, with priority given to exercise interventions but supplemented with targeted educational and psychological support whenever feasible. For nephrologists, incorporating intra-dialytic and home-based exercise prescriptions can enhance dialysis adequacy and functional performance. For nurses and allied health professionals, structured patient education on fluid and dietary control, combined with psychological counseling, can

yield additive benefits. Policymakers and hospital managers may also consider resource allocation to support at least partial integration of multidomain rehabilitation, particularly for high-risk or newly diagnosed dialysis patients.

Study Limitations

Several limitations must be acknowledged when interpreting these findings:

1. Heterogeneity of interventions and outcome measures — The included studies varied significantly in program content, duration, and delivery methods, which may influence comparability and consistency of results.
2. Limited number of multidomain intervention studies — This restricts the ability to generalize the superiority of integrated over single-component programs.
3. Language restriction — Only publications in English or Persian were included, which may have excluded relevant studies in other languages.
4. Potential publication bias — Studies reporting positive results are more likely to be published, potentially overestimating the effectiveness of interventions.
5. Small sample sizes in several included studies — This may limit statistical power and affect reliability of observed effects.

Impact of limitations on interpretation: The variability in study designs and small number of high-quality, multidomain trials suggest that while current findings are promising, they should be viewed as indicative rather than conclusive for forming universal guidelines.

Recommendations for future research: Future studies should focus on:

- Large-scale, randomized controlled trials examining fully integrated rehabilitation programs over extended follow-up periods.
- Standardization of outcome measures, including both clinical indices and patient-reported outcomes.
- Cost-effectiveness analyses to support healthcare policy decisions.
- Strategies to improve accessibility and adherence, particularly in resource-limited settings.

In conclusion, current evidence strongly supports the design and implementation of comprehensive renal rehabilitation programs encompassing exercise, education,

and psychological interventions. While it may not always be feasible to deliver fully multidimensional rehabilitation due to resource constraints, prioritizing physical activity interventions—supported by the highest volume and quality of evidence—should remain the mainstay of care. Nevertheless, incorporating even limited elements of educational and psychological support can lead to superior outcomes. Continued future research in this field is essential to develop more comprehensive and effective protocols for the management and rehabilitation of hemodialysis patients.

Conclusion

This systematic review demonstrates that renal rehabilitation programs substantially improve dialysis adequacy, reduce fluid overload, enhance cognitive function, and lower mortality in patients undergoing hemodialysis. Among the intervention domains, physical activity consistently has the strongest evidence for improving both physiological outcomes and patient-reported quality of life, while educational/nutritional and cognitive-psychological interventions provide additional benefits, especially when integrated into a multidomain program. These findings support the incorporation of structured renal rehabilitation as a standard component of hemodialysis care. Comprehensive programs addressing physical, nutritional, and psychological needs produce greater overall benefits than single-domain approaches; however, even in resource-limited settings, implementing at least one structured component—preferably exercise—along with targeted patient education can lead to clinically relevant improvements. Based on this evidence, nephrologists should integrate individualized intra- or interdialytic exercise prescriptions and monitor dialysis adequacy, nurses and allied health professionals should deliver structured fluid and dietary education with follow-up counseling, and rehabilitation teams and psychologists should provide targeted cognitive-behavioral and emotional support to address anxiety, depression, and treatment adherence. Dialysis center administrators and policymakers should allocate resources and establish protocols to embed multidomain rehabilitation within routine care. Future research should focus on large-scale, long-term randomized controlled trials to determine the most effective combination and dosage of rehabilitation

components, and on developing standardized clinical guidelines to facilitate broader and more consistent implementation in clinical practice.

Conflict of Interest

The authors declare no conflicts of interest.

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