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Impact of renal diet on wellbeing of the patients of chronic kidney disease undergoing hemodialysis: A review

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Abstract
Background: Dietary status plays a vital role in the management of chronic kidney disease (CKD), particularly in patients undergoing hemodialysis. Given the disease's high prevalence, assessing nutritional status is essential for optimizing treatment outcomes.
Objectives: This systematic review and meta-analysis aimed to evaluate the impact of renal dietary interventions on the wellbeing of CKD patients.
Methods: Thirty-five relevant publications were identified through PubMed, MEDLINE, EMBASE, Google Scholar, and Cochrane databases. Of these, 25 studies with complete data were included in the meta-analysis.
Results: The analysis highlighted the pivotal role of nutrition in CKD management. Most studies showed that tailored dietary interventions improved biochemical parameters, delayed disease progression, and enhanced quality of life. Balanced intake of energy, protein, and micronutrients maintained nitrogen balance, reduced uremic toxins, and mitigated oxidative stress, whereas excessive protein, sodium, and phosphorus accelerated renal decline.
Conclusion: Evidence supports individualized, balanced nutrition with adequate calories, moderate protein restriction, and optimal micronutrient intake are beneficial for CKD patients. However, variability in study design, dietary monitoring, and patient adherence remains a key limitation.

Keywords: Renal diet, Chronic kidney disease, Hemodialysis

Introduction
Chronic kidney disease (CKD) is prevalent, affecting 10% of the world's population, or over 700 million people [1, 2]. Almost 80% of the population with CKD reside in low-income countries (LICs) and lower middle-income countries (LMICs), with approximately 1/3 of the known affected population living in China and India alone [2, 3]. Prevalence of CKD increased by 33% between 1990 and 2017 [2, 4]. Increasing prevalence of CKD is driven by population growth, aging and the obesity epidemic, resulting in higher prevalence of two major risk factors for CKD: type-2 diabetes mellitus (T2DM) and hypertension. In addition, risk factors for CKD beyond cardiometabolic conditions contribute to the rising burden of kidney disease, including social deprivation, pregnancy-related acute kidney injury (AKI), preterm birth and increasing environmental threats (infections, toxins, climate change, air pollution) [2, 5]. These threats disproportionately affect people in LICs and LMICs [6].
Hemodialysis is a life sustaining approach for patients with AKI, CKD & end-stage renal disease (ESRD), a time-consuming therapy that greatly affects way of living [7]. In spite of the positive effect of hemodialysis (HD), patients are at likelihood of developing malnutrition, which worsens grade of life and can lead the way to organ dysfunction. The phenomenon of the mentioned disorders depends largely on the diet which is a underlying aspect in the management of CKD patients. So, changes in diet composition are an essential part of the therapeutics of kidney disease. Under-nutrition is very common among patients with ESRD undergoing hemodialysis [8]. Medical nutrition therapy is crucial for CKD patients because it may slow the growth of the disease through careful monitoring of protein, calcium, phosphorus, potassium, and sodium [9]. In the nutritional intervention of kidney disease, restricting salt is typically recommended and low protein diets have always been a significant concern. Clinical manifestations of excess salt ingesting in CKD patients are

hypertension, hydropsy, and proteinuria [10]. As high-protein diets exasperate kidney dysfunction and excess sodium may be associated with CKD development [11]. The outcome of high-protein diets (HPDs) on renal health increased kidney weight. Chronic protein intake (more than 1.2 g/kg/body weight/d) leads to expand glomerular morphologic changes, proceed to renal dysfunction [9]. For dialysis patients, specifically appropriate protein intake is essential for maintaining nutritional well-being [1]. Hypokalemia is correlated with myasthenia and hypertension, whereas hyperkalemia is associated with cardiac arrhythmia. Therefore, recommend modified dietary potassium intake on an individual basis to maintain serum potassium levels within the standard range. Proper dietary calcium intake is recommended to maintain calcium balance in patients with CKD [11]. Because in CKD patients, hypercalcemia lead to vascular calcification, potentially causing heart attacks and strokes, while hypocalcemia can trigger bone disease and weaken bones, increasing fracture risk. These diets are designed to reduce the overburden on the kidneys and slow down further decline in kidney function [1]. Long-term hemodialysis provokes a risk of dietary deficiency due to the catabolic reaction of this renal replacement therapy [12]. As nutritional supervision of patients with ESRD is thought to regulate uremic syndrome and provide gainful effects on the progression of kidney impairment, the diet of patients with ESRD should be the paramount aspect in their care [11]. However, consistency with these strict recommendations is burdensome because of their negative impact on quality of life. Renal patients benefit from nutrition counseling because dietitians prepare them with requisite information on food choices, meal preparation, and intake. Patients, when correctly informed and kept motivated by a dietitian, overcome difficulties related to adherence and follow the diet [13]. The fundamental target is the continuation of stable nutrition status and prohibiting of malnutrition by providing sufficient energy, protein, and micronutrients [14]. A renal diet inflicts numerous restrictions, which can make observance challenging and stressful. On that account, the diet must be individualized to account for each patient's individual state of affairs. [15]. Outside the field of nephrology, there is empirical testimony to suggest that consistency with dietary recommendations in the general population or in patients with CKD is associated with better outcomes [16]. Considering the above, the present study aims to conduct an updated systematic review and meta-analysis to assess impact of renal diet on wellbeing of the patients of CKD undergoing hemodialysis.

Methods and Methods

A total of 36 references were reviewed upto August, 2025 which were closely related to dietary status and quality of life in patients with CKD (Fig. 1). These articles were consulted from databases such as PubMed, MEDLINE, EMBASE, Google Scholar, Cochrane databases. The inclusion criteria were as followed: (1) articles containing the dietary patterns of patients of CKD undergoing hemodialysis (2) Articles reviewed critically with the prescribed and practiced diet programs for CKD patients. Of those, 25 articles were screed for meta-analysis considering their complete information.

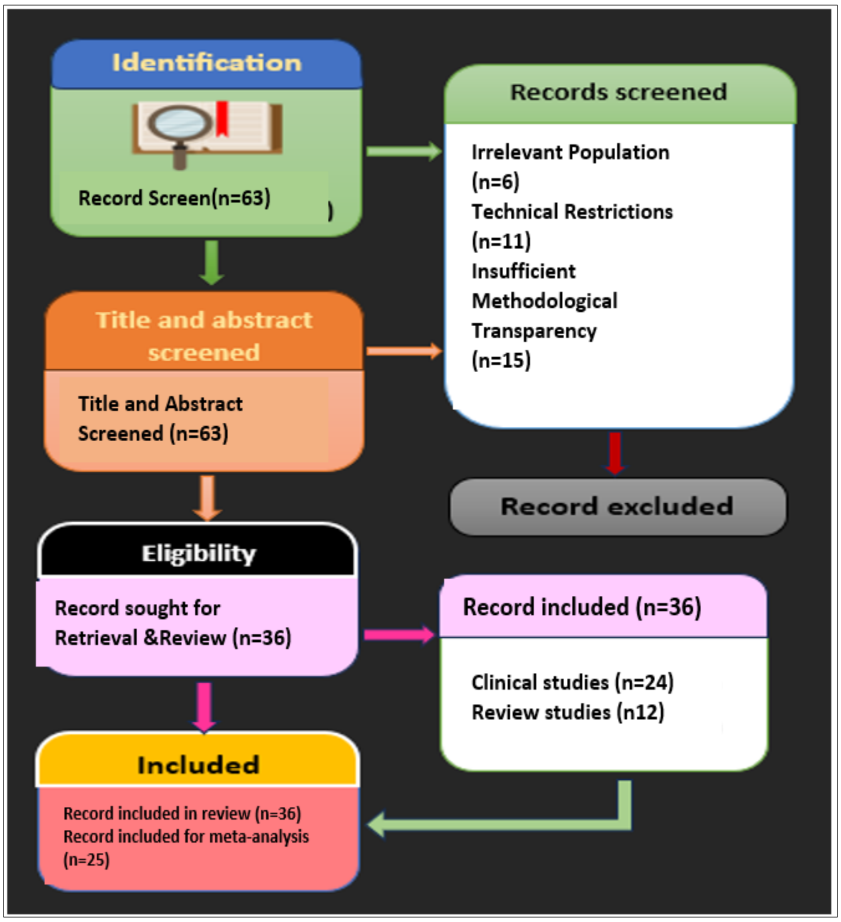

Fig 1: Flowchart for Preferred Reporting Items for Reviews.

Results

Table 1: Analysis of the related articles reported between 2017 and 2025

Sl. No.	Sources	Study Type, No of Patients	Dietary Intervention	Outcome	Specific Findings	Remarks
1	Khanna *et al.* [15]	Narrative review 66 + 28 patients.	Focus on protein-energy malnutrition	Prevalence of malnutrition.	Malnutrition prevalence ranges 20-60%.	Highlights urgent need for systematic nutritional assessment and interventions
2	Xie *et al.* [1]	Systematic review and meta-analysis (4 studies, ≥40 participants).	Compared low-protein vs normal diet.	Evaluated residual renal function and nutritional status.	Low-protein diet preserved GFR and urine volume, improved albumin, and reduced phosphorus.	Suggests long-term low-protein diet helps maintain renal function and nutrition in dialysis patients.
3	Espinoza *et al.* [17]	Observational study.	Individualized renal diet by licensed dietitians.	Assessed nutritional outcomes in CKD patients.	Reduced protein intake without loss of albumin or muscle strength; slight BMI improvement.	CEAN Centers effective for renal nutrition therapy with good adherence and stable outcomes.
4	Ekbote *et al.* [13]	Cross-sectional exploratory study (107 patients).	Assessed dietary intake vs KDOQI guidelines.	Evaluated intake adequacy and QOL in MHD patients.	Energy (~21 kcal/kg) and protein (~0.7 g/kg) below recommendations; sodium high; females had higher intake/kg.	Highlights need for individualized nutrition counseling and regular dietary assessment to improve QOL.
5	Pall *et al.* [18]	Systematic scoping review (23 studies, 3,345 patients).	Self-management interventions targeting diet and lifestyle.	Evaluated dietary habits, biochemical markers, and QoL.	Improved diet, self-management, biochemical markers, and QoL; nurse-led and virtual programs most effective.	Self-management interventions show promise for CKD patients; further research needed.
6	Shusterman *et al.* [19]	Educational/practical article (no participants).	Provides home-based, adaptable CKD recipes (low sodium, adjustable for phosphorus, potassium, or protein).	Aims to educate patients on dietary practices and reduce confusion.	Encourages balanced nutrition, protects renal function, and supports practical, sustainable meal planning.	Serves as a patient education tool emphasizing individualized diet guidance by renal dietitians.
7	Piccoli *et al.* [20]	Critical review/expert consensus (not a clinical trial).	Older adults with CKD.	Focused on malnutrition-protein-energy wasting (PEW) and nutrition-CKD balance.	Recommends individualized protein management: avoid restriction if malnourished;consider restriction in stable, well-nourished patients.	Highlights need for ongoing nutritional monitoring, patient-centered decisions, and more research in elderly CKD patients.
8	Sakaguchi *et al.* [21]	Narrative review/expert opinion (CKD patients, especially advanced stages).	Compared traditional low-protein diets vs plant-dominant low-protein diet (PLADO).	Evaluated CKD progression, kidney failure risk, and metabolic complications. PLADO may reduce kidney failure risk, improve fiber intake.	acidosis/phosphatemia, and protect vasculature; plant proteins safer than animal proteins.	Evidence limited; large RCTs needed; emphasizes balancing kidney protection with nutritional adequacy.
9	Joshi *et al.* [22]	Perspective/narrative review (no patient cohort).	Reviewed low-carb/ketogenic, Mediterranean, intermittent fasting, and plant-based diets in CKD.	Focused on CKD progression, CVD risk, and metabolic complications.	Low-carb safe; Mediterranean cardioprotective; intermittent fasting promising; plant-based low-protein may slow CKD.	Emphasizes whole, unprocessed, plant-based foods, individualized plans, and balanced dietary patterns; some evidence still limited.
10	Pawlaczyk *et al.* [7]	Observational comparative study (167 patients: pre-dialysis 39, dialysis 65, transplant 63).	Assessed nutritional status and QOL (Mini Nutritional Assessment, KDQoL).	Evaluated malnutrition risk across CKD stages and post-transplant.	One-third of dialysis and transplant patients at risk; QOL influenced by nutrition, age, disease, and body composition.	Highlights need for systematic nutritional assessment and QOL monitoring to identify at-risk patients early.
11	Losappio *et*	Narrative review (no	Compared Western vs	Focused on	Western diet promotes	Suggests

	al. [23]	specific patient number).	Mediterranean diets in ESRD and pre-transplant patients.	inflammation, gut health, and QoL.	inflammaging; Mediterranean diet improves microbiota, reduces oxidative stress, and enhances clinical status.	Mediterranean diet as key nutritional therapy to reduce inflammation and improve transplant readiness.
12	Cordeiro *et al.* [24]	Cross-sectional observational study (344 HD patients, 10 centers, Brazil).	Assessed habitual dietary intake (no intervention).	Evaluated intake adequacy and relation to nutritional status.	Most patients had low protein and energy intake; higher MIS linked to poorer intake.	Highlights poor adherence to nutrition guidelines and need for ongoing dietary counseling in HD patients.
13	Kramer *et al.* [25]	Perspective/narrative review (no patient cohort).	Reviewed low-carb/ketogenic, Mediterranean, intermittent fasting, and plant-based diets in CKD.	Focused on CKD progression, CVD risk, and metabolic management.	Low-carb safe under supervision; Mediterranean diet strongly cardioprotective; intermittent fasting promising; plant-based low-protein diets slow CKD.	Emphasizes individualized, balanced, plant-based dietary patterns; evidence for some diets (e.g., fasting) remains limited.
14	Bruci *et al.* [26]	Prospective observational real-life study (92 obese patients: 38 mild CKD, 54 controls).	Followed a very low-calorie ketogenic diet (VLCKD) for ~3 months.	Assessed weight loss, metabolic changes, and renal/liver safety.	Significant fat loss, metabolic improvement, and stable kidney/liver function; 27.7% of CKD patients normalized GFR.	VLCKD appears safe and effective in obesity management with mild CKD under professional supervision.
15	Naber & Purohit [9]	Narrative review (no primary patient data).	Discussed DASH, Mediterranean, and whole-food plant-based diets in CKD.	Evaluated dietary impact on CKD progression and patient outcomes.	Whole-food plant-based diets may offer added benefits but require nutrient monitoring.	Highlights importance of dietitian-led medical nutrition therapy to slow CKD progression and enhance outcomes.
16	Saglimbene *et al.* [16]	Cross-sectional study (6,906 MHD patients, 10 European countries).	Assessed dietary intake vs European Best Practice Guidelines.	Evaluated adherence for energy, protein, phosphate, potassium, sodium, and calcium.	Only 1% m*et al*l six recommendations; adherence lowest for phosphate/potassium and highest for sodium/protein.	Stresses need for better dietary counseling and individualized interventions to improve compliance and outcomes.
17	Hafi *et al.* [8]	Cross-sectional study (118 diabetic HD patients, Palestine).	Assessed nutritional status using Malnutrition-Inflammation Scale (MIS).	Examined links between nutrition, sociodemographics, and QoL.	Higher MIS and longer HD duration associated with poorer QoL ($r = -0.616$, $p<0.001$).	Highlights strong impact of malnutrition on QoL; calls for multidisciplinary nutritional care in diabetic HD patients.
18	Fiaccadori *et al.* [27]	Practice guideline/consensus (ESPEN) for hospitalized patients with AKD/CKD.	Provides evidence-based recommendations on nutrition support (oral, enteral, parenteral).	Aims to improve outcomes by reducing complications, malnutrition, and muscle loss.	Key points: use indirect calorimetry for energy needs; protein 0.6-0.8 g/kg in stable CKD, 1.0-1.3 g/kg in AKI/critical illness; prefer enteral nutrition; monitor electrolytes closely; assess body composition, not just weight.	Evidence largely expert consensus due to patient variability; emphasizes frequent reassessment and individualized nutrition care.
19	Kim & Jung, [11]	Narrative review (no specific patient sample).	Discussed general dietary management in CKD—protein restriction, sodium, potassium, and calcium control.	Focused on individualized nutritional strategies for CKD progression and health maintenance.	High protein and sodium intake worsen outcomes; potassium and calcium need careful balance.	Stresses personalized diet planning to slow CKD progression and improve quality of life.
20	Ikizler *et al.* [28]	Guideline development/evidence-based review for CKD (stages 1-5, dialysis, transplant).	Covers nutritional assessment, MNT, protein/energy intake, micronutrients, and electrolytes.	Provides standardized framework for nutrition care and clinical decision-making.	Developed using GRADE methodology; focuses on dietary management and monitoring.	Serves as an essential tool for clinicians and dietitians to ensure evidence-based nutritional care in CKD.
21	Kalantar-Zadeh *et al.*	Narrative review/perspective	Recommends 0.6-0.8 g/kg/day protein with	Aims to slow CKD progression, delay	PLADO reduces glomerular hyperfiltration, nitrogenous	Described as a feasible, kidney- and

	[29]	proposing the Plant-Dominant Low-Protein Diet (PLADO) for CKD management.	>50% from plant sources, emphasizing fiber-rich, low animal protein foods under dietitian supervision.	dialysis, and improve cardiovascular and gut health.	waste, and uremic toxins while promoting a healthy microbiome.	heart-protective approach needing validation through large clinical trials.
22	Laboux *et al.* [30]	Review article with no specific patient cohort.	Examined dietary control of metabolic acidosis in CKD.	An interesting alternative to correct acidosis would consist on the modulation of the endogenous production of acid by playing with the alimentary incomes.	Clinical trial evidence still limited.	Low protein diet and rich fresh fruits and vegetables diet would manage to correct the supplementation by sodium bicarbonate the metabolic acidosis.
23	Hershey *et al.* [31]	Narrative review/educational overview (no trial cohort).	Focused on sodium reduction, Mediterranean and DASH diets, and nutrient monitoring in CKD.	Aimed at maintaining renal function and preventing CVD, HTN, and malnutrition.	Sodium restriction key; Mediterranean/DASH diets beneficial in early CKD; phosphorus, calcium, protein, and potassium require close monitoring in advanced stages.	Emphasizes individualized, balanced dietary therapy tailored to CKD stage and comorbidities.
24	Visiedo *et al.* [12]	Cross-sectional study (120 HD patients).	Assessed nutritional status via Malnutrition-Inflammation Score (MIS).	Examined link between malnutrition and QOL in HD patients.	62% at nutritional risk; malnutrition significantly reduced all QOL domains and explained up to one-third of variance.	Highlights importance of early malnutrition detection and targeted nutritional interventions to enhance QOL in HD patients.
25	Rysz *et al.* [32]	Review including human and animal studies (variable sample sizes).	Focused on kidney-friendly diets—protein restriction, higher intake of fruits, vegetables, legumes, fish, and whole grains; reduced red meat, sodium, and sugars.	Examined diet effects on CKD progression, complications, and survival.	Protein restriction improved outcomes in animals and slowed CKD in some human studies but risked malnutrition; healthy diets linked to lower mortality.	Concludes that diet strongly influences CKD survival; calls for further research on long-term safety and effectiveness.

Discussion

Chronic kidney disease (CKD) is clinically associated with the development of the uremic syndrome, a complex of signs and symptoms arising from the retention of nitrogenous waste products, disturbances in water and electrolyte balance, and abnormalities in hormonal function. The most prominent features of uremic syndrome stem from nitrogen retention, marked by elevated plasma concentrations of protein metabolism byproducts, particularly urea. The accumulation of these metabolites contributes to characteristic clinical manifestations such as nausea, anorexia, vomiting, and fatigue, as well as systemic complications including metabolic acidosis, anemia, fluid and electrolyte imbalance, and increased levels of toxic substances in the blood. Furthermore, uremia is associated with insufficient production of renal hormones such as erythropoietin and 1,25-dihydroxyvitamin D, and with abnormal tissue responses to growth hormone [33-35].

In the present review, a total of 25 studies were analysed, consistently underscoring the crucial role of nutrition in the management and prognosis of CKD. A majority of studies (Sl. No. 3, 7, 10, 14, and 18) demonstrated that tailored dietary interventions significantly improved biochemical parameters, delayed disease progression, and enhanced quality of life (QoL) among CKD patients. Common findings emphasized that a balanced intake of energy, protein, and essential micronutrients supports nitrogen balance, reduces uremic toxin accumulation, and mitigates oxidative stress. Conversely, excessive intake of protein, sodium, and phosphorus was found to exacerbate metabolic acidosis and accelerate renal deterioration (Sl. No. 5, 8, 15, and 21).

Protein intake emerged as a critical determinant of patient outcomes. Studies (Sl. No. 2, 7, and 10) reported that a low-protein diet (LPD) supplemented with keto analogues helped maintain nutritional status while reducing the glomerular hyperfiltration burden. The biochemical rationale for this effect is that restricted protein intake lowers nitrogenous waste generation, thereby decreasing uremic toxin concentrations and intraglomerular pressure. However, other studies (Sl. No. 11 and 20) cautioned that excessive protein restriction may lead to malnutrition and muscle wasting, underscoring the need for individualized dietary monitoring based on serum albumin and prealbumin levels.

Micronutrients and dietary patterns also play vital roles. Studies (Sl. No. 4, 9, 13, and 17) highlighted the benefits of plant-based diets rich in antioxidants and fibre, which improve gut microbiota composition and reduce systemic inflammation. Bioactive compounds such as polyphenols, flavonoids, and vitamin C act as modulators of oxidative stress by scavenging free radicals and activating nuclear factor erythroid 2-related factor 2 (Nrf2), a key regulator of cellular antioxidant defence. This mechanism enhances endothelial function and delays CKD progression. Nevertheless, two studies (Sl. No. 16 and 19) warned that excessive potassium and phosphorus intake from certain plant sources may be harmful, particularly in advanced

CKD stages, emphasizing the need for dietary counselling and food processing techniques (e.g., soaking, boiling) to lower mineral content.

A recurrent theme across studies is the relationship between nutrition and quality of life. Research (Sl. No. 6, 12, and 22) revealed that adequate dietary education and adherence improved physical performance, appetite, and emotional well-being. These outcomes appear to be mediated through the stabilization of metabolic parameters such as blood urea nitrogen, serum creatinine, and hemoglobin, contributing to better clinical outcomes and fewer hospitalizations. Moreover, improved nutritional status has been correlated with reduced inflammatory markers (CRP, IL-6, TNF-α) in several studies (Sl. No. 7, 15, and 23), reinforcing the central role of diet in modulating systemic inflammation.

The biological value (BV) of dietary protein, reflecting its essential amino acid composition, remains an important consideration in CKD nutrition. Proteins with high BV provide all essential amino acids in proportions aligned with daily requirements. Such proteins reduce the accumulation of nitrogenous waste and acid load, thereby alleviating renal excretory burden and supporting positive nitrogen balance [32-36]. Further studies are required in this direction to formulate the dietary programs for the patients with CKD undergoing haemodialysis.

Conclusion

From a critical standpoint, while most studies align in supporting nutritional therapy as beneficial, heterogeneity in sample size, dietary monitoring methods, and patient compliance remains a limitation across the studies. Nonetheless, the converging evidence suggests that individualized, balanced nutrition, emphasizing adequate caloric intake, moderate protein restriction, and micronutrient optimization, remains beneficial, whereas nutrient excess or unmonitored restriction can be detrimental to CKD patients.

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Conflicts of interest

There are no conflicts of interest.

Author's Contribution

Not available

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