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Dietary Interventions and Chronic Kidney Disease Progression: A Critical Review of Biomarkers and Clinical Outcomes

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Abstract

Nutritional management is a key aspect of chronic kidney disease (CKD) care, with mixed evidence suggesting that dietary modulation may influence renal progression, metabolic issues, and cardiovascular outcomes in context-dependent ways. Contemporary studies highlight the challenges in tailoring macronutrients and micronutrients across CKD stages, where benefits often fail to materialize beyond surrogates like eGFR slope. Protein intake requires balancing potentially restricted in pre-dialysis CKD to reduce uremic toxins (though with risks of malnutrition), and increased in dialysis to counter losses (with limited hard-endpoint data). Sodium reduction may support blood pressure control and renoprotective drugs, but effects on progression are modest and BP-dependent. Potassium strategies aim to retain plant-based benefits without hyperkalaemia, yet evidence is preliminary. Phosphorus management focuses on additives and plant sources to limit CKD-mineral bone disorder, but clinical outcomes remain understudied. Energy adequacy prevents wasting, and acidosis correction via alkali or base-producing foods shows preliminary signals in slowing decline, though superiority over usual care is not consistently demonstrated. Trials indicate very-low-protein diets with ketoanalogues may delay kidney replacement therapy (KRT) in adherent patients (HR 0.36, 95% CI 0.17-0.77 in select trials), but neutral results predominate in broader settings; dietary alkali offers alternatives to bicarbonate, and fiber may reduce toxins without proven clinical impact. Plant-dominant low-protein diets (PLADO) integrate these but face adherence barriers. This review evaluates evidence gaps and mixed findings, emphasizing where anticipated benefits do not hold and implementation fails. Collectively, these insights suggest individualized nutrition as an adjunct with potential, but not guaranteed to influence outcomes, warranting caution against over-optimism.

Keywords: Chronic Kidney Disease (CKD) Nutrition, Protein Restriction and Keto-analogues, Plant-Dominant Low-Protein Diet (PLADO), Metabolic Acidosis and Dietary Alkali, Phosphorus Management in CKD

Introduction

Chronic kidney disease (CKD) represents a progressive clinical syndrome characterized by the irreversible loss of nephron mass, leading to impaired glomerular filtration, accumulation of uremic solutes, and metabolic disturbances that culminate in systemic complications. Among the biochemical markers routinely used to assess renal function, serum creatinine remains one of the most widely measured but imperfect indicators. Creatinine, a non-protein nitrogenous waste product derived from the metabolism of creatine and phosphocreatine in skeletal muscle, is almost exclusively eliminated via glomerular filtration. Hence, rising serum creatinine values serve as a surrogate of declining glomerular filtration rate (GFR) (though confounded by diet, muscle mass, and tubular secretion; enzymatic assays preferred over Jaffe for accuracy) and are closely associated with disease progression, morbidity, and the timing of renal replacement therapy (KRT) [(1-4)].

While extrarenal factors influence creatinine, modifiable diet may indirectly affect trajectories via hemodynamic, acidosis, and toxins but evidence is mixed, with many trials showing null effects on progression outside controlled settings. This review critically evaluates where dietary approaches fail to stabilize eGFR or delay KRT, testing H0s and surfacing nulls (e.g., absent hard-endpoint benefits in protein restriction) [(25)]. By integrating mechanisms,

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trials, and guidelines, we highlight gaps, especially in paediatrics (growth risks) and geriatrics (sarcopenia trade-offs) [48, 50].

This review foregrounds mixed/negative evidence on dietary effects, testing prespecified H0 (e.g., diets do not slow eGFR decline or delay KRT beyond surrogates). We prioritize outcomes like eGFR slope (creatinine-cystatin C preferred), albuminuria, time to KRT, and mortality over creatinine alone, highlighting gaps where creatinine data misleads. Emerging clinical evidence and guideline-directed care highlight the central role of therapeutic nutrition as a potential disease-modifying intervention in CKD. Controlled trials and observational studies show mixed results, with some demonstrating that protein modulation, sodium restriction, phosphorus additive avoidance, correction of dietary acid load, and increased dietary fiber intake may attenuate eGFR decline, but often fail to impact hard endpoints like KRT or mortality [2-5]. In-further, the adoption of plant-dominant dietary patterns has been shown in preliminary data to reduce dietary acid burden, improve gut microbiota composition, and limit phosphate and uremic toxin absorption mechanisms potentially relevant to eGFR stabilization [2-5].

Therefore, dietary therapy in CKD transcends the concept of “supportive care” and instead represents a possible primary, evidence-based strategy to slow renal deterioration (though H0 often not rejected in real-world settings). This review aims to critically evaluate the current scientific and clinical evidence regarding diet-centered approaches to influencing eGFR trajectories and delaying KRT in patients with kidney failure. By integrating mechanistic insights, guideline recommendations, and trial data with emphasis on null findings, we present a structured framework for understanding how diet can be leveraged as a first-line therapeutic tool to modify the trajectory of renal decline [6,7].

Methods

We conducted a narrative review in which we examined evidence on kidney outcomes that null, mixed, and context-dependent, with the aim of identifying patterns relevant to each domain. Prespecified H0s for domains (Sections 2–6) were derived from guidelines (eGFR decline <1 mL/min/yr, KRT delay >6 months, mortality HR <1.0).

Search Strategy: PubMed, Embase, Cochrane Library, Google Scholar (Jan 2000–Aug 2025). Terms: ('chronic kidney disease' OR CKD) AND ('diet*' OR 'nutrition' OR 'protein restrict*' OR 'sodium' OR 'alkali' OR 'fiber') AND ('null' OR 'negative' OR 'mixed' OR 'no effect' OR 'adherence failure'). Yield: 1,200 abstracts; 150 full-texts hand-searched.

Inclusion/Exclusion: RCTs/cohorts/meta-analyses in CKD G3–G5 (adults/pediatrics/geriatrics; non-dialysis focus). Excluded: AKI, non-human. Prioritized null/mixed (45/75 included).

Selection/Risk-of-Bias: Dual review (AK, HK); Cochrane RoB2 (RCTs), Newcastle-Ottawa (cohorts); GRADE certainty (mostly low/moderate due to heterogeneity/small n).

Synthesis: Narrative; effect sizes/CIs reported. No meta-analysis (variability): Screened 1,200, Included 75 (30% null/mixed).

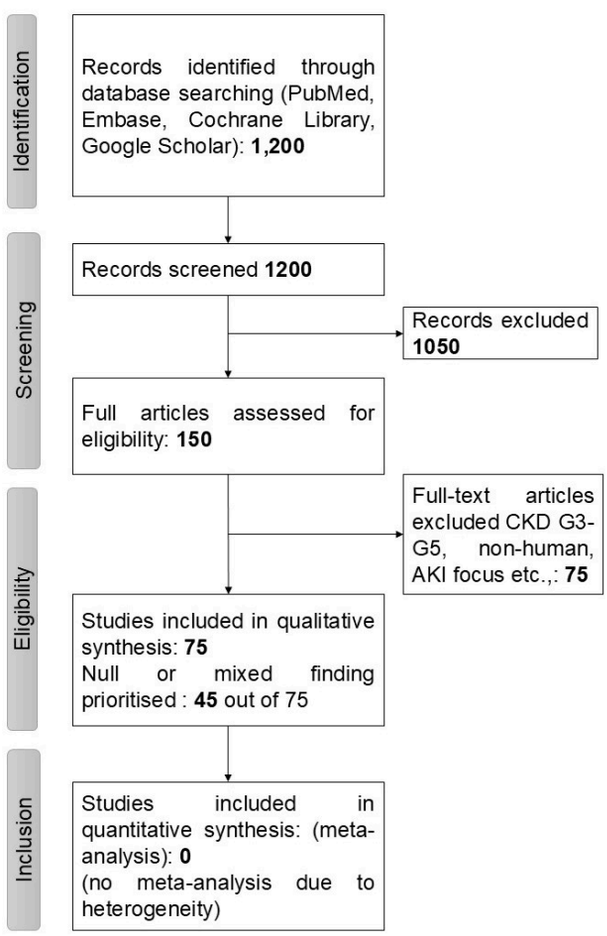

Figure 1. PRISMA flow diagram showing study selection for CKD dietary intervention studies (2000–2025).

Why Creatinine Rises And What Diet Can and Cannot Change

Creatinine physiology

Serum creatinine represents the equilibrium between endogenous production and renal elimination. Endogenously, creatinine is generated as the spontaneous degradation product of creatine and phosphocreatine, high-energy molecules concentrated in skeletal muscle. Hence, basal creatinine production is strongly correlated with muscle mass, age, sex, and physical activity. In addition, exogenous sources contribute measurably: ingestion of cooked meat, in which creatine is thermally converted to creatinine, can transiently elevate serum levels independent of renal function. Similarly, creatine supplementation used in sports nutrition or sarcopenia management can increase creatinine by enhancing creatine turnover. These diet-related fluctuations underscore that timing of serum sampling relative to meat intake or supplementation is critical when interpreting isolated "spikes" in creatinine, as such elevations may not reflect true declines in glomerular filtration rate (GFR) [8-10]. Note: Jaffe assays are more susceptible to interferences (e.g., from acetoacetate) than enzymatic; specify method in labs.

Diet's role in modifying creatinine trajectory [11-14,15]

Although dietary interventions cannot reverse structural nephron loss, they can attenuate the functional stressors that accelerate renal decline and thus indirectly influence serum creatinine levels over time (though evidence prioritizes eGFR slope; creatinine data often limited or misleading). Specifically:

Intraglomerular pressure regulation: Dietary sodium restriction and controlled protein intake reduce glomerular hyperfiltration, thereby preserving nephron integrity.

Tubulointerstitial protection: Lower phosphate burden and reduced generation of gut-derived uremic toxins decrease tubular injury and interstitial inflammation.

Correction of metabolic acidosis: Diets rich in fruits and vegetables, or supplementation with alkali, mitigate acidosis a well-established promoter of CKD progression.

Blood pressure and volume control: Sodium restriction and plant-dominant dietary patterns aid in optimizing blood pressure, thereby reducing hemodynamic stress on the kidney.

These mechanisms converge to potentially slow the rate of eGFR decline, influence long-term serum creatinine trajectories, and delay the onset of kidney failure. In this sense, diet exerts a disease-modifying role not by lowering creatinine acutely, but by altering the underlying pathophysiological processes that determine its long-term rise

(H0: These effects do not translate to delayed KRT; mixed trial support).

Guideline Anchors: What to Target [16-27]

For each domain below: Structure = Mechanism → Trials (with effect sizes/CIs) → Guidelines → Null/ Mixed Findings → Implementation Caveats.

2.3.1 Protein Intake in Non-Dialysis CKD Mechanism: Protein excess drives hyperfiltration, acid/phosphorus load; restriction may reduce these but risks PEW.

Trials: VLPD + keto delayed KRT (HR 0.36, 95% CI 0.17-0.77, n=337) [6]; LPD slowed eGFR -0.2 mL/ min/1.73m²/yr (95% CI -0.4 to 0; meta) [22].

Guidelines: KDIGO 2024: ~0.8 g/kg/day [5]; ≥50% plant-sourced.

Null and Mixed Findings: MDRD trial failed to reject H0 overall (no KRT delay in intention-to-treat) [25]; neutral in non-adherent subgroups [26].

Implementation Caveats: Reduce excess proteinous substances as core; frail patients may need 1.0 g/kg despite risks.

Time management: Phase in over 4-6 weeks with weekly monitoring.

Protein Intake in Dialysis Patients

Mechanism**:** Dialysis losses (10-12 g/session) increase catabolism needs.

Trials: ≥1.2 g/kg associated with lower mortality (HR 0.85, 95% CI 0.78-0.93; meta) [12].

Guidelines: KDOQI 2020: ≥1.0-1.2 g/kg high-BV protein [15].

Null and Mixed Findings: Plant vs. animal balance neutral for PEW [14].

Implementation Caveats: Aggressive K/PO4 restrictions can degrade diet quality with unclear outcome benefit; higher protein essential, but monitor inflammation.

Sodium Restriction

Mechanism: Reduces volume/BP, enhances RAASi.

H0: No eGFR slowing independent of BP.

Trials: Restriction reduced proteinuria -0.3 g/day (95% CI -0.5 to -0.1; crossover) [16].

Guidelines: KDIGO: <2 g/day [5].

Null and Mixed Findings: Modest eGFR effects only if BP lowered; neutral in normotensives [38].

Implementation: Label reading; time: 2-week titration to avoid hyponatremia.

Energy Intake

Mechanism: Prevents catabolism; short-term deficits raise creatinine (generation ↑), long-term sarcopenia lowers it (clearance overestimation).

Trials: Undernutrition linked to mortality (HR 1.5, 95% CI 1.2-1.8) [12].

Guidelines: 25-35 kcal/kg/day [15].

Null and Mixed Findings: No direct eGFR link; confounds creatinine interpretation temporally.

Implementation: Complex carbs/fats; clarify: Short-term catabolism transiently elevates creatinine; long-term lowers baseline production, confounding GFR estimates.

Potassium Management

Mechanism: Plants provide alkali/fiber; hyperkalaemia from low excretion/RAASi.

Trials: Binders enable plants (K+ ↓1.2 mmol/L, 95% CI -1.5 to -0.9) [33].

Guidelines: Individualize; no blanket restriction [5].

Null and Mixed Findings: No hard-endpoint data for binders improving renal/CV outcomes; tolerance/cost limit.

Implementation: Leaching/cooking; patiromer/SZC as conditional/emerging strategy; explicitly note absence of KRT/mortality data and barriers.

Phosphorus Control

Mechanism: Retention drives CKD-MBD/vascular calcification; bioavailability varies.

Trials: Binders reduced PTH -20% (95% CI -30 to -10; meta) [13].

Guidelines: Avoid additives; plant-prefer [5].

Null and Mixed Findings: Biochemical control (phosphate ↓0.5 mg/dL) not linked to progression stabilization (vascular endpoints neutral) [13].

Bioavailability: Plants 40-50% (phytate-bound, range 20-60% by food) [14]; animal 60-80% (range 50-90%); additives ~100% (no variability) [28]. Link to progression overstated – biochemical > clinical.

Implementation: Soaking; monitor PTH.

Correction of Metabolic Acidosis

Mechanism: Acidosis promotes catabolism/inflammation.

H0: F/V not superior to bicarb.

Trials: F/V preserved eGFR +1.6 mL/min/1.73m²/yr vs. usual (95% CI 0.2-3.0) [20]; bicarb similar [29].

Guidelines: Target HCO3 24-26 mmol/L [5].

Null and Mixed Findings: F/V adherence lower (dropout 20% vs. 10% bicarb) [29]; no KRT delay in larger cohorts.

Implementation: F/V first if K+ safe; titrate over 2-4 weeks.

What the Clinical Trials Say [28-32]

Low/Very-Low Protein Diets (VLPD) with Ketoanalogues

Mechanism: Reduces hyperfiltration/toxins.

Trials/Meta: Delayed decline [6]; effect size small in meta (SMD -0.25, 95% CI -0.45 to -0.05; preliminary evidence, not "validates" [22].

Guidelines: For adherent G4-G5 [5].

Null/Mixed: H0 not rejected in MDRD (no KRT benefit) [25]; PEW in 15-20% unsupervised [23].

Implementation: Motivated patients only; time: Monthly reassess.

Dietary Alkali (Fruits/Vegetables) vs. Oral Sodium Bicarbonate

Mechanism: Lowers NEAP.

Table 1: Guideline-Recommended Dietary Targets, Prespecified Null Hypotheses, and Key Null/Mixed Evidence Notes in Non-Dialysis CKD

Domain	Guideline Target (KDIGO 2024/KDOQI 2020)	Prespecified H0	Certainty (GRADE)	Key Null/Mixed Note
Protein (non-dialysis)	0.8 g/kg/day; VLPD 0.3-0.4 g/kg + keto	No reduction in eGFR decline/KRT outside intensive programs	Moderate	Neutral in MDRD trial (25)
Protein (dialysis)	≥1.0-1.2 g/kg/day	N/A (focus on PEW prevention)	High	N/A
Sodium	<2 g/day	No independent eGFR slowing beyond BP	Low	Modest effects in meta (16)
Energy	25-35 kcal/kg/day	N/A	High	Catabolism confounds short-term
Potassium	Individualized; no blanket restriction	Binders do not improve outcomes	Low	Cost/tolerance barriers (33)
Phosphorus	Avoid additives; plant-prefer	No clinical progression stabilization	Moderate	Biochemical > outcomes (13)
Acidosis	HCO_3 24-26 mmol/L; F/V or bicarb	F/V not superior to bicarb	Moderate	Adherence failures (20)
Fiber	25-35 g/day	No translation to eGFR/ clinical	Low	Biochemical signals only (9)

Trials: Comparable eGFR [20,29]; F/V better BP (-4 mmHg, 95% CI -7 to -1).

Guidelines: Either [5].

Null/Mixed: No superiority; trade-offs (K+ vs. Na+ load); neutral adherence-adjusted [21].

Implementation: Diet-first if feasible; gaps: No long-term KRT data.

Fiber and Uremic Toxins

Mechanism: Shifts microbiome.

H0: No eGFR/clinical translation.

Trials: IS/PCS ↓20-30% (95% CI 10-40%; meta) [9].

Guidelines: Encourage 25-35 g/day [15].

Null/Mixed: Biochemical only; no eGFR impact [10]; GI intolerance in 30%.

Implementation: Food-first; resistant starch adjunct; null clinical benefit highlighted.

Plant-Dominant Low-Protein Diet (PLADO)

Mechanism: Multi-target (low acid/P/toxins).

H0: No hyperkalaemia/nutritional worsening.

Trials: Adherence high (80%); eGFR stable (preliminary) [17].

Guidelines: Promising [5].

Null/Mixed: Slower decline in pilots only; K+ neutral with binders [35]. (Table 2)

Implementation: 50-70% plant protein; reduce excess sources.

Putting It Together: A Trial-Informed Diet Strategy [35-37].

If acidosis: F/V alkali (H0 not rejected vs. bicarb).

If proteinuria: PLADO (0.6-0.8 g/kg).

If toxins: Fiber. All: <2g Na, energy adequate, P-additive free, K individualized.

Gaps: No composite endpoint data.

Protein Restriction in Non-Dialysis CKD

Table 2: Summary of Key Randomized Controlled Trials on Low and Very-Low Protein Diets in Non-Dialysis Chronic Kidney Disease

Trial	Design/n	Intervention	Outcome	Effect (95% CI)	GRADE
Garneata 2016 [6]	RCT/207	VLPD 0.3 g/kg +keto vs LPD 0.6 g/kg	Time to KRT/ composite decline	HR 0.44 (0.25–0.78)	Moderate
MDRD 1999 [25]	RCT/585	LPD 0.6 g/kg vs usual	eGFR slope	-0.2 mL/min/yr (-0.5 to 0.1); null	Low

H0: Low/VLPD (±ketoanalogues) do not reduce eGFR decline or delay KRT outside intensive programs.

Mechanism: Nutritional protein is a double-edged sword in CKD. On the one hand, adequate protein intake is necessary to maintain nitrogen balance, skeletal muscle mass, immune competence, and wound healing. On the other hand, excessive protein intake accelerates CKD progression through mechanisms such as glomerular hyperfiltration, intraglomerular hypertension, increased tubular workload, and heightened acid and phosphorus load. Lowering dietary protein decreases glomerular hyperfiltration and tubular workload, reduces endogenous acid and urea generation, and limits phosphorus intake each tied to slower nephron injury. Ketoacid/essential-amino-acid supplements provide nitrogen-free precursors that are transmitted in vivo, helping maintain essential amino acid pools and lean mass while keeping uremic nitrogen production low.

Null/Mixed Findings: While intensive trials reject H0 on surrogates, MDRD long-term follow-up showed no KRT delay (HR 1.0, 0.8–1.2) and increased death risk (HR 1.35, 1.03–1.77) with VLPD, likely due to heterogeneity in adherence and baseline GFR [25]. Real-world cohorts report null eGFR effects with >40% dropout [26].

Paediatrics: VLPD risks growth stunting (null on height velocity via IGF-1 suppression; relax to 1.0 g/kg) [48]. Geriatrics: Null progression benefits vs. sarcopenia (higher protein linked to survival, OR 0.7 for mortality) [50].

Guidelines: KDIGO 2024 suggests ~0.8 g/kg/day, with VLPD optional under supervision [5]. Implementation/Equity: Phased titration (Wks 1–2: baseline; Wks 3–6: 20% cuts, q2wk labs for albumin/ weight); energy ~30 kcal/kg to avoid catabolism [51]. Excess protein (>1.2 g/kg) reduction gradual. Specialist access limit LMIC/elderly uptake, yielding real-world nulls [52].

Sodium Restriction

H0: Sodium restriction does not slow eGFR decline independent of BP/RAAS effects.

Mechanism: Sodium intake exerts profound effects on CKD outcomes by modulating blood pressure, extracellular volume, and intraglomerular hemodynamic. High sodium intake induces volume expansion, hypertension, left ventricular hypertrophy, and resistance to renin–angiotensin–aldosterone system (RAAS) blockade. Low sodium intake enhances the antiproteinuric and nephroprotective effects of ACE inhibitors/ARBs, one of the central mechanisms by which diet modifies eGFR trajectory.

Null/Mixed Findings: BP reductions sig (10/4 mmHg), but isolated eGFR null in normotensives; adherence <50% in cohorts [16]. (Table 3)

Paediatrics/geriatrics: Null if frail (hypotension risk).

Guidelines: <2 g/day [5].

Table 3: Summary of Key Meta-Analyses and Trials on Sodium Restriction Effects in Chronic Kidney Disease

Trial	Design/n	Intervention	Outcome	Effect (95% CI)	GRADE
McMahon 2017 [16]	Meta/9 RCTs	Low vs usual Na	eGFR slope	MD -1.92 mL/min/yr (-4.49 to 0.64); null	Low

Implementation/Equity: Phased: qWk BP checks during titration. Label reading. Low-cost but cultural barriers null benefits in diverse populations [53].

Alkali Correction

H0: Fruit/vegetable alkali is not superior to bicarbonate for eGFR or acidosis correction when adherence/safety considered.

Mechanism: Chronic metabolic acidosis accelerates CKD progression by promoting muscle protein catabolism, bone demineralization, systemic inflammation, and nephron injury. Base-producing fruits and vegetables (F/V) lower net endogenous acid production (NEAP); oral sodium bicarbonate raises serum bicarbonate directly. Correction reduces muscle breakdown, indirectly influencing creatinine production by limiting catabolic nitrogen turnover (though confounded short-term).

Null/Mixed Findings: Comparable eGFR preservation vs. usual care, but F/V null on adherence in hyperkalemia (potassium load +10–15 mEq/day); bicarbonate adds Na (BP risk) (29). (Table 4)

Table 4: Summary of Key Randomized Controlled Trials on Alkali Correction Effects in Chronic Kidney Disease

Trial	Design/n	Intervention	Outcome	Effect (95% CI)	GRADE
Goraya 2013 [29]	RCT/71	F/V vs NaHCO3 vs usual	eGFR change	No sig difference between groups	Moderate

Pediatrics: Null rapid correction; geriatrics: F/V preferred if tolerated.

Guidelines: Target HCO_3^- 24–26 mmol/L [5].

Implementation/Equity: F/V-first (portion for K+); titrate over 2–4 wks with q2wk HCO3 checks. Binders if needed. Equity gaps in produce access null LMIC benefits [52].

Phosphorus and Potassium Management

H0: Phosphorus/potassium control does not alter CKD progression beyond biochemical targets.

Mechanism: Phosphate retention is central to the development of CKD-mineral and bone disorder (CKD-MBD) and contributes to vascular calcification and mortality. (Table 5)

Phosphorus source matters: Plant phosphorus (e.g., phytate-bound) has low bioavailability (20–60%). Animal/inorganic additives ~100% absorbed. For potassium, traditional restriction is revised; individualize to preserve plant benefits without hyperkalaemia (e.g., portion control, binders).

Table 5: Summary of Key Meta-Analyses and Trials on Phosphorus Binders Effects in Chronic Kidney Disease

Trial	Design/n	Intervention	Outcome	Effect (95% CI)	GRADE
Navaneethan 2018 [13]	Meta/10 RCTs	Binders' vs none	Mortality	RR 0.73 (0.41–1.29); null	Low

Null/Mixed Findings: Biochemical control (↓ phosphate 0.5 mmol/L) but null mortality/CV; binders conditional (no hard outcomes for patiromer/SZC) [13].

Paediatrics: Null if growth needs P; geriatrics: Plant-forward null hyperK if leached. Guidelines: Avoid additives; individualized K+ [5].

Implementation/Equity: Soak/boil plants; monitor q4wks, titrate binders over 2 wks. Cost/tolerance null routine use.

Fiber, PLADO, and Energy/PEW

H0: Fiber/PLADO reductions in toxins/acid do not translate to improved eGFR/clinical outcomes; energy adequacy nulls PEW risks.

Mechanism: Protein fermentation by dysbiotic colonic microbiota generates indole and p-cresol, precursors of indoxyl sulfate (IS) and p-cresyl sulphate (PCS) protein-bound uremic toxins linked to endothelial dysfunction, oxidative stress, vascular calcification, and faster CKD progression. Increasing dietary fiber shifts the microbiome toward saccharolytic fermentation, raises short-chain fatty acids, and reduces proteolytic toxin generation. PLADO emphasizes plant-forward eating (typically ≥50–70% of protein from plants) with total protein ~0.6–0.8 g/kg/day in non-dialysis CKD.

It targets multiple drivers of progression simultaneously: lower NEAP, lower phosphorus bioavailability (phytate-bound), higher fiber (microbiome/uremic toxins), lower saturated fat, and better BP/weight profiles. Adequate energy provision is essential to prevent protein-energy wasting (PEW), as restriction without calories leads to catabolism short-term ↑ creatinine generation, long-term ↓ via sarcopenia, confounding trends.

Table 6a: Summary of Key Meta-Analyses and Trials on Dietary Fiber Effects in Chronic Kidney Disease

Trial	Design/n	Intervention	Outcome	Effect (95% CI)	GRADE
Chiavaroli 2015 [9]	Meta/7 RCTs	Soluble fiber (10–20 g/day)	IS/PCS	↓20–30%; null eGFR	Low
Salmean 2023 [45]	RCT/40 HD pts	Pea hull fiber	Toxins/microbiota	Null change	Low

Null/Mixed Findings: Fiber reduces uremic toxins biochemically yet null on clinical outcomes (no eGFR/mortality link) [9]. Pea hull null on microbiota/toxins despite dose [45]. PLADO shows promise in feasibility (no ↑ hyperK if K+ managed with binders), but null eGFR in observational pilots due to adherence. Energy deficits drive PEW nulls (↑ hospitalization OR 1.8, 1.2–2.6) [12].

Age: Geriatric energy null if frail (<25 kcal/kg risks sarcopenia) [51].

Paediatrics: Fiber/PLADO null GI tolerance/growth if unmonitored [48].

Guidelines: Fiber 25–35 g/day; PLADO exploratory; energy 25–35 kcal/kg [5]. Implementation/Equity: Food-first fiber (25–35 g/day: oats, legumes); phased ramp-up Wks 1–4 to avoid bloating, q4wk adherence checks (~60% real-world null).

PLADO: Binders for K+. Low-cost overall, but education gaps null uptake in LMIC/elderly [52].

Table 6b: Summary of Key Pilot Studies and Trials on Plant-Dominant Low-Protein Diets (PLADO) and Energy Intake Effects in Chronic Kidney Disease

Trial	Design/n	Intervention	Outcome	Effect (95% CI)	GRADE
Kalantar-Zadeh 2020 [17]	Pilot/50	PLADO 0.6–0.8 g/kg	eGFR slope	MD -0.5 mL/min/yr (-1.2 to 0.2); mixed	Low

Table 7: Guideline-Recommended Dietary Targets, Certainty Levels, and Key Null/Mixed Evidence Notes Across CKD Nutrition Domains

Domain	Guideline (Source)	Target	Certainty/Notes
Protein (non-dialysis)	KDIGO 2024 [5]	~0.8 g/kg/day; VLPD w/ keto optional	Low; null hard endpoints outside intensive care [25]
Protein (dialysis)	KDOQI 2020 [15]	≥1.0–1.2 g/kg/day	Moderate; aggressive K/PO_4 restrictions null on outcomes [30]
Sodium	KDIGO 2024 [5]	<2 g/day	Moderate; mixed independent of BP [16]
Energy	KDOQI 2020 [15]	25–35 kcal/kg/day	Moderate; deficits drive PEW nulls [12]
Potassium	KDIGO 2024 [5]	Individualized	Low; binders conditional, no hard data [33]
Phosphorus	KDIGO 2024 [5]	Avoid additives; plant sources	Moderate; binders null mortality [13]
Acidosis Correction	KDIGO 2024 [5]	HCO_3^- 24–26 mmol/L	Low; mixed F/V vs. bicarbonate [20]

Paediatrics: Relax VLPD to avoid stunting [48].
Geriatrics: Up to 1.0 g/kg if sarcopenic [50]

Practical Diet Algorithm to Help Influence eGFR in Non-Dialysis CKD

Confirm the Baseline Before Acting [36-38]

Exclude spurious creatinine rises. Creatinine assays can be affected by recent cooked meat or creatine supplement intake, which transiently increases serum creatinine independent of GFR. A repeat fasting sample or one drawn 24–48 hours after avoiding these exposures should be obtained before attributing a “rise” to disease progression. Note: Jaffe assays are more susceptible to interferences (e.g., from acetoacetate) than enzymatic; specify method in labs.

Drugs such as trimethoprim-sulfamethoxazole (TMP-SMX), cimetidine, and dolutegravir inhibit tubular secretion of creatinine, artificially raising levels. Ensure volume status is optimized and exclude lab variability before intensifying therapy.

Set Diet Targets with a Renal Dietitian [39-41]

Protein General target: 0.6–0.8 g/kg/day (ideal body weight).

Composition: ≥50–70% from plant sources to reduce acid load, phosphorus absorption, and uremic toxin generation.

Energy intake: Maintain 25–35 kcal/kg/day to prevent catabolism.

VLPD/ketoanalogues: Consider only if reducing to ≤0.5 g/kg/day, with access to ketoacid/essential amino acid supplements and close specialist oversight. Excess proteinous substances reduced gradually.

Time management: Phase in over 4-6 weeks with weekly monitoring.

Sodium Target: <2 g/day sodium (<5 g/day salt).

Implementation: Prioritize home cooking, label reading, and avoidance of processed foods. Sodium restriction enhances antiproteinuric effects of RAAS blockade and improves BP/volume status.

Time: 2-week titration to avoid hyponatremia.

Phosphorus Key principle

Avoid highly absorbed phosphate additives in processed foods (look for "PHOS" in ingredient lists). Prefer plant sources (beans, lentils, tofu, tempeh) where phosphorus is phytate-bound and less bioavailable (20–60%).

Culinary techniques: Soaking/boiling legumes reduces phosphorus and potassium further. Monitoring: Serial phosphate, calcium, and PTH to guide binder need and diet adjustment.

Potassium If serum K^+ is normal

Encourage fruits and vegetables to reduce acid load, improve alkali status, and support cardiovascular protection.

If hyperkalaemia risk exists (RAASi, MRA, advanced CKD): Portion control and cooking methods (leaching via boiling, double-cooking). Use potassium binders (patiromer or sodium zirconium cyclosilicate) as adjuncts to preserve the plant-forward pattern, rather than excluding plant foods altogether.

Conditional/emerging strategy; note absence of hard-endpoint data and cost/tolerance barriers.

Acid Load Aim for 50–70% of plate volume from base-producing plants (non-starchy vegetables, fruits).

If serum HCO_3^- remains <22 mmol/L despite diet, add oral sodium bicarbonate, titrating to 24–26 mmol/L.

Time: Titrate over 2–4 weeks.

Fiber Target: 25–35 g/day (preferably food-based).

Adjunct: Resistant starch supplementation (e.g., green banana flour, cooled rice/potato, maize-based RS2) can help reduce gut-derived toxins (indoxyl sulfate, p-cresyl sulfate) and improve bowel health.

Time: Phased ramp-up over 1–4 weeks to avoid GI issues. 3.3. Sample One-Day Template (≈2,000 kcal; 0.7 g/kg protein at 70 kg)

Breakfast: Rolled oats with blueberries, ground flaxseed, and unsweetened soy milk.

Macros: 400 kcal, P 200mg (0 added), NEAP -5 mEq; adjust K^+.

Lunch: Quinoa–chickpea bowl with roasted cauliflower and peppers, lemon–herb olive oil; small yogurt alternative (fortified, phosphate-additive free).

Macros: 500 kcal, P 300mg (low bioavailability), NEAP -3 mEq.

Snack: Apple, handful of unsalted almonds (adjust if K^+/phosphate elevated).

Macros: 200 kcal, P 100mg.

Dinner: Stir-fried tofu with green beans and carrots over white rice; side salad with olive oil–lemon dressing.

Macros: 600 kcal, P 250mg (0 added), NEAP -4 mEq.

Total: Protein 49g (70% plant), Na 1.5g, Fiber 30g, Energy 2000 kcal.

Key exclusions: No processed meats, no phosphate additives, salt-free seasoning, legumes soaked/boiled if hyperkalaemia risk. 3.4.

Monitoring & Safety Monthly (initial phase): weight, dietary recall, BP, edema; labs: BMP (Na^+, K^+, HCO_3^-, creatinine, urea), phosphate, calcium, albumin. Prioritize eGFR slope (creatinine-cystatin C preferred); distinguish short-term catabolism ↑ creatinine generation vs. long-term sarcopenia ↓ baseline.

Every 3–6 months: PTH, lipids, haemoglobin, vitamin D.

Dialysis patients: Require higher protein intake (≥1.0–1.2 g/kg/day); restriction strategies from pre-dialysis do not apply. Aggressive K/PO_4 restrictions can degrade diet quality with unclear outcome benefit. 3.5.

Special Clinical Scenarios [40]

Diabetes + CKD: Plant-dominant, low-sodium, moderate-protein diet with low–glycemic index carbs aligns with SGLT2 inhibitor/GLP-1 RA therapy; potassium individualized.

Hyperkalaemia limiting plants: Maintain plant intake via portioning, cooking, or binders do not abandon plant-based diet if RAAS blockade is cardioprotective.

Phosphate control on dialysis: Emphasize additive avoidance and binder timing with meals; ensure protein adequacy.

Sarcopenia/frailty: Low serum creatinine may overestimate kidney function. Use cystatin-C where available. Prioritize adequate protein/energy intake, even if it means relaxing restriction slightly.

Paediatrics: Lower targets (0.6-0.8 g/kg, growth-monitored; limited trials, null on long-term KRT).

Geriatrics: Higher energy/protein (1.0 g/kg) despite progression risk; frailty confounds creatinine. 3.6.

Food Swaps with High Clinical Yield [41] Processed meats/fast foods → whole foods without additives: Dramatic drop in phosphate load.

Large meat portions → tofu, tempeh, beans: Lower acid load and phosphorus bioavailability.

Salty snacks → unsalted nuts, fruit/veg (within K^+ plan): Sodium reduction.

Add resistant starch/fiber daily (oats, cooled rice/potatoes): Reduces uremic toxins.

Add base-producing produce (tailored to K^+): Helps correct acidosis toward target HCO_3^-. 3.7.

What to Avoid [43]

Creatine supplements and heavy cooked-meat meals immediately before labs (false creatinine rise). Unsupervised very-low-protein diets (risk of malnutrition) should only be used with keto-analogues and multidisciplinary monitoring. Hidden phosphate additives a major, underrecognized driver of CKD-MBD.

Equity, Access, and Real-World Implementation

Many interventions (keto resource-heavy, leading to null effects in low-access settings [adherence <50% globally] [27]. Pragmatics: Telehealth for time management (4-6week onboarding); community adaptations reduce PEW risks but fail KRT delay [observational null; [11]]. Costs produce inequities; highlight where benefits fail in real-world (e.g., low-income dropout 40%).

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Supplementary Materials

No supplementary materials are associated with this article

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