

# Protein Supplementation in Preventing and Managing Individuals with Chronic Kidney Disease

Gopika S Menon<sup>1</sup>, Niharika Shanker<sup>2,\*</sup> and Sunayan Sharma<sup>2</sup>

<sup>1</sup> Research Scholar, Amity Institute of Food Technology, Amity University Uttar Pradesh, Noida – 201303, India

<sup>2</sup> Assistant Professor, Amity Institute of Food Technology, Amity University Uttar Pradesh, Noida – 201303, India

\*Corresponding author Email: [nshanker1@amity.edu](mailto:nshanker1@amity.edu)

**Abstract.** Protein metabolism is disturbed by chronic kidney disease (CKD), a progressive illness that raises the risk of cardiovascular disease and causes metabolic problems such as inflammation and protein-energy waste (PEW). Maintaining nutritional health, lowering uremia, and slowing the course of CKD all depend on proper dietary protein control. The impact of dietary changes, such as low-protein diets (LPD) and plant-based protein sources, and protein supplements on the management of CKD are examined in this study. Research indicates that although LPD aids in the management of metabolic issues, it necessitates close observation to avoid muscular atrophy and malnutrition. While consuming too much animal protein, especially red meat, can hasten the evolution of CKD, plant-based proteins assist the kidneys by lowering acid load, phosphorus bioavailability, and uremic toxin generation. Additionally, although more research is required, LPD may improve renal protection when used with renin-angiotensin-aldosterone system (RAAS) inhibitors. Specialised nutritional techniques are needed for the management of paediatric CKD in order to balance growth and avoid malnutrition. The study emphasises the value of tailored dietary therapies and the need for more research to improve long-term dietary plans and protein consumption guidelines for individuals with chronic kidney disease.

**KEYWORDS:** Chronic Kidney Disease, Cardiovascular Risk, Plant-Based Protein Diet, Animal-Based Protein Diet, Protein-Energy Wasting, Nutritional Therapy.

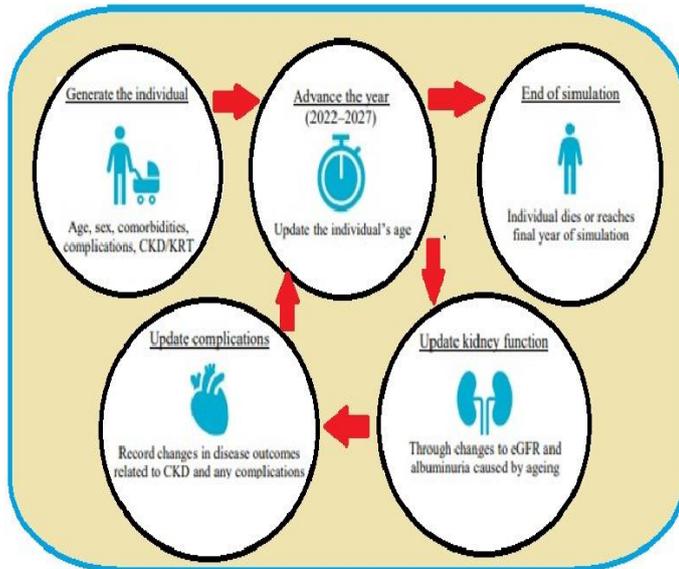
## 1. INTRODUCTION

Chronic kidney disease (CKD) is a significant and growing global health concern. However, there is limited data on the overall regional prevalence of CKD and variations in national prevalence within Asia. This study aims to consolidate available information and provide estimates of the CKD burden in this region. A systematic search of multiple databases, along with input from national experts, was conducted to determine CKD prevalence in different Asian countries. CKD was defined based on estimated

glomerular filtration rate (eGFR) and the presence of proteinuria. In cases where no direct data was available, estimates were made using clustering techniques based on country-level risk factors. The findings reveal substantial

variations in CKD prevalence across Asia, with some of the highest burdens observed in certain populous countries. The large number of people affected, including those with advanced

stages of CKD, emphasizes the need for urgent collaborative efforts to prevent and manage CKD and its complications in Asia [1]. A "microsimulation modelling study" uses microsimulation modelling to project the prevalence and impact of CKD in 31 countries and regions (Fig.1). By 2027, there will be 436.6 million cases of CKD, with 80% of cases going untreated. Significant increases in kidney replacement therapy (KRT), such as dialysis and transplants, are predicted by the simulation, which also reveals regional differences in CKD diagnosis, treatment accessibility, and mortality rates [2]

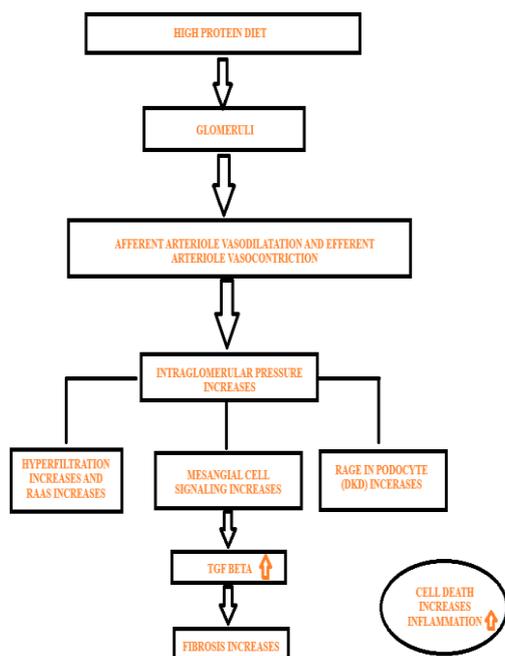


**Fig. 1 Model of microsimulation**

Dietetic-nutritional therapy (DNT) is highlighted in the paper as an essential part of treating CKD, especially when it has progressed. It emphasizes how effective dietary management can minimize medical expenses, improve patient outcomes, and postpone dialysis. The 20 main points of the agreement stress the significance of keeping an eye on dietary intake of calories, protein, salt, and phosphates because excessive consumption might exacerbate the symptoms of CKD. It emphasizes the importance of regular nutritional status assessments to prevent malnutrition, as well as the importance of essential amino acid and keto acid supplements for patients following extremely LPD. It also emphasizes how physical activity might improve medical outcomes. In order to guarantee successful implementation and adherence to dietary therapies, the paper also promotes a multidisciplinary approach involving patients, dietitians, and nephrologists. Along with its potential to support integrated dialysis regimens and preventative kidney transplants, the economic advantages of DNT in lowering CKD management expenses are also covered [3]. The article addresses a useful dietary strategy for non-dialysis patients with CKD. It highlights that by addressing important issues such protein-energy waste (PEW), phosphate levels, protein intake, and sodium consumption, dietary changes can help slow the progression of CKD. The study describes a methodical process that starts with a baseline nutritional evaluation that takes into account eating patterns, protein requirements, and body mass index. It is emphasized how crucial it is to eat a low-protein diet (0.6 g/kg/day) with a sufficient energy intake (30 kcal/kg/day) in order to reduce uremic symptoms and preserve nutritional balance. Additionally covered is how limiting salt (6

g/day) might lower proteinuria and control blood pressure. The goals of nutritional follow-ups at various phases of CKD are to prevent inadvertent weight loss, enhance dietary plan adherence, and address calcium-phosphate balance to lower the risk of bone and mineral diseases. The report advocates for some patients to postpone dialysis by following VLPD supplemented with ketoanalog. Furthermore, it emphasizes how crucial renal dietitians are in teaching and assisting patients in making long-lasting dietary adjustments that will improve clinical results and adherence over time [4].

The importance of nutritional therapy in managing CKD and delaying disease progression. Protein intake plays a critical role, with low-protein diets (LPD) and very-low-protein diets (VLPD) supplemented with keto-analogues (KAs) showing potential benefits in reducing uremic toxin accumulation, metabolic acidosis, and CKD progression. However, patient adherence remains a challenge. The study contrasts animal-based protein diets, which may worsen CKD due to hyperfiltration, increased blood pressure, and metabolic stress, with plant-based diets, which are linked to better cardiovascular health and slower CKD progression. Additionally, specific dietary patterns like the Mediterranean and DASH diets are associated with lower CKD risk, better metabolic control, and improved cardiovascular outcomes. Despite these potential benefits, hyperkalemia and patient non-compliance are concerns, necessitating individualized dietary interventions, education, and close monitoring. The study underscores the need for personalized nutrition strategies to balance CKD management, quality of life, and patient preferences [5]. In order to stabilize kidney function and prevent further end-organ problems, patients with CKD must get balanced dietary therapy in addition to the right pharmaceutical therapies. Certain dietary approaches, such limiting the quantity and quality of protein consumed by CKD patients, are still controversial, though. Furthermore, because risk-benefit ratio profiles vary depending on the stage of CKD, recommendations for a LPD may also vary. The nephron-protective function of LPD in CKD patients is the main subject of this study, which also summarizes current clinical practice guidelines and supporting data for nutritional therapy with regard to protein consumption in CKD patients (Fig. 2).

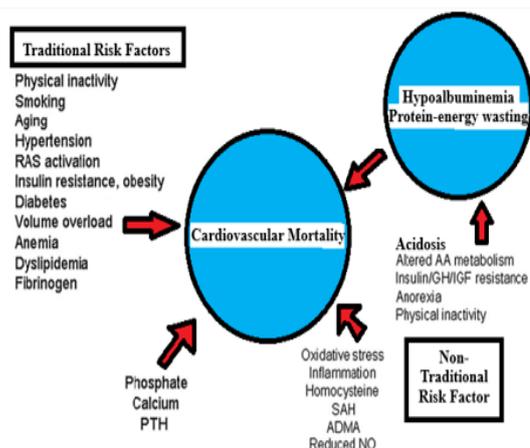


**Fig.2 Mechanisms of Protein on Kidney Health**

*(The above represents the high-protein diet which causes the afferent arteriole to dilate and raises GFR, which over time may cause glomerular hyperfiltration to harm kidney structure) [6]*

## 2. PROTEIN METABOLISM IN KIDNEY FUNCTION

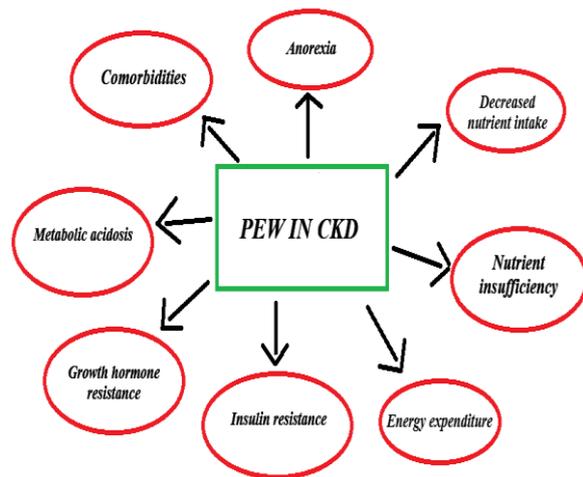
To maintaining overall body homeostasis requires the metabolism of proteins and amino acids, which is mostly dependent on the kidney. The progressive loss of kidney function in people with CKD results in metabolic abnormalities that impact inflammation, nutrition, and cardiovascular health. The kidney maintains the correct balance of different substances required for physiological functions by filtering, producing, and excreting amino acids. However, changes in amino acid metabolism brought on by deteriorating renal function can lead to problems like malnutrition, cardiovascular disease, and protein-energy waste. The control of hormones and vasoactive substances is linked to modifications in protein excretion, turnover, and amino acid synthesis. Moreover, dialysis treatments, inflammation, and metabolic acidosis all affect protein metabolism and lead to muscular atrophy (Fig.3). Managing CKD and its related problems requires addressing these metabolic alterations [7].



**Fig.3 Excess Cardiovascular Mortality in Patients with CKD**  
*(The above figure represents the traditional and non-traditional risk factors contribute to excess cardiovascular mortality in patients with CKD)[7]*

Protein metabolism is greatly impacted by CKD and dialysis, which frequently results in protein-energy malnutrition because of decreased food intake and increased protein breakdown. Research indicates that metabolic acidosis is the main driver of catabolism, despite the traditional belief that uremia drives it. By eliminating vital proteins, peptides, and amino acids, dialysis makes protein loss much worse and raises the requirement for protein in the diet. Persistent catabolism is caused by chronic inflammation and resistance to anabolic hormones like as insulin and IGF-1. Correcting acid-base imbalances, managing diet, and optimising dialysis procedures are essential for preventing malnutrition and muscle wasting in individuals with chronic kidney disease [8].

The metabolism of proteins and amino acids is severely disrupted by renal failure because of decreased intake, losses during dialysis, and metabolic abnormalities. Malnutrition, muscular atrophy, and changed amino acid levels are caused by a number of factors, including uremic toxins, hormonal imbalances, and reduced kidney function. Dialysis eliminates waste, but it also depletes vital proteins, making nutritional deficiencies worse. Muscle mass and general health are further impacted by the accelerated breakdown of proteins caused by metabolic acidosis and chronic inflammation. Protein supplements, specialised nutritional therapy, and optimised dialysis methods are necessary to



manage these metabolic problems and enhance patient outcomes and quality of life [9].

Numerous studies have examined the connection between dietary protein intake and renal function, raising concerns that consuming too much protein may exacerbate kidney disease by raising glomerular pressure and hyperfiltration. Nonetheless, data indicates that these alterations are a typical adaptive reaction rather than a negative consequence in healthy people. The notion that high-protein diets harm kidneys in those with normal renal function is not well supported by science, even though protein restriction is advised for those who already have kidney disease. Increased protein consumption may also help regulate blood pressure, according to certain research. Since there is currently insufficient evidence to definitively link excessive protein intake to the development or progression of renal disease in healthy adults, more study is necessary before public health recommendations about protein limitation for kidney health can be made [10].

## 2.1 CHANGES IN PROTEIN METABOLISM DUE TO CKD

Muscle protein metabolism is significantly impacted by insulin resistance, a major issue in people with CKD. By preventing the breakdown of proteins, insulin often plays a crucial part in preserving muscle mass. But in CKD, the muscle's reaction to insulin is compromised, especially when insulin levels are low, which can lead to muscular weakening and loss. Furthermore, insulin transmission is further disrupted by metabolic acidosis, a common problem in CKD, which increases protein breakdown. Insulin's overall capacity to control muscle protein metabolism is weakened, even though elevated insulin levels can

still have some protective effects. These results emphasize how crucial it is to treat insulin resistance and metabolic abnormalities in order to stop muscle atrophy in CKD patients [11].

A common side effect of CKD is metabolic acidosis, which is brought on by the kidneys' incapacity to remove excess acid, which results in pH and buffering capacity imbalances. Diet is important; alkaline precursors from fruits and vegetables assist balance acidity, while protein metabolism increases the acid load. Dietary acid impact is predicted by models such as net endogenous acid generation, which emphasises the necessity of dietary measures to lower acid burden. A high acid load may deteriorate bone health, muscular function, and the course of CKD. More research is required to prove long-term benefits, even though existing research supports nutritional therapy of metabolic acidosis in CKD [12].

In CKD and ESRD, protein-energy wasting (PEW) is a serious disorder that causes inflammation, metabolic acidosis, hormone imbalances, insulin resistance, and accelerated protein breakdown, which results in muscle loss and decreased energy storage. PEW is caused by uremic toxins, appetite loss, and disturbed hunger-regulating hormones including ghrelin and leptin, as opposed to malnutrition, which results from insufficient consumption. While metabolic conditions like low testosterone and oxidative stress lead to muscle wasting, dialysis exacerbates protein loss. Resistance training, dietary changes, protein supplements, metabolic correction, and possible pharmaceutical therapies are all necessary components of a complete strategy for managing PEW (Fig.4). Improving the quality of life for people with chronic kidney disease requires early detection and treatment [13]

Using a rat model, the study examines how the metabolism of intestinal amino acids varies as CKD progresses. It investigates the connection between these modifications, metagenome changes, and dysbiosis of the gut microbiota. The study discovered that uremic toxins (IS and PCS) and their precursors (indole and p-cresol) had higher fecal concentrations and plasma levels in CKD rats. Additionally, certain populations of gut bacteria changed, and the profile of amino acid metabolism in the gut was disturbed. According to the study, controlling the metabolism of gut amino acids may be a useful tactic to halt the advancement of CKD. According to the study, the dysbiosis of the gut

microbiota and metagenome changes were closely linked to the disordered metabolism profile of gut amino acids that accompanied the course of CKD. Additionally, controlling the metabolism of intestinal amino acids may be a means of slowing the progression of CKD [14].

The study examines how two distinct LPD affect metabolic regulation in people with stages 4-5 of CKD. Researchers tracked urinary excretion of urea nitrogen, creatinine, salt, and phosphate as well as markers such as serum urea nitrogen, phosphate, PTH, and bicarbonate levels. They also monitored the use of diuretics, bicarbonate supplements, allopurinol, and phosphate binders. Protein-calorie malnutrition and other medical problems that might need study discontinuation were taken into consideration. The study's primary goal was to assess the metabolic management of renal failure in individuals with CKD who had a diet with 0.55 g/kg/day of protein against one that included 0.80 g/kg/day. In the end, the study aimed to ascertain whether a lower protein consumption may improve metabolic control and lessen the need for medication without raising the patient population's risk of malnutrition [15].

## **2.2 PROTEIN ENERGY WASTING (PEW) IN CKD**

Patients with CKD frequently have PEW, which raises morbidity and mortality because of things like frailty, dialysis difficulties, and uremic changes. Dietitians are advised to perform nutritional evaluations at the beginning of dialysis, once a year, and when a patient is referred. Even while tools like SGA and MIS evaluate PEW, their regular application is constrained by the time and skill levels needed. Although it needs more research, handgrip strength (HGS) appears to be a promising alternative screening technique. Standardised evaluation methods and cutoff values for successful PEW screening in busy clinical settings require more study [16].

A serious global health concern, CKD raises the risk of cardiovascular disease, end-stage renal disease, and premature death. Protein-energy waste (PEW), which results in decreased body and muscle mass, low blood albumin, and poor dietary intake, is more prevalent as renal function deteriorates. PEW is a powerful predictor of poor health outcomes in people with chronic kidney disease, despite being underdiagnosed. An insulin-sensitizing and anti-inflammatory cytokine, adiponectin is typically

associated with decreased risks of diabetes, hypertension, and metabolic syndrome. Ironically, though, a higher risk of death is linked to increasing adiponectin levels in CKD, which are caused by decreased renal clearance and increased adipose tissue production. Using a nationwide CKD cohort, this study investigates the association between adiponectin and PEW. Clinical, laboratory, and anthropometric data are analysed to identify the PEW indicators that are most strongly associated with adiponectin levels [17].

PEW is a prevalent problem in older adults with CKD, especially those in more advanced stages. Negative consequences include decreased muscle mass, weakness, and an increased risk of death are linked to it. PEW is caused by a number of reasons, including as inflammation, hormone imbalances, decreased nutritional intake, and metabolic changes, in contrast to general starvation. It is advised to identify PEW using the SGA technique, which is frequently used to assess nutritional status in CKD patients. According to research, the prevalence of PEW rises with age and is higher in women, those with mental health issues, and people who have had metabolic or cardiovascular diseases in the past. Furthermore, even though CKD patients are often obese, a small percentage of obese people may still have muscle atrophy, underscoring the difficulty of nutritional evaluation in this population. Improving results requires early detection and management, highlighting the significance of regular nutritional monitoring and focused interventions for patients who are at risk.

A prevalent feature of CKD is PEW, which raises morbidity, mortality, and quality of life. The SGA is a commonly used method for evaluating nutritional status, particularly in dialysis patients, and early discovery is essential to minimising negative effects. PEW in early-stage CKD is still poorly understood, though. This study verified the substantial association between SGA and anthropometric indicators and discovered that the most prevalent PEW symptoms were muscle and fat wasting. The results emphasise how crucial early intervention and regular nutritional evaluation are to helping CKD patients achieve better results.

For haemodialysis patients, PEW is a significant risk factor for morbidity and death. PEW is frequently caused by inadequate dietary protein intake, and conventional dietary assessments have drawbacks. One possible biomarker for protein intake and PEW is fibroblast growth factor 21 (FGF21). The purpose

of this study was to look into the relationship between haemodialysis patients' fatigue, muscle mass, protein intake, and plasma FGF21 levels. The findings indicated that lower protein intake, decreased muscle mass, and increased fatigue were associated with higher plasma FGF21 levels. Furthermore, during haemodialysis, plasma FGF21 levels rose, indicating a metabolic effect of amino acid loss. According to these results, FGF21 may be a helpful indicator for evaluating PEW and nutritional status in patients receiving haemodialysis.

### **3. DIETARY PROTEIN REQUIREMENTS IN CKD**

The study examines the relationship between overall mortality and dietary protein intake (DPI), highlighting the ways in which kidney function affects this relationship. Although high-protein diets are well-liked for promoting weight loss and muscle growth, they may have a detrimental effect on kidney health, especially in those with chronic renal disease. The results imply that whereas low protein intake plus inactivity raises mortality in people with normal renal function, physically inactive CKD patients with high protein intake are at higher risk of dying. This emphasises how crucial it is to adjust dietary protein guidelines according to renal function and general health. The study urges further investigation to elucidate the advantages of plant-based proteins and comprehend the ways in which protein consumption influences long-term health outcomes, particularly in the treatment of chronic kidney disease.

The accumulation of uremic toxins, specifically p-cresyl sulphate (PCS) and indoxyl sulphate (IS), in individuals with CKD is examined in connection to dietary protein and fibre intake. These toxins are associated to impaired kidney function and cardiovascular risks. They are created when gut bacteria digest food protein. Results show that, independent of other health conditions like diabetes or renal function, a higher protein-to-fiber ratio is linked to higher levels of toxins. The study emphasises that examining each nutrient independently has less of an effect on gut microbiota metabolism than the relationship between protein and fibre. In CKD patients, a diet with a lower protein-to-fiber ratio may encourage a healthy gut flora, which would minimise the production of toxins and improve metabolic health.

In severe CKD (stages 3 and 4), protein intake frequently surpasses recommended amounts, according to the study, which uses NHANES data to

analyse protein intake in CKD patients across various stages. Intake stays above clinical recommendations even though it slightly declines as CKD worsens. Protein intake is influenced by demographic factors like age, race, and awareness of CKD; older persons and CKD patients tend to consume less protein, whereas younger people, men, and some ethnic groups, such as Mexican Americans, consume more. In order to manage CKD, the study emphasises the necessity of individualised dietary interventions and education that strike a balance between the hazards of excessive protein intake and adequate nutrition.

The study offers clinical practice guidelines for energy and protein consumption for children with stages 2–5 of CKD and those receiving dialysis, which were created by the Pediatric Renal Nutrition Taskforce (PRNT). These recommendations seek to offer an organized method of nutritional management in light of the intricacies of growth failure, malnutrition, and obesity hazards in this population.

**Table.1 Summary of Recommendations for Children with CKD**

Class	Recommendation	Levels
Needs of Energy	<ul style="list-style-type: none"> <li>• Children with CKD2–5D should first be prescribed an energy intake that is similar to that of healthy children of the same age.</li> <li>• The energy intake should be shifted towards the higher end of the recommended daily intake (SDI) in order to support optimal growth in individuals with linear growth and inadequate weight gain.</li> <li>• Children who are overweight or obese should have their calorie intake adjusted to gain the right amount of weight without sacrificing nutrition.</li> </ul>	Level B moderate recommendation  Level D weak recommendation  Level X strong recommendation
Needs of Protein	<ul style="list-style-type: none"> <li>• In order to support optimal growth, children with CKD2–5D should consume protein at the upper end of the SDI.</li> <li>• Protein intake shouldn't be lowered below the lowest end of the range since it is thought to be the minimal safe amount.</li> <li>• To compensate for dialysate protein losses, children on dialysis may need to consume more protein than non-dialysis patients.</li> </ul>	Level C moderate recommendation  Level X strong recommendation  Level C weak recommendation
Prescription for Nutrition	<ul style="list-style-type: none"> <li>• The best way to feed a baby with chronic kidney disease is to breastfeed them.</li> <li>• Recommend using whey-dominant infant formulae for infants with CKD when breastfeeding is not feasible or when expressed breastmilk is not readily available in sufficient quantities.</li> <li>• When there is a recommended fluid restriction or when a more nutrient-dense or energy-dense meal is needed to meet nutritional needs, breastmilk and baby formulae should be fortified.</li> <li>• To increase acceptability and tolerance, feed concentrations and dietary supplement additions are recommended gradually.</li> <li>• As advised for healthy infants, solid meals should be introduced gradually, moving on to different textures and contents based on the infant's oral motor skills and cues. In light of potential dietary restrictions, we recommend that all children get a nutritious, well-balanced diet that includes a wide range of food options.</li> <li>• When feasible, oral feeding is the recommended method. To stop food aversion from developing, oral stimulation is preferable, even if oral intake is restricted.</li> <li>• To enhance nutritional status, children who cannot fulfil their nutritional needs orally should be started on supplemental or exclusive enteral tube feeding.</li> </ul>	Level X strong recommendation  Level A strong recommendation  Level A strong recommendation  Level D weak recommendation  Level D weak recommendation   Level C weak recommendation  Level B moderate recommendation  Level B moderate recommendation

To ascertain if LPD increases survival and postpones dialysis without resulting in malnutrition, the study examines the long-term impacts of a LPD and a MPD in patients with advanced chronic kidney disease. Researchers tracked renal function, metabolic control, and nutritional health for a few years. The two diets did not significantly alter the commencement of dialysis, death rates, or overall

patient outcomes, according to the results. Although LPD decreased the need for medicine and enhanced metabolic control, it did not clearly increase lifespan. The results indicate that protein restriction is safe for managing CKD, but more investigation is required to determine its long-term effects on the course of the disease.

#### **4. TYPES OF PROTEIN SUPPLEMENTATION**

This study examined the safety of PBD in conjunction with sodium zirconium cyclosilicate (SZC) for potassium management in CKD stages 4-5, while PBD can result in hyperkalaemia in CKD patients. Within 72 hours of using SZC, plasma potassium levels decreased and stayed steady, exhibiting no signs of severe hyperkalaemia. The diet raised consumption of healthy protein sources including chicken and fish, decreased consumption of red meat, and increased intake of fibre. While gastrointestinal symptoms did not change, patient happiness and quality of life did. Although more research is required, these results imply that a potassium-rich PBD combined with SZC may be a safe and beneficial dietary strategy for CKD patients [26]. Although there was little clinical evidence, this evaluation looked at the effects of plant-based

proteins on renal function and mineral bone disorders in individuals with stage 3-5 CKD who were not receiving dialysis.

The majority of research on renal function and CKD-MBD outcomes concentrated on low-protein diets rather than protein sources. Leaf protein concentrate is extracted from the leaves of plants. Some showed minor improvements in phosphorus levels and urea reduction, but small sample sizes, varied methodologies, and biases weakened conclusions. Even while plant-based proteins might have advantages like reduced phosphorus bioavailability and anti-inflammatory properties, there is currently not enough data to support clinical recommendations, underscoring the need for more thorough, long-term studies.

#### **5. PROTEIN SUPPLEMENTATION IN PREVENTION AND IN MANAGEMENT OF CKD**

The three primary objectives of the article's discussion of the significance of reduced dietary protein intake in the management of CKD are to decrease the illness's progression, reduce uremia, and preserve nutritional health. For non-dialysis CKD patients, a LPD is advised to lower metabolic problems like metabolic acidosis, hyperparathyroidism, and hypertension. Although there is evidence that LPD can enhance some health markers and be renoprotective, there are still worries regarding PEW, which could have a negative clinical impact. The study stresses the necessity of customised dietary modifications, especially for older or undernourished individuals, and the significance of striking a balance between sufficient energy intake and protein intake. Notwithstanding the advantages of LPD, further study is required to identify the optimal protein intake amounts for

The benefits of a LPD are highlighted as the article examines the significance of dietary protein intake in the management of CKD. Consuming a lot of protein can raise renal workload, which over time may cause glomerular hyperfiltration and possible kidney injury. LPD is advised to treat metabolic issues such acidosis and hyperphosphatemia, postpone the start of dialysis, and reduce the course of CKD. The benefits of a plant-dominant low-protein diet (PLADO) are emphasised because of its favourable effects on gut flora, decreased formation of uremic toxin, and lower acid load. However, issues like essential amino acid adequacy and PEW need to be addressed with professional supervision, individualised dietary planning, and close monitoring [6].

The difficulty of controlling PEW in CKD that is not dependent on dialysis while striking a balance with the requirement for dietary protein restriction is covered in the article. The hallmark of PEW is a reduction in body protein and energy stores brought on by dietary limitations, inflammation, anorexia, and metabolic abnormalities. The study emphasises how uremic toxicity and hormonal alterations cause

PEW to worsen with CKD and be a powerful predictor of unfavourable outcomes. Reducing protein consumption increases the risk of muscle loss and nutritional inadequacies even if it may decrease the progression of CKD and ease metabolic problems. The goal of several nutritional therapies, such as supplementing with amino acids and keto acids, is to maximise patient health without exacerbating PEW. The optimal dietary options to balance the progression of CKD and nutritional health, however, require more investigation as the efficacy of these techniques is still unknown.

In order to manage CKD, the paper examines the possible advantages of combining an LPD with renin-angiotensin-aldosterone system (RAAS) inhibitors. Although both approaches alone delay the progression of CKD, lower proteinuria, and lessen metabolic problems such as the formation of uremic toxin and acid load, their combined benefits have not been thoroughly investigated. According to experimental research, LPDs may improve the efficacy of RAAS inhibitors by lowering oxidative stress, fibrosis, and glomerular pressure. It is unclear if LPDs and RAAS inhibitors should be regularly prescribed together, nonetheless, due to the paucity and lack of solid clinical trials on this combination. The findings emphasises the necessity of conducting extensive randomised clinical trials to ascertain whether this combination offers additional advantages in reducing the course of CKD and enhancing patient outcomes.

## 6. MATERIALS AND METHODS

The published scientific literature, clinical practice guidelines, and consensus reports pertaining to protein supplements and dietary recommendations in the management of chronic kidney disease (CKD) were thoroughly examined in order to perform this review study. Keywords like "chronic kidney disease," "low-protein diet," "plant-based diet," "protein-energy wasting," and "nutritional therapy" were used to find relevant publications in databases like PubMed, Scopus, and Google Scholar. The information was retrieved, combined, and arranged according to themes such as dietary needs, metabolic impacts, and results related to various protein sources.

## 7. RESULT AND DISCUSSION

The metabolism of proteins and amino acids is disturbed by CKD, which raises the risk of cardiovascular disease, PEW, muscle atrophy, and

malnutrition [7]. Protein loss is even worse by dialysis, and catabolism is accelerated by inflammation and metabolic acidosis [8]. Hormonal abnormalities, reduced intake, and dialysis-related losses can all result in nutritional deficits [9]. To enhance muscle maintenance and quality of life, PEW—which is caused by inflammation, insulin resistance, and protein breakdown—needs dietary changes, physical activity, and metabolic correction [12]. Low-protein diets (0.55 g/kg/day vs. 0.80 g/kg/day) in CKD may improve metabolic regulation without raising the risk of malnutrition, according to a study [15]. Despite their insulin-sensitizing qualities, elevated adiponectin levels in CKD are paradoxically associated with increased mortality, highlighting the necessity of identifying important PEW indicators [17]. Individualised calorie-protein intake is advised by paediatric CKD guidelines, which place a strong emphasis on non-protein energy sources and, if required, enteral feeding. Although more research is required, a potassium-rich plant-based diet (PBD) supplemented with sodium zirconium cyclosilicate (SZC) for potassium control was found to be safe and advantageous for dietary quality and quality of life. Although a LPD may reduce the progression of CKD and metabolic consequences, PEW must be prevented with careful monitoring, especially in sensitive populations [4].

Nutrition, inflammation, and cardiovascular health are all impacted by metabolic imbalances caused by CKD, which interferes with the metabolism of proteins and amino acids. Muscle atrophy and protein breakdown are caused by metabolic acidosis, insulin resistance, and chronic inflammation; dialysis exacerbates protein loss [7,8,11]. Because uremic toxins, hormonal imbalances, and comorbidities increase morbidity and mortality, PEW continues to be a major issue [9,12,16,]. Maintaining appropriate nutritional balance is crucial to preventing malnutrition, even if LPD can assist manage CKD by lowering metabolic complications [10]. While consuming too much animal protein, especially red meat, can hasten the progression of CKD, plant-based proteins may provide renal protection due to their reduced acid load and phosphorus bioavailability [4]. Furthermore, although further clinical research is needed, combining LPD with RAAS inhibitors may improve kidney protection. Optimising CKD management and patient outcomes still requires a customised nutritional approach based on individual needs.

## 8. CONCLUSION

The metabolism of proteins and amino acids is severely disturbed by CKD, which increases the risk of PEW, inflammation, malnutrition, and cardiovascular disease. Dietary protein management is complicated since problems arise from both too much and too little consumption. While a well-managed LPD can regulate acidosis, lower uremia, and decrease the progression of CKD, inappropriate restriction might result in muscle loss, particularly in susceptible populations. While eating too much animal protein, especially red and processed meats, can hasten CKD, plant-based proteins provide advantages such as a lower acid load and less uremic toxins. Additional renal protection may be possible when LPD and RAAS inhibitors are combined, but more research is required. Further research is needed on nutritional tactics including protein supplements, fibre intake modifications, and the usage of keto-analog. For paediatric CKD patients, specialised therapies are necessary to promote growth, prevent malnutrition, and balance nutrition. Optimising dietary programs and enhancing patient outcomes require a multidisciplinary approach that includes nutritionists and nephrologists.

## REFERENCE

1. Liyanage, T., Toyama, T., Hockham, C., Ninomiya, T., Perkovic, V., Woodward, M., et al. Prevalence of chronic kidney disease in Asia: a systematic review and analysis. *BMJ Glob Health* **7**, e007525 (2022).
2. Chertow, G.M., Correa-Rotter, R., Eckardt, K.U., Kanda, E., Karasik, A., Li, G. et al. Projecting the clinical burden of chronic kidney disease at the patient level (Inside CKD): a microsimulation modelling study. *eClinicalMedicine* **72**, 102614 (2024).
3. Cupisti, A., Brunori, G., Di Iorio, B.R., D'Alessandro, C., Pasticci, F., Cosola, C. et al. Nutritional treatment of advanced CKD: twenty consensus statements. *J. Nephrol.* **31**, 457–473 (2018).
4. Bellizzi, V., Carrera, J.J., Chauveau, P., Cozzolino, M., Cupisti, A., D'Alessandro, C. et al. Retarding chronic kidney disease (CKD) progression: a practical nutritional approach for non-dialysis CKD. *Nephrol. Point Care* **2**, pocj.5000207 (2016).
5. Apetrii, M., Timofte, D., Voroneanu, L. & Covic, A. Nutrition in chronic kidney disease—The role of proteins and specific diets. *Nutrients* **13**, 956 (2021).
6. M. Thakur & T. Belwal. *Bioactive Components*. Springer, Singapore (2023). [https://doi.org/10.1007/978-981-19-2366-1\\_34](https://doi.org/10.1007/978-981-19-2366-1_34).
7. Garibotto, G., Sofia, A., Saffioti, S., Bonanni, A., Mannucci, I. & Verzola, D. Amino acid and protein metabolism in the human kidney and in patients with chronic kidney disease. *Clin. Nutr.* **29**, 424–433 (2010).
8. Lim, V.S. & Kopple, J.D. Protein metabolism in patients with chronic renal failure: role of uremia and dialysis. *Kidney Int.* **58**, 1–10 (2000).
9. Kopple, J., Jones, M., Fukuda, S. & Swendseid, M. Amino acid and protein metabolism in renal failure. *Am. J. Clin. Nutr.* **31**, 1532–1540 (1978).
10. Martin, W.F., Armstrong, L.E. & Rodriguez, N.R. Dietary protein intake and renal function. *Nutr. Metab.* **2**, 25 (2005).
11. Garibotto, G., Sofia, A., Russo, R., Paoletti, E., Bonanni, A., Parodi, E.L. et al. Insulin sensitivity of muscle protein metabolism is altered in patients with chronic kidney disease and metabolic acidosis. *Kidney Int.* **88**, 1419–1426 (2015).
12. M. Thakur & V.K. Modi. *Emerging Technologies in Food Science – Focus on the Developing World*. Springer Nature (2020).
13. Wing, M.R., Raj, D.S. & Velasquez, M.T. Protein energy metabolism in chronic kidney disease. In: *Chronic Renal Disease* 106–125 (Elsevier, 2015).
14. Liu, Y., Li, J., Yu, J., Wang, Y., Lu, J., Shang, E.X. et al. Disorder of gut amino acids metabolism during CKD progression is related with gut microbiota dysbiosis and metagenome change. *J. Pharm. Biomed. Anal.* **149**, 425–435 (2018).
15. Cianciaruso, B., Pota, A., Pisani, A., Torraca, S., Anneschini, R., Lombardi, P. et al. Metabolic effects of two low protein diets in chronic kidney disease stage 4–5— a randomized controlled trial. *Nephrol. Dial. Transplant.* **23**, 636–644 (2007).

16. Patoc, G.R. Jr., Fajutag, J.D., Blanco, J.L.J., Villanueva, A.R.T. & Briones, M.V.A. Diagnostic value of the handgrip strength in detecting protein-energy wasting among patients on maintenance hemodialysis at National Kidney and Transplant Institute, Philippines. *Clin. Nutr. Open Sci.* **55**, 48–56 (2024).
17. Hyun, Y.Y., Lee, K.B., Oh, K.H., Ahn, C., Park, S.K., Chae, D.W. *et al.* Serum adiponectin and protein–energy wasting in predialysis chronic kidney disease. *Nutrition* **33**, 254–260 (2017).