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Therapeutic nutrition for kidney disease: A Comprehensive review

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Abstract
A chronic renal parenchymal illness results in a progressive decrease of glomerular function, which is known as chronic kidney disease (CKD). It is observed in patients with kidney impairment that has persisted for three months or longer when their glomerular filtration rate (GFR) is less than 60 ml/min/1.73 m^2 for three consecutive months, or when it is greater than or equal to this number. A non-communicable disease, CKD is typically brought on by hypertension and diabetes. Renal replacement therapy, such as dialysis or kidney transplantation, is frequently required due to a progressive decrease of kidney function. End-stage renal disease (ESRD) is the term used to describe a patient's need for renal replacement treatment. Therapeutic nutrition plays a crucial role in managing kidney disease, aiming to slow the progression of the disease, manage symptoms, and improve overall health. This review explores current dietary recommendations, nutritional interventions, and emerging trends in the nutritional management of CKD.

Keywords: Kidney disease, human health, dietary modification, blood pressure

Introduction
Chronic kidney disease is characterized by a gradual loss of kidney function over time. Proper nutritional management is vital for patients with CKD to maintain optimal health, delay disease progression, and prevent complications (Kitamura *et al*., 2019) [10]. Dietary modifications must be tailored to individual needs, considering factors such as disease stage, comorbidities, and nutritional status (Tewari, 2019; Cristello Sarteau *et al*., 2024) [19, 4].

Stages of CKD
CKD is classified into five stages based on GFR levels (Levey *et al*., 2005) [13].

1. **Stage 1:** Kidney damage with normal or increased GFR (≥90 mL/min/1.73 m^2).
2. **Stage 2:** Mild reduction in GFR (60-89 mL/min/1.73 m^2).
3. **Stage 3a:** Moderate reduction in GFR (45-59 mL/min/1.73 m^2).
4. **Stage 3b:** Moderate to severe reduction in GFR (30-44 mL/min/1.73 m^2).
5. **Stage 4:** Severe reduction in GFR (15-29 mL/min/1.73 m^2).
6. **Stage 5:** Kidney failure (GFR <15 mL/min/1.73 m^2 or dialysis).

Causes of CKD
CKD can result from various conditions, including (Zoccali *et al*., 2017) [21].

1. **Diabetes Mellitus:** The leading cause of CKD, diabetic nephropathy results from prolonged high blood sugar levels damaging the kidneys.
2. **Hypertension:** High blood pressure damages blood vessels in the kidneys, impairing their function.
3. **Glomerulonephritis:** Inflammation of the kidney's filtering units (glomeruli) can lead to CKD.
4. **Polycystic Kidney Disease:** A genetic disorder characterized by the growth of numerous cysts in the kidneys.
5. **Other Causes:** Urinary tract obstructions, autoimmune diseases (e.g., lupus), and prolonged use of certain medications (e.g., NSAIDs) can also contribute to CKD.

Symptoms of CKD

CKD often progresses silently with few symptoms until significant kidney damage has occurred. Symptoms may include (Castner, 2010) [2].

1. Fatigue and weakness.
2. Swelling (edema) in the legs, ankles, feet, or hands.
3. Shortness of breath.
4. Nausea and vomiting.
5. Persistent itching.
6. Changes in urination frequency and appearance.
7. Muscle cramps and twitching.
8. Difficulty concentrating and confusion.

Nutritional Goals in CKD

The primary nutritional goals in CKD include.

1. **Slowing Progression:** Reducing the workload on kidneys by managing protein intake.
2. **Managing Symptoms:** Controlling symptoms such as edema and hypertension through sodium and fluid restriction (Kovesdy and Kalantar, 2016) [11].
3. **Preventing Malnutrition:** Ensuring adequate intake of essential nutrients to prevent protein-energy wasting (Dukkipati and Kopple, 2009) [8].
4. **Electrolyte Balance:** Regulating potassium and phosphorus levels to prevent hyperkalemia and hyperphosphatemia (DiBartola and Willard, 2006) [7].

Key Nutritional Interventions

1. **Protein Management**

- **Early CKD (Stages 1-3):** Moderate protein intake is recommended to prevent malnutrition while avoiding excessive protein load on the kidneys. The National Kidney Foundation suggests a protein intake of 0.8-1.0 g/kg/day (Watanabe, 2017) [20].
- **Advanced CKD (Stages 4-5):** Lower protein intake (0.6-0.75 g/kg/day) is advised, potentially supplemented with ketoanalogues to prevent malnutrition (Daphnee and Rajalakshmi, 2022) [5].

2. **Sodium Restriction:** Sodium intake should be limited to less than 2,300 mg/day to control blood pressure and reduce fluid retention. This helps manage hypertension and edema, common complications in CKD (Krikken *et al*., 2009) [12].
3. **Potassium Management:** Hyperkalemia is a risk in CKD due to impaired kidney function. Potassium intake should be adjusted based on serum levels, with recommendations typically ranging from 2,000 to 3,000 mg/day (Picard *et al*., 2020) [15].
4. **Phosphorus Control:** Phosphorus restriction is crucial in CKD to prevent hyperphosphatemia and subsequent bone disorders. A dietary intake of 800-1,000 mg/day is generally recommended, often requiring the avoidance of high-phosphorus foods and phosphate additives (Gutiérrez and Wolf, 2010) [9].
5. **Fluid Management:** Fluid intake should be individualized based on urine output and the presence of edema. For many patients, fluid restriction helps in managing fluid balance and reducing the burden on kidneys (Prowle *et al*., 2014) [16].

Dietary Patterns and Recommendations

1. **DASH Diet (Dietary Approaches to Stop Hypertension):** The DASH diet emphasizes fruits, vegetables, whole grains, and low-fat dairy while limiting sodium, red meat, and added sugars. It is beneficial for CKD patients, particularly those with hypertension (Song *et al*., 2021) [17].
2. **Mediterranean Diet:** Rich in fruits, vegetables, whole grains, and healthy fats, the Mediterranean diet supports cardiovascular health and has been associated with slower CKD progression (Chauveau *et al*., 2018) [3].
3. **Plant-Based Diets:** Plant-based diets, which are lower in phosphorus and potassium, are increasingly recommended for CKD patients. These diets reduce the intake of bioavailable phosphorus and potentially harmful protein sources (Carrero *et al*., 2020) [1].

Emerging Trends and Future Directions

1. **Personalized Nutrition:** Advances in genomics and metabolomics are paving the way for personalized nutrition plans tailored to individual genetic profiles and metabolic needs (Tebani and Bekri, 2019) [18].
2. **Role of Gut Microbiota:** The gut-kidney axis is a burgeoning area of research. Dietary interventions that modulate gut microbiota, such as prebiotics and probiotics, may offer new therapeutic avenues for CKD management (Pantazi *et al*., 2023) [14].
3. **Novel Nutritional Therapies:** Supplementation with compounds such as omega-3 fatty acids, antioxidants, and anti-inflammatory nutrients is being explored for their potential benefits in CKD (de Abreu *et al*., 2022) [6].

Conclusion

Therapeutic nutrition is a cornerstone in the management of chronic kidney disease. Adhering to dietary recommendations can significantly impact disease progression, symptom management, and overall patient outcomes. Ongoing research and personalized nutrition approaches promise to enhance the efficacy of dietary interventions, offering hope for improved quality of life for CKD patients.

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