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Nutritional Assessment and Dietary Requirements in Kidney Transplant Patients: A Literature Review as a Clinical Guideline

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ABSTRACT

Kidney transplantation is a preferred treatment and the 'last resort' in chronic kidney disease after end-stage renal disease. Considering the key role of nutrition in post-transplant recovery, the present study aimed to review the nutritional assessment and dietary requirements of kidney transplant patients. Relevant articles were retrieved via searching in databases such as PubMed, Medline, Google Scholar, Scopus, and Web of Science using various keywords and phrases, including kidney transplantation, end-stage disease, nutrition, dietary intake, nutritional assessment, and nutritional evaluation. According to the literature, medical nutrition therapy is essentially involved in the post-transplantation recovery of patients with kidney failure. Furthermore, it seems that nutritional and medical evaluation based on laboratory methods, vital signs, and anthropometric measurements are critical to improving the quality of nutritional interventions after kidney transplantation and may help decrease the risk of kidney transplant rejection. Therefore, the periodic evaluation and follow-up of these could yield beneficial outcomes.

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Introduction

Chronic kidney disease (CKD) is a general term referring to various disorders that affect the structure and function of the kidneys. One of the definitions of CKD is the reduction of the glomerular filtration rate to less than 60 ml/min per 1.73 m^2 of the body surface (1). The incidence of CKD varies in different regions across the world. In general, the incidence of the disease in most countries has been reported to be higher than 200 cases per million annually (2).

Kidney transplantation is the preferred treatment and the 'last resort' for CKD after end-stage renal disease (ESRD) (3). In kidney transplantation, nutritional requirements change entirely due to comorbidities, immunosuppressive drugs, and recovery from major surgery, thereby leading to malnutrition and mineral deficiencies. Statistics suggest that more than 70% of CKD patients experience malnutrition (4, 5). Several factors may contribute to the deterioration of nutritional status in these patients, including obesity, renal replacement therapy, anorexia, and dietary restrictions. Therefore, the periodic evaluation of nutritional status in these patients by a clinical nutritionist is essential (6, 7).

A proper dietary pattern may reduce the risk of transplant rejection and length of hospital stay and prevent threatening diseases, obesity, and multiple adverse conditions associated with transplants (8). According to a study in this regard, controlling the nutritional status and providing a proper and healthy diet to kidney transplant recipients could reduce body fat and body weight, while also contributing to an ideal weight and improved cholesterol, triglyceride, and blood sugar levels (9). The nutritional assessment of kidney transplant recipients during the treatment process could prompt timely and appropriate interventions. Among the most important nutritional assessment tools are subjective global assessment (SGA) forms, immunological tests, and biochemical and anthropometric indices, which could be largely

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beneficial for the nutritional status monitoring of these patients (10).

This comprehensive review aimed to evaluate the nutritional assessment methods used for kidney transplant recipients, as well as the nutritional requirements of these patients based on the most recent guidelines and studies.

Materials and Methods

Search Strategy

Relevant articles were identified via searching in databases such as PubMed, Medline, Scopus, and Web of Science databases using various keywords, including "kidney transplantation", OR "kidney transplant", OR "end-stage renal disease", ", OR "renal transplant" OR "kidney failure" OR "renal failure" in combination with "nutrition" "dietary requirements", "nutrition intervention", nutritional assessment", "nutrition evaluation", "dietary assessment", "food intake", and "nutrition intakes". The identified studies and review articles were assessed, and eligible studies were selected for the review, including reports on the nutritional and dietary requirements of kidney transplantation. Notably, our literature review was not performed within a systematic framework, and duplicates and unrelated articles were excluded.

Nutritional Assessments Tools

Candidates for kidney transplantation often have an abnormal nutritional status due to organ dysfunction and the associated symptoms (11).

The importance of the nutritional assessment of kidney transplant recipients is due to the need for an initial and general assessment, followed by detailed examination (12). Several methods are applied to assess the nutritional status of kidney transplant recipients, some of which have been discussed in the following sections.

Medical History and Social Status

Medical history and social status encompass primary and secondary diagnosis, disease history, previous surgeries, previous weight, history of weight changes, and health assessment of various organs (gastrointestinal tract, liver and bile ducts, circulation, cardiovascular system, nerves, lungs, and immune system). Social status refers to the data on socioeconomic status, religion, living facilities, and food security (13). The most common clinical symptoms in kidney transplant recipients include edema, fatigue, nausea and vomiting, and anorexia, which should be evaluated meticulously (14).

Anthropometric Indices

Anthropometry is the concept of measuring the body size and the related scales. Anthropometric measurements indicate health and the growth status and are commonly used to assess nutritional status, such as obesity due to overeating and weight loss due to protein-energy malnutrition (13, 15). These data are beneficial in determining the impact of nutritional interventions on various diseases, traumas, surgeries or malnutrition. Anthropometrics are also a method used for the estimation of the body mass in clinical trials (16). Height and weight measurements are among key anthropometric indicators, and body mass index is employed as an indirect method to determine obesity or body fat percentage (16). If height and weight cannot be measured (e.g., in unconscious or bedridden patients) to estimate the muscle mass (body protein stores) and fat stores, waist circumference (WC) and mid-arm muscle circumference are the alternatives. WC is an estimate of the subcutaneous and intra-abdominal distribution of the adipose tissue, as well as a simple anthropometric index associated with the visceral adipose tissue. If WC is higher than 102 centimeters in men and higher than 88 centimeters in women, it indicates the increased risk of disease and mortality (17).

Although previous findings have introduced an association between the primary grade of obesity with increased survival in ESRD patients, the hypothesis has been ruled out, and a normal body mass in these patients has been associated with better outcomes (18). In addition, a normal body mass has been associated with improved quality of life and reduced complications, such as wound infections, delayed graft function, and rejection in kidney transplant recipients (19, 20). The measurement of triceps skinfold thickness is also used to measure the subcutaneous fat reserves of the body (21).

Bioelectrical Impedance Analysis (BIA)

Bioelectrical impedance analysis (BIA) is a practical method to measure the body composition (22). BIA is commonly used for estimating the body composition, especially the body water, body fat, and muscle mass (22). The BIA device measures parameters such as resistance and reactance, with the former showing the hydration status of the patient in association with body water and the latter indicating the available energy to the body tissues (capacitator) (12, 23).

Food Intake Assessment

Nutritional intake is an inherent element of nutritional assessment as these evaluations provide data on the quantity and quality of the diet, appetite changes, food sensitivity, food intolerance, and causes of inadequate food intake during illness or in the recovery period (13). The food frequency questionnaire (FFQ) is a primary tool used for dietary assessment, collecting data on the proper amount and consumption of foods (per week, month or year). Furthermore, FFQ is a retrospective evaluation of food consumption frequency (24). The 24-hour recall and dietary record are the other methods of assessing food intake in these patients, which accurately measure their dietary intake (25, 26).

SGA

The SGA consists of two sections, which are medical history and physical examination. The first section is based on the medical history of the patient and has five components, including weight changes, diet, gastrointestinal symptoms, functional capacity, and underlying hypercatabolic diseases (e.g., physical injuries, burns, inflammatory diseases, infections, and malignancies) (27-29). The second section of the SGA is physical examination, which has the three components of subcutaneous fat analysis, muscle analysis, and the presence of edema/ascites. If these components are normal, they are defined as component A. If they are mildly to moderately affected, they are rated B, and if they are severely affected, they are graded C (27). In the final scoring of the SGA, if most of the components are scored A, the patient has a normal nutritional status, and if most of the components are scored B, mild-to-moderate malnutrition is confirmed. If most of the components are scored C, severe malnutrition is recognized (27, 28).

Evaluation of Biochemical Data

Biochemical tests are highly sensitive and could be altered by food/medications or certain diseases. Blood and urine are the main sources of biochemical tests (30). Visceral protein measurement includes the measurement of total serum proteins (albumin and transferrin), the changes in which occur due to dietary protein deficiency, altered metabolism and body fluid status, inflammation, and use of certain medications (30, 31). Among the other biochemical measurements are creatinine, serum levels of sodium, potassium, calcium, magnesium, and phosphorous, fasting blood sugar, liver enzymes, blood urea nitrogen, and lipid profile, which play a key role in the monitoring and management of the clinical and nutritional status of patients with CKD (30, 32).

Nutritional Requirements of Kidney Transplantation

In kidney transplantation, the patient has a wider choice of diets and food intake and often require less medical, nursing, and nutritional care compared to hemodialysis patients (Table 1) (33). The nutritional care of kidney transplant recipients normally depends on the metabolic effects of treatment with immunosuppressive drugs, such as corticosteroids, cyclosporine, and azathioprine (34). However, the side-effects of anti-rejection medications (e.g., diarrhea, constipation, nausea and vomiting, high glucose, high potassium [cyclosporine]) may occur after transplantation and affect food intake, thereby requiring medical and nutritional interventions (35).

Table 1. Comparison between hemodialysis and kidney transplantation

Variable	Hemodialysis patients	Transplant patients
Primary Treatment responsibility	Health care personnel	Patient
Diet	Low K, low PO4, low Na, moderate protein, fluid restriction	High and moderate protein, no K or PO4 restrictions, no fluid restriction
Location	Clinical dialysis unit	No limitations
Risks	Bleeding, sepsis, infection	Immuno-compromised, diabetes, cancer
Contraindications	Poor cardiac status, poor blood vessels for access	High body mass index, noncompliance with medications

Corticosteroid intakes has been reported to increase protein catabolism, hyperlipidemia, sodium retention, weight gain, and glucose intolerance, while also inhibiting the normal metabolism of calcium, phosphorus, and vitamin D (36-38). Cyclosporine therapy is associated with hyperkalemia, hyperlipidemia, and hypertension; therefore, it is essential to control the nutritional status of the recipients (39). The control of nutritional status (anthropometric assessments, food intake, and food allergies) and routine biochemical tests are also important in this regard, and these patients should be periodically monitored by nutritionists (40, 41).

The dietary pattern following kidney transplantation is often divided into two stages, which are the first month (4-6 weeks) after transplantation and more than one month after transplantation. During the first month, a high-protein diet (1.3-1.5 g/kg/day) with the energy level of 30-35 kilocalories is recommended to prevent negative nitrogen balance, while more protein (1.6-2 g/kg/day) is usually required in the patients with infections, surgery or stress (4, 39).

The protein recommendations in the chronic post-transplant population may vary depending on the diabetes status. A patient without diabetes mellitus (DM) may have an estimated protein requirement of 0.6-0.8 g/kg/day, while a patient diagnosed with DM might have slightly higher protein requirements (0.9-1 g/kg/day) (Table 2) (42). Fat intake recommendations in the acute and chronic phase of transplantation are 25-30% and 30-35% of the total calories, respectively. It is important to emphasize on the consumption of monounsaturated and polyunsaturated fatty acids, minimal intake of trans fats, and low intake of saturated fats (43). According to the National Kidney Foundation, carbohydrates should provide 50-65% of the non-protein calories in the acute post-transplant phase, while in the chronic post-transplant phase, they should be reduced to 45-50% of the total energy (43). In addition, sodium restriction to 80-100 mEq/day minimizes fluid retention and contributes to blood pressure control. After one month, protein intake could be reduced to 1 g/kg/day, and sodium intake is adjusted individually (39).

Table 2. Nutritional requirements in kidney transplantation

	Acute phase after kidney transplantation (Less than 1-month)	Chronic phase after kidney transplantation (More than 1-month)
Energy (Kcal)	Calculate with the formula provided at the bottom of the table * or (30-35 kcal/kg IBW**)	Calculation with pre-dialysis formula (32-35 kcal/kg IBW**)
Protein (g/Kg/day)	Transplant from living person 1.3-1.5 Transplant from brain death person; 1.1-1.3	Without DM; 0.6-0.8 g/Kg/day With DM; 0.9-1 g/Kg/day
High biological value (HBV) protein	50% of total protein	50% of total protein
Fat	25-30% from total calorie	30-35% from total calorie
Carbohydrate	Remaining percentage of calories (50-65% of nonprotein calories)	Remaining percentage of calories (45-50% of total energy)
Potassium	Without limitation	Without limitation
Phosphorus	Without limitation	Without limitation
Sodium	2000-3000 mg/day	3000-4000 mg/day
Fluids	500-600 ml+ Excreted urine volume+ Excretion of urine from other routes	Without limitation
Medication side effects	Adjust diet to address the potential for hyperglycemia and hyperkalemia; observe food safety practices to minimize the risk for food-borne infections	
Bone health	Monitor laboratory values. Consider need for supplementation of calcium, magnesium, phosphorus, and vitamin D	

* Total daily energy requirements in the acute phase of kidney transplantation=[Basal metabolic rate × Stress Coefficient × Physical activity coefficient].
Stress Coefficient in kidney surgery=1.2
Stress Coefficient in Inpatients= 1.2
Stress Coefficient in Outpatients= 1.3
Abbreviations: IBW; Ideal Body Weight, DM; Diabetes Mellitus

Hyperkalemia is associated with cyclosporine intake and often requires potassium restriction although it may be temporary (34). After kidney transplantation, most patients present with mild hypophosphatemia and hypercalcemia due to the bone resorption induced by hyperparathyroidism and the effects of corticosteroids on the metabolism of calcium, phosphorus, and vitamin D (44). In such cases, the routine diet should contain sufficient calcium and phosphorus (1200 mg/day), and their serum levels should be monitored regularly. Furthermore, phosphorus supplementation may be required to correct hypophosphatemia (45).

Hydration status should also be closely monitored after kidney transplantation; since most kidney transplant patients require fluid restriction during dialysis, they should be reminded by a nutritionist to receive adequate fluids after transplantation (Table 2) (45, 46). Most of the patients who receive a kidney transplant have high triglycerides or cholesterol due to multifactorial issues, and interventions such as calorie restriction are recommended for overweight or obese patients. Among the other strategies in this regard are cholesterol intake of less than 300 mg/day and restricted total fat intake (47).

Conclusion

Nutrition therapy and counseling play a key role in the recovery after transplantation in patients with renal failure. It seems that nutritional and medical evaluation based on laboratory methods, vital signs, and anthropometric measurements are essential to improving the quality of nutritional interventions after kidney transplantation, while these measures also contribute to reducing the risk of kidney transplant rejection. Therefore, the periodic evaluation and follow-up of these patients may yield beneficial outcomes.

Authors' Contributions

S. H. Z., N. P., F. Y., and A. N. designed the research; S. H. Z., N. P., and A. N. conducted the library search and drafted the manuscript; N. P. and F. Y. designed the tables; A. N., S. H. Z., and N. P. participated in the drafting and editing of the manuscript. All the authors read and approved the final manuscript.

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Conflicts of Interest

None declared

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