Context-specific optimal dietary patterns for managing kidney disease for hospitalized patients in Tanzania.

Happyness Kisighii A[1*], Jofrey Raymond[1], Musa Chacha[2]

[1]Department of Food Sciences and Technology, Nelson Mandela African Institution of Science and Technology, Arusha, Tanzania
[2]Department of Sustainable Agriculture Biodiversity and Ecosystem Management, The Nelson Mandela African Institution Science and Technology, Arusha, Tanzania

Abstract

Objective: There is a global disproportion in the availability of nephrology services as a result of scarce services and resources for addressing the growing burden of kidney disease. However, the available services are expensive to be implemented by patients themselves, whereas dietary interventions are underused as among kidney management strategies. This study aimed at formulating food-based dietary guidelines for managing the problem.

Method: A seven days weighted food record method was used to measure dietary intake to hundred hospitalized patients with chronic kidney disease in five hospitals (twenty patients per hospital) providing food services to hospitalized patients in Northern Tanzania. Food and nutrient intake were compared with the standard intake. A market survey was conducted in shops near the hospitals to collect data on foods and prices. Then, the LP approach was used to formulate optimal dietary patterns using food ingredients recorded from the market survey data.

Results: It was found that patients had inadequate intake of nutrients such as iron, folate, beta-carotene, vitamin A, E, selenium, and zinc. While sodium, potassium, and phosphorus were above recommendation. Optimized dietary patterns had reduced sodium, potassium and phosphorus.

Conclusion: Dietary patterns generated in this guideline aim to meet all food groups to enhance the distribution of all nutrients in a recommended amount for early recovery from illnesses and delay the progression of complications allied with the disease conditions.

Keywords: Hospitalized patients, Kidney diseases, Dietary adequacy, Linear programming, Diet plans.

Background

Chronic kidney disease is a worldwide health crisis and has been recognized as a leading public health problem. The burden is most in low and middle-income countries where treatment with dialysis and kidney transplantation creates a huge financial barrier for the majority of the people who need it. A large number of deaths are due to poor access to kidney therapy in developing countries [1]. Different treatments and lifestyle modifications are needed to protect kidneys from further damage and improve the well-being of the affected individuals. The lack of consistent dietary guidelines to complement chronic kidney disease treatments in Tanzania has worsened the problem among patients, especially during hospitalization. This is due to the complexity of dietary recommendations among these patients. Varied dietary needs based on individual cases are a challenge among clinicians to recommend an appropriate and individualized diet with adequate nutrients to meet patients' requirements. This is due to increased various restrictions on their diet intending to lower major nutrients which are regulated by the kidney [2]. Inadequate intake leads to disease progression and increased hospital stays. Kidneys play key roles in the body including nutrient metabolism and homeostasis, so a patient with chronic kidney disease face problems including fluid overload, metabolic acidosis, inflammation, hyperkalaemia, altered hormone regulation and hypophosphatemia. Therefore, nutrition interventions strategies are mostly required during this crisis. However, in recent studies still, there are no consistent dietary interventions for the management of chronic kidney disease. Despite the available intervention, they are too restrictive to some foods in which may be the source of inadequate intake among patients [3].

It has been estimated that about 11 to 13% of the world's population has chronic kidney disease which is equal to about 800 million people, where 10% of the affected individual are older adults (elders). Since the disease condition is irreversible

***Correspondence to:** Happyness Kisighiia A, Department of Food Sciences and Technology, Nelson Mandela African Institution of Science and Technology, Arusha, Tanzania, E-mail: amanihappy9@gmail.com

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and has no cure, it worsens over time, especially if not well managed [4]. The associated comorbidities and adverse outcomes have been on the rise especially the mortality rate among patients at the end stages of chronic kidney disease [5]. Currently, it has been estimated that people with kidney disease (end-stage) reach up to 3 million where the majority depend on dialysis. This situation has been difficult as it is associated with high costs [5]. For instance, costs per one session of hemodialysis per patient are USD 176 (230000 to 300000 TSH), which makes up to USD 440 per week per patient. In Tanzania, as in much of sub-Saharan Africa, the infrastructure for emergency care for patients with kidney disease is limited throughout the country. According to the World Health Organization, there were 4,704 deaths linked to kidney disease in 2014 of total deaths in Tanzania this is due to the failure of patients to afford kidney treatment costs such as hemodialysis, in which about 44% of patients on hemodialysis cannot afford the cost of treatment.

Nutrition has been reported to play a crucial role in slowing the progression of chronic kidney disease [6]. And other associated comorbidities such as cardiovascular diseases [7]. Patients with kidney diseases face poor nutritional care worldwide [7]. Following an adequate diet has been informed to play an important role in the management of kidney diseases [6]. An adequate diet approach has been shown to delay the progression of chronic disease, dialysis (and other kidney replacement therapies [5]. Adequate nutrition nutrients can meet nutritional requirements of an individual by maintaining energy balance, reduce chances of other complications associated with chronic kidney diseases including protein-energy malnutrition [4,7] by ensuring that patients are provided diets with minimum protein, potassium, calcium, phosphorus and sodium while meeting intake levels of other nutrients.

The adoption of an optimal dietary pattern can be used to complement medical treatment to ensure quality outcomes during the treatment of kidney disease in all stages [8]. The failure to adhere to the dietary recommendation by most of the patients results in the progression of kidney failure and its associated complications [9]. Therefore, the required dietary appropriate dietary pattern to generate diet plans for the management of chronic kidney disease, enhance early recovery and maintain the health of patients. A linear programming approach has been used in this study for the generation of a diet that provides an adequate amount of all nutrients while limiting nutrients that have been reported to increase the progression of kidney disease.

Materials and Methods

Site description

This study was conducted in 5 Tanzanian hospitals located in Northern zone. Inclusion criteria were that a hospital must be currently attending patients with chronic kidney disease and providing food services to the hospitalized patients.

Study participants

This study included 100 patients with kidney disease admitted to 5 hospitals in Tanzania. Only patients who were receiving food services offered by the hospitals were selected in this study. Ethical approval for this study was obtained from the Ethics Review Committee of the School of Life Sciences and Bioengineering at The Nelson Mandela African Institution of Science and Technology (NM-AIST). The written informed consent was obtained from each hospital's administration [10].

Nutritional assessment

Food intake: The number of foods and beverages consumed by inpatients at the hospital were measured using Weighed Food Records (WDR) for 7 days. Foods and beverages were weighed in a digital electronic weighing scale. Food weighing utensils such as plates, spoons and cups were used. All food ingredients and beverages available in the hospitals' kitchen were weighed, followed by weighing portion sizes of each patient and the remaining uneaten foods from patients [11]. Food intake data were then converted into daily energy and nutrient intake using nutritional databases including Tanzania, Kenya and Uganda Food Composition Tables. Data were then entered into an Excel sheet 2013 for analysis.

Dietary pattern: Single food items were aggregated into predefined food groups based on food group classification of FAO standards. Diet index-based pattern was then used to assess quantities, frequency proportion and variety of each food in a given food group which were routinely consumed by hospitalized patients with chronic kidney disease. Identified dietary pattern was then optimized to generate healthy dietary pattern for patients with chronic kidney disease. The optimization dietary pattern was converted into practical serving sizes.

Dietary diversity: The DDS was calculated based on 13 food groups as classified by FAO guidelines including, whole grains, refined grains, fruits, green leafy vegetables, red and orange vegetables, starchy vegetables, beans, lentils and peas, other vegetables, dairy, oils, meat, poultry and eggs, fish and seafood, nuts, seeds and soy products [12]. To calculate the dietary diversity score (DDS), each given quantity of any food item from a defined food group consumed at least once per day was given a score of 1. Then obtained scores in all food groups were summed. The obtained result was divided by the number of patients included in this study to calculate DDS [13].

Nutrient intake: Energy and nutrient intakes from each food item obtained from nutritional databases such as food composition tables and nutrient databases for each food item recorded from patients' food intakes were used to calculate median intake for each patient to determine daily nutrient intake per patient. The median calculations for each nutrient intake were compared with daily Recommended Nutrient Intakes (RDI) to identify nutrient adequacy and the quality of dietary patterns among diabetic patients.

Food market survey: A food market survey was conducted on markets and shops available near the hospital settings to validate the price of foods and identify other nutrient-dense local foods that were missing in the hospital food catering menu. The data was used in formulating optimal dietary

patterns for hospitalized diabetic patients. The price was obtained from raw food ingredients [14].

The setting of linear programming model

Prices of each food item were recorded from the requisition books in the hospitals' catering unit. Data collected were analyzed Microsoft Excel 2016 solver add-in. different nutritional databases such as nutritional databases (WHO 2003, USDA) and food composition tables (Tanzania and Kenya food composition tables) used to determine the amount of all essentials nutrients in each food item collected from patients' menus.

Formulation of optimal dietary pattern

The linear goal programming model was formulation for the generation of the optimal diet for in patients with chronic kidney disease. The constraints in the model for this study were WHO, ESPEN manual and other authorized published reports [14,15]. Cultural traditions and individual preferences were included by ensuring that foods to be included in the model were suited from common food patterns in the hospitals. The minimum and maximum value of essential nutrients were set based on the WHO, ESPEN manual and other authorized published reports when choosing food items to ensure a menu generated per meal avoids repetition of food items.

Excel solver

Essential nutrients for each food item, the price of each food ingredient per serving, and the dietary reference (nutritional value) were filled in Microsoft excel spreadsheet 2013 with their upper bound and lower bound limit based on the RNI from the dietary manual of clinical nutrition, Malaysian RNI 2017 and Kenyan clinical nutrition manual 2010 (Ministry of Health Malaysia 2005) [16]. Excel solver from the Add-in was installed, then, the objective function for cost minimization was set followed by the variables and their constraints.

Initially, optimization dietary intake collected among patients was analyzed using a nutritional database including USDA nutrient content value, Tanzania, Kenya, Indian, and Canadian food composition tables with a variety of food ingredients and their nutrients content. Then, identified nutrients content used to obtain average intake for all patients in the study from food consumed in the hospital and compared with the reference nutrient intake as recommended per individual per day [17]. Linear programming was then used to find an optimal diet, where obtained optimized nutrients intake from the hospitals' food ingredients was compared with observed nutrients intake before optimization.

The optimization model was repeated several times to produce two more suggested palatable menus with the lowest possible costs. The linear goal programming model was applied by adding new food ingredients to generate balanced diet plans with diversified food ingredients and adequate nutrients supply at minimum cost for chronic disease management. The equation used to set LP is shown below;

There are 25 food items available in hospital settings that have been determined to be decision variables (**Table 1**). These food items are presented as:

$$\sum Xai$$

Xi= weight (g) of a certain food item
i= food item (name)

Aimed at minimizing the number of food items in grams to be consumed per day but meeting the nutrition requirements of individuals and cost of each food item.

$$Min\ C\ =\ \sum XiW_i \geq\ b$$

Where, c is cost; Xi= weight (g) of a certain food item; Wi= type of food ingredient, b is the RNI for a specific nutrient

The minimum and maximum values of essential nutrients were customary based on WCRF/AICR 2018, and RNI 2017 (Ministry of Health Malaysia 2005), and WHO [16]. To meet the palatability of the planned diet, food ingredients were selected from the catering unit and nearby markets to avoid diet repetition in different meals.

Results

Food intake

Dietary adequacy among hospitalized patients with kidney disease was assessed by considering seven aspects including dietary pattern, food preferences, cultural acceptability, affordability, dietary diversity, nutritional needs among individuals and flexibility of food intakes seasonally.

Dietary pattern

Dietary data collected from participants were analyzed statistically to generate the combinations of foods (dietary patterns) people are eating. Observed dietary pattern comprised of grains mainly refined grains (white bread, stiff porridge,

Table 1. *Food items found in hospitals and their prices.*

# of items	Food item	Unit kg	Cost
	Sugar	1	2300
	Tea leaves	0.3	15000
	Salt	1	16000
	Cooking oil	1	4400
	Rice	1	2500
	Onions	1	1500
	Tomatoes	1	1400
	Carrots	1	1400
	Meat	1	7000
	Beans	1	2300
	Chicken	1	6800
	Cabbage	1	700
	Amaranth	1	700
	Wheat flour	1	1300
	Whole maize flour	1	900
	Eggs	1	400
	Whole fresh milk	1	1200
	White bread	1	1100
	Pasta	1	1500
	Irish potatoes	1	1400
	Green pepper	1	2000
	Margarine	1	4000
	Unripe banana	1	2200
	Ginger	1	1400
	Garlic	1	2000

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chapatti, chips), vegetables, legumes (kidney beans), meat (beef) as shown in (**Table 2)** with their daily intake quantity.

Dietary diversity

Food groups used to calculate dietary diversity score from the hospital menus were vegetables, fruits, refined grains, oils, whole grains, seafood, poultry, seafood, fish legumes nuts and seeds. The obtained dietary diversity score from hospital dietary pattern was 4.

Nutrient intake

Nutrients intake from observed intake was as follows potassium 2628 mg, sodium 1139 mg, phosphorus 2023 mg and protein 42 g. Others iron 1.5 ± 0.8, zinc 0.56 ± 0.4, and chromium 1.9 ± 1.2 as shown in (**Table 3)**.

Discussion

Healthy' dietary pattern is categorized by high intakes of vegetables, nuts and seeds, legumes, whole grains, meat alternatives, fruit, fish, seafood and spices. A healthy dietary pattern associate with positive health outcomes. It is characterized by the inclusion of all major food groups including vegetables, fruits, whole grains, seafood, poultry, seafood, fish legumes nuts and seeds. It is possible to develop a dietary pattern that can generate adequate essential nutrients for patients with kidney disease at minimum cost while maintaining the limitations of specific nutrients. A healthy dietary pattern should consider nutrient content in food ingredients especially levels of potassium, protein, sodium, potassium, and phosphorus [18,19]. With consideration of each food group to ensure balanced and dietary diversity, food ingredients with the lowest levels of these nutrients (potassium, protein, sodium, potassium, and phosphorus) were included in the dietary pattern for management of kidney disease based on their approximated nutrients. The amount to be taken in foods with the highest level of potassium, protein, sodium, potassium, and phosphorus should be limited.

The observed dietary pattern from hospitals had a total of 25 food items collected from requisition books in hospitals' catering units. Four food groups were mainly consumed in the hospitals however, refined grains were commonly consumed

Table 2. *Observed intake versus optimized intake of food groups among hospitalized CKD patients.*

Food group	Recommendation(g)	Observed intake(g)	Final Optimized (g)
Grains	30-45	1265.5±12.5[b]	745.09
Roots, tubers, and plantains	20-44	39±10.5	340
Legume	75	20±5.46[a]	140
Nuts and seeds	30	-	-
Vegetables	400	50±2.5[a]	1209
Fruits	400	-	-
Meat, poultry	85	40±1.5[a]	103.3
Eggs		-	64.78
Fish and seafood	150 per week	-	150
Dairy products	244	38	150
Fats and oils	44- 77	24±1.2[a]	4.6[a]
Sweets		-	-
Spices, condiments,		38	-
Total cost TSH(USD)		**2782 (1.2)**	**3000(2.37)**

[a]*Represents an inadequate intake among a defined food group*

[b] *Represents an excess intake among a defined food group*

Table 3. *Obtained dietary patterns from optimization models.*

Food group	Standards (g/day)	Optimized (g/day)
Grains	30-45	**36**
Roots, tubers, and plantains	20-44	48
Legume(pulses)	100	342
Nuts and seeds	30	48.1
Vegetables	400	378
Fruits	400	592
Meat, Poultry, and insects	28.3	12
Eggs	3 eggs per week	2
Dairy	147ml	164.5ml
Fish and seafood	300-400 per week (85g/day)	25
Fats and oils		22.6
Sweets		0
Spices and condiments		
Total cost		**3500TSH (1.16 USD)**

**New food ingredient added, locally available*

compared to other food groups. The average intake of refined grains comprised of chapatti, white bread, and white rice (1265.5 ± 12.5 g) was higher compared to vegetables and legumes with (20 ± 5.46 g) as per recommendation. While some food groups such as kinds of seafood, nuts, and seeds; and fruits were not included in their diet. Few food ingredients lead to limited dietary diversity among patients as a result of an inadequate supply of essential nutrients [20] (**Table 4**).

Patients with kidney diseases have been reported to have various complications which lead to difficulty in planning diets suitable for their conditions (**Table 5**). Instead, health care providers opt to restrict the inclusion of foods with high potassium, sodium and phosphorus. This affects dietary diversity, as a result, failure to meet other essential nutrients. Dietary diversity is important to identify the food groups which are mostly consumed (dietary pattern) in a given setting.

Table 4. *Comparison between average observed nutrients intake and optimized intake from hospitals' food ingredients.*

Nutrients	Recommendation	Observed intake	Initial Optimized
Calorie (kcal)	1600	2000±10	1820
Protein (g)	60	42[1]	58.2
Total fat (g)	36.7	60.9	45
Omega-3 (g)	1.6	89.2	1.9
Omega-6 (g)	14	140	140
Fiber (g)	30	10±7.5	12[1]
CHO (g)	130	334±12	330[2]
Ca (mg)	1000	970±23.2	2000
Fe (mg)	8	1.5±0.8[1]	2.4[1]
Mg (mg)	420	98	50[1]
P (mg)	700	2023	1000[2]
K (mg)	4700	2.628	5000
Na (mg)	1200	1139	1600[2]
Zn (mg)	11	0.56±0.4[1]	1.4[1]
Se (µg)	60	2.3±1.5[1]	12.4[1]
Cu (mg)	430	160	430
Flu (mg)	4	67	14
Mn (µg)	2.3	134	2.3
Cr (µg)	33	1.9±1.2[1]	3.5[1]
Vit.A (µg)	200	111±20[1]	180[1]
Thiamin (µg)	200	124[1]	200
Rib (µg)	400.5	137[1]	630.1
Niacin (mg)	35	16±12[1]	35
Vit. B6 (mg)	100	13[1]	20.9[1]
Folate (µg)	1000	30±14.9[1]	84.3[1]
Vit B12 (µg)	120	110[1]	134
Path (µg)	12	0.4	120
Vit C (mg)	1000	16±3.1[1]	21.4[1]
Vit D (µg)	110	51	110
Vit E (mg)	12000	38±2[1]	100[1]
Vit K (µg)	2232	145	223
Choline (mg)	3.5	20±1.54[b]	3.5
Biotin (µg)	115	9	115

[1] *Inadequate intake per defined nutrient*

[2] *Excess intake of a defined nutrient*

Table 5. *Adjustment of nutrients-based stage of chronic kidney disease.*

CKD stage	Nutrients	Requirements
1 to 2	Protein	0.8g/kg/day to 1g/kg/day
3 to 4	Protein	0.6-0.8g/kg/day
Dialysis	Protein	1.2g/kg/day to 1.3g/kg/day
Dialysis	Calorie	30-35 kcal/day
Malnourished patient	Protein	1.5g/kg/day
	Potassium	3g/day
	Sodium	<1.5g/day
	Fluids	
	Calcium	800-1000mg/day
	Phosphorus	800mg/day

Source: (Kalantar-Zadeh and Fouque 2017; Jee, Obi, and Tortorici 2017).

Thirteen (13) food groups were categorized according to FAO classification including vegetables, fruits, cereals, roots and tubers, legumes, nuts and seeds, meat, fish and other seafood, eggs, poultry, milk and milk products, oils and fats, sweets, spices condiments and beverages. Then, dietary diversity was calculated by summing the number of daily major food groups consumed by patients during hospitalization. Any food item from a given food group included in a meal per day was taken into consideration. Unfortunately, obtained dietary diversity score had poor food varieties in which even when meet the minimum intake score but could not provide adequate nutrients as per recommendation.

Micronutrients are components of metalloenzymes and participate in reactive oxygen metabolism, free radical scavenging, and hormone activities. Therefore, the micronutrient levels are significant in ensuring optimal management among patients with chronic kidney disease. Observed food intake among patients did not meet an adequate distribution of nutrients especially some specific micronutrients with the exclusion of nutrients targeted to be minimized. Some previous studies have also reported inadequate intake of required nutrients among hospitalized patients. The same as the first model optimized using only hospital food ingredients found in hospitals showed an inadequate distribution of some nutrients such as iron, folate, vitamin A, vitamin C, vitamin E, zinc, calcium, chromium, and selenium [2,21].

Common nutrients which are limited among patients with chronic kidney disease include sodium, potassium and phosphorus, despite of their advantages in the body. For instance, Sodium is an electrolyte involve in the control of the fluids going in and out of the body's tissues and cells, regulates blood pressure and blood volume, nerve function and muscle contraction, the acid-base balance of blood, balancing how much fluid the body keeps or eliminates. Potassium is also essential for maintaining fluid and electrolyte balance in the bloodstream. Followed by the normal kidneys which help to keep the right amount of potassium, sodium and phosphorus in your body and they expel excess amounts into the urine. When kidney function is compromised, the kidneys no longer remove excess phosphorus. High phosphorus levels can pull calcium out of your bones, making them weak. This also leads to dangerous calcium deposits in the blood vessels, lungs, eyes, and heart.

Therefore, the model designed to ensure the distribution of nutrients in a diet from optimized pattern do not exceed the range of these nutrients as per recommended levels to patients. Linear goal programming applied in which new food ingredients available near the hospital settings with minimum cost and culturally acceptable were added to the model (**Table 6**). Food items added were to fulfill all food groups missing from hospital dietary patterns, these include nuts and seeds; fruits and fish and seafood and increase food varieties. All vegetables recommended for patients with kidney disease selected from food groups with lower levels of potassium and phosphorus. Though other foods with medium and high levels of potassium and phosphorus are encouraged to be unsalted then peeled or sliced and cooked in a large amount of water to reduce potassium through evaporation [22]. Patients with kidney disease should restrict any raw vegetables as they are high in potassium, potassium, and phosphorus. Examples of foods with lower potassium and phosphorus levels included in the optimized dietary pattern were cucumber, lettuce, green pepper sweet, chard, Chinese cabbage, beans sprout, and green beans. The recommended intake is only ½ cup per serving. In which each serving can provide about 20 mg phosphorus, 1 g protein, 15 mg sodium and 25 kcal calories.

In dairy food group, one serving of milk contains 100 kcal, 4 g protein, 5 g fat, 185 mg potassium, 110 mg phosphorus, and 80 mg sodium. At least ½ cup per serving is enough for patients with chronic kidney disease. However, the intake should be limited based on fluid amount intake per day which is a total of 1000 ml. Recommended whole bread, pancake and white bread intake per serving is 1 slice as it provides 80 kcal, 35 mg potassium, 2 g protein, 80 mg sodium, 15 g carbohydrate, and 1 g fat. During the planning diet, processed cereals such as bread and other starches were limited by linear programming based on their sodium and other inorganic minerals (potassium, phosphorus and sodium) content.

It is recommended one serving of meat per day for patients with kidney disease. One serving of all meat groups is consists of 7 g, 4 g, 65 kcal, 25 mg, 100 – 120 mg, and 65 mg of protein, fat, calories, sodium, potassium, and phosphorus respectively. Therefore, optimized diet limited meat amount to 28 g (1 oz.) to prevent excess protein, potassium and sodium. Thus, the optimized meat group was limited per serving. Fruits with low potassium were selected to be included in diet planning. These include apples, blueberries, cranberries, grapes, lemon, papaya, peach, and pears. Fruits with medium potassium content include pineapple, mango, papaya, tangerines, watermelon, and peach are recommended to decrease intake quantity. Recommended intake is about 1 cup of fruits with the lowest potassium level while fruits with medium and high potassium the recommended intake required to be lowered between ¼ to ½ cup per serving where each serving provides 15 g carbohydrate, 15 mg phosphorus, 1 to 2 mg sodium, 60 kcal energy and 0.5 proteins (**Table 7**).

This group is considered to contribute calories thus, during diet planning it is required to identify food ingredients with desired and healthy fat content. Recommended unsaturated intake is 1- 2 Tbsp per serving such as sunflower oil, corn oil, olive oil, canola, and others of the like. Each serving provides about 45 kcal, 15 mg potassium, 55 mg sodium, 55 mg phosphorus, and 0 proteins. Therefore, the diet pattern had an emphasis on limiting to 1-2 tablespoons per serving (**Table 8**). The observed dietary pattern had a low cost per patient's intake per day approximated 2782.7 Tanzanian shillings (1.20 USD) compared to the optimized dietary pattern which was Tanzanian shillings 3500 (1.5 USD). Optimized dietary patterns using available food ingredients to ensure patients' diets cover at least all food groups while considering food items with low potassium, phosphorus and sodium [23].

Table 6. *Obtained nutrients from optimized dietary patterns using a linear goal programming.*

Nutrients	Observed intake	Standard	Model 1	Model 2	Model 3
Calorie *kcal*	2000±10	2100	2500	2000	2100
Protein *g*	42	46	60	59	50
Total fat *g*	60.9	333.3	48.3	45	40.3
ω -3 *g*	89.2	1.1	1100	1200	1500
ω-6 *g*	140	12	1200	1500	1000
Fiber *g*	10±7.5	35	25	15	10
CHO *g*	334±12	130	130	200	230
Ca *mg*	970±23.2	1000	3000	3100	2900
Fe *µg*	1.5±0.8[b]	18	20	25	18
Mg *mg*	98	465	300	500	200
P *mg*	2023	700	500	500	400
K *µg*	2.628	3554.1	4.7	4.7	4.7
Na *mg*	1139	246.8	1500	1300	1000
Zn *µg*	0.56±0.4[b]	8	12	8	10
Se *µg*	2.3±1.5[b]	550	490	500	510
Cu *µg*	160	100.4	100	160	179.5
Flu *µg*	67	103	300	228	110
Mn *µg*	134	1.8	1.8	1.8	1.8
Cr *µg*	1.9±1.2	25	25	30	45.9
Vit.A *IU*	111±20[b]	2010	1560	1160	1453
Thiamin *µg*	164	150	300	320	253
Rib *mg*	137	65	801	900	860.1
Niacin *mg*	1612	305.4	350	350	350
Vit. B6 *mg*	135	100	100	150	300
Folate *µg*	30±14.9[b]	100	400	300	120
Vit B12 *µg*	140	8	10	10	10
Path *µg*	0.4	120	60	60	60
Vit C *mg*	76±3.1[b]	2100	1200	2000	1800
Vit D *µg*	51	100	100	200	320
Vit E *mg*	38±2[b]	1000	1400	1000	1200
Vit K *µg*	145	200	3	105	200
Choline *mg*	20±1.54[b]	3.5	410	472	400
Biotin *µg*	9	100	180	120	159

[b] *Represents inadequate intake of a given nutrient*

Table 7. *Sample diet plan for patients with kidney disease using an optimal dietary pattern.*

Meal	Diet plan 1 2500kcal	Diet plan 2 3000kcal	Diet plan 3 2000kcal	Diet plan 4 2100kcal
Breakfast	cauliflower ¼ cup Egg 1 Toast bread 1slice Pineapple ½ cup Coffee ½ cup Sugar 2 tsp Salt 1/8 tsp	Apple juice ½ cup Pears ½ Margarine 1tsp Egg 1 Toast bread 1 slice Coffee 1cup	Corn flakes ½ cup Strawberries 5 Low-fat milk 1 cup Nuts 1 tbsp Margarine 1 tsp	Egg whole 1 Lamb 1oz Honey 1tbsp Margarine 1 tsp Pancake 1 small Coffee ½ cup
Lunch	spaghetti ¼ cup roast beef 1 oz(28g) white rice ¼ cup carrots ½ cup margarine 1tsp sugar 1tsp papaya	Beef 2 oz Rice ½ cup Cabbage 1 cup Sugar 1tsp 1 cup carrots Strawberries 5 Vegetable oil 1tsp	Fresh beans ¾ cups Low-fat milk 1/8 cup Spinach 1 cup Salad ¼ cup cucumber 1 cup	milled maize flour ½ cup lima beans ½ cup Cucumber slices 1/2cup Lemon ½
Afternoon snack	Cucumber 1 medium	Enriched bread 2 slice	Popcorn, no salt cups	Oyster 1 ½ oz
Dinner	Green beans 1cup Chicken without skin 2 pieces Apple juice ½ cup Bread white, 1 slice Pears	Roast turkey 2 oz Pasta ½ cup green beans 1 cup Tea 1 cup Honey 1 tbsp	Catfish 1piece Sweet potatoes 2 scoops Cauliflower ½ cup Apple 1	Potatoes 1cup Green beans 1 cup Mango 1 piece Rice 1/3 cup
Food Cost per day	TSH 5000 (USD 2.16)	TSH 6000 (USD 2.59)	TSH 7500 (USD 3.23)	TSH 8,000 (USD 3.45)

Tbsp.-tablespoon; tsp-tea spoon

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Table 8. *Sample diet plan for patients with kidney disease and diabetes using an optimal dietary pattern.*

Meal	Diet plan 1 1477kcal	Diet plan 2 1545kcal	Diet plan 3 1700kcal
Breakfast	Bagel 1 Apple 1 medium Cream milk 1 tbsp Whole milk 4 oz	Popcorn ½ cup Bread toast 1 slice Non-fat milk ½ cup Egg 1 Margarine 1tbsp	Cranberry juice 4 oz Rice ½ cup Peach 1 medium Whole milk 4 0z
Lunch	Bread 2 slices Turkey roast 2oz Carrots ½ cups Strawberries 1 cup	Bread 2 slice Chicken without skin 2 oz Broccoli 1 cup Strawberries ½ cup Mayonnaise 1tbsp Non-fat milk 1 cup	Bread 2 slice Roast beef 2 0z Carrots ½ cup Apple ½ cup Mayonnaise 2tbsp
Afternoon snack	Popcorn 3g	Non -fat milk ½ cup	Popcorn 1 scoop
Dinner	Roast beef 3oz Rice 2/3 cup Green beans ½ cup paster 1 cup	Chicken 3 0z Rice ½ cup Cabbage 1 cup Pasta 1 cup Margarine 1tbsp Non-fat milk 1 cup	½ rice Apple 1 Beans sprout ½ cup Pasta ½ cup
Food Cost per day	**TSH 3000 (USD 2.16)**	**TSH 3100 (USD 2.59)**	**TSH 3500 (USD 3.23)**

Tbsp.-tablespoon; tsp-tea spoon

Conclusion

Particularly, appropriate nutritional management of kidney disease based on a comprehensive assessment of individual conditions, risks, and compliance is necessary. To meet adequate diet for management of kidney disease while meeting the nutritional requirements of patients is important. This means, development of healthy dietary patterns easier the generation of adequate diet plans useful during hospitalization. Also, provides patients with foods based on their preferences, affordable cost as a result of reduced mortality. A healthy diet is a basic requirement for promoting and maintaining good health during illnesses of diseases such as chronic kidney disease and other renal diseases. An adequate diet is important as it helps early recovery and prevents the progression of disease-associated complications such as hypertension and death. It can generate cheap diets based on local market available food ingredients and costs. Dietary patterns developed may not only be used in hospitals but also by outpatients to help them meet their recommended nutritional requirements at affordable costs. The generated adequate diet also is important as it may improve the patient's outcome as well as reduce the hospitalization longevity.

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