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Original Article

Dietary Protein Consumption Pattern in Hyperphosphatemia Management Among Haemodialysis Patients: A Cross-Sectional Study at Kenyatta National Hospital, Kenya

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Nutrition Status, Dietary Protein, Haemodialysis, Hyperphosphatemia, Low Phosphorus Diet.

ABSTRACT

Poor nutrition status in haemodialysis patients is associated with high mortality rates. A low phosphorus diet is likely to compromise dietary protein intake and nutrition status in this population. This study evaluated dietary protein consumption pattern and nutrition status among forty out-patient haemodialysis patients from Renal Unit at Kenyatta National Hospital using cross-sectional study. The Chi-square test and Kruskal–Wallis H test were used to determine relationship between variables. More than half (58%) of the patients were male. Study participants had a mean age of 45.4±14.7 years with the majority (40%) between 40-59 years. More than three quarters (88%) had poor nutrition status with more than a third (38%) severely undernourished. More than half of the patients (53%) had dialysed for a period of more than one year. Most of study participants consumed only five types of legumes. Yellow bean, butterfly Kenyan kidney bean, butterfly haricot bean, red kidney bean and green lentil were commonly consumed legumes; 2-4 times per week by 45%, 23%, 23%, 8% and 15% of the patients respectively. Beef was the most consumed animal protein by more than half (53%) of the patients in 2-4 times a week. Second most consumed animal protein was egg white at least 2-3 times a week. Majority of the patients (58%) had poor knowledge scores (<50 % score) on food phosphorus reduction food preparation procedures in protein rich foods. This study found high prevalence of poor nutrition status and inadequate consumption of dietary protein among haemodialysis patients. This study recommends nutrition education and counseling on locally available dietary proteins and their preparation in order to meet dietary protein requirements without risk of hyperphosphatemia.

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INTRODUCTION

Chronic kidney disease (CKD) impacts more than 800 million individuals worldwide (Kalantar-Zadeh et al., 2010). It has been identified as the twelfth leading cause of global mortality (Carney, 2020). The disease burden is estimated to result in approximately 35.8 million disability-adjusted life years (DALYs) (Bikbov et al., 2020). A decrease in kidney function is linked to elevated serum phosphate levels or hyperphosphatemia especially when the estimated glomerular filtration rate (eGFR) falls below 29 ml/min/1.73 (Rastogi et al., 2021).

Persistent elevated serum phosphorus levels are associated with chronic kidney disease -mineral bone disorder (CKD-MBD), cardiovascular calcification, and secondary hyperparathyroidism (SHPT). Cardiovascular calcification is a significant risk factor in the progression of cardiovascular disease, that contribute to more than half of the deaths reported in haemodialysis patients. While dialysis therapy is the primary intervention for patients with end-stage chronic kidney disease, it may not be entirely effective in eliminating all metabolic waste especially phosphate. The primary source of phosphorus in the body is predominantly from diet. Restricting dietary phosphorus plays a critical role in the prevention and management of CKD-MBD in haemodialysis patients (Bikbov et al., 2020; Doshi & Wish, 2022; Vogt et al., 2019).

Importantly, decrease in glomerular filtration rate (GFR) is associated with metabolic changes that contribute to protein energy wasting (Hendriks et al., 2021). Consequently, without appropriate nutrition intervention, high prevalence of under-nutrition is likely to occur among haemodialysis patients (Sahathevan et al., 2020). Patients undergoing regular haemodialysis require a high protein diet to counteract catabolic nature of the heamodialysis treatment, However, there are challenges in achieving adequate protein intake. Firstly, reduced oral intake resulting from suppressed appetite due to uremic toxins which hinders overall food intake (Fathurrohman et al., 2020). Secondly, inherent relationship between dietary protein and phosphorus in foods poses practical challenges in meeting high protein requirements among haemodialysis patients without surpassing the recommended dietary phosphorus intake levels in absence of appropriate dietetic intervention (Picard et al., 2021).

Medical nutrition therapy plays a critical role in management of haemodialysis patients. Prompt nutrition assessment and provision of appropriate nutrition intervention are critical in improving haemodialysis patients' clinical outcomes. Adequate protein intake among haemodialysis

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patients may argument deterioration of nutrition status and improve clinical outcomes without risk of hyperphosphatemia (Bramania et al., 2021; Kalantar-Zadeh et al., 2020). To our knowledge, there are no studies which have investigated dietary protein consumption pattern and knowledge on their preparation in dietary phosphorus load reduction among haemodialysis patients. Therefore, the main purpose of this study was to evaluate dietary protein consumption pattern and knowledge on phosphorus reduction food preparation procedures among haemodialysis out-patients at Kenyatta National Hospital, Kenya.

MATERIALS AND METHODS

Study Setting

This study was conducted between 20th May 2022 and 5th July 2022 at Kenyatta National Hospital (KNH) in Nairobi County, Kenya. The KNH serves as the largest government teaching and referral hospital in Kenya. It has the Renal Unit which offers nephrology services countrywide. Most referrals in the unit consist of patients with end-stage renal disease (ESRD) with catheter related complications or dialysis related complications. It also has an outpatient dialysis unit.

Study population

The study participants were selected from the patients who were undergoing maintenance haemodialysis sessions as outpatients at the Renal Unit in KNH. The inclusion criteria were as follows: outpatients who were eighteen years old and above, clinically stable, undergone maintenance haemodialysis for at least two months, able to communicate and willing to provide informed written consent. Patients who previously underwent kidney transplant were not included in this study. All study participants who met the inclusion criteria were included in the study.

Study procedure and data collection

Data were collected using a semi-structured researcher administered questionnaire. Research assistants received three days of training before the implementation of the study on questionnaire administration and anthropometric measurements. A pilot study was conducted using a sample of ten haemodialysis in-patients in a different ward to determine the reliability and validity of research instruments. This sample was not included in the final analysis.

All patients on maintenance haemodialysis attended dialysis sessions twice per week. Their bi-weekly dialysis schedules were as follows: Monday and Wednesday, Tuesday and Thursday and Wednesday and Saturday or Sunday. On the day of dialysis, patients were approached by research assistants as they waited for their turn to dialyze and were explained on the details of the study. Those who met eligibility criteria and provided written informed consent were enrolled in the study.

The patients' socio-demographic data collected included age, sex, marital status and education level. Clinical data gathered included vintage time and estimated glomerulus filtration rate. Biochemical data included serum urea, serum creatinine, serum albumin and serum phosphate levels. Nutrition assessment was performed using the subjective global assessment dialysis malnutrition score (SGA-DMS) tool. The SGA-DMS score tool gathered data related to study participants' medical history and nutrition-focused physical examination. Study participants' related medical history had five components: weight loss for the last six months, change in dietary intake, functional capacity (nutritionally related functional impairment) and comorbidity. Each of these components had five variables. Nutrition-focused physical examination had two components namely, assessment of loss of subcutaneous fat and loss of muscle wasting. Each of the components had five variables (Janardhan et al., 2011).

A score of between one and five was assigned to each of the variables above based on the extent of change. A score of one was assigned to no change, and a score of five was assigned to extreme change.

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For example, zero changes in weight for the last six months was assigned a score of one, while weight loss of more than 15% in the last six months was assigned a score of five. A total of seven to ten points was assigned to normal nutrition status while a total score of between eleven and fifteen points was assigned to moderate malnutrition, and a total score between sixteen and thirty-five points was assigned to severe malnutrition (Bramania et al., 2021).

A food frequency questionnaire (FFQ) was used to assess the consumption pattern of dietary protein in the past one month. The FFQ had a list of plant protein and animal protein food items likely available in Kenyan food markets. It had seven response categories from which study participants had to choose. The response categories on consumption were as follows: twice per day, once per day, 2-4 times a week, once a week, 2-3 times a month, once per month and never. This FFQ was adapted from a validated semi-quantitative FFQ for the Kenyan urban adult population by Vila-Real 2021(Vila-Real et al., 2021). In order to enhance memory recall, visual aids such as pictures of different types of legumes commonly available in the Kenyan food market were used (Dodd et al., 2020; Gallani et al., 2021).

A five-item questionnaire was designed to assessed knowledge on phosphorus food preparation procedures in legumes and animal protein. Correct multiple-choice question had a score of two points and open-ended questions had a score of two points each. After scoring, all scores were converted into percentages by dividing individual scores by total scores and then multiplying by a hundred. These scores were graded based on validated cut offs as follows: more than 75% good knowledge, 50-<75% fair knowledge and <50% poor knowledge ((Bikbov et al., 2020; Carney, 2020; Kovesdy, 2022).

Ethical Considerations

This study was approved by the Kenyatta National Hospital-University of Nairobi (KNH-UoN) research and ethics committee under approval number P876/11/2019. All eligible study participants were briefed on the study protocol, and informed written consent was obtained before they were included in the study. Study participants' confidentiality was assured by assigning a unique identification code to their questionnaires during study data collection and analysis rather than using their actual names.

Statistical analysis

Data were analysed using the Statistical Package for Social Sciences (SPSS, version 21, Chicago, IL, United States). A P-value of ≤0.05 was considered statistically significant. The Kolmogorov–Smirnov test for normality was done to all variables before proceeding with statistical analysis. All continuous variables were presented in terms of means ± standard deviations while categorical variables were presented as percentages. The chi-square test was used to determine the relationship between categorical variables. The Kruskal–Wallis H test was used to determine statistically significant differences between continuous variables and ordinal variables.

RESULTS

Socio-demographic data and clinical characteristics of the study participants

A total of forty haemodialysis patients were enrolled in the study. Fifty-eight percent (n=23) of the study participants were male. The mean age was 45.4±14.7 years, with the majority (40%) between 40-59 years. The vintage time had a median duration of dialysis of 16.5 (IQR: 7-29) months. The majority (53%) of the study participants had secondary school education. The median serum urea level (n=33) was 19.9 (IQR: 15-27) mmol/L. Ten percent (n=3) of study participants had elevated serum phosphorus levels. Majority of study participants, 58% (n=23) had poor knowledge (<50 % score) on food preparation procedures to reduce phosphorus in protein-rich foods. Out of these, 89% (n=20) were under-nourished, (Table: 1).

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Nutrition status and dietary changes of study participants

The prevalence of under-nutrition among the study participants was 88% (n=35). Of these, 50% (n=20) were moderately undernourished and 38% (n=15) were severely undernourished according to SGA-DMS score. Fifty-five percent (n=11) of study participants who were moderately undernourished had lost 5-10% of their body weight within the last six months, while approximately 47% (n=7) of those severely undernourished had lost more than 15% of their body weight within the same period (P value=0.001). Fifty eight percent (n=20) of undernourished study participants had a mild to moderate loss of subcutaneous fat, while forty nine percent (n=17) of undernourished study participants had a mild to moderate loss of muscle mass. The most common gastrointestinal symptom reported was vomiting among 35% (n=12) of undernourished study participants. Approximately thirty-five percent (n=12) of undernourished study participants reported dietary changes that consisted of the intake of a sub-optimal solid diet during study period. Ninety percentage (n=17) of study participants who had poor knowledge on phosphorus reduction food preparation procedures were under-nourished (P-value-0.936), (Table: 1).

Table 1: Distribution of study participants by prevalence, under-nutrition status, socio-demographic and clinical characteristics. N=40

Demographic characteristics and biochemical/clinical indicators	Sample Distribution(p%)	Proportion under-nourished n(p%)	P Value
Age (Years)			
18-39	15(37)	15(100)	
40-59	16(40)	12(75)	0.325**
60 and above	9(23)	8(89)	
Gender			
Male	23(58)	19(74)	
Female	17(42)	16(95)	0.405**
Marital status			
Married	27(68)	21(78)	0.671**
Single	13(32)	12(94)	
Education Level			
Primary education	7(15.7)	6(86)	
Secondary education	23(57.5)	20(96)	0.874**
Tertiary education	10(25)	9(90)	
Vintage time in months			
Below 12 months	17(43)	14(83)	
Between 12 - 48 months	21(53)	18(86)	0.659**
Above 48 months	2(5)	1(50)	
Serum Phosphorus Level(n=29)			
Low phosphorus	15(38)	13(87)	
Normal Phosphorus	11(28)	10(91)	0.656**
High Phosphorus	3(8)	3(100)	
Serum Albumin (n=26) (median, IQR) mmol/l	35.9(30.9-39.9)		0.353*
Serum Urea (n=33) (median, IQR) mmol/l	19.9 (15-27)		0.408*
eGFR (median, IQR) (n=33) ml/min/1.73^2	6(5-8)		0.959*
Knowledge on phosphorus reduction food preparation procedures			
<50% Poor knowledge	19(48)	17(90)	
50-70% Fair knowledge	16(40)	14(88)	0.936**
>70% Good knowledge	5(12)	4(80)	

Footnote: Numbers in parentheses () are proportions ** Chi-square test analysis; * Kruskal–Wallis H test analysis test

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Dietary protein consumption pattern

Plant-based proteins consumption pattern

a) Bean consumption pattern

Most of the study participants (78%, n=31) consumed yellow bean. Approximately 58% (n=18) of the study participants who consumed yellow bean used it at least 2-4 times per week. Butterfly Kenyan kidney (Nyayo) beans was another relatively common type of bean which was consumed by approximately 37.5% (n=15) of the study participants. About 60% (n=9) of the study participants consumed it at least 2-4 times per week. The third most consumed type of bean was butterfly haricot beans (Wairimu) by 72% (n=29) of the study participants. About 31% (n=9) of these study participants consuming it at least 2-4 times per week. Saitoti and Red kidney beans (gituru) were consumed by 32% (n=13) of the study participants, with 23% (n=3) consuming it at least 2-4 times per week, (Figure 1). The rest of study participants either rarely or never consumed other types of bean protein.

b) Lentil consumption

In this category of legume, only green lentil (Ndengu) was consumed by about forty-three percent (n=17) of the study participants. However, only about 35% (n=6) consumed green lentils at least 2-4 times per week. The rest of study participants never consumed any other type of lentils, (Figure 1).

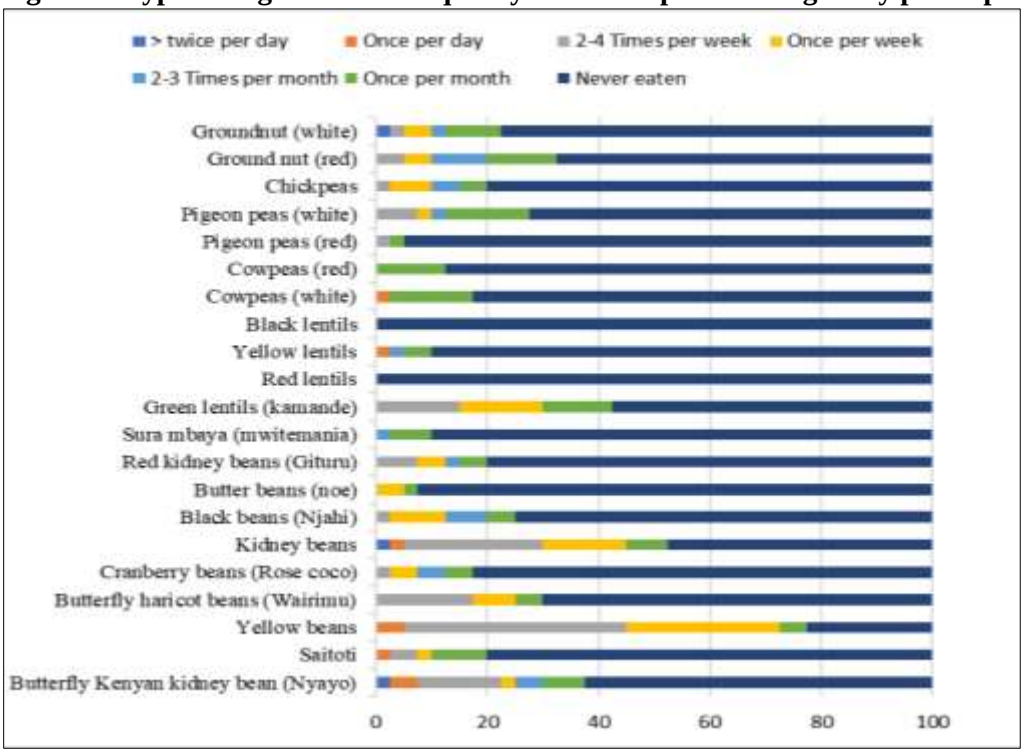
c) Peas consumption

Cow peas, pigeon peas and chickpeas were the most commonly consumed type of peas but by a small proportion (20%, n=8) of study participants, (Figure 1).

d) Oil seed pulse consumption

About a third of study participants (33%, n=13) consumed both red and white groundnut. Among these study participants, 69% (n=9) and 55% (n=5) consumed red and white ground nuts at least once per month respectively, (Figure 1).

Figure 1: Types of legumes and frequency of consumption among study participants



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ii) Animal-based proteins

The most commonly consumed type of animal protein was beef by 53% (n=22) of the study participants, 2-4 times a week. This was followed by egg white which was consumed by 38%(n=15) of study participants, 2-3 times a week. The rest of study participants either rarely consumed animal proteins, (Table 2).

Table 2: Types of animal protein and consumption frequency by study participants, N=40

Type of animal protein	Once per day	2-4 Times per week	Once per week
	n (%)	n (%)	n (%)
Fish	0	13 (32.5)	8(20)
Chicken	1(2.5)	6(15)	11(27.5)
Beef	1(2.5)	21(52.5)	7(17.5)
Mutton	0	1(2.5)	3(7.5)
Goat	0	3(7.5)	8(20)
Matumbo	0	2(5)	1(2.5)
Liver	0	4(10)	2(5)
Pork	0	3(7.5)	1(2.5)
Whole egg	0	15(37.5)	8(20)
Egg white	1(2.5)	14(35.0)	10(25)

Footnote: Numbers in parentheses () are proportions ****** Chi-square test analysis; ***** Kruskal–Wallis H test analysis test

DISCUSSION

The present study was conducted to evaluate qualitative dietary protein consumption pattern of patients of maintenance haemodialysis. It also evaluated their knowledge on phosphorus reduction food preparation procedures. The study also assessed their current nutrition status. This study evaluated forty adult patients on maintenance haemodialysis who met the inclusion criteria.

The majority of haemodialysis patients were male and in late middle age with a median vintage time of nearly one and a half years. This was in agreement with a study conducted in Tanzania that found that haemodialysis patients had a vintage time of one and a half years (Bramania et al., 2021). However, two studies from Egypt and Iran reported different findings where study participants were older (average age of 61.15 ±13.06 years) and 27.76±31.45 months respectively (Emara, R.H. & Zahra, 2022). This difference is probably attributed to the fact that most haemodialysis patients at Kenyatta National Hospital are often short stayed.

In the present study, haemodialysis patients had a high education level, with the majority being high school graduates (Khamis, et.al., 2021). Three studies reported similar findings that the majority of haemodialysis patients had secondary school education (Alikari, 2019; Lazarus, 2019; Sayed et al., 2021). However, two studies, one from India and another from China, had different findings, where the majority of the study participants had less than secondary school education (Dsouza et al., 2023; Xi et al., 2023). The discrepancies in education level among the haemodialysis population across these regions may be attributed to varying geographical settings of education systems and socioeconomic structures.

In this study, SGA-DMS score composite tool to was used to assess the nutrition status of haemodialysis patients which revealed relatively very high prevalence of under-nutrition. This finding concurred with a recent study conducted in Wahu, China, which reported a prevalence of under-nutrition among haemodialysis of 85.7% (Yin et al., 2023). However, this prevalence was higher than

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the reported global prevalence of between 28% to 54% (Sahathevan et al., 2020). Also, two other recent studies that assessed nutrition status using the same tool in Iran and Tanzania in the same population reported a prevalence of under-nutrition of 57.3% and 98%, respectively (Afaghi et al., 2021; Bramania et al., 2021).

In these studies, a great variance is observed in prevalence of under-nutrition among haemodialysis patients even when the SGA tool was used to assess nutrition status. The SGA-DMS tool is highly sensitive in detecting under-nutrition among haemodialysis patients compared to body mass index, which could partly account for the reported high prevalence compared to the estimated global prevalence (Xi et al., 2023). Furthermore, the differences in the reported prevalence of malnutrition rates in these studies based on SGA-DMS tool in different regions may be attributed to different health care systems among haemodialysis patients and clinical presentation of haemodialysis patients during the time of assessment.

The present study found that the most common gastro-intestinal symptom among study participants was vomiting. Similar finding was reported in two studies conducted in Iran and Indonesia among haemodialysis population (Asgari et al., 2017; Fathurrohman et al., 2020). Nausea and vomiting in haemodialysis patient occur due to number of factors such as hyperkalaemia, inadequate dialysis, fluid overload, disequilibrium and presence of high urea levels. In addition, study participants reported dietary changes that consisted of sub-optimal solid diet intake. This finding was consisted with a recent study conducted in Tanzania which found haemodialysis patients on limited food intake due to nausea and vomiting in about 31.2% of the study participants (Bramania et al., 2021). Compromised oral food intake in haemodialysis patients may worsen nutrition status and affect quality of life and increase their risk of death (Kalantar-Zadeh et al., 2020; Sahathevan et al., 2020).

Nevertheless, despite study participants noted to have a high education level, most of study participants had poor knowledge on phosphorus reduction food preparation procedures on dietary protein foods such as legumes and animal proteins. This finding was comparable to two different studies that reported insufficient knowledge on dietary phosphorus among haemodialysis patients (El Khoury et al., 2021; Isa et al., 2020). Another study published more than a decade ago found that patients undergoing maintenance haemodialysis had poor knowledge on dietary phosphorus compared with knowledge on other nutrients important in chronic kidney disease (0.38 versus 0.72, $p = 0.003$) (Pollock & Jaffery, 2007). Observed poor knowledge on phosphorus reduction food preparation knowledge despite high education level among the study participants may be attributed inadequate nutrition education on dietary phosphorus.

In this study, a qualitative analysis of dietary protein intake using one-month food frequency questionnaire was done. The findings on this analysis suggested inadequate consumption of dietary protein. A limited variety and low frequency in consumption of both plant-based and animal based dietary proteins was noted. This finding was in agreement with two recently published studies among haemodialysis patients. One study reported that more than half of the study participants consumed less than one serving of legume per week (Falbo et al., 2023). Two other different two studies also found a low protein intake in 74.5% and 70% of haemodialysis patients (Emara, R.H. & Zahra, 2022; Gityamwi et al., 2021).

Another study also reported a low mean protein intake of 43.7±7.6 g per day (Su et al., 2022) This may be because haemodialysis patients are extremely vigilant regarding their dietary phosphorus food counts, leading to unreasonably highly restricted dietary protein intake. This potentially compromising on their dietary protein intake. Another possible reason may be intra-house-

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hold food insecurity. A number of studies have reported that most haemodialysis patients are unemployed or lack sustainable livelihoods. This adversely affects their ability to have economic access to buy adequate food to meet their daily nutritional requirements (Bramania et al., 2021; Clark-Cutaia et al., 2018; Emara, R.H. & Zahra, 2022).

In this study, prevalence of hyperphosphatemia was relatively low than expected. This finding was contradictory to three different studies in the same population that reported a relatively high prevalence of hyperphosphatemia of 43.9%, 51.2% and 60% (Hendriks et al., 2021; Isa et al., 2020; Sahathevan et al., 2020). An inherent relationship between protein and phosphorus may contribute to high protein intake with concurrent phosphorus intake. This may potentially lead to high dietary phosphorus load leading to hyperphosphatemia. On the other hand, unreasonably highly restrictive low phosphorus diet, characterized by low protein intake, may likely lead to poor nutrition status due to inadequate dietary protein intake (Picard et al., 2021).

A recent study found a statistically significant relationship between protein intake and dietary phosphorus adherence (OR =1.084, $p<0.001$). In general, this suggest that protein intake is the main determinant of dietary phosphorus adherence among haemodialysis patients (Emara, R.H. & Zahra, 2022). Inadequate dietary knowledge on appropriate protein foods to be consumed would probably explain another reason for low consumption frequency of dietary protein observed in this study.

Based on dietary protein consumption frequency of protein rich foods among study participants in this study, there was relatively low intake of plant-based proteins. This concurred with findings from another multinational prospective cohort study found that only 35.8% of study participants consumed plant-based proteins (Su et al., 2022; Yin et al., 2023). While the previous KDOQI nutrition guideline released in the year 2000 recommended more than half of dietary protein intake to be from proteins of higher biological value, such as animal proteins, the recent KDOQI nutrition guideline released in year 2020 encourages liberal used of plant-based proteins due to their outstanding positive benefits (Picard et al., 2021). Low protein intake observed in this study may relate to lag in practice due to use of previous KDOQI nutrition guideline.

Limitations of the study

The findings from this study may not be generalized to other haemodialysis patients owing to the heterogeneity of healthcare system structures for the management of chronic kidney disease patients in different geographical regions.

CONCLUSION AND RECOMMENDATION

This study found that majority of patients on maintenance haemodialysis had a high prevalence of under-nutrition. The study noted limited frequency and variety in consumption of dietary protein foods among haemodialysis patients. Also, there was inadequate knowledge on phosphorus reduction food preparation procedures. These results are important for patients and healthcare providers because under-nutrition is associated with increased odds of death in haemodialysis patients. This study recommends nutrition education and counseling on locally available dietary proteins and their preparation in order to meet dietary protein requirements without risk of hyperphosphatemia.

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Author contribution

AM developed the study protocol, collected the data, participated in data analysis (assisted by a statistician from Kenyatta National Hospital) and compiled the final report. SN, AA, PK and SM supervised the development of the protocol and provided input during manuscript development.

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Conflicts of interest

Authors have no conflicts of interest to disclose.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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