Appetite as a predictor of malnutrition in end-stage renal disease patients in Saudi Arabia

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ABSTRACT

Background and Objectives: Patients with chronic kidney disease (CKD) undergoing hemodialysis (HD) are at high risk for malnutrition. This study aimed to 1) Investigate the prevalence of malnutrition among CKD patients undergoing maintenance HD; 2) Assess level of knowledge and appetite among patients; 3) Identify potential predictors of malnutrition. **Methods and Study Design:** This cross-sectional study included 71 CKD patients on HD who were recruited from two principal outpatient dialysis centers located in Jeddah, Saudi Arabia. Data were collected using an interviewer-administered questionnaire which included sociodemographic and health characteristics, nutritional status (assessed using the Patient-Generated Subjective Global Assessment [PG-SGA]), biochemical data, nutritional knowledge, and appetite status (assessed using Council of Nutrition Appetite Questionnaire [CNAQ]). **Results:** Forty-four percent of patients included in this study were malnourished, and over half of the patients had limited nutritional knowledge and appetite. Hemoglobin level and the CNAQ score were found to be independently negatively associated with the PG-SGA score (B: -1.03 [95% confidence interval (CI): -1.99, -0.08] and B: -0.37 [95% CI: -0.64, -0.11], respectively). **Conclusions:** Renal healthcare professionals should assess the nutritional status of HD patients and identify barriers to adequate nutrition. Patients with poor appetite should specifically be targeted for nutrition-focused evaluation and management.

Key Words: malnutrition, appetite, hemodialysis, chronic kidney disease, nutritional status

INTRODUCTION

Chronic kidney disease (CKD) is a public health concern affecting around 9% of the population globally.[1] As CKD progresses to end-stage renal disease (ESRD), patients must be treated by dialysis or transplantation.[2] The Saudi Center for Organ Transplantation estimated the number of patients on hemodialysis (HD) to be around 15,590 patients, and projected rising numbers if the prevalence of diabetes and hypertension remained on the rise.[3]

Malnutrition refers to poor nutritional status resulting from inadequate dietary intake, poor absorption, or excessive loss of nutrients.[4] In patients with CKD, malnutrition may result from multiple factors, such as metabolic and hormonal derangements, infections, and poor energy and protein intake associated with poor appetite and taste.[5,6] The nutritional status of CKD patients could be further aggravated by the dialysis procedure and advanced uremia. During HD, patients lose approximately 8 g of free amino acids.[7] The HD procedure has also been shown to decrease protein synthesis and increase resting energy expenditure and protein breakdown, posing higher risk for malnutrition among patients. To compensate for the effect of HD and to maintain a stable nutritional status, the Kidney Disease Outcomes Quality Initiative (KDOQI) Clinical Practice for Nutrition recommends a protein consumption of 1.0-1.2 g/kg/day and energy intake of 25-35 kcal/kg/day.[2]

The multiple dietary restrictions recommended to CKD patients between HD sessions may be difficult to achieve and may result in poor diet quality and, ultimately, malnutrition.[8] HD patients are often required to carefully restrict their diets to avoid excess accumulation of phosphate, potassium, sodium, and fluids due to deteriorated kidney function.[9] Health care teams usually work with the patient to maintain safe levels and to encourage adequate intake of energy and nutrients. However, successful nutritional management requires sufficient knowledge of foods to be restricted and careful adherence to dietary recommendations.

The existing evidence suggest a high prevalence of malnutrition among CKD patients, ranging between 22% and 55%.[10-13] However, recent data in Saudi Arabia are lacking. This study aimed to 1) Investigate the prevalence of malnutrition among CKD patients undergoing maintenance HD; 2) Assess level of knowledge and appetite among patients; 3) Identify potential predictors of malnutrition. Such data are needed to support the development of evidence-based interventions in order to improve the nutritional status of CKD patients.

MATERIALS AND METHODS

This cross-sectional study included 71 patients recruited from two principal outpatient dialysis centers located in Jeddah, Saudi Arabia. The study included CKD patients on HD for at least one year, with normal cognitive function, requiring dietary restriction of phosphorus, potassium, and sodium, and residing in Saudi Arabia (Figure 1). Written consents were obtained from adult patients and parents of children. The study protocol and procedures were approved by the Unit of Biomedical Ethics at King Abdulaziz University Hospital [Reference No. 50-19]. Data remained anonymous for all patients to maintain confidentiality.

Measures

Data were collected using an interviewer-administered questionnaire, wherein questions and response options were read aloud, and answers were recorded by trained health care research team members. Content validity of the questionnaire was evaluated by four experts in the field who rated the questionnaire items, and modifications were made accordingly.

Study outcome: nutritional status

The Patient-Generated Subjective Global Assessment (PG-SGA) score was utilized to evaluate the nutritional status, which has been previously validated among CKD patients.[14-16] The numerically scored PG-SGA consists of medical history (history of weight change, changes in food intake, nutrition-related symptoms, and functional capacity) completed by the patients using a checkbox format, and physical examination assessed by the examiners to assess muscle and fluid status and fat stores, comorbidity conditions, and metabolic stress. Total scores of the PG-SGA assessment tool typically range between 0-35. A summative score ≥9 indicated malnutrition, and the higher score indicated a greater level of malnutrition.[15]

Sociodemographic and health characteristics, biochemical data, nutritional knowledge, and appetite status

Sociodemographic data regarding patients' sex, age, and monthly income in Saudi Riyals were collected. Health-related data included years on dialysis, history of diabetes, hypertension, anemia, and whether patients received dietary advice from a renal dietitian. Pre-dialysis biochemical data, including phosphorus, potassium, sodium, albumin and blood urea nitrogen (BUN) were collected from patients' electronic medical records.

Patients' knowledge of restricted foods (food sources rich in sodium, potassium, and phosphorus) was assessed using the following questions: Which of these foods are high in potassium (banana, apple, pomegranate, okra, spinach, potatoes, cucumber), phosphorus (milk, nuts, whole grain, apple), and sodium (canned foods, chips, eggs, cucumber). Response options for each food item were "Yes", "No", and "Not sure". Correct answers were recorded as "one", while incorrect answers and answers of "not sure" were recorded as "zero". The knowledge score for each nutrient was recorded, and the summative score of the patient's knowledge was calculated (maximum score=15). The patients were later categorized into two groups (limited and good knowledge) according to the median score.[17]

Patients' appetite was assessed using the Council of Nutrition Appetite Questionnaire (CNAQ).[18] The CNAQ is a screening tool that evaluates patients' appetite using 8 items: appetite, fullness after eating, feeling hungry, taste of food and flavor changes, meals eaten per day, feeling nauseous after eating, and usual mood. Each item was scored using a 5-point scale ranging from one to five. The summative score ranges from 8 to 40, wherein the lower score indicated a deteriorated appetite. Patients were classified into one of the two groups according to the total score of the CNAQ: poor appetite (CNAQ score 8 to 28) and good appetite (CNAQ score 29 to 40).[18]

Statistical analysis

Data were described using descriptive analyses. Internal validity of the CNAQ items was assessed using Cronbach's alpha. The associations between the PG-SGA scores and sociodemographic and health variables, biochemical data, knowledge scores, and CNAQ scores were tested using Chi-square test for categorical variables and Spearman's correlation test for continuous variables. Man-Whiney test was used to investigate the associations of the nutritional status (categorical variable) with continuous variables. Multiple linear regression analysis was used to identify potential predictors of malnutrition among the sample. We first ran separated unadjusted models to examine the association of the PG-SGA score with the CNAQ score (Model 1); then we ran two additional models; Model 2 was adjusted for patients' age and hemoglobin level whereas Model 3 was adjusted for patients' age and phosphorus level. These two models were ran separately to avoid the multicollinearity between hemoglobin and phosphorus. Two-sided tests were used for all analyses, and a p<0.050 denoted significance. SPSS version 24.0 (Armonk, NY) was used for data analyses.

RESULTS

Sociodemographic and health characteristics

According to the PG-SGA score, 43.7% of the patients had mild to moderate malnutrition (n=31). Sociodemographic and health characteristics of the sample stratified by the nutritional status are presented in Table 1. Patients' age ranged between 13 and 82 years, of whom 54.9% (n= 39) were males. Over half of the patients reported monthly household income of 5,000 Saudi Riyals or less (66.2%, n=47). Hypertension was more prevalent among the sample (76.1%, n= 54) compared to diabetes (43.3%, n= 30) and anemia (12.7%, n= 9). The majority of the patients reported that they have been previously counseled by dietitians for nutritional management (88.7%, n=63). No significant association was observed between the nutritional status and any of the sociodemographic and health characteristics among the patients.

The mean hemoglobin level among patients was 11.4±1.40 g/dL. The mean albumin, phosphorus, potassium, sodium, and BUN were 34.9±6.37 g/L, 1.68±0.44 mmol/L, 4.79±0.80 mmol/L, 136.4±3.08 mEq/L, and 21.1±5.27 mmol/L, respectively. Results of the correlational analyses between the biochemical data and PG-SGA score are presented in Table 2. The PG-

SGA score was significantly negatively correlated with hemoglobin (r_s=-0.350, p<0.01) and phosphorus (r_s=-0.250, p<0.05) levels.

Patients' nutritional knowledge and appetite

The mean knowledge score ranged between 0.00 and 15.0, with a mean score of 10.2±4.23. Knowledge score of the patients was not found to be correlated with the PG-SGA score (r_s=0.05, p>0.05), and the mean knowledge score of malnourished patients (10.3±4.20) did not statistically significantly differ from that of well-nourished patients (10.1±4.30), p>0.05. According to the median score of patients' nutritional knowledge (12.0/15.0), about two-thirds of patients had limited nutritional knowledge (64.8%, n=46).

Cronbach's alpha value of the CNAQ items indicated a high level of internal consistency among the sample ($\propto$=0.90). The CNAQ scores of the sample ranged between 11 and 40, with a mean score of 27.1±5.15. Nearly half of the patients (56.3%, n=40) scored <29, indicating poor appetite. The CNAQ score was found to be significantly positively correlated with the PG-SGA score (r_s=0.39, p<0.01); The mean CNAQ score of malnourished patients (25.8±5.16) was significantly lower than that of well-nourished patients (28.0±4.99), p<0.05.

Predictors of nutritional status among HD patients

Multiple linear regression analysis was performed to examine the association between patients' appetite and the PG-SGA scores (Table 3). The adjusted models (Models 2 and 3) explained 24.0% and 20.0% of the variance in the data, respectively. Patients' appetite score was found to be negatively associated with the PG-SGA score despite patients' age and hemoglobin level (B: -0.41 [95% CI (confidence interval): -0.67, -0.17]. Similarly, patients' appetite score was negatively associated with the PG-SGA score despite patients' age and phosphorus level (B: -0.43 [95% CI: -0.69, -0.17], respectively).

DISCUSSION

We aimed in this study to investigate the prevalence of malnutrition, assess levels of knowledge and appetite, and identify the potential predictors of malnutrition in CKD patients undergoing HD. Our data showed that 43.7% of the patients were malnourished, and over half of the patients had limited nutritional knowledge and poor appetite. Deteriorated appetite predicted greater risk for malnutrition. In previous studies, malnutrition in HD patients was found to independently predict all-cause mortality.[19] Therefore, evaluating the nutritional status of individuals on HD is necessary to improve patients' quality of life and prevent complications.

High prevalence of malnutrition among CKD patients has been previously reported in multiple settings. For example, a study conducted in Korea among 125 CKD patients on HD reported that using the PG-SGA tool, one-third of the sample were found to be malnourished; Age, household income, depression, appetite, and albumin status have been suggested to predict the risk of malnutrition.[11] Another study conducted in Palestine reported that nearly half of the patients were malnourished; The PG-SGA score was not found to be associated with the presence of comorbid conditions, level of education, or occupation.[12] In Saudi Arabia, recent data are lacking. A single-center study was carried out in Riyadh, Saudi Arabia, in 2009 reported that approximately one-third of HD patients were malnourished.[13] Another study conducted in Jeddah, Saudi Arabia, in 2012 reported higher prevalence of malnutrition among the sample (55%).[10] As malnutrition appears to be prevalent among HD patients, it becomes necessary to identify factors that could influence patients' nutritional status in order to design effective interventions.

CKD is characterized by a deterioration of kidney function that affects the ability to excrete excess potassium, phosphate, and sodium from blood. Hence, many patients are required to limit their intake of certain nutrients to maintain safe levels.[9] The renal dietitians work with CKD patients to maintain potassium, phosphate, and sodium levels within normal range and to encourage adherence to renal diet while maintaining adequate energy intake.[20] However, a sufficient level of knowledge regarding nutritional values of food and proper recognition of restricted food items are necessary to reach optimal outcomes.

In the present study, the majority of patients were counseled by renal dietitians yet presented limited nutritional knowledge. We hypothesized that the number of sessions delivered by dietitians was probably insufficient to achieve desired outcomes. Furthermore, the limited education level of patients may interfere with their ability to comprehend information provided. Therefore, patients may benefit from a pre- and post-education knowledge testing to ensure comprehension. A quasi-experimental study conducted by Ford et al. evaluated the effectiveness of monthly renal diet education among patients attending outpatient dialysis centers using pre- and post-knowledge tests; The data indicated significantly greater knowledge at 6-months post education test in the intervention group compared to controls, with a significantly lower serum phosphate levels.20 Furthermore, patients on HD often require psychological support and motivation to comply with renal dietary restrictions. A previous study examined the association of knowledge of dietary restrictions with the dietary compliance among HD patients and no association was observed.[17] Therefore, renal dietitians may utilize counseling techniques focusing on delivering information as well as motivating patients to comply with dietary restrictions. The patients may also benefit from regular educational sessions to enhance their knowledge on foods to be restricted as well as alternative food options to meet their energy requirements and prevent wasting, and to answer possible questions that may arise while adhering to the renal diet.

The multivariate regression analysis revealed that poor appetite among HD patients independently predicts higher degrees of malnutrition. In fact, poor appetite among CKD patients was evident in many studies, which has been attributed to complex dysregulation of neuroendocrine pathways[21] and to the presence of gastrointestinal symptoms.[22] A cohort study of 331 HD patients reported a high prevalence of poor appetite (38%), which has been linked to increased rate of hospitalization and mortality.[23] Hence, renal health care professionals must assess and evaluate the nutritional status of the renal patients. Patients with poor appetite need to be closely monitored, and renal dietitians should address potential barriers to adequate nutrition and tailor interventions according to patient's needs. Furthermore, future longitudinal studies that investigate potential causes of poor appetite could reveal possible intervention options to improve appetite and nutritional status of HD patients.

The present study provides updated data on the prevalence of malnutrition among HD patients. Additionally, to assess patients' knowledge on renal diet, we developed a culture-specific nutritional knowledge questionnaire that can be utilized in practice as well as in future studies. However, we did not assess the number of counseling sessions delivered to patients. Future research may consider and investigate the number of sessions needed for optimal outcomes. Furthermore, dietary intake of patients was not evaluated in this study. Incorporation of dietary assessment can aid in evaluating the effectiveness of nutritional counseling delivered to ESRD patients.[24]

Conclusion

In conclusion, high prevalence of malnutrition and limited knowledge on renal diet were observed among our sample. Poor appetite independently predicted higher levels of malnutrition. Renal healthcare professionals should assess and evaluate the nutritional status of HD patients and identify barriers to adequate nutrition. A special attention should be directed to patients with poor appetite for nutrition-focused evaluation and management.

Renal dietitians should ensure sufficient nutritional knowledge of foods to be restricted as well as acceptable food alternatives to maintain adequate intakes of energy and nutrients.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors declare no conflict of interest.

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REFERENCES

1. Bikbov B, Purcell CA, Levey AS, Smith M, Abdoli A, Abebe M et al. Global, regional, and national burden of chronic kidney disease, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2020;395(10225):709-33. doi: 10.1016/S0140-6736(20)30045-3.
2. Ikizler TA, Burrowes JD, Byham-Gray LD, Campbell KL, Carrero J-J, Chan W et al. KDOQI clinical practice guideline for nutrition in CKD: 2020 update. Am J Kidney Dis. 2020;76:S1-S107. doi: 10.1053/j.ajkd.2020.05.006.
3. Dialysis in the Kingdom of Saudi Arabia. Saudi J Kidney Dis Transpl. 2018;29:1012-20.
4. Becker PJ, Carney LN, Corkins MR, Monczka J, Smith E, Smith SE, Spear BA, White JV. Consensus statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: indicators recommended for the identification and documentation of pediatric malnutrition (undernutrition). J Acad Nutr Diet. 2014;114:1988-2000. doi: 10.1016/j.jand.2014.08.026.
5. Oliveira CM, Kubrusly M, Lima AT, Torres DM, Cavalcante NM, Jerônimo AL, Oliveira TC. Correlation between nutritional markers and appetite self-assessments in hemodialysis patients. J Ren Nutr. 2015;25:301-7. doi: 10.1053/j.jrn.2014.09.006.
6. Ikizler TA, Cano NJ, Franch H, Fouque D, Himmelfarb J, Kalantar-Zadeh K et al. Prevention and treatment of protein energy wasting in chronic kidney disease patients: a consensus statement by the International Society of Renal Nutrition and Metabolism. Kidney Int. 2013;84:1096-107. doi: 10.1038/ki.2013.147.
7. Ikizler TA, Flakoll PJ, Parker RA, Hakim RM. Amino acid and albumin losses during hemodialysis. Kidney Int. 1994;46:830-7. doi: 10.1038/ki.1994.339.
8. Luis D, Zlatkis K, Comenge B, García Z, Navarro JF, Lorenzo V, Carrero JJ. Dietary quality and adherence to dietary recommendations in patients undergoing hemodialysis. J Ren Nutr. 2016;26:190-5. doi: 10.1053/j.jrn.2015.11.004.
9. Palmer SC, Ruospo M, Campbell KL, Larsen VG, Saglimbene V, Natale P et al. Nutrition and dietary intake and their association with mortality and hospitalisation in adults with chronic kidney disease treated with haemodialysis: protocol for DIET-HD, a prospective multinational cohort study. BMJ Open. 2015;5:e006897. doi: 10.1136/bmjopen-2014-006897.

10. Alharbi K, Enrione EB. Malnutrition is prevalent among hemodialysis patients in Jeddah, Saudi Arabia. Saudi Journal of Kidney Diseases and Transplantation. 2012;23(3):598.
11. Park OL, Jang YJ, Jung JH, Kim SR. Factors affecting malnutrition in hemodialysis patients. Korean Journal of Adult Nursing. 2016;28:226-36. doi: 10.7475/kjan.2016.28.2.226.
12. Rezeq HA, Khdair LN, Hamdan ZI, Sweileh WM. Prevalence of malnutrition in hemodialysis patients: A single-center study in Palestine. Saudi Journal of Kidney Diseases and Transplantation. 2018;29(2):332.
13. Al-Saran KA, Elsayed SA, Molhem AJ, AlDrees AS, AlZara HM. Nutritional assessment of patients in a large Saudi dialysis center. Saudi Med J. 2009;30:1054-9.
14. Steiber AL, Kalantar-Zadeh K, Secker D, McCarthy M, Sehgal A, McCann L. Subjective Global Assessment in chronic kidney disease: a review. J Ren Nutr. 2004;14:191-200. doi: 10.1053/j.jrn.2004.08.004.
15. Desbrow B, Bauer J, Blum C, Kandasamy A, McDonald A, Montgomery K. Assessment of nutritional status in hemodialysis patients using patient-generated subjective global assessment. J Ren Nutr. 2005;15:211-6. doi: 10.1053/j.jrn.2004.10.005.
16. Kosters CM, van den Berg MG, van Hamersvelt HW. Sensitive and practical screening instrument for malnutrition in patients with chronic kidney disease. Nutrition. 2020;72:110643. doi: 10.1016/j.nut.2019.110643.
17. Durose CL, Holdsworth M, Watson V, Przygrodzka F. Knowledge of dietary restrictions and the medical consequences of noncompliance by patients on hemodialysis are not predictive of dietary compliance. J Am Diet Assoc. 2004;104:35-41. doi: 10.1016/j.jada.2003.10.016.
18. Wilson M-MG, Thomas DR, Rubenstein LZ, Chibnall JT, Anderson S, Baxi A, Diebold MR, Morley JE. Appetite assessment: simple appetite questionnaire predicts weight loss in community-dwelling adults and nursing home residents. Am J Clin Nutr. 2005;82:1074-81. doi: 10.1093/ajcn/82.5.1074.
19. Dekker M, Marcelli D, Canaud B, Konings C, Leunissen K, Levin N et al. Unraveling the relationship between mortality, hyponatremia, inflammation and malnutrition in hemodialysis patients: results from the international MONDO initiative. Eur J Clin Nutr. 2016;70:779-84. doi: 10.1038/ejcn.2016.49.
20. Ford JC, Pope JF, Hunt AE, Gerald B. The effect of diet education on the laboratory values and knowledge of hemodialysis patients with hyperphosphatemia. J Ren Nutr. 2004;14:36-44.
21. Iorember FM. Malnutrition in chronic kidney disease. Front Pediatr. 2018;6:161. doi: 10.1053/j.jrn.2003.09.008.
22. Ariffin N, Naing L, Pisharam J, Khalil M, Tamin N, Chong V, Tan J. Appetite and gastrointestinal symptoms in end stage renal disease patients. J Clin Exp Nephrol. 2016;1(6). doi: 10.21767/2472-5056.100006.
23. Kalantar-Zadeh K, Block G, McAllister CJ, Humphreys MH, Kopple JD. Appetite and inflammation, nutrition, anemia, and clinical outcome in hemodialysis patients. Am J Clin Nutr. 2004;80:299-307. doi: 10.1093/ajcn/80.2.299.

24. Molfino A, Chiappini MG, Laviano A, Ammann T, Bollea MR, Alegiani F, Fanelli FR, Muscaritoli M. Effect of intensive nutritional counseling and support on clinical outcomes of hemodialysis patients. Nutrition. 2012;28:1012-5. doi: 10.1016/j.nut.2012.01.008.

Table 1. Sociodemographic and health characteristics and associations with the nutritional status of hemodialysis patients†

Characteristics	Nutritional status		Total	*p*-value
	Well-nourished n=40 (56.3%)	Malnourished n=31 (43.7%)	n=71	
Sex, n (%)				0.621
Male	23 (57.5)	16 (51.6)	39 (54.9)	
Female	17 (42.5)	15 (48.4)	32 (45.1)	
Age, mean (SD)	49.2 (18.5)	52.6 (17.1)	50.7 (17.9)	0.592
Monthly household income in SAR, n (%)				0.438
Less than 5000	24 (60.0)	23 (74.2)	47 (66.2)	
5000 to less than 10000	9 (22.5)	5 (16.1)	14 (19.7)	
Over 10000	7 (17.5)	3 (9.70)	10 (14.1)	
Years on dialysis, mean (SD)	6.33 (3.83)	5.77 (4.50)	6.08 (4.12)	0.253
Diabetes, n (%)				0.662
no	24 (60.0)	17 (54.8)	41 (57.7)	
yes	16 (40.0)	14 (45.2)	30 (42.3)	
Hypertension, n (%)				0.055
no	13 (32.5)	4 (12.9)	17 (23.9)	
yes	27 (67.5)	27 (87.1)	54 (76.1)	
Anemia, n (%)				0.136
no	37 (92.5)	25 (80.6)	62 (87.3)	
yes	3 (7.5)	6 (19.4)	9 (12.7)	
Counseled by a dietitian, n (%)				0.259
no	6 (15.0)	2 (6.5)	8 (11.3)	
yes	34 (85.0)	29 (93.5)	63 (88.7)	

†Chi-square test was used for categorical variables and Spearman's correlation for continuous variables.

Table 2. The correlation matrix of laboratory data, knowledge, and PG-SGA scores of HD patients

Variable	PG-SGA	Hgb	Phosphorus	K	Na	BUN	Albumin	Knowledge
Hgb (g/dL)	-0.35**	--	--	--	--	--	--	--
Phosphorus (mmol/L)	-0.25*	0.220	--	--	--	--	--	--
K (mmol/L)	-0.04	0.00	0.16	--	--	--	--	--
Na (mEq/L)	0.01	-0.03	-0.16	-0.00	--	--	--	--
BUN (mmol/L)	-0.142	0.25*	0.45**	0.14	-0.19	--	--	--
Albumin (g/L)	-0.02	-0.01	-0.02	0.03	0.14	-0.19	--	--
Knowledge score	0.05	0.08	-0.03	0.04	0.17	-0.10	0.01	--
CNAQ score	-0.39**	0.21	0.11	0.13	-0.17	0.23	-0.01	-0.11

PG-SGA: Patient-Generated Subjective Global Score; HD: hemodialysis; Hgb: hemoglobin; K: potassium; Na: sodium; BUN: blood urea nitrogen; CNAQ: Council of Nutrition Appetite Questionnaire.
*Correlation is significant at the 0.050 level (2-tailed).
**Correlation is significant at the 0.010 level (2-tailed).

Table 3. Multivariate linear regression analysis of PG-SGA scores

Variable	B	SE	*p*-value	95% confidence interval	R^2
Unadjusted Model					
Model 1					
CNAQ score	-0.44	0.13	0.001	-0.70, -0.18	0.14
Adjusted Models†					
Model 2					
CNAQ score	-0.41	0.13	0.003	-0.67, -0.15	0.24
Hgb	-1.11	0.46	0.019	-2.03, -0.19	
Model 3					
CNAQ score	-0.43	0.13	0.002	-0.69, -0.17	0.20
Phosphorus	-3.22	1.51	0.069	-6.04, 0.23	

PG-SGA: Patient-Generated Subjective Global Score; SE: standard error; Hgb: hemoglobin; CNAQ: Council of Nutrition Appetite Questionnaire.
†Models 2 and 3 were adjusted for age.

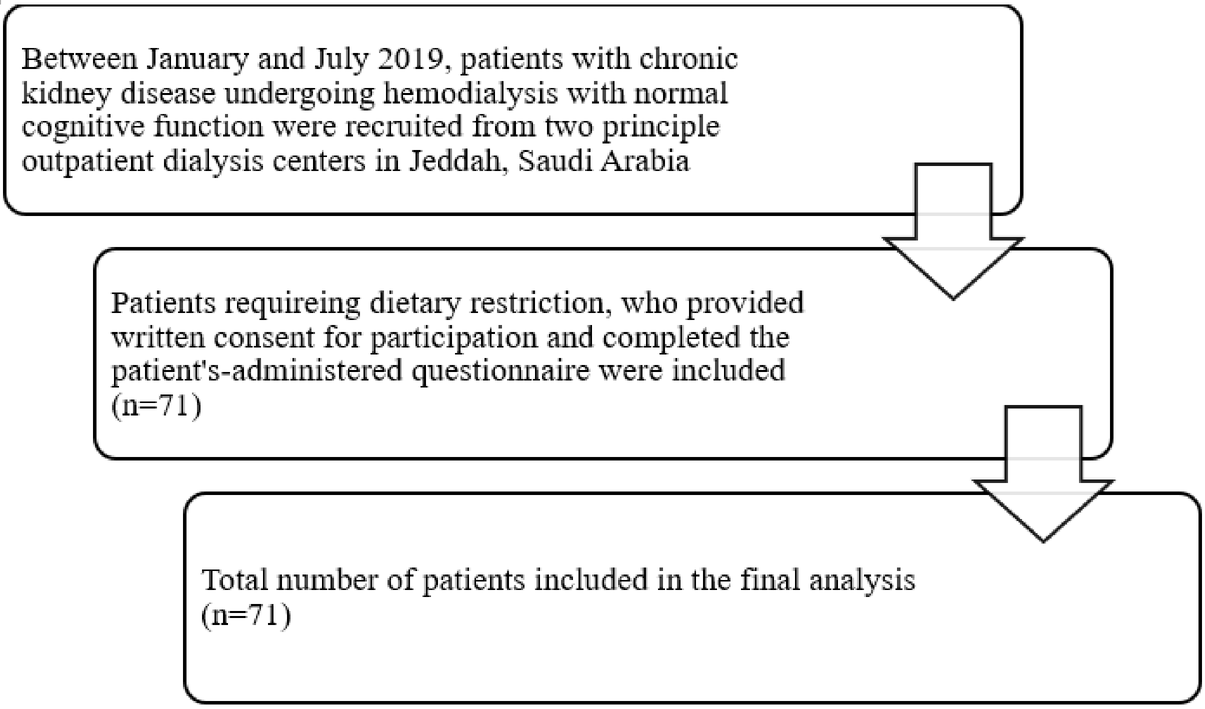

Figure 1. Flowchart of patient selection.