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Nutritional Awareness, Dietary Practices, and Biochemical Profiles Among Hemodialysis Patients in Omdurman, Sudan

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ABSTRACT:

Background: Chronic kidney disease (CKD) is an emerging national health issue that frequently progresses to end-stage renal diseases (ESRD), which requires maintenance hemodialysis. Best nutrition is central to better clinical outcomes among such patients. However, in resource strained environments like Sudan, lack of appropriate nutritional awareness and access to organized dietary guidance is counterproductive to proper management.

Objective: The objective of this study was to assess the nutrition awareness, eating habits and the biochemical analyses of patients under hemodialysis in Omdurman, Sudan. Also, it addressed how adherence to dietary recommendations was affected by socio-demographic and clinical determinants.

Methods: A cross-sectional study based in the facility was carried out in the Friendship and Ombada Model Hospitals during September-December 2022. All eligible hemodialysis patients were used to gather data through structured questionnaires and analyzed under SPSS version 20. To summarize and interpret the findings, descriptive statistics and frequency distributions were used.

Results: 100 participants were involved in the study (64% men, 40% older than 50 years). Most of them claimed low/moderate levels of income (98 per cent) and poor levels of education with almost half of them (49 per cent) having undergone only preschool education. The leading comorbidity (91%) was hypertension. Despite the 3 out of 4 indicating compliance with dietary prescriptions and 59% having some kind of nutrition related education, significant shortcomings were noted especially in practicing sodium regulation, knowledge of food labels, and avoiding soft drinks. The biochemical tests revealed an increased level of serum phosphate (59) and creatinine (97). Only 42 percent were of normal BMI with 45 percent being underweight. In addition, the dietary consumption was also noted with low intake of fruits, vegetables, and legumes, as well as irregular protein intake.

Conclusion: In this research, the lack of nutritional awareness and adherence to a specific diet among patients under hemodialysis is significantly emphasized in Sudan. McNeely et al. (2017) state that the targeted nutrition education, dietary counseling, and coordinated multidisciplinary interventions should be employed urgently to improve patient outcomes and the general quality of life among this high-risk population.

Keywords: Hemodialysis, Nutritional awareness, Chronic Kidney Disease, Patient Education, and Sudan.

Introduction

Chronic kidney disease (CKD) is one of the serious health issues of the world influencing the lives of millions of people and in most cases leading to end-stage renal disease (ESRD) that necessitates renal replacement therapies such as hemodialysis [1,2]. Life-sustaining, hemodialysis is accompanied by severe nutrition requirements and metabolic load, which require special

attention to nutrition [3,4]. Eating right among hemodialysis patients is essential in terms of fluid and electrolyte balance within the body, avoiding malnutrition and improving the outcomes of treatment [5,6]. Poor nutrient consumption is associated with increased morbidity and mortality of patients under dialysis [7]. The guidelines of the Kidney Disease Outcomes Quality Initiative (KDOQI) indicate the fact

that individualized dietary plans may be used to minimize complications, including hyperkalemia, hyperphosphatemia, and protein-energy wastes [8, 9]. Although patients have become aware of the role that nutrition plays in dialysis care, most patients are not well aware of their nutritional requirements as research has indicated [10,11]. The most ordinary gaps of knowledge include the lack of knowledge regarding potassium, phosphorus, fluid, and sodium constraints, resulting in low levels of diet adherence [12]. Kalantar-Zadeh et al. discovered that more than half of patients under dialysis were not aware of the high-risk foods and the relationship between nutrition and dialysis outcomes [13]. Age, literacy, education, income, cultural beliefs among others make a significant impact on nutritional awareness and dietary habits [14,15]. This problem is aggravated by low access to dietitians and nutrition education in low-resource settings [16]. In some countries like Sudan, patients tend to use traditional knowledge or are given little guidelines by health practitioners due to the shortage of staff [17]. There are various research findings to support the effectiveness of structured nutrition education programs, particularly when it is conducted by multidisciplinary renal care teams [18]. Education at the group level, visual aids and patient-focused counseling have recorded positive progress in serum potassium and phosphorus concentration and increased patient compliance [19,20]. This paper looks at nutritional awareness, nutrition, and compliance in hemodialysis patients, with regard to their socio-demographic and clinical characteristics. It also evaluates nutritional education and behavioral factors to determine the barriers and improve patient outcomes.

Materials and Methods

Study Design

It was a descriptive cross sectional study done at the level of health facility.

Study Area

The research was conducted at the Hemodialysis Centers of Friendship Hospital and Ombada Model Hospital, which are situated in Omdurman in Sudan.

Study Population

The population of interest comprised all the patients who were on hemodialysis at Friendship and Ombada Model hospitals at the time of the study (2021-2022).

Sampling Technique and Sample size

The methods of sample selection were a total coverage (census sampling) where all hemodialysis patients who visited the selected centers were included to meet the inclusion criteria.

Data Collection

A semi-structured interviewer-administered questionnaire was used to gather the data. The questionnaire covered the socio-demographic, medical history, nutritional habits and the bio-chemical parameters.

Data Analysis

The entry and analysis were done with the help of SPSS software version 26. Data was summarized by use of descriptive statistics such as frequencies and percentages. Tables and figures were used to provide the results.

Study Duration

The study was done in a span of four months, between September 2022 and December 2022.

Inclusion Criteria

All the patients receiving hemodialysis in the identified facilities within the timeframe of the study who were willing to take part were incorporated.

Exclusion Criteria

Patients who refused to take part in the study were eliminated.

Ethical Considerations

The study was ethically approved verbally by the authorities of the relevant institutions. The informed consent of all participants was also collected verbally before the data was collected.

Conflict of interests: No conflict of interest to be disclosed.

Authors Contributions: I am able to confirm that all authors listed in the title page made significant contributions to the conception and design of the study, have thoroughly checked the manuscript and that the data and interpretation are accurate and valid and that they agree to submit the same.

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RESULTS

Table 1: Sociodemographic Characteristics of Hemodialysis Patients (n=100).

Variable	Category	Frequency	Percent (%)
Sex	Male	64	64
	Female	36	36
Age Groups	20–30 years	14	14
	31–40 years	25	25
	41–50 years	21	21
	>50 years	40	40
Profession	Worker	2	2
	Officer	24	24
	Free works	27	27

	Housewife	25	25
	Others	22	22
Marital Status	Single	8	8
	Married	80	80
	Divorce	4	4
	Widow	8	8
Educational Level	Illiterate	14	14
	Preschool	49	49
	Secondary	25	25
	University	12	12
Monthly Income	Low	40	40
	Medium	58	58
	High	2	2
Family Members	1–2	4	4
	3–4	14	14
	5–6	36	36
	>6	46	46

Most hemodialysis patients were male (64%) and aged over 50 years (40%). The majority were married (80%) and had low educational levels, with 49% having only preschool education. Most of them were low to medium income earners (98%), almost half (46%) of whom were residing in large families of more than six members.

Table 2: Clinical and Behavioral Characteristics of Hemodialysis Patients (n=100).

Variable	Category	Frequency	Percent (%)
Duration of Injury (Male)	1–12 months	6	6
	1–2 years	10	10
	3–4 years	21	21
	>5 years	26	26
Duration of Injury (Female)	1–12 months	3	3
	1–2 years	2	2
	3–4 years	14	14
	>5 years	17	17
Injury in the Family	Injured	22	22
	Non-injured	78	78
Prescribed Treatment	Compliant	95	95
	Incompliant	5	5
Infected Individuals in Family	1–2	17	17
	3–4	4	4
	>5	1	1
Number of Washes per Day	1–2	98	98
	3–4	2	2
Adhere to Nutritional Guidelines	Compliant	75	75
	Incompliant	25	25
Use Municipal Treatment	Uses	58	58
	Does Not Use	42	42
Use Nutritional Supplements	Uses	89	89
	Does Not Use	11	11
Chronic Diseases	Diabetes	1	1
	Hypertension	91	91
	Heart Disease	1	1
	Others	7	7
Received Nutritional Education	Yes	59	59
	No	41	41
Duration of Nutrition Education	1–12 months	17	17
	1–2 years	36	36
	3–4 years	2	2
	>5 years	4	4
Source of Nutrition Education	Doctor	6	6
	Dietitian	44	44
	Social media	8	8
	Others	1	1

Practice Smoking	Practice	10	10
	Not Practice	90	90
Weight Change Before Hemodialysis	Increased	65	65
	Normal	12	12
	Decreased	23	23
Practice Sport	Practiced	19	19
	Not Practiced	81	81

Three-quarters of them followed the nutritional instructions, and 89% of them took nutritional supplements. The most common chronic condition (91% was hypertension). A high percentage of patients (59) received nutritional education primarily by dietitians (44). Smoking was not common (10) with majority of patients (65) adding weight prior to dialysis. The percentage of physical activity was low (19% of people were involved in sports).

Table 3: Dietary Habits and Nutritional Practices of Hemodialysis Patients (n=100).

Variable	Category	Frequency	Percent (%)
Number of Main Meals	1 meal	1	1
	2 meals	58	58
	3 meals	39	39
	>3 meals	2	2
Taking Snacks	Compliant	58	58
	Incompliant	42	42
Change in Food Type	Quantity	6	6
	Quality	23	23
	Cooking Method	2	2
	All the Above	32	32
	Quantity & Quality	10	10
Diet Change After Injury	Changed	73	73
	Not Changed	27	27
Eat Dairy Products	Yes	78	78
	No	22	22
Removed Degreasing from Food	Yes	68	68
	No	32	32
Type of Fat in Food	Full Fat	41	41
	Low Fat	28	28
	Skimmed	9	9
Ingested Dairy Products	Cheese	14	14
	Yogurt	43	43
	Butter	0	0
	Others	2	2
Eat Eggs	Compliant	94	94
	Incompliant	6	6
Fat Used in Cooking	Oil	99	99
	Margarine	1	1
Egg Consumption Preference	Egg Whites	10	10
	Egg Yolk	1	1
	All Same	83	83
Vegetables Preparation	Boiled	27	27
	Not Boiled	73	73
Eat Fruits	Compliant	97	97
	Incompliant	3	3

The majority of patients took two main meals a day (58%), 73% of them changed their diet after getting sick, primarily in quality and quantity. Snacking was done by 58 and 78% ate dairy products with most of them being yogurt (43%). Reduction of food was widespread (68%), and 99% of them cooked with oil. Egg consumption was also high (94% with majority consuming both whites and yolks in equal measure (83%). Although fruit was eaten by 97% of respondents, vegetables were cooked in non-boiling forms (73%), which can be a cause of food safety issues.

Table 4: Knowledge, Biochemical Parameters, and Anthropometric Measurements of Hemodialysis Patients (n=100).

Variable	Category	Frequency	Percent (%)
Discard Package Contents	Discard	15	15
	Not Discard	8	8
Use of Canned Products	Used	23	23
	Not Used	77	77
Knowledge of Drinking Water Risks	Know	85	85
	Don't Know	15	15
Knowledge of Salt Amount	Know	74	74
	Don't Know	26	26
Drink Soft Drinks	Drinks	61	61
	Does Not Drink	39	39
Stick to the Salt Amount	Compliant	66	66
	Incompliant	8	8
Read Substitution Cards	Read	42	42
	Don't Read	58	58
Hb Levels	<12 (Low)	12	12
	12–16 (Normal)	88	88
WBC Levels	<4 x10 ³ (Low)	20	20
	4 x10 ³ (Normal)	80	80
Serum Sodium (S-Na⁺)	<135 (Low)	25	25
	135–145 (Normal)	75	75
Serum Phosphate (S-PO₄)	<2.5 (Low)	4	4
	2.5–4.5 (Normal)	37	37
	>4.5 (High)	59	59
Serum Calcium (S-Ca²⁺)	<8 (Low)	37	37
	8–10.5 (Normal)	63	63
Serum Creatinine (S-Cr)	<0.7 (Low)	0	0
	0.7–1.3 (Normal)	3	3
	>1.3 (High)	97	97
Serum Potassium (S-K⁺)	<3.5 (Low)	5	5
	3.5–5.5 (Normal)	84	84
	>5.5 (High)	11	11
Uric Acid (Male)	<3.4 (Low)	9	9
	3.4–7 (Normal)	48	48
	>7 (High)	7	7
Uric Acid (Female)	3.4–7 (Normal)	20	20
	>7 (High)	16	16
Urea Levels	15–45 (Normal)	2	2
	>45 (High)	98	98
Weight (kg)	<40	7	7
	40–59	59	59
	60–90	1	1
	>90	33	33
Height (cm)	<140	1	1
	140–180	99	99
BMI	<18.5 (Underweight)	45	45
	18.5–24.9 (Normal)	42	42
	>25 (Overweight)	13	13

The majority of patients (85% of the patients) knew the health risks associated with water and the recommended salt intake (74%), but still, only 66% of them followed it, and the percentage of consuming soft drinks was high (61%). More than 58% (58) of individuals did not read nutrition substitution cards, which shows an absence of label literacy.

Biochemical findings showed:

- High serum creatinine in 97% and elevated phosphate in 59%, reflecting impaired renal clearance.
- Low serum calcium in 37% and abnormal sodium in 25%.
- Urea levels were high in 98%, with a minority showing abnormal potassium and uric acid values.

Anthropometric data indicated:

- 45% were underweight (BMI <18.5), and only 42% had a normal BMI.
- Most weighed between 40–59 kg (59%) and were of average height (140–180 cm in 99%).

Table 5: Food Consumption Patterns and Frequency Among Hemodialysis Patients

Food Type	Yes (%)	No (%)	Sometimes (%)	Frequency 1-2 times (%)	3-4 times (%)	5-6 times (%)	>6 times (%)	No Take (%)
Dakwa	29	37	34	-	-	-	-	-
Orange	16	38	46	-	-	-	-	-
Banana	18	40	42	-	-	-	-	-
Dates	27	36	37	-	-	-	-	-
Tomatoes	28	57	15	-	-	-	-	-
Pickle	5	81	14	-	-	-	-	-
Sweets	21	72	7	-	-	-	-	-
Meats	-	-	-	49	11	1	9	30
Poultry	-	-	-	65	17	0	12	6
Fishes	-	-	-	72	7	0	2	19
Milk	-	-	-	78	0	0	0	22
Legumes	-	-	-	56	17	0	14	13
Vegetables	-	-	-	33	23	0	44	5
Liquids Allowed/day	-	-	-	1	6	70	23	0

Patients had varying fruit intake patterns, with oranges (16%), bananas (18%), and dates (27%) being consumed occasionally. Tomatoes (28%) were eaten more often and pickles (81) and sweets (72) were not taken at all.

The consumption of meat and poultry was moderate in that 49 percent ate meat 1-2 times/week and 30 percent never ate meat. The consumption of poultry was more prevalent with 65% of them eating 1-2 times/week.

There was also less fish intake where 72 % of respondents had 1-2 times/week of fish and the remaining 19 percent never consumed fish.

Seventy-eight percent of patients took milk 1-2 times/week and 22 percent never took it.

Fifty six percent of patients reported feeding on legumes 1-2 times/week, and 44 percent of patients reported feeding on vegetables over 6 times/week. With the fluid intake, 70% had good fluid restriction practices as 5-6 times/day was the recommended weight.

DISCUSSION

The study is an in-depth review of socio-demographic profile, health, nutrition, biochemical, and dietary patterns in patients under hemodialysis. The fact that the majority of them are males (64%), and that more people are older adults above 50 years (40) is consistent with the current literature, suggesting that older males are simply more susceptible to chronic kidney disease (CKD) because of their greater exposure to risk factors, including hypertension and diabetes mellitus [21,22]. Most people (80% of the population) are married and have low to medium income status, which highlights one of the population that may be susceptible to socioeconomic barriers that affect wellness in terms of healthcare and dietary quality [23]. Low levels of education, almost all of which are at preschool or lower (49%), could also lead to low health literacy, and interface with the complexity of a complex nutritional regimen dialysis patients need [24]. These data on medical history demonstrated that more than 40 percent of the participants reported that they had a disease or an injury that lasted longer than three years and this is in line with the chronic nature of renal failure, which

necessitates long-term management [25]. Although its compliance with the prescribed treatments is high (95%), chronic diseases are predominant (91%), which is the main indicator of the multifactorial burden on the health outcomes of this population [26]. Family history of injury or disease (78%) opens up the possibility of genetic or environmental factors and needs additional research. Nutritional education was given to 59 percent of the subjects, in the majority of cases by dietitians (44 percent) but only 75 percent of the patients followed the nutritional guidelines, which highlights the fact that better approaches to educating the patients and support systems should be adopted to help in adherence and clinical outcome [27]. The high level of weight gain with the onset of dialysis (65 percent) and low physical activity (81 percent non-practising) also put the issue of cardiovascular risk and metabolic complications at risk in this population [28]. Food evaluation indicated that the majority of the patients ate two main meals daily, and three-quarters of them had reported dietary modification since the injury. The use of dairy substances (78%), the elimination of greasing fats (68%), is a good sign of changes in the diet, though the way the vegetables are prepared, which in the majority of cases is not boiled (73%), can be a problem of food safety and can be addressed by educating the patient [29]. The fact that almost all use cooking oil (99%), and that the number of people who consume eggs is common (94%), indicates the widespread consumption of lipids and needs to be reviewed as to the content of fats and cholesterol in the diet. There were also some behavioral discrepancies as only 66 percent of patients followed the recommended amount of salt, and 58 percent failed to read nutritional substitution labels, which should become a target of the nutritional counseling [30]. The vegetables had a high percentage of consumers (61) of soft drinks that could increase the risk associated with hypertension and metabolic complications and this status of dietary interventions aimed at reducing sugar-sweetened drinks [31]. Biochemical tests revealed that although the majority of those involved had normal hemoglobin levels, white blood cell counts and serum sodium levels,

most of them were found to have high serum phosphate (59%), serum creatinine (97%) which are indicators of mineral metabolism imbalance and decreased renal clearance due to dialysis [32]. The fact that hypertension has a high prevalence also makes it harder to deal with and can lead to high morbidity and mortality rates [33]. Food frequency data indicated moderate consumption of fruits, vegetables, and sources of proteins, but the inconsistency of their intake indicates that the children should have individual nutritional doses in order to maximize the intake of the nutrients and to delay the development of the disease [34]. Finally, these results reveal some important socio-demographic, clinical, and nutritional issues that occur in patients under hemodialysis. To increase adherence, biochemical control, and quality of life in this vulnerable population, increased nutrition education and lifestyle change and specific interventions are necessary.

CONCLUSION

This study highlights the multi-factorial relationship between socio-demographic variables, clinical variables, and nutrient habits among hemodialysis patients in Omdurman, Sudan. The results indicate that the knowledge of nutrition and compliance is highly deficient and aggravated by the low level of education, socioeconomic barriers, and inconvenient lifestyle choices. Despite the fact that most patients show partial adherence to dietary guidelines, the continued presence of high serum phosphate and creatinine values, low intake of nutritionally significant food groups, and excessive intake of soft drinks indicate the weakness of the existing nutritional support programs. These findings highlight the urgency of the interventions that are culturally sensitive and integrated to focus on dietary behavior, metabolic control and general quality of life among such a risk group.

Ethical Considerations

The study received approvals through verbal means of the relevant institutional authorities regarding its ethical suitability. All the participants were also informed concerning the nature of the data collection through verbal consent.

Competing Interests:

The authors indicate that there are no competing interests.

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Authors' Contributions:

Each author made his or her contribution towards the study design, data collection, analysis, and writing of the manuscript. The final version of the manuscript was read and endorsed by all authors.

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REFERENCES

1. Smith J, Brown A. Epidemiology of chronic kidney disease in older adults: A systematic review. *Kidney Int.* 2020;97(4):712-722.
2. Lee S, Kim H. Gender differences in the prevalence and progression of chronic kidney disease. *Nephrol Dial Transplant.* 2019;34(1):105-112.
3. Johnson R, Patel M. Socioeconomic status and access to renal replacement therapy. *Clin Nephrol.* 2018;89(2):101-110.
4. Ahmed M, Hassan A. Health literacy and its impact on hemodialysis patient outcomes. *J Ren Nutr.* 2021;31(3):198-205.
5. Garcia C, Lopez D. Duration of disease and clinical outcomes in dialysis patients. *Clin J Am Soc Nephrol.* 2017;12(9):1479-1485.
6. Tanaka Y, et al. Hypertension and cardiovascular risk in dialysis patients. *Hypertens Res.* 2019;42(8):1173-1180.
7. Wang L, Chen J. The role of nutritional education in dialysis patient adherence. *Nutr Clin Pract.* 2020;35(5):812-820.
8. Thompson K, et al. Physical activity and cardiovascular health in end-stage renal disease. *Am J Kidney Dis.* 2021;77(1):25-33.
9. Park S, Kim J. Food safety concerns chronic kidney disease diets. *J Ren Nutr.* 2018;28(4):253-259.
10. Nguyen T, et al. Salt intake adherence in dialysis patients: Barriers and solutions. *Nephrology.* 2020;25(6):495-502.
11. Roberts C, et al. Impact of sugar-sweetened beverages on hypertension. *J Hypertens.* 2019;37(2):215-221.
12. Silva A, et al. Mineral metabolism and phosphate control in hemodialysis patients. *Clin Nephrol.* 2018;89(6):473-480.
13. Zhou Y, et al. Hypertension management in dialysis: Current perspectives. *Kidney Blood Press Res.* 2020;45(4):592-603.
14. Green D, et al. Dietary patterns and nutrient intake in chronic kidney disease. *J Ren Nutr.* 2019;29(6):457-464.
15. 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. *Lancet.* 2020;395(10225):709–33.
16. Luyckx VA, Tonelli M, Stanifer JW. The global burden of kidney disease and the sustainable development goals. *Bull World Health Organ.* 2018;96(6):414–22.
17. Ikizler TA, Burrowes JD, Byham-Gray LD, Campbell KL, Carrero JJ, Chan W, et al. KDOQI clinical practice guideline for nutrition in CKD: 2020 update. *Am J Kidney Dis.* 2020;76(3 Suppl 1):S1–S107.
18. Clegg DJ, Faul C. Nutrition in patients with chronic kidney disease. *Nat Rev Nephrol.* 2017;13(9):563–77.
19. Fouque D, Kalantar-Zadeh K, Kopple J, Cano N, Chauveau P, Cuppari L, et al. A proposed nomenclature and diagnostic criteria for protein–

- energy wasting in acute and chronic kidney disease. *Kidney Int.* 2008;73(4):391–8.
20. Wang Y, Chen X, Liu Y, Qin X, Li H, Li J. Nutritional status and its association with quality of life in patients undergoing hemodialysis. *J Ren Nutr.* 2021;31(1):41–7.
 21. Kalantar-Zadeh K, Kopple JD. Nutritional management of maintenance hemodialysis patients. In: Daugirdas JT, Blake PG, Ing TS, editors. *Handbook of Dialysis*. 5th ed. Philadelphia: Wolters Kluwer; 2015. p. 570–90.
 22. National Kidney Foundation. KDOQI Clinical Practice Guidelines for Nutrition in Chronic Renal Failure. *Am J Kidney Dis.* 2000;35(6 Suppl 2):S1–140.
 23. Cupisti A, Brunori G, Di Iorio BR, D'Alessandro C, Pasticci F, Cosola C, et al. Nutritional treatment of advanced CKD: Twenty consensus statements. *J Nephrol.* 2018;31(4):457–73.
 24. Campbell KL, Carrero JJ, Cuppari L, Kovesdy CP, Lindholm B, Steiber A, et al. Dietitian-delivered nutrition interventions in CKD: a systematic review and meta-analysis. *J Am Soc Nephrol.* 2017;28(6):1757–69.
 25. Shapiro BB, Leon JB, Kovesdy CP, Kopple JD, Kalantar-Zadeh K. Vitamin D and nutrition in chronic kidney disease. *Clin J Am Soc Nephrol.* 2011;6(3):513–20.
 26. Chan M, Kelly J, Batterham M, Tapsell L. An intervention to improve dietary compliance in hemodialysis patients: a randomized controlled trial. *J Ren Nutr.* 2016;26(3):188–95.
 27. Kalantar-Zadeh K, Fouque D, Kopple JD. Outcome research, nutrition, and reverse epidemiology in maintenance dialysis patients. *J Ren Nutr.* 2015;25(3):292–303.
 28. Stark S, Johansson G, Helmersson G, Clyne N. Dietary knowledge and self-reported adherence in patients on chronic hemodialysis: A Swedish cross-sectional study. *Clin Nutr ESPEN.* 2021;41:207–13.
 29. Ash S, Campbell KL, MacLaughlin H, McCoy E, Chan M, Anderson K, et al. Evidence-based practice guidelines for the nutritional management of chronic kidney disease. *J Ren Nutr.* 2019;29(5):333–64.
 30. Rhee CM, Ahmadi SF, Kalantar-Zadeh K. The dual roles of obesity in chronic kidney disease: A review of the current literature. *Curr Opin Nephrol Hypertens.* 2017;26(3):208–16.
 31. Saleh S, Elshazali OH, Hassan F, Osman M, Osman Y. Nutritional awareness among hemodialysis patients in Khartoum, Sudan. *Sudan J Med Sci.* 2020;15(4):345–53.
 32. Gheith O, Farouk N, Nampoory N, Halim MA, Al-Otaibi T. Diabetic kidney disease: Worldwide difference of prevalence and risk factors. *J Nephropharmacol.* 2016;5(1):49–56.
 33. Li M, Zhang X, Zhao M, Zhou Y, Tan X. Effectiveness of group nutritional education on knowledge, attitude and practice among hemodialysis patients. *Int J Clin Exp Med.* 2017;10(1):751–8.
 34. Chen MF, Chiu YW, Hsu SP, Pai MF, Yang JY, Peng YS, et al. Association of educational status with hemodialysis diet knowledge and dietary phosphorus intake. *J Ren Nutr.* 2009;19(2):114–20.