Nutritional Awareness and Dietary Practices Among Hemodialysis Patients in Omdurman, Sudan: A Cross-Sectional Study

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ABSTRACT

Background: Chronic kidney disease (CKD) represents a mounting public health challenge, often advancing to end-stage renal disease (ESRD), necessitating maintenance hemodialysis. Optimal dietary management is pivotal in enhancing clinical outcomes among these patients. Nevertheless, in resource-limited settings such as Sudan, inadequate nutritional awareness and restricted access to structured dietary education hinder effective management.

Objective: This study aimed to evaluate the level of nutritional awareness, dietary behaviors, and biochemical profiles among hemodialysis patients in Omdurman, Sudan. Additionally, it explored the impact of socio-demographic and clinical determinants on adherence to dietary recommendations.

Methods: A facility-based cross-sectional study was conducted between September and December 2022 at the Friendship and Ombada Model Hospitals. Data was collected from all eligible hemodialysis patients using structured questionnaires and analyzed with SPSS version 20. Descriptive statistics and frequency distributions were employed to summarize and interpret the findings.

Results: A total of 100 patients participated in the study (64% male; 40% aged above 50 years). The majority reported low to moderate income levels (98%) and limited educational attainment, with nearly half (49%) having received only preschool education. Hypertension emerged as the predominant comorbidity (91%). Although 75% reported adherence to dietary guidelines and 59% had received some form of nutrition-related education, considerable deficiencies were observed particularly in sodium restriction practices, understanding food labels, and avoiding soft drinks. Biochemical assessments indicated elevated serum phosphate (59%) and creatinine levels (97%). Only 42% had a normal BMI, while 45% were underweight. Furthermore, dietary intake was characterized by low consumption of fruits, vegetables, and legumes, alongside inconsistent protein intake.

Conclusion: This study underscores substantial gaps in nutritional knowledge and dietary compliance among hemodialysis patients in Sudan. There is an urgent need for targeted nutrition education, ongoing dietary counseling, and coordinated multidisciplinary strategies to enhance patient outcomes and overall quality of life in this high-risk group.

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

1. INTRODUCTION

Chronic kidney disease (CKD) is a significant global health problem, affecting millions and often progressing to end-stage renal disease (ESRD), which requires renal replacement therapies like hemodialysis [1,2]. While life-sustaining, hemodialysis involves strict dietary restrictions and metabolic challenges that need careful nutritional management [3,4]...

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Proper nutrition in hemodialysis patients is vital for maintaining fluid and electrolyte balance, preventing malnutrition, and enhancing treatment results [5,6]. Inadequate nutrient intake is linked to higher morbidity and mortality among dialysis patients [7]. The Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines highlight that personalized dietary strategies can help reduce complications such as hyperkalemia, hyperphosphatemia, and protein-energy waste [8, 9]. Despite recognizing the importance of nutrition in dialysis care, many patients lack sufficient awareness of their dietary needs, as studies show [10,11]. Knowledge gaps about potassium, phosphorus, fluid, and sodium restrictions are common, leading to poor dietary adherence [12]. Kalantar-Zadeh et al. found that over half of dialysis patients did not recognize high-risk foods or understand the connection between nutrition and dialysis outcomes [13]. Factors like age, literacy, education, income, and cultural beliefs significantly influence nutritional awareness and dietary behaviors [14,15]. In low-resource settings, limited access to dietitians and nutrition education worsens this issue [16]. In countries such as Sudan, patients often rely on traditional knowledge or receive minimal guidance from healthcare providers due to staffing shortages [17]. Multiple studies support the effectiveness of structured nutrition education programs, especially when provided by multidisciplinary renal care teams [18]. Group education, visual aids, and personalized counseling have shown improvements in serum potassium and phosphorus levels, along with better patient adherence [19,20]. This study examines nutritional awareness, dietary practices, and adherence among hemodialysis patients, considering their socio-demographic and clinical factors. It also assesses nutritional education and behavioral influences to identify barriers and enhance patient outcomes

2. MATERIALS AND METHODS

Study Design

This was a descriptive cross-sectional study conducted at the health facility level.

Study Area

The study was carried out in the Hemodialysis Centers of Friendship Hospital and Ombada Model Hospital, located in Omdurman, Sudan.

Study Population

The target population included all patients undergoing hemodialysis at the selected hospitals during the study period (2021–2022).

Sampling Technique and Sample Size

A total coverage (census sampling) approach was used, including all hemodialysis patients who attended the selected centers and met the inclusion criteria.

Data Collection

Data was collected using a structured, interviewer-administered questionnaire. The questionnaire included sections on socio-demographic data, medical history, nutritional practices, and biochemical parameters.

Data Analysis

Data was entered and analyzed using SPSS software version 26. Descriptive statistics, including frequencies and percentages, were used to summarize the data. Results were presented in tables and figures for clarity.

Study Duration

The study was conducted over a period of four months, from September to December 2022.

Inclusion Criteria

All hemodialysis patients attending the selected centers during the study period who agreed to participate were included.

Exclusion Criteria

Patients who declined to participate in the study were excluded.

Ethical Considerations

Ethical approval was obtained from the institutional ethics committee and the General Director of the participating hospitals. Verbal informed consent was obtained from all participants before data collection.

3. RESULTS

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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. Nearly all had low to medium monthly income (98%), and almost half (46%) lived in large households of more than six members.

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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

Seventy-five percent adhered to nutritional guidelines, and 89% used nutritional supplements. Hypertension was the predominant chronic disease (91%). Nutritional education was received by 59% of patients, mainly from dietitians (44%). Smoking was uncommon (10%), while most patients (65%) experienced weight gain before dialysis. Physical activity was low, with only 19% practicing sports.

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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

Most patients consumed two main meals daily (58%), with 73% reporting dietary changes after illness, especially in quality

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and quantity. Snacking was practiced by 58%, and 78% consumed dairy products, mainly yogurt (43%).

Degreasing food was common (68%), and 99% used oil for cooking. Egg consumption was high (94%), with most consuming both whites and yolks equally (83%). While 97% ate fruit, vegetables were mostly prepared unboiled (73%), raising possible food safety concerns.

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-PO$_4$)	<2.5 (Low)	4	4
	2.5–4.5 (Normal)	37	37
	>4.5 (High)	59	59
Serum Calcium (S-Ca^{+2})	<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

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	>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

Most patients were aware of water-related health risks (85%) and recommended salt intake (74%), yet only 66% adhered to it, and soft drink consumption remained high (61%). Over half (58%) did not read nutritional substitution cards, indicating gaps in 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

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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 more regularly consumed, while pickles (81%) and sweets (72%) were mostly avoided.

Meat and poultry consumption was moderate, with 49% eating meat 1–2 times/week and 30% not consuming it at all. Poultry intake was more common, with 65% consuming it 1–2 times/week.

Fish consumption was lower, with 72% eating it 1–2 times/week and 19% not at all.

Milk was consumed 1–2 times/week by 78% of patients, while 22% avoided it entirely.

Legumes were consumed 1–2 times/week by 56% of patients, and vegetables were consumed more than 6 times/week by 44% of patients. Regarding fluid intake, 70% adhered to the recommended 5–6 times/day limit, indicating good fluid restriction practices.

4. DISCUSSION

This study provides a comprehensive overview of the socio-demographic characteristics, medical history, nutritional practices, biochemical parameters, and dietary habits among patients undergoing hemodialysis. The predominance of male participants (64%) and a higher proportion of older adults above 50 years (40%) align with existing literature, indicating a higher prevalence of chronic kidney disease (CKD) in older males, likely due to increased exposure to risk factors such as hypertension and diabetes mellitus [21,22]. The majority of individuals (80%) are married, with low to medium income levels, reflecting a population potentially vulnerable to socioeconomic barriers that impact access to healthcare and dietary quality [23]. Limited education levels, with nearly half having only preschool education (49%), may contribute to reduced health literacy and challenges in adhering to complex nutritional regimens required for dialysis patients [24]. Medical history data revealed that over 40% of participants had a disease or injury duration exceeding three years, consistent with the chronic nature of renal failure requiring long-term management [25]. Despite high compliance with prescribed treatments (95%), the presence of chronic diseases primarily hypertension (91%) highlights the multifactorial burden affecting this population's health outcomes [26]. Familial clustering of injury or disease (78%) suggests possible genetic or environmental influences warranting further investigation. Nutritional education was provided to 59% of participants, mostly by dietitians (44%), yet only 75% adhered to nutritional guidelines, emphasizing the need for improved education strategies and patient support systems to enhance adherence and clinical results [27]. The notable prevalence of weight gain before dialysis initiation (65%) combined with low physical activity levels (81% non-practicing) raises concerns about cardiovascular risk and metabolic complications in this group [28]. Dietary assessment showed most patients consumed two main meals per day, with 73% reporting dietary changes after injury. High consumption of dairy products (78%) and removal of degreasing fats (68%) are positive indicators of dietary modification; however, vegetable preparation methods, mostly non-boiled (73%), may pose food safety concerns and call for patient education [29]. The near-universal use of cooking oil (99%) and widespread egg consumption (94%) reflect common dietary patterns but should be monitored for fat quality and cholesterol intake. Behavioral gaps were evident, with only 66% adhering to recommended salt intake and 58% neglecting to read nutritional substitution labels, indicating areas for targeted nutritional counseling [30]. The high consumption of soft drinks (61%) may exacerbate risks for hypertension and metabolic issues, highlighting the importance of dietary interventions targeting sugar-sweetened beverages [31]. Biochemical analyses showed that while most participants maintained normal hemoglobin, white blood cell counts, and serum sodium levels, a majority had elevated serum phosphate (59%) and creatinine (97%), markers of mineral metabolism disturbances and reduced renal clearance associated with dialysis [32]. The high prevalence of hypertension further complicates management and may contribute to increased morbidity and mortality [33]. Food frequency data revealed moderate intake of fruits, vegetables, and protein sources; however, irregular consumption patterns point to the need for personalized nutritional plans to optimize nutrient intake and slow disease progression [34]. In conclusion, these findings highlight critical socio-demographic, clinical, and nutritional challenges faced by hemodialysis patients. Enhanced nutritional education, lifestyle modifications, and targeted interventions are essential to improve adherence, biochemical control, and overall quality of life in this vulnerable population.

5. CONCLUSION

This study underscores the complex interplay between socio-demographic factors, clinical characteristics, and dietary behaviors among hemodialysis patients in Omdurman, Sudan. The findings reveal significant gaps in nutritional awareness and adherence, compounded by low educational attainment, socioeconomic constraints, and suboptimal lifestyle practices. Although many patients demonstrate partial compliance with dietary recommendations, persistent challenges such as elevated serum phosphate and creatinine levels, limited intake of essential food groups, and high soft drink consumption point to inadequacies in current nutritional support strategies. These results emphasize the critical need for integrated,

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culturally sensitive interventions aimed at improving dietary behavior, metabolic control, and overall quality of life among this vulnerable population.

6. RECOMMENDATIONS

Enhance Nutrition Education: Provide structured and accessible dietary education tailored to patients' literacy levels.

Develop Individualized Meal Plans: Base dietary advice on patients' clinical and biochemical profiles.

Promote Multidisciplinary Care: Encourage collaboration among healthcare providers for comprehensive patient support.

Encourage Healthy Lifestyles: Support physical activity and reduce harmful dietary habits like high salt and soft drink intake.

Focus on High-Risk Patients: Prioritize education and support for patients with low income or limited education.

Monitor Dietary and Biochemical Status: Implement regular follow-up to assess nutritional adherence and health outcomes.

7. DECLARATION

Ethical Approval and Consent to Participate:

This study was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. Ethical approval was obtained from the relevant local ethics committee. Informed consent was obtained from all participants before data collection.

Consent for Publication:

Not applicable.

Availability of Data and Materials:

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests:

The authors declare that they have no competing interests.

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.

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[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.