

Assessment of nutritional status, daily nutrient intake and adherence to dietary recommendations among patients undergoing maintenance hemodialysis

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Abstract. Malnutrition is a common phenomenon in patients with chronic kidney disease, which accelerates the progression of the disease and negatively affects treatment outcomes. Therefore, the present study aimed to evaluate the nutritional status and dietary intake of patients undergoing hemodialysis to propose further optimal interventions. A cross-sectional study was conducted on 56 participants at a dialysis unit, from November, 2020 to June, 2021. Body mass index (BMI), subjective global assessment (SGA) and biochemical tests (serum albumin and hemoglobin) were used to assess the nutritional status of the participants. The method of 24-h dietary recall was utilized to assess the dietary food consumption of the patients, in comparison with the recommended dietary allowance (RDA). According to the assessment of BMI and SGA, the percentage of participants who were at a having a risk of malnutrition was 26.8 and 25%, respectively. It was found that 87.5% of the participants experienced anemia. The average dietary energy intake of the patients was 1,389 kcal (SD, 403), corresponding to 25.3 kcal/kg/day (SD, 8.3). The total dietary protein intake was 58.7 g (SD, 16.9), which accounted for 16.9% of the total dietary energy consumption. The daily consumption of iron and zinc was under the RDA levels, at 87.0 and 54.0% respectively, while the amount of sodium intake was higher than the recommendation (118.8%). As demonstrated herein, malnutrition remains highly prevalent among patients undergoing hemodialysis, marked by an inadequate intake of energy, essential minerals and vitamins. Early assessment using validated tools, combined with structured

nutritional counseling, holds immense promise in optimizing dietary intake, improving treatment adherence, and ultimately reducing morbidity and mortality in this vulnerable group.

Introduction

According to a guideline released in 2012 by Kidney Disease Improving Global Outcomes (KDIGO), chronic kidney disease (CKD) is structural or functional kidney impair, lasting for >3 months and is presented by albuminuria, imaging abnormalities, or damaged renal function defined by glomerular filtration rate (GFR) <60 ml/min/1.73 m² (1). Renal replacement therapy is required when the GFR is <15 ml/min/1.73 m² or when CKD has progressed to end-stage (2). Methods of dialysis that can be used are cyclic hemodialysis, peritoneal dialysis or kidney transplantation (3). Dialysis with an artificial membrane filter, hemodialysis, is a method of using a machine and a filter to replace the function of the kidneys to eliminate toxins and metabolic products in the body (4). This method uses an artificial filter, which is a semi-permeable membrane. Molecules are transported through the membrane and can be transported into the blood or out of the blood based on the mechanism of diffusion, osmosis, and ultrafiltration (4).

Malnutrition is defined as one of the most severe issues among patients with CKD as it accelerates the development of kidney disease and affects treatment outcomes and the prognosis of the disease (5). In addition, malnutrition reduces the quality of life of patients, enhances the risk of developing infections and comorbidities, and weakens wound healing (6,7). It triggers poor rehabilitation, tiredness, lethargy, and accreted hospitalization and mortality (8). Thus, the screening and assessment of the nutritional risk for all patients with CKD could be of immense benefit for proposing nutritional intervention strategies, as well as for improving the treatment efficacy and quality of life of patients.

Factors related to malnutrition in patients undergoing hemodialysis can be divided into two categories: i) Iatrogenic; and ii) non-iatrogenic factors (9). Iatrogenic factors are an unintentional outcome during dialysis or the treatment process

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of patients with CKD, while non-iatrogenic factors progress spontaneously from contributed components regarding the development of CKD, but are not associated with the primary treatment. Iatrogenic contributors may be considered as dialysis-induced nutrient loss, particularly protein and amino acids. It has been reported that in each hemodialysis treatment, 6–12 g of amino acids and 7–8 g of protein may be lost (9). Iatrogenic aspects also involve factors, such as multiple dialyzer reuse, dialysis-related inflammation, uremia correction, dialysis adequacy, frequency and duration, and metabolic acidosis. On the other hand, suboptimal dietary intake, an alteration in taste and anorexia, insulin resistance and certain mental health factors may be non-iatrogenic causes of malnutrition (9).

A previous study revealed that 25% of patients undergoing dialysis (>12,000 patients) had serum albumin concentrations <3.7 g/dl (10). In another study, ~25% of patients experiencing renal replacement therapy were found to have insufficient dietary protein and energy intake (11). In addition, according to a systematic review and meta-analysis published in 2021, the global prevalence of malnutrition associated with CKD was found to be 42.7%, ranging from 35.2–50.6%, in which the figure for the hemodialysis group accounted for 43.1% (12).

There is no single measurement that can be used to determine the existence of malnutrition (13). Thus, a set of measurements should be implemented, covering an assessment of body composition, dietary protein intake and at least one measure of serum protein status. A previous study demonstrated that subjective global assessment (SGA) and biochemical laboratory tests, such as albumin, pre-albumin, fasting lipid profile (total cholesterol, triglycerides, high-density lipoprotein and low-density lipoprotein), serum creatinine, serum calcium and phosphorus, white blood cell count, fasting glucose, HbA1c and pre and post-dialysis blood urea nitrogen could be applied to evaluate the nutritional status of patients undergoing hemodialysis (14).

However, in spite of the existence of a nutrition department and nutritional counsellors in hospitals, routine nutritional screening and assessment are not conducted due to the overwhelming workload of physicians and nurses. In addition, patients with CKD have to adhere to a strict dietary intake to reduce toxin accumulation during their disease progress. The present study thus aimed to determine whether there is a significant difference between the actual dietary intake and the recommended nutritional intake among patients undergoing hemodialysis. The present study aimed to evaluate the nutritional status and dietary intake of patients undergoing hemodialysis in comparison with the recommendations to implement optimal interventions.

Patients and methods

Study design and study subjects. A cross-sectional study was conducted at the Dialysis Unit, Dong Da General Hospital, Hanoi, Vietnam, from November, 2020 to June, 2021. Dong Da General Hospital is one of the prestigious front-line hospitals in Hanoi with a scale of ~300 beds. An average of 30–35 patients is under treatment at the Dialysis Unit every day. The inclusion criteria for the selection of patients were as follows: i) Patients aged between 20 to 65 years; ii) a diagnosis of CKD and patients received dialysis treatment; iii) patients

who had never changed to another renal replacement modality (such as peritoneal dialysis or kidney transplantation).

The exclusion criteria were as follows: i) Patients who received enteral nutrition via tube feeding or parenteral nutrition; ii) those who experienced trauma or dementia and were not able to communicate with interviewers; iii) those who suffered from acute diseases, terminal cancer, or a massive intestinal resection.

Convenience sampling was applied to recruit participants. Patients who were undergoing hemodialysis at Dong Da General Hospital and met the aforementioned inclusion criteria were invited to take part in the study. The sample size was determined using the single population proportion formula, based on a malnutrition prevalence of 85% among patients undergoing hemodialysis from a previous study (15), with a 95% confidence interval (CI), a 10% margin of error and 80% power. This resulted in a minimum required sample size of 49. An additional 10% was included to account for potential non-response or missing data. In fact, the total number of selected patients was 56 with a response rate of 93.3%.

Ethics approval. Patients were invited and provided consent to participate in the study and the research purpose was clearly explained to them. The interviews were only conducted under the agreement of the participants. The authors ensured personal confidentiality for participants by keeping their information privately and encrypting all collected data. Participants had the right to refuse, to stop the interview at any time which did not interrupt their treatment progress. All results were only used for research and medical purposes. The study was ethically approved by Dong Da General Hospital under Decision No. 176/QĐ-BV.

Measurement and instruments. A 20-min-interview-administered questionnaire was carried out to collect the data. A pilot study was performed on 5 patients to ensure the training of data collectors. Only minor changes to the questionnaire were made to help patients understand the questions adequately.

Socioeconomic characteristics and clinical information. Information regarding age, sex, educational level and employment was collected. Participants also reported their medical condition, including the duration of having CKD, dialysis and comorbidities.

Assessment of nutritional status. The anthropometric indices of the participants were evaluated by height and weight. Weight was reported two times, at pre- and post-dialysis. Bodyweight and height were measured when the participants were wearing light clothing without shoes. A Tanita scale and a wooden parameter with an accuracy of 0.1 kg and 0.1 cm were used to measure the weight and height of the participants. The average value of height and weight was recorded after two times of taking measurements. Body mass index (BMI) was computed as the ratio of weight (kg) per height squared (m^2). According to the Asia-Pacific classification of BMI, BMI <18.5 kg/m^2 was considered underweight, BMI ≥ 23 to 24.9 was considered overweight, and BMI ≥ 25 was considered as obesity (16).

SGA, a version of Detsky (17), was used for assessing the nutritional status of the patients. SGA has been widely used to

evaluate the nutritional status of patients undergoing dialysis due to its high mortality predictive value (18). The nutritional status was categorized into three different categories, as follows: i) SGA-A, well-nourished (weight loss <5%, normal diet, no signs of muscle atrophy and subcutaneous fat loss); ii) SGA-B, mild to moderate malnutrition (weight loss 5-10%, the reduction of dietary intake lasted at least 2 weeks prior, examination with muscle atrophy and mild or moderate loss of subcutaneous fat); iii) SGA-C, severe malnutrition (weight loss >10%, poor appetite, can only eat thick and liquid foods, examination with muscle atrophy and severe loss of subcutaneous fat or edema and ascites). The validated Vietnamese version of the SGA questionnaire was used to evaluate the nutritional status of the participants (19). Prior to the main data collection, the questionnaire was pilot-tested with 7-10 patients undergoing hemodialysis to confirm clarity, cultural relevance and ease of administration. Necessary refinements were incorporated following the pilot test.

As regards serum albumin, an amount <35 g/l was defined as hypoalbuminemia (20). The albumin levels were classified into the following four categories: Marked hypoalbuminemia (<2.5 mg/dl), mild hypoalbuminemia (2.5-3.5 mg/dl), normal albumin (3.5-4.5 mg/dl) and hyperalbuminemia (>4.5 mg/dl) (21). Anemia was defined as follows: In males, marked anemia [hemoglobin (Hb), ≤80 g/l], moderate anemia (Hb, >80 and ≤109 g/l), mild anemia (Hb, >110 and ≤129) and normal (Hb, ≥130 g/l). In females, the cut-off value for normal was Hb ≥120 g/l (22).

Dietary food intake. The method of 24-h dietary recall was applied to assess the dietary food consumption of the patients. The participants were requested to report all the foods that they had consumed the previous day from the time of waking up in the morning to the sleeping time at night. Food consumption was not investigated on days with special events. All foods and beverages that had been consumed, including food types, food brands and processing methods were recorded in detail. To secure precise answers on food measurement, common measurement units that were reasonably sized were utilized; standardized measurement units were applied to ensure the accuracy and comparability in quantifying the amount of food consumed by the participants (23).

Statistical analysis. The data in the present study were computerized using the Epidata application version 3.1 and analyzed using Stata version 13.0 software (StataCorp. LP). Descriptive analysis was applied to present information on general characteristics, clinical and biochemical results, nutritional status and dietary food intake. To examine the differences in characteristics between males and females, a t-test was used for quantitative variables, and Chi-squared or Fisher's exact tests were used for qualitative variables. Dietary energy intake, nutritional value of macronutrients, vitamins and minerals were calculated based on the database composed by the National Institution of Nutrition (24).

Results

The general socioeconomic characteristics of the patients are presented in Table I. Half of the patients were between

40 to 60 years of age (50%) and had an educational level of high school and above (57.1%). A total of 35.6% of the participants experienced CKD for ≥10 years. In addition, more than half of the participants (53.5%) had <5 years of dialysis.

The characteristics of anthropometric indices among the patients undergoing dialysis are presented in Table II. The mean weight of the males was 57.1 kg (SD, 8.8) at pre-dialysis and this decreased to 55.1 kg (SD, 8.2) after dialysis. The values for the mean weight of the females before and after dialysis were 52.1 kg (SD, 8.5) and 49.7 kg (SD, 8.3), respectively. The average height of the males was significantly higher than that of the females [163.7 cm (SD, 4.3); and 156.2 cm (SD, 5), respectively]. The mean BMI for the males and females was 20.6 and 20.3, respectively. The average hemoglobin index of the males was 102.6 g/l (SD, 17.7) and that of the females was 106.0 g/l (SD, 16.4). The mean serum albumin level was 37.0 g/l (SD, 1.2).

As demonstrated in Table III, according to the BMI classification, the percentage of underweight patients was 26.8% and this figure was higher among females than males (30.4 and 24.2%, respectively). However, the difference was not statistically significant ($P=0.9$). By using the SGA scale to assess the nutritional status of the patients, having the risk of mild malnutrition accounted for 25% in total, 24.2% in males and 26.1% in females. The percentage of patients having malnutrition according to serum albumin levels was 14.3%, of which moderate deficiency was 1.8% and mild deficiency was 12.5%. As regards anemia, it was found that 87.5% of the participants experienced anemia and moderate anemia accounted for the highest percentage (51.8%).

The average dietary energy intake of the patients was 1,389 kcal (SD, 403), corresponding to 25.3 kcal/kg/day (SD, 8.3), as demonstrated in Table IV. The total dietary protein intake was 58.7 g (SD, 16.9), which accounted for 16.9% of the total dietary energy consumption. The percentage of animal protein was 53.4% of total protein intake. The amount of total lipid and carbohydrate intake was 28.5 g (SD, 17.8) and 222.6 g (SD, 73.5), which comprised 19.1 and 64.0% of dietary energy, respectively. As regards vitamins and minerals, the amount of dietary intake of vitamin B1 (thiamine) was 1.2 mg (SD, 0.6), vitamin B2 (riboflavin) was 0.7 mg (SD, 0.3) and vitamin PP (niacinamide) was 11.3 mg (SD, 4.7). In addition, the dietary intake consumption of vitamin C was 122.1 mg (SD, 131.7). The daily intake of calcium and phosphorus was 385.9 mg (SD, 208.5) and 778.7 mg (SD, 222.4), which contributed to the odd of calcium and phosphorus (Ca/P) of 0.5. The amount consumption of two other important minerals, iron and zinc, was 8.7 mg (SD, 3.19) and 8.1 mg (SD, 3.4) respectively.

Based on the RDA for Vietnamese individuals published by the National Institute of Nutrition in 2016 (25), the dietary energy intake of patients met 72.2% of the recommendation and the figure for protein and lipids was 91.6 and 74.0%. Iron and zinc daily consumption was under the RDA, which met 87.0 and 54.0% respectively, while the amount of sodium was higher than the recommendation (118.8%). Minerals did not meet the recommended needs (vitamin A, 48.4%; vitamin D, 11.6%; vitamin B2, 63.6%; vitamin PP, 80.7%), apart from vitamin B1 (100%) and vitamin C (135.6%).

Table I. Socio-economic characteristics of the study participants.

	Frequency (n)	Percentage (%)
Sex		
Male	33	58.9
Female	23	41.1
Age group, years		
<40	7	12.5
40-60	28	50.0
60-65	21	37.5
Educational level		
Primary school	3	5.4
Secondary school	21	37.5
High school and above	32	57.1
Occupation		
Farmer/worker	17	30.4
Self-employed business	21	37.5
Officer	9	16.0
Retired	9	16.1
Duration of having chronic kidney disease		
<5 years	20	35.8
5 to <10 years	16	28.6
≥10 years	18	35.6
Duration of dialysis		
<5 years	30	53.5
5 to <10 years	18	32.1
≥10 years	8	14.4
Having comorbidities	31	55.4

Table II. Anthropometric indices and laboratory test results of the patients undergoing hemodialysis.

Parameter	Male (n=33)		Female (n=23)		Total (n=56)		P-value
	Mean	SD	Mean	SD	Mean	SD	
Pre-dialysis weight (kg)	57.1	8.8	52.1	8.5	54.4	5.8	0.04
Post-dialysis weight (kg)	55.1	8.2	49.7	8.3	52.0	5	0.03
Height (cm)	163.7	4.3	156.2	5.1	160.1	3.2	<0.01
Body mass index (kg/m ²)	20.6	2.8	20.3	2.8	20.2	1.8	0.80
Serum albumin (g/l)	37.9	2.9	36.5	2.9	37.0	1.2	0.15
Hemoglobin (g/l)	102.6	17.1	106.0	16.4	106.5	11.5	0.50

Data were analyzed using the t-test.

Discussion

The present study, to the best of our knowledge, is one of the first studies in Vietnam to assess the nutritional status of patients undergoing dialysis using different tools. The findings of the present study are crucial to implementing optimal nutritional counselling for patients receiving hemodialysis to enhance their treatment outcomes, as well as decrease the mortality rates. A high percentage of undernourished participants was

reported using the BMI classification and the SGA method. As regards dietary intake, the daily food energy did not meet the RDA, while the amount of protein consumption was approximately as per the recommendation. The contents of several vital minerals and vitamins, such as zinc, iron and vitamin D were markedly lower than the RDA; however, sodium was higher than the recommendation.

The present study found a high proportion of patients undergoing dialysis who were malnourished. This finding

Table III. Nutritional status of the patients undergoing hemodialysis according to BMI, SGA and anemia.

Parameter	Male (n=33)		Female (n=23)		Total (n=56)		P-value
	Frequency (n)	%	Frequency (n)	%	Frequency (n)	%	
BMI ^a							0.9
Underweight	8	24.2	7	30.4	15	26.8	
Normal	18	54.5	12	52.2	30	53.6	
Overweight and obesity	7	21.3	4	17.4	11	19.6	
SGA ^a							0.80
SGA-A	25	75.8	17	73.9	42	75.0	
SGA-B	8	24.2	6	26.1	14	25.0	
Anemia ^b							0.02
Severe anemia	3	9.1	1	4.4	4	7.1	
Moderate anemia	16	48.4	13	56.5	29	51.8	
Mild anemia	13	39.3	3	13.0	16	28.6	
Normal	1	3.0	6	26.1	7	12.5	
Albumin deficiency ^b							0.70
Moderate	0	0	1	4.3	1	1.8	
Mild	4	12.1	3	13.0	7	12.5	
Normal	29	87.9	19	82.7	48	85.7	

Data were analyzed using the ^aChi-squared test or ^bFisher's exact test. BMI, body mass index; SGA, subjective global assessment.

is consistent with the findings of previous studies, which revealed that undernourishment was common among patients with CKD from an early stage of substitutive treatment (18). Patients undergoing dialysis normally experience lower dietary intakes than the healthy population (26). This phenomenon can be explained by insufficient protein-calorie or cachexia, which were contributed by poor appetite or anorexia (27) and the loss of amino acids during dialytic treatment (28). In addition, the present study presented a lower mean BMI and a higher rate of malnutrition in comparison with the studies of Chen *et al* (29) and Tonbul *et al* (30), of which the values for BMI were 21.6 ± 3.1 and 25.6 ± 5.8 , respectively. Using the SGA assessment tool, the results of the present study are similar to those of a previous study conducted in Korea (2016) (31), but lower than those of another study in India (2011), which demonstrated that the values for SGA-B and SGA-C were 90.9 and 6.06%, respectively (32). This difference may be due to the subjective nature of the tool; therefore, the interpretation of small differences in SGA score should be taken into consideration (18).

Hypoalbuminemia is a presentation of protein-energy wasting (PEW) regarding CKD (33). PEW, a dysfunctional state common in chronic inflammation, is defined as the alteration of metabolism and nutrition characterized by the loss of protein and energy stores that leads to muscle and fat mass loss, and cachexia (34). Patients with CKD and not receiving renal replacement therapy (RRT) are often prescribed dietary restrictions, particularly protein intake limitations. Secondary anorexia is contributed by uremic toxins, delayed gastric emptying, systemic inflammation reaction and comorbidities (33). In addition, patients receiving RRT, particularly those undergoing continuous hemodialysis, may lose a marked mass

of amino acids into the dialysate, ~6-8 g of total amino acids per hemodialysis session (35). However, although serum albumin is commonly utilized as a nutritional marker in patients experiencing dialysis, it does not totally reflect nutritional status. In fact, albumin and pre-albumin decline in the presence of inflammation, regardless of underlying nutrition status (36).

The present study demonstrated that the average dietary energy intake did not meet the recommendation of RDA for Vietnamese individuals and the guidelines for the nutrition of patients with CKD. The Kidney Disease Outcomes Quality Initiative (KDOQI) prescribed an energy intake of 25-35 kcal/kg body weight/day based on age, sex, level of physical activity, body composition, weight status goals, CKD stage, and concurrent illness or the presence of inflammation (37). In addition, the European Society of Parenteral and Enteral Nutrition (ESPEN) guideline in 2019 on acute and chronic kidney diseases also concluded that 30-35 kcal/kg/day was recommended for non-critically ill patients with CKD with kidney failure [without kidney replacement therapy (KRT)] (38). To maintain a positive nitrogen balance in continuous ambulatory peritoneal dialysis patients, an energy intake >30 kcal/kg body weight/day was recommended (39). As regards protein intake, the requirement for hospitalized patients with CKD and kidney failure on conventional intermittent chronic KRT without acute/critical illness is ≥ 1.2 g/kg body weight/day according to ESPEN (38), and 1.0-1.2 g/kg body weight/day according to KDOQI (37). If the deficit of protein lasts longer, protein wasting and sarcopenia may occur. It is evident that protein requirements vary under different guidelines, and the protein intake of individuals may depend on their stages of renal failure and hemodialysis (40), and their comorbidities (18). The amount of protein intake in the present

Table IV. Mean energy, macronutrients and micronutrient intake of patients undergoing hemodialysis.

Parameter	Male (n=33)	Female (n=23)	Total (n=56)	Recommended dietary allowance (RDA) ^a	Level of meeting RDA (%)
Energy (kcal), mean $\pm$ SD	1508 $\pm$ 411	1219 $\pm$ 330	1389 $\pm$ 403		
Energy (kcal/kg/day), mean $\pm$ SD			25.3 $\pm$ 8.3	35 ^b	72.2
Protein, mean $\pm$ SD or %					
Total (g)	63.0 $\pm$ 17.1	52.7 $\pm$ 12.1	58.7 $\pm$ 16.9		
Total (g/kg/day)			1.1 $\pm$ 0.3	1.2 ^b	91.6
Animal protein (g)	34.2 $\pm$ 12.7	28.5 $\pm$ 13.5	31.9 $\pm$ 13.2		
Percentage of dietary energy intake (%)			16.9		
Animal protein/total protein (%)			53.4		
Lipids, mean $\pm$ SD or %					
Total (g)	33.1 $\pm$ 21.1	24.4 $\pm$ 10.2	28.5 $\pm$ 17.8		
Total (g/kg/day)			18.5 $\pm$ 8.8	25-35	74.0
Unsaturated fats (g)	6.0 $\pm$ 5.4	6.4 $\pm$ 4.8	6.1 $\pm$ 5.1		
Percentage of dietary energy intake (%)			19.1		
Unsaturated fats/ total lipids (%)			27.1		
Carbohydrate, mean $\pm$ SD or %	239.9 $\pm$ 76.7	197.6 $\pm$ 61.9	222.6 $\pm$ 73.5		
Percentage of dietary energy intake (%)			64.0		
Minerals, mean $\pm$ SD					
Calcium (Ca, mg)	396.7 $\pm$ 225.4	370.4 $\pm$ 185.3	385.9 $\pm$ 208.5	<1,000	
Phosphorus (P, mg)	840.8 $\pm$ 206.3	689.7 $\pm$ 223.1	778.7 $\pm$ 222.4	800; 1,000	97.3
Ca/P (%)			50		
Sodium (Na, mg)	2378.6 $\pm$ 328.0	2373.3 $\pm$ 314.9	2376.4 $\pm$ 319.7	750; 2,000	118.8
Potassium (K, mg)	1854.1 $\pm$ 579.8	1635.7 $\pm$ 478.4	1764.4 $\pm$ 546.7	2,000; 2,500	88.2
Magnesium (Mg, mg)	144.4 $\pm$ 61.5	125.2 $\pm$ 42.5	136.4 $\pm$ 54.8	200; 300	68.2
Iron (Fe, mg)	9.6 $\pm$ 3.4	7.4 $\pm$ 2.2	8.7 $\pm$ 3.19	10; 18	87.0
Zinc (Zn, mg)	7.7 $\pm$ 3.7	7.3 $\pm$ 2.6	8.1 $\pm$ 3.4	15	54.0
Vitamins, mean $\pm$ SD					
Vitamin A (μ g)	393.8 $\pm$ 313.5	377.8 $\pm$ 235.3	387.3 $\pm$ 281.8	800; 1,000	48.4
Vitamin D (μ g)	3.3 $\pm$ 2.1	2.5 $\pm$ 1.7	2.9 $\pm$ 1.9	1,000; 1,500 ^c	11.6
Vitamin B1 (mg)	1.4 $\pm$ 0.6	1.0 $\pm$ 0.4	1.2 $\pm$ 0.6	1.1; 1.2	100
Vitamin B2 (mg)	0.7 $\pm$ 0.3	0.6 $\pm$ 0.3	0.7 $\pm$ 0.3	1.1; 1.3	63.6
Vitamin PP (mg)	12.2 $\pm$ 4.7	9.9 $\pm$ 4.3	11.3 $\pm$ 4.7	14; 16	80.7
Vitamin C (mg)	145.0 $\pm$ 160.9	89.2 $\pm$ 61.8	122.1 $\pm$ 131.7	75; 90	135.6

^aRecommended dietary allowance (RDA) for Vietnamese individuals published by the National Institute of Nutrition in 2016; in this column, two values separated by a semicolon indicate the RDA range, with the first value representing the minimum recommended intake and the second value representing the maximum recommended intake. ^bEuropean Society of Parenteral and Enteral Nutrition (ESPEN) guidelines in 2019 on acute and chronic kidney diseases. ^cInternational unit (IU).

study could be relatively acceptable for both maintaining total lean body mass and preventing uremia.

Sodium intake in the present study was considerably high compared to the recommended levels (37,41). Previous research has suggested that, due to the need of accommodating lengthy treatments and fatigue after dialysis, patients undergoing dialysis often consumed fast foods and junk

foods that contained a higher level of sodium rather than regular meals (40). Although vitamin C deficiency is very common among patients undergoing dialysis, a high level of vitamin C is not recommended, as vitamin C is transferred into oxalate in the body (18). Currently, 50-60 g per day of vitamin C is recommended for patients with CKD (18,42). The results of the present study also demonstrated that the

amount of daily intake of vitamin A and vitamin D was very low, reaching under half of the recommended needs. Vitamin D levels were markedly lower than the recommendation in patients undergoing dialysis, which is consistent with the findings of previous studies (43-45). Some of risk factors of vitamin D deficiency in patients with CKD are the failure of converting 25(OH)D₃ into 1,25 (OH)₂ D₃ due to reducing skin synthesis of vitamin D, impaired 25(OH)D tubular reabsorption, proteinuria, or peritoneal dialysis (46).

The level of zinc intake in the present study was lower than the recommended value, which is similar to the results of previous studies (47,48). The amount of blood zinc in patients undergoing hemodialysis is normally lower than that of the general population, which is contributed by the inadequate consumption of dietary protein and energy, and impaired absorption (49). Moreover, zinc is considered an indicator of nutritional assessment, as the zinc level is associated with albumin and pre-albumin concentration and is high in healthy individuals (47). Zinc deficiency is also related to anemia in patients undergoing hemodialysis, which is presented by red blood cells, hemoglobin and hematocrit parameters (50). The zinc deficiency anemia phenomenon is caused by the fragility of red blood cells and can be effectively treated by zinc-based polaprezinc (50).

The findings of the present study may be of value for enhancing the nutritional status and treatment outcomes of patients undergoing dialysis. Several implications can be drawn to address any issues. Prior to modifying the dietary intake, it is necessary to consider biochemical and physical assessments to evaluate the manifestation level of protein, mineral and vitamin deficiencies. Patients should increase their consumption of high-quality protein food such as meat, poultry, fish and eggs, as well as limit the amount of sodium intake by consuming fresh, naturally low-sodium foods. Fatty fish such as salmon, tuna and mussels are good sources of vitamin D, apart from omega-3 (DHA and EPA) (46). Patients undergoing hemodialysis are regularly prescribed several nutritional supplements, including vitamin D [in the form of 25(OH)D₃], iron, zinc, vitamin B and vitamin C. However, the efficacy of dietary supplements containing 25(OH)D₃ and zinc have not been widely proven; thus, future research is warranted to evaluate their benefits for patients undergoing dialysis. Regular optimal nutritional counseling and the monitoring of the nutritional status of patients undergoing dialysis could help ensure adequate nutrition and improve their treatment outcome, as well as reduce the mortality rate. Currently, there are no structured counseling programs at the national or institutional level to educate patients undergoing hemodialysis and caregivers about dietary practices. The findings presented herein highlight the need for comprehensive, regular nutrition education sessions, which could be integrated into routine care to enhance dietary adherence and improve long-term outcomes. Future research with larger, multicenter samples is recommended to improve generalizability and assess the effectiveness of tailored nutrition education and counseling programs. Moreover, the present study opens prospects for integrating structured dietary counseling into routine dialysis care and influencing national policy for chronic kidney disease management.

However, several limitations of the present study should be acknowledged. The present study did not compare the dietary intake characteristics of patients between non-dialysis and dialysis days; therefore, the differences in average energy, macro-and micro-nutrients cannot be concluded. Participants subjectively reported their dietary consumption on the past day, which may lead to recall bias. In addition, another limitation of the present study was the relatively small sample size, which may limit the generalizability of the findings to the broader population of hemodialysis patients. Future studies with larger and more diverse samples across multiple centers are recommended to confirm and extend these results.

In conclusion, malnutrition is a common phenomenon among patients receiving hemodialysis therapy with a deficiency of energy intake and several important minerals and vitamins from the daily diet. In order to decrease the amount of accumulated toxin from renal impairment and maintain adequate nutritional status. Therefore, in order to follow a healthy dietary intake, regular nutritional counseling and monitoring nutritional status may be helpful in securing sufficient nutrition for patients undergoing hemodialysis, as well as enhancing treatment outcomes and decreasing the mortality rate.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

DQN, LKTN, NTL and TQB conceptualized the study. ATB, LKTN, NXH and AKD were involved in the formal analysis. AKD, DQN, HL and HBP were involved the study methodology. DQN, HL, NXH, HBP and AKD supervised the study. DQN, ATB, LKTN and AKD were involved in the writing of the original draft of the manuscript. DQN, HL, NXH, NTL, TQB and HBP were involved in the writing, review and editing of the manuscript. All authors have read and approved the final manuscript. DQN and HL confirm the authenticity of all the raw data.

Ethics approval and consent to participate

Patients were invited and provided consent to participate in the study and the research purpose was clearly explained to them. The interviews were only conducted under the agreement of the participants. The authors ensured personal confidentiality

for participants by keeping their information privately and encrypting all collected data. Participants had the right to refuse, to stop the interview at any time which did not interrupt their treatment progress. All results were only used for research and medical purposes. The study was ethically approved by Dong Da General Hospital under Decision No. 176/QĐ-BV.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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