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Vegetarian diet in dialysis patients

A significant gap between actual intake and current nutritional recommendations

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Abstract

Nutritional status is a predictor of mortality and morbidity in dialysis patients. This study aimed to assess dietary behaviors in dialysis patients compared to the recommendations of the Kidney Disease Outcomes Quality Initiative.

Ninety five dialysis patients recruited from a hospital completed a 24-hour dietary recall questionnaire. Body weight, energy requirements, protein requirements, albumin, normalized protein catabolic rate, and 25(OH) vitamin D levels were measured.

Of the 95 patients, 11 (11.6%) were below the desirable body mass index range, 59 (62.1%) were within the desired range, and 25 (26.3%) were above the desired range. However, only 32.7% of patients met the target energy intake, 29.5% reached the protein intake target, and 20.0% had adequate vitamin D concentrations. Vegetarian patients had lower energy, protein, fat, vitamin D intake, lower body mass index, serum blood urea nitrogen, creatinine, phosphate, normalized protein catabolic rate, and vitamin D status than the omnivorous patients ($P<.05$). After adjusting for age, sex, and body weight, vegetarianism was an independent risk factor for severe vitamin D deficiency (<10 ng/ml, $P<.01$).

Most dialysis patients do not meet their dietary recommendations or goals. The risk of a vegetarian diet may outweigh the benefits in dialysis patients. Careful consideration of dietary behaviors is required for dialysis patients to prevent malnutrition, more so in vegetarians.

Abbreviations: BMI = body mass index, BUN = blood urea nitrogen, DEI = dietary energy intake, DPI = dietary protein intake, ESRD = end-stage renal disease, K/DOQI = Kidney Foundation Kidney Disease Outcomes Quality Initiative, MHD = maintenance hemodialysis, NAHSIT = Nutrition and Health Surveys in Taiwan, PEW = protein energy wasting.

Keywords: body mass index, dialysis, malnutrition, omnivore, protein, vegetarian, vitamin D

1. Introduction

The incidence and prevalence of end-stage renal disease (ESRD) are increasing in Taiwan. According to data reports from Taiwan at the end of 2018, there were 85,000 individuals receiving dialysis (i.e., hemodialysis and peritoneal dialysis), marking the nation's highest annual number of dialysis cases.[1,2]

Many previous studies have reported a relationship between protein-energy malnutrition and increased morbidity and mortality in dialysis patients.[3] Malnutrition is a known cause of death among these patients.[4] The etiology of malnutrition is complex. Malnutrition can be caused by dietary restrictions during the pre-dialysis period and appetite loss with increased catabolism during the dialysis period.[5] Diets intended for

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dialysis patients are often not accepted by patients due to limitations. Moreover, social factors affect the development of malnutrition in these patients. A frequent and important cause of malnutrition in patients on maintenance dialysis is inadequate dietary protein and energy intake. Protein energy wasting (PEW) is common in patients receiving maintenance dialysis therapy. Patients often find it difficult to choose a permissible food product with low phosphate and potassium contents, and either do not comply with the restrictions or categorically reject dietary guidelines. Alternatively, they zealously adhere to the diet while eliminating most food products and consequently do not meet their required energy intake.[6]

Appropriate nutrition is crucial for the health of dialysis patients who experience metabolic disturbances. For ESRD dialysis patients, diets that consist of protein-rich animal products or soybeans are recommended to meet the higher protein requirements. Additionally, they are advised to consume limited quantities of fruits, vegetables, and whole grains to help control their serum potassium and phosphorus levels. Some dialysis patients consume vegetarian diets because of personal habits, beliefs, or religious reasons in Taiwan. However, vegetarian diets are often low in protein, which contradicts the high protein diet guideline recommendation while undergoing renal replacement therapy. Low dietary protein intake may be associated with an increased risk of mortality among hemodialysis patients.[7,8] Some studies suggest that protein intake is an independent predictor of outcome.[7,9]

According to the US National Kidney Foundation Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines,[10] the recommended dietary protein intake (DPI) during maintenance hemodialysis (MHD) is 1.2 g/kg body weight/d. The recommended daily energy intake (DEI) for MHD patients is 35 kcal/kg body weight/d for those less than 60 years of age, and 30 to 35 kcal/kg body weight/d for individuals aged 60 years or older. Other clinically useful markers such as serum albumin, serum creatinine, serum cholesterol, and anthropometric measurements are valid and clinically useful indicators of protein-energy nutritional status in MHD patients are recommended in the K/DOQI guidelines.[11] An important limitation of strategies to improve dietary protein intake in ESRD patients is increasing the intake of several potentially harmful elements, especially phosphorus. Although strictly limiting dietary phosphorus intake may indirectly lead to increased risk for PEW, allowing an unrestricted protein intake will undoubtedly increase the phosphorus load. Epidemiologic data indicate that for MHD patients, a combination of decreased serum phosphorus and increased protein intake has the best outcomes, whereas combinations of low serum phosphorus and low protein intake have the worst outcomes.[12]

In the current study, we aimed to investigate the prevalence of nutritional status in patients undergoing dialysis. We conducted a cross-sectional study, assessing dietary intake and examined diet quality using a validated 24-hour dietary recall and food record, and clinical biochemical data to determine clinical nutrition status.

2. Material and methods

2.1. Study design and recruitment

We conducted a cross-sectional study in the dialysis unit of the Kaohsiung Veterans General Hospital in Taiwan between February 1, 2014 and April 30, 2014. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the institutional review board of the hospital (IRB No: VGHKS19-CT4–22).

2.2. Participants and eligibility criteria

We enrolled patients who had ESRD and were undergoing maintenance hemodialysis for $\geq$3 months. The exclusion criteria were:

1. Less than 18 years old;
2. A stable disease for at least 3 months. Patients with signs and symptoms of acute inflammation, and those with mental disabilities that made them unable to understand and answer the questionnaires were excluded. Moreover, we did not enroll patients with ESRD in the course of systemic connective tissue disease and patients with active cardiovascular disease (myocardial infarction, heart failure, and coronary bypass surgery) within 3 months before the study period were not included;
3. Taking nutritional vitamin D supplementation, which was confirmed by the patient's medical charts and an interview.

2.3. Data collection

We collected baseline characteristics of the enrolled patients including age, sex, body mass index, dietary patterns, duration of dialysis, and underlying renal disease. The height and body weight of the patients were measured. Desirable body weight was derived from the height of patients using the desirable body mass index (BMI) guidelines for adult Taiwanese. Specifically, it was calculated considering dry body weight (after dialysis). BMI results were interpreted using the Ministry of Health and Welfare of Taiwan classification guidelines. The range from $\geq$18.5 to $<$24.0 ($18.5 \leqq \text{BMI} < 24.0$) was considered normal.

Dietary intake was estimated using 24-hour dietary recalls by a registered dietitian asking participants for quantification of portion sizes such as a cup (240 ml), a bowel, a tablespoon, or a standard food simulation card was employed to increase accuracy. We compared and analyzed differences in these demographics and laboratory data considering the K/DOQI guideline recommendations. The dietary pattern included omnivorous patients and vegetarian patients, which included strict vegetarians and ovo-lacto vegetarians. Their energy and protein requirements were calculated by multiplying the desirable body weight by 30 kcal and 1.2 g, respectively. We also routinely collected biochemical measurement parameters during the study period, including serum blood urea nitrogen (BUN), creatinine, albumin, total cholesterol, and normalized protein catabolic rate. We measured serum 25(OH) vitamin D, which is considered to be a better biomarker of total vitamin D status.[13] Vitamin D deficiency was defined as serum 25(OH) vitamin D level $<$30 ng/ml.[14]

2.4. Sensitivity analysis

Patients with diabetes mellitus were removed one at a time, and sensitivity analysis was performed to evaluate the stability of the results. The results were similar to the sensitivity analyses (Supplementary file 1–5, http://links.lww.com/MD/F621).

2.5. Statistics

Statistical analyses were performed using Statistical Product and Service Solutions statistical software version 12.0.1C (SPSS, Chicago, IL). All data are expressed as mean ± standard deviation or percentage of the total, as appropriate. The analyzed variables were tested for normality using the Kolmogorov–Smirnov test. Differences between groups were assessed using the Mann–Whitney *U* test, Student *t* test, or Chi-Squared test as appropriate. All significant variables from the univariate analysis were included in the multiple linear regression analysis to assess the independent determinants of severe hypovitaminosis D. All *P* values were two-tailed, and values <.05 were considered significant.

3. Results

The clinical characteristics and demographics of all participants are listed in Table 1. There were 95 patients (37 men, 58 women) who had received dialysis for a mean duration of 121.6 ± 74.50 months. The mean age of the patients was 56.8 ± 12.31 years (range 18–82 years). Based on the reference for BMI in adult Taiwanese, 11 patients (11.6%) were below the desirable range, 59 patients (62.1%) were within the desirable range, and 25 patients (26.3%) were above the desirable range. There were 28 patients (29.5%) who consumed a vegetarian diet. The causes of ESRD were chronic interstitial nephritis (n = 39), chronic glomerulonephritis (n = 30), diabetes mellitus nephropathy (n = 13), IgA nephropathy (n = 5), adult polycystic kidney disease (n = 4), and lupus nephritis (n = 4). Biochemical tests included BUN, creatinine, phosphate, albumin, total cholesterol, 25(OH) vitamin D, and normalized protein catabolic rate. Dietary information included dietary energy intake, dietary protein intake, protein to energy ratio, total energy, protein, carbohydrate, fat, and vitamin D.

The percentage of patients meeting the energy requirements and content of basic nutrients according to the K/DOQI are listed in Table 2. We further used the K/DOQI guidelines to analyze nutritional status. According to baseline biochemical analyses, there were only 45 patients with albumin levels ≥4.0 g/dl, 41 patients had creatinine levels of ≥10.0 g/dl, and 55 patients had cholesterol levels of ≥180 g/dl.

In this study, we also focused on nutritional supplements. The 24-hour dietary recall and food record revealed 17 (17.9%) patients used commercial formula milk for nutrition supplementation (e.g., Nu-Reno, Nepro. etc.) ranging from 103 to 425 kcal/day. Regarding protein and energy intake, we found that in 28 patients (29.5%) the daily protein intake was ≥1.2 g/kg/day, and 44 patients (46.3%) reached the recommended target of daily energy intake of ≥30 kcal/kg/d. There were 76 patients (80%) with vitamin D deficiency (<25(OH) vitamin D 30 ng/ml), and 11 patients (11.6%) with severe vitamin D deficiency (<25(OH) vitamin D 10 ng/ml).

Differences in biochemical characteristics and dietary composition between the vegetarians and omnivores are listed in Table 3. In a subgroup analysis, vegetarian patients had significantly lower BMI (20.92 ± 2.50) than the omnivore group (22.75 ± 3.36; *P* = .011). Biochemical results, including BUN, creatinine, phosphate, albumin, normalized protein catabolic rates, and 25(OH) vitamin D were significantly lower in the vegetarian group than in the omnivores group (*P* < .05). Total cholestero and c-reacive protein serum levels did not differ between the vegetarian and omnivore groups.

Table 1

Baseline clinical characteristics of the 95 study participants.

Baseline character	
Mean Age (years)	56.8 ± 12.31
≥60 years [n (%)]	40 (42.1)
Male [n (%)]	37 (38.9)
Duration of dialysis (months)	121.6 ± 74.50
Body metabolic index (kg/m^2)	22.2 ± 3.23
BMI < 18.5 [n (%)]	11 (11.6)
18.5 ≤ BMI < 24 [n (%)]	59 (62.1)
BMI ≥ 24 [n (%)]	25 (26.3)
Vegetarian [n (%)]	28 (29.5)
Underlying renal disease	
Chronic interstitial nephritis [n (%)]	39 (41.1)
Chronic glomerulonephritis [n (%)]	30 (31.6)
Diabetes mellitus nephropathy [n (%)]	13 (13.7)
IgA nephropathy [n (%)]	5 (5.3)
Adult polycystic kidney disease [n (%)]	4 (4.2)
Lupus nephritis [n (%)]	4 (4.2)
Baseline biochemical test results	
Blood urea nitrogen (mg/dl)	63.3 ± 16.46
Creatinine (mg/dl)	9.7 ± 0.85
Phosphate (mg/dl)	4.9 ± 1.54
Albumin (g/dl)	3.9 ± 0.35
Total Cholesterol (mg/dl)	186.8 ± 37.49
25(OH) Vitamin D (ng/ml)	21.96 ± 9.75
normalized protein catabolic rate (g/day/kg)	1.2 ± 0.33
The dietary intake	
Diet energy intake (kcal/kg/d)	29.88 ± 10.02
Diet protein intake (g/kg/d)	1.05 ± 0.39
Diet protein/Diet energy ratio (%)	14.35 ± 2.62
Energy (kcal)	1656.44 ± 522.92
Protein (g)	58.56 ± 21.16
Carbohydrate (g)	209.50 ± 72.34
Fat(g)	62.39 ± 23.82
Vitamin D (μg)	5.03 ± 5.34

Values are expressed as mean ± Standard Deviation or as number (percentages).
BMI = body mass index.

Dietary composition, including DEI and DPI, was significantly lower in the vegetarian group than in the omnivore group (*P* = .04, *P* = .004, respectively). Energy, protein, fat, and vitamin D intake was also significantly lower in the vegetarian group than in the omnivore group (*P* < .05). Daily carbohydrate intake did

Table 2

Percentage of patients meeting the energetic values and content of basic nutrients according to the K/DOQI.

Baseline Biochemical Test, n (%)	
Albumin ≥4.0 g/dl	45 (47.4%)
Creatinine ≥10.0 g/dl	41 (43.2%)
Cholesterol ≥180 g/dl	41 (43.2%)
Normalized protein catabolic rate ≥1.2 g/day/kg	44 (46.8)
Actual Dietary Intake, n (%)	
Daily protein intake ≥1.2 g/kg/d	28 (29.5%)
Daily energy intake≥30 kcal/kg/d	31 (32.7%)
Serum 25(OH) Vitamin D level, n (%)	
Dufficient Vitamin D (≥30 ng/ml)	19 (20.0%)
Vitamin D deficiency (<30 ng/ml)	65 (68.4%)
Severe vitamin D deficiency (<10 ng/ml)	11 (11.6%)

Values are expressed as number (percentage).
K/DOQI = Kidney Foundation Kidney Disease Outcomes Quality Initiative.

Table 3

Differences in biochemical characteristics and dietary composition between vegetarians and omnivores.

	Vegetarians (n = 28)	Omnivores (n = 67)	*P* value
Body metabolic index (kg/m^2)*	20.92 ± 2.50	22.75 ± 3.36	.011
BMI < 18.5, n (%)	5 (17.9)	6 (9.0)	
18.5 ≤ BMI < 24, n (%)	21 (75.0)	38 (56.7)	
BMI≥24, n (%)	2 (7.1)	23 (34.3)	
Biochemical characteristics			
Blood urea nitrogen (mg/dl)**	53.12 ± 13.21	67.56 ± 15.88	<.001
Creatinine (mg/dl)**	8.63 ± 1.76	10.20 ± 2.17	.001
Phosphate (mg/dl)**	3.90 ± 1.22	5.28 ± 1.48	<.001
Albumin (g/dl)*	3.79 ± 0.37	3.97 ± 0.33	.016
Total Cholesterol (mg/dl)	183.21 ± 41.50	188.31 ± 35.92	.548
Normalized protein catabolic rate (g/day/kg)**	1.03 ± 0.29	1.26 ± 0.33	.002
25(OH) Vitamin D**	14.91 ± 8.41	24.90 ± 8.76	<.001
C- reactive protein	0.75 ± 1.21	1.03 ± 2.83	.611
The dietary composition			
Diet energy intake (kcal/kg/d)*	26.68 ± 7.39	31.21 ± 1 0.70	.04
Diet protein intake (g/kg/d)**	0.88 ± 030	1.13 ± 0.40	.004
Diet Protein/Diet energy ratio (%)*	13.35 ± 3.19	14.77 ± 2.23	.015
Energy (kcal)**	1391.26 ± 410.92	1767.26 ± 527.33	.001
Protein (g)**	45.88 ± 16.09	63.86 ± 20.86	<.001
Carbohydrate (g)	192.87 ± 59.58	216.45 ± 76.39	.148
Fat (g)**	46.83 ± 18.34	68.90 ± 22.91	<.001
Vitamin D (μg)*	3.01 ± 2.64	5.88 ± 5.94	.016

Values are expressed as mean ± Standard Deviation or as number (percentage).
* $P < .05$.
** $P < .01$.
BMI = body mass index.

not differ between the vegetarian and omnivore groups. The differences between the proportions of vegetarian and omnivorous patients meeting the basic nutrient contents according to the K/DOQI for dialysis patients are listed in Table 4. The baseline biochemical tests showed significant differences between the vegetarian and omnivore groups for serum albumin ≥4.0 g/dl (28.6% vs 55.2%, $P = .017$), serum creatinine ≥10.0 g/dl (21.4% vs 52.2%, $P = .005$) and normalized protein catabolic rate ≥1.2 g/day/kg (28.6% vs 53.7%, $P = .021$) levels. There was a statistically significant difference in vitamin D deficiencies between the vegetarian (60.7%) and omnivore groups (71.6%; $P = .009$). The percentage of daily protein intake (≥1.2 g/kg/d) was significantly lower in the vegetarian group (14.3%) than in the omnivore group (35.8%; $P = .036$). Risk factors for severe vitamin D deficiency in patients undergoing hemodialysis are listed in Table 5. A multiple logistic regression was performed to determine the risk factors for severe vitamin D deficiency in patients undergoing hemodialysis. The results revealed that a vegetarian diet was the only independent risk factor for severe vitamin D deficiency in patients undergoing hemodialysis ($P = .002$).

4. Discussion

Assessments of nutrient intake are essential for identifying patients at an increased risk of malnutrition and for developing

Table 4

Differences between the proportions of vegetarian and omnivore patients meeting the basic nutrient contents according to the K/DOQI for dialysis patients.

	Vegetarians (n = 28)	Omnivores (n = 67)	*P* value
Baseline Biochemical Test, n (%)			
Albumin ≥4.0 g/dl*	8 (28.6)	37 (55.2)	.017
Creatinine ≥10.0 g/dl**	6 (21.4)	35 (52.2)	.005
Cholesterol ≥180.0 g/dl	14 (50.0)	41 (61.2)	.319
Normalized protein catabolic rate ≥1.2 g/day/kg*	8 (28.6)	36 (53.7)	.021
Serum 25(OH) Vitamin D level, n (%)			
Vitamin D deficiency (<30 ng/ml)**	17 (60.7)	48 (71.6)	.009
Severe vitamin D deficiency (<10 ng/ml)**	10 (35.7)	1 (1.5)	<.001
Actual Dietary Intake, n (%)			
Daily protein intake ≥1.2 g/kg/d*	4 (14.3)	24 (35.8)	.036
Daily energy intake ≥30 kcal/kg/d	6 (21.4)	25 (37.3)	.081

Values are expressed as number (percentages).
* $P < .05$.
** $P < .01$.
K/DOQI = Kidney Foundation Kidney Disease Outcomes Quality Initiative.

Table 5

Binary logistic regression analysis of severe vitamin D deficiency (<10 ng/ml).

	Exp (beta)	95% confidence interval	*P* value
Vegetarian (1/0)**	32.371	3.609–290.366	.002
Sex(1/0)	0.191	0.018–1.993	.167
Age (year)	0.988	0.928–1.052	.710
BMI	0.941	0.671–1.320	.726

The regressions coefficients and 95% coefficient interval values are included. All models are after adjustment for all the above covariates including sex, age, and body mass index (BMI).
*$P<.05$.

strategies to improve nutritional status. However, previous research focused primarily on body metabolic index and energy–protein intake, with little attention to vitamin D status. The present study revealed that most patients on dialysis do not meet their dietary recommendations or nutritional goals. All patients were considered well-nourished. Only 44 (46.3%) patients reached the target for energy, 28 (29.5%) patients reached the target of protein intake, and 19 (20.0%) patients reached the target of vitamin D adequacy in this study. Furthermore, there are huge differences between the vegetarian and omnivore groups. Assessments of the demand for nutrients in dialysis patients should not be based on the analysis of their body metabolic index only, but should also consider the analysis of dietary behavior.

Many previous studies reported that dietary intakes of energy and protein in hemodialysis patients are insufficient when compared to the recommendations.[3–6] Similar to previous studies, the intake of energy (29.88 ± 10.02 kcal/kg/d) and protein (1.05 ± 0.39 g/kg/d) were considerably lower than the nutrition recommendations in this study. The proportion of patients meeting the protein/dietary energy requirements was approximately 14.35%. Among them, the proportion of omnivores was 14.77%, and that of vegetarians was 13.35%. The dietary protein/dietary energy ratio recommendation for high protein intake for dialysis patients should reach more than 16% (provide 1.2 g protein/kg/d). One of the interesting findings of the current study was that energy was closely correlated with protein intake ($P<.001$), and the density of dietary protein per energy was lower than the dietary recommendation. This indicates that energy intake can be considered to be adequate if protein intake reaches the recommended level. These results suggest that the current Taiwan dialysis dietary education for prevention of hyperphosphatemia incorporates lower protein dietary intake complicated with inadequate energy supply and malnutrition. Reduction of protein intake as a method to decrease hyperphosphatemia risk cannot be recommended for most patients, due to the need to replenish the loss of amino acids and proteins during dialysis. Given that phosphorus is ubiquitous in food, and dietary restrictions have little effect, there are medications used to bind phosphates within the alimentary tract. This allows for adequate energy intake if protein intake reaches the recommended level.

In this study, we further evaluated protein-energy nutritional status differences between vegetarians and omnivores. Plant-based proteins are richer in phosphorus than animal proteins; however, the phosphate in plant proteins is only 30% to 50% bioavailable, while animal proteins are estimated to be 70% bioavailable. Therefore, it appears that the consumption of grain-based vegetarian food may be associated with decreased phosphorus absorption compared with meat-based diets.[15] In this study, vegetarian patients had significantly lower BMI, serum BUN, creatinine, phosphate, albumin, normalized protein catabolic rates, and 25(OH) vitamin D than the omnivore group ($P<.05$). The basic principle followed by vegetarians is to prohibit consumption of all animal products, where most choices are from plant-based foods. From the 24-hour dietary recalls, vegetarians chose mostly cereals, vegetables, and less soy protein or its products for intake. This increases the risk for PEW for vegetarians. We suggest a minimum target for normalized protein catabolic rate of 1.2 g/kg/day. This is consistent with both the K/DOQI clinical practice guidelines and the European Best Practice Guidelines on hemodialysis.[16,17] Although only 8 vegetarians (28.6%) reached the target, only 36 omnivores (53.7%) reached were able to reach the target. The choice of vegetarian diet should be cautious for dialysis patients, since it did not allow for increased protein and energy consumption above the required value. Overall protein and energy intake may be inadequate in dialysis patients across both groups in our study. However, careful consideration of diet behaviors is required for dialysis patients to prevent malnutrition, especially in vegetarians.

This study demonstrated that the prevalence of vitamin D insufficiency in dialysis patients was high (80.0%) at the end of winter. Additionally, a vegetarian diet is an independent risk factor for predicting severe vitamin D deficiency in dialysis patients in Taiwan. Our finding of the prevalence of vitamin D insufficiency in dialysis patients is higher but also similar to previous reports of patients on renal replacement therapy,[18–21] and close to the prevalence of vitamin D insufficiency (86.6%) in Taiwanese women with osteoporosis and hip or vertebral fracture.[22] Our analysis concentrated on identifying severely vitamin D deficient dialysis patients through common clinical demographics and biochemical laboratory analyses. We defined severe vitamin D deficiency as a serum level of 25(OH) vitamin D < 10 ng/ml because it was the highest value ever reported to be associated with adult osteomalacia.[23] Risk factors for vitamin D insufficiency, including age, BMI, and serum albumin, failed to be significantly associated with severe vitamin D deficiency in this study. However, vegetarian diet was the only and strongest predictor of severe vitamin D deficiency. Our analysis further supported that vegetarians on dialysis had a significantly lower energy, protein, fat, and vitamin D intake in comparison to omnivores on dialysis. In other words, dietary restriction related to vegetarianism in dialysis patients has an adverse impact on total body storage of vitamin D. Vitamin D_3 is found in animal foods, including oily fish and eggs. Additionally, vitamin D_2 is produced in sun-exposed yeast and mushrooms. Milk sold in Taiwan is generally not fortified with vitamin D. During 1993 to 2002, a series of population representative Nutrition and Health Surveys in Taiwan (NAHSIT) were conducted, revealing that fish, milk, and mushrooms were the most important source of vitamin D for individuals in Taiwan.[24] Among these, mushrooms accounted for 3% to 5% of the main source of vitamin D for vegetarians. The OPIC-Oxford study pointed out that the serum 25(OH) vitamin D levels in vegetarians were lower than those in omnivores, where complete vegetarians also had lower levels than lacto-ovo-vegetarians.[25] We propose that education for vegetarians on dialysis, including the incorporation of more vitamin D_2-rich foods and lacto-ovo-vegetarian diet intake, more sun exposure, and vitamin D supplementation is important to decrease the risk of severe vitamin D deficiency and its associated complications.

Some studies demonstrated that the serum 25(OH)vitamin D levels varied according to season,[26–28] and this effect was also observed in Taiwan.[29] We applied a cross-sectional model in this study within a narrow time period to avoid the influence of different seasons. Our results represent the actual prevalence of hypovitaminosis D in Taiwanese dialysis patients at the end of winter. In other words, there was a high prevalence of hypovitaminosis D in southern Taiwanese dialysis patients, where there is more sunshine. However, this study has some limitations. First, the study enrolled stable dialysis patients. Selection bias cannot be entirely dismissed as participation in the study was voluntary. Second, when using a 24-hour dietary recall combination with real food records, there are some deviations in calorie and nutrient estimation due to the patient's poor memory, different perceptions of food, and because of differences between weekdays and holidays. Third to a lack of vitamin D food composition data, we compiled data for the present study from various sources.[23] Fourth we did not analyze associations between sun exposure and vitamin D insufficiency. However, the aim of this study was to identify vegetarianism as an independent risk factor for severe vitamin D deficiency (defined as <10 ng/ml).

The prevalence of nutritional status on gross healthy dialysis patients has not yet been documented in Taiwan. Only patients with stable vegetarian dietary behavior were included in the vegetarian diet group. This study was the first to report diet and nutrition status using an inexpensive nutritional assessment. Additional limitations of the present study include its cross-sectional nature, which limits the ability to make causal inferences between study variables. Furthermore, 24-hour dietary recall may not represent a patient's long-term intake. However, a 24-hour dietary recall was more likely to result in successful data collection than a 3-day diet diary and was less time consuming. Additional longitudinal investigations with larger numbers of patients, especially with respect to the foregoing limitations, are necessary to support our results and outcome evaluation.

5. Conclusions

The present study revealed that most patients on dialysis do not meet their dietary recommendations or nutritional goals. Careful planning and consideration of diet behaviors should be made for dialysis patients to prevent inadequate protein intake, malnutrition, and vitamin D deficiency. The medical risks of a vegetarian diet may far outweigh the benefits in dialysis patients. To ensure adequate dietary intake in dialysis patients who are vegetarian, the development and introduction of more specific food recipes should be provided to motivate patients to adapt these foods within their recommended diet therapy. Additionally, serum 25(OH) D levels in high-risk dialysis patients should be periodically monitored, and additional vitamin D supplements could be provided as needed.

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