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ORIGINAL RESEARCH

Dietary Intake in Hemodialysis Patients Does Not Reflect a Heart Healthy Diet

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Objective: Cardiovascular disease is highly prevalent and has a major effect on morbidity and mortality in patients undergoing maintenance hemodialysis (MHD). Dietary factors that may contribute to cardiovascular disease have not been well studied in this population. We hypothesize that dietary intake in this population does not meet the guidelines for cardiovascular risk reduction.

Design: A cross-sectional study was completed using the validated "Block Dialysis 1 Food Frequency Questionnaire" to assess dietary intake of MHD patients.

Setting and Patients: A total of 70 patients undergoing MHD at our outpatient dialysis center completed the questionnaire under the supervision of a trained dietitian. The population consisted of 38 men and 32 women.

Main Outcome Measure: Dietary intake was the main outcome measure, with a focus on calories, soluble fiber, saturated fatty acid (SFA), unsaturated fatty acid intake (UFA), and protein.

Results: The mean fiber intake was 10.77 (±5.87) g/day, and only 2 of 71 (2.9%) were in compliance with the recommended daily intake of >25 g/day. As percentage of total calories, of the 70 patients, 5 (7.1%) had a fat intake of <30%, 22 (31.4%) had SFA intake of <10%, 64 (91.4%) had a UFA of ≤30%, 22 (31.4%) had a protein-based diet of ≥15%, and 66 (94.3%) had a carbohydrate diet of <60%.

Conclusions: Most patients did not meet the dietary guidelines for reducing the risk of cardiovascular disease. Substituting UFA or soluble fiber for SFA improves low density lipoprotein (LDL) cholesterol levels without negative effects on other lipid parameters.

PROTEIN-ENERGY WASTING (PEW), or uremic malnutrition, is highly prevalent in patients with end-stage renal disease on maintenance hemodialysis (MHD); estimates range from 23% to 76%.[1] PEW is thought to be a predictor of morbidity and mortality.[2] Hypoalbuminemia, a biochemical surrogate of PEW, is closely and incrementally associated with increased death risk. Thus, patients undergoing dialysis are encouraged to eat a high-protein diet to avoid muscle wasting and mitigate the risk of PEW.[3,4] Several factors are associated with the high prevalence of malnutrition in MHD patients, including poor dietary intake as a result of anorexia induced by uremic toxins.[5]

Cardiovascular disease is highly prevalent and has a major effect on morbidity and mortality in patients undergoing MHD.[6,7] Besides conventional

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risk factors, numerous other factors including, hypoalbuminemia, elevated troponin levels, anemia, hyperhomocystinemia, increased calcium-phosphate product, inflammation, increased oxidant stress, and decreased nitric oxide activity, could contribute to an increased risk of coronary artery disease (CAD) in MHD patients.[8,9] Dietary factors that may contribute to cardiovascular disease and increased mortality have not been well studied in this population. In this study, our primary aim was to examine the dietary intake of a group of MHD population and to ascertain whether they meet the National Kidney Foundation (NKF), Kidney Disease Outcome Quality Initiative (K/DOQI), American Heart Association (AHA) guidelines, or other relevant dietary guidelines for cardiovascular risk reduction. We hypothesized that MHD patients ingest an atherogenic diet. Our secondary aim was to explore the relationship between background history of cardiac disease and nutritional intake. We used Block's Dialysis Food Frequency Questionnaire (FFQ) version 1 (NutritionQuest Block Dialysis, Berkeley, CA), a version of Block 2005 FFQ, developed for the dialysis population.

Methods

Patients

The study protocol was reviewed and approved by the hospital institutional review committee before beginning the study. All patients gave informed consent, in writing, before enrollment in the study.

All patients undergoing MHD at the outpatient dialysis unit at Staten Island University Hospital were considered for the study. The patients varied in race, age, socioeconomic status, and cause of renal failure, although diabetes and hypertension were predominant (see later in the text). The major inclusion criteria were: age between 18 and 90 years; at least 6 months of uninterrupted thrice-weekly MHD; ability to understand, read, and write English, and to fill out the questionnaire; and the ability to ingest 3 meals a day independently. Exclusion criteria included terminal or active cancer, active systemic inflammatory disease, AIDS, inflammatory bowel disease, severe congestive heart disease (NYHA class III, or IV), severe lung disease, the use of nonoral feedings, the inability to ingest food because of medical conditions, a history of dementia, and patients not oriented to person, place, or time.

As part of the standard dietary intake process, all patients underwent routine dietary education which included an assessment of height, weight, body mass index (BMI), dentition, and education on the importance of appropriate nutrition for the MHD patient. A 3-day diet diary was reviewed with the dietician to highlight specific changes necessary to each individual. Before leaving, patients were provided with a handout to guide them in choosing appropriate foods. The handout included the current recommendation of the AHA and NKF for a heart healthy diet. Further counseling was triggered by an inappropriate gain or loss of dry weight, high levels of phosphorous or potassium found on monthly laboratory results, and after review of a routine 3-day diet diary conducted in all patients every 6 months.

All patients continued their standard MHD treatments, as well as treatments of all chronic diseases and issues related to MHD including, but not limited to treatment of anemia, calcium, phosphorous and parathyroid hormone (PTH) abnormalities, and iron deficiency.

Dietary Assessment Instrument

To assess dietary intake, we used the Block Dialysis FFQ. The FFQ is an extensive questionnaire designed to measure nutrient and calorie intake on the basis of the description of food and vitamins consumed by the patient. It has been validated in different settings.[10–13] The questionnaire is 8 pages long and contains approximately 150 multiple choice questions regarding which foods are eaten, the frequency of eating each item, and the size of the portion generally eaten. Each variable has multiple choices to be answered, and the answers are appropriate to the food. Food is grouped together in ways that are sensible and familiar to patients to increase the ease and accuracy of the questionnaire. The questionnaire also has a section of questions designed to assess the patients' perception of overall health and well being, as well as certain demographic information.

The questionnaire has gone through several revisions to improve the accuracy of the assessment. The Block dialysis 1 FFQ was designed specifically to assess dietary intake of patients on dialysis, and there are several important differences to note. The list of food in the multiple choice questions

was developed by examining 24-hour diet diaries, specifically those of patients who were on dialysis. Foods listed together in a single question were placed together to more accurately reflect intake of minerals most important to patients who are on dialysis. Portion sizes were adapted to reflect dialysis diet exchange serving sizes for protein foods, and questions were added to capture dietary intake from high- and low-protein liquid diets used in the care of patients suffering from kidney disease. A question was added to specifically address vitamins designed for dialysis patients, such as Nephro-Vite, Dialyvite, and so forth. Although the final product is in fact very similar to the original Block FFQ, the specifications allowed for a better assessment of intake most important to the dialysis population.

The questionnaire was administered by a group of medical residents trained to administer the FFQ. The subjects were given the questionnaire at the hemodialysis (HD) sessions, and were permitted to fill it out there, or complete it at home and return it at their next scheduled HD session. Any questions not addressed were reviewed with the patient by the researchers and the correct answer was filled in. In this manner, all questionnaires were filled out completely.

Study Population

A total of 70 individuals agreed to participate in the study. The studied population consisted of 38 (54%) men and 32 (56%) women. The mean age was 61.47 years (±standard deviation: ±14.42 years), ranging from 19 to 87 years. This included 44 (62.9%) nonHispanic whites, 20 (28.6%) African Americans, and 6 (8.6%) Hispanics. The mean dry weight was 75 kg (±standard deviation: ±22.3 kg). The mean duration of chronic intermittent MHD was approximately 55 months. The mean BMI (kg/m^2) was 27.50 ± 7.44, hemoglobin (g/dL) 11.15 ± 1.22, serum albumin (g/dL) 3.77 ± 0.39, serum calcium (mg/dL) 8.98 ± 0.71, serum phosphorus (mg/dL) 4.93 ± 1.55, and serum ferritin (ng/mL) 651.40 ± 318.62. As would be expected, there were differences in the baseline characteristics of the groups. The group with cardiac disease was older (65.44 ± 14.49 vs. 55.86 ± 12.54; $P = .001$), had more diabetic nephropathy (61% vs. 38%; $P = .008$), had a greater level of comorbidities (Charlson Comorbidity Index: 4.88 ± 1.75 vs. 3.21 ± 1.52; $P = .004$), and were more frequently on clopidogrel (48.8% vs. 13.8%; $P = .0025$) and statins (65.9% vs. 31%; $P = .007$). Although there was a trend toward more diabetes, higher BMI, and lower LDL and high density lipoprotein (HDL) in the group with cardiac disease, this did not meet statistical significance. There was no difference between the 2 groups with regard to hemoglobin, serum albumin, serum calcium, serum phosphorus, and serum ferritin (Table 1).

Statistical Methods

The primary objective of the statistical analysis was to provide descriptive statistics on dietary intake in the studied subjects; thus, the sample size used for this study was not based on any formal power calculations.

Overall mean values of demographic variables and dietary information from the FFQ were calculated, and values were also tabulated according to the presence or absence of background cardiac disease. Comparison between the 2 groups was performed using the nonparametric Mann–Whitney test. Comparisons were also performed according to various demographic characteristics of the patient (e.g., age group (> or <60), ethnicity, presence of diabetes, etc.).

This study is purely descriptive and was designed to provide guidance to the existing trends in dietary intake and compliance with current guidelines. This will assist the investigators in designing a future study examining whether dietary counseling helps patients meet dietary recommendations.

Results

Participating MHD patients were divided into 2 groups on the basis of the existence of known cardiac disease at baseline (assessed by reviewing the record in the patients chart) or lack thereof. The rationale was that there might be an association between poor diet and cardiac disease, or possibly that those with cardiac disease might be more compliant with dietary recommendations.

Table 2 displays the dietary results of the FFQ, and includes data with and without supplementation with vitamins. The total average kilocalories were 1,626.1 ± 672.84, with approximately half in the form of 201.28 ± 90.79 g of carbohydrates, 15% in the form of 54.79 ± 23.36 g of protein, and 40% in the form of 69.58 ± 30.13 g of fat.

Table 1. Demographics

	Total	Background Cardiac Disease	No Background Cardiac Disease	
	N = 70	n = 41	n = 29	*P*
Clinical and demographic characteristics				
Age	61.47 ± 14.42	65.44 ± 14.49	55.86 ± 12.54	.001
Men/Women	39/31	23/18	16/13	1.0
Diabetes mellitus	36/70 (51.4%)	25/41 (61%)	11/29 (37.9%)	.09
Diabetic nephropathy	37/70 (52.9%)	25/41 (61%)	8/29 (27.6%)	.008
Hypertension	61/70 (87.1%)	36/41 (87.8%)	25/29 (86.2%)	1.0
Smoking	17/70 (24.3%)	11/41 (26.8%)	6/29 (20.7%)	.59
BMI (kg/m^2)	27.50 ± 7.44	27.95 ± 5.29	26.87 ± 9.78	.06
Dialysis (months)	55.14 ± 62.91	50.41± 45.71	61.84 ± 81.79	.69
Charlson comorbidity index	4.19 ± 1.84	4.88 ± 1.75	3.21 ± 1.52	.0004
Charlson comorbidity index-adjusted	6.00 ± 2.33	7.07 ± 2.07	4.48 ± 1.79	.0001
Medications				
ASA	31/70 (44.3%)	20/41 (48.8%)	11/29 (37.9%)	.47
Plavix	24/70 (34.3%)	20/41 (48.8%)	4/29 (13.8%)	.0025
Statins	36/70 (51.4%)	27/41 (65.9%)	9/29 (31.03%)	.007
B-blocker	37/70 (52.9%)	24/41 (58.6%)	13/29 (44.8%)	.33
ACEI or ARB	24/70 (34.3%)	17/41 (41.5%)	7/29 (24.1%)	.20
Erythropoietin	67/70 (95.7%)	40/41 (97.6%)	27/29 (93.1%)	.57
Biochemical characteristics				
Hemoglobin (g/dL)	11.15 ± 1.22	11.05 ± 1.24	11.30 ± 1.19	.49
Serum albumin (g/dL)	3.77 ± 0.39	3.81 ± 0.37	3.71 ± 0.41	.33
Serum calcium (mg/dL)	8.98 ± 0.71	8.92 ± 0.71	9.06 ± 0.72	.55
Serum phosphorus (mg/dL)	4.93 ± 1.55	4.96 ± 1.50	4.89 ± 1.64	.74
Low-density lipoprotein cholesterol (mg/dL)	61.80 ± 25.03	57.2 ± 21.8	68.24 ± 28.19	.06
High-density lipoprotein cholesterol (mg/dL)	37.90 ± 11.77	36.78 ± 13.10	39.48 ± 9.57	.09
Triglycerides (mg/dL)	172.33 ± 83.13	179.6 ± 89.0	162.1 ± 74.4	.58
Serum ferritin (ng/mL)	651.40 ± 318.62	689.3 ± 329.5	597.8 ± 299.9	.30

BMI, body mass index; ASA, aspirin; ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker.

Table 2. Dietary Intake With and Without Vitamin Supplements in Comparison With the Current Recommendations

Variable (N = 70)	Dietary Intake	Supplementation Intake	Dietary + Supplementation Intake	Recommended Intake
Total calories (Kcal)	1.626 ± 6.7284	None	1.626 ± 6.7284	
Calorie density (cal/kg)	23,067 ± 11,556	None	23,067 ± 11,556	35 kcal/kg (<60 years); 30-35 kcal/kg (≥60 years)†,‡
Total protein (g)	54.79 ± 23.36	None	54.79 ± 23.36	Individualized, 15% of calorie intake*,†
Protein density (g/kg)	0.77 ± 0.39	None	0.77 ± 0.39	>1.2 g/kg*,†,‡
Total fat (g)	69.58 ± 30.13	None	69.58 ± 30.13	Individualized, 25%-35% of calorie intake*,†
Saturated fat (g)	19.38 ± 8.34	None	19.38 ± 8.34	Individualized, 7% of calorie intake*,†
Carbohydrate (g)	201.28 ± 90.79	None	201.28 ± 90.79	Individualized, 50%-60% of calorie intake*,†
Cholesterol (mg)	213.08 ± 103.08	None	213.08 ± 103.08	<200 mg*,†
Vitamin A (mcg)	453.24 ± 250.15	242.33 ± 227.29	689.58 ± 374.74	80-100 mcg/day†,§
Vitamin D (IU)	83.59 ± 54.61	223.27 ± 210.25	306.86 ± 218.81	Individualized†
Thiamin (B1) (mg)	1.17 ± 0.53	1.70 ± 2.11	2.86 ± 2.18	1.1-1.2 mg/day†
Riboflavin (B2) (mg)	1.39 ± 0.54	1.86 ± 2.13	3.25 ± 2.23	1.1-1.3 mg/day†
Niacin (mg)	15.69 ± 7.15	21.06 ± 21.72	36.75 ± 22.85	14-16 mg/day†
Vitamin C (mg)	67.24 ± 54.25	120.73 ± 278.70	187.97 ± 292.75	60-100 mg/day†
Vitamin B6 (mg)	1.14 ± 0.69	4.16 ± 4.00	5.30 ± 3.98	2-10 mg/day†
Vitamin B12 (μg)	3.02 ± 1.66	5.47 ± 3.41	8.49 ± 3.79	3 μg/day†
Vitamin E (IU)	6.19 ± 3.89	26.69 ± 67.76	32.87 ± 67.71	15 IU/day†
Folate (μg)	138.71 ± 82.33	657.71 ± 355.71	796.43 ± 383.71	1-5 mg/day†
Calcium (mg)	487.86 ± 210.49	598.90 ± 516.22	1,086.8 ± 577.42	<2 g/day†
Phosphorus (mg)	841.23 ± 339.44	None	841.23 ± 339.44	1,000 mg/day†
Iron (mg)	10.72 ± 4.72	9.06 ± 15.76	19.77 ± 17.06	Individualized†
Zinc (mg)	7.25 ± 3.52	8.20 ± 7.18	15.45 ± 8.47	15 mg/day†
Copper (mg)	0.84 ± 0.39	0.61 ± 0.92	1.45 ± 1.12	2 mg/day¶
Selenium (mcg)	83.68 ± 38.95	6.37 ± 9.32	90.05 ± 41.70	70 mcg/day¶
Magnesium (mg)	172.71 ± 74.71	53.27 ± 49.96	225.97 ± 103.86	400 mg/day¶
Sodium (mg)	2,502.0 ± 1,094.7	None	2,502.0 ± 1,094.7	2 g/day†
Potassium (mg)	1,695.1 ± 701.55	None	1,695.1 ± 701.55	2-3 g/day†
Fiber (g)	10.77 ± 5.87	None	10.77 ± 5.87	20-25 g/day†
Oleic acid (g)	29.30 ± 14.17	None	29.30 ± 14.17	Individualized, <20% of calorie intake†
Linoleic acid (g)	12.57 ± 6.28	None	12.57 ± 6.28	Individualized, <10% of calorie intake†
Alpha carotene (μg)	297.47 ± 317.82	None	297.47 ± 317.82	A caretenoid, no range set
Beta carotene (μg)	2,156.4 ± 2,286.2	674.89 ± 634.31	2,831.3 ± 2,499.9	A caretenoid, no range set
Cryptoxanthin (μg)	70.15 ± 56.42	None	70.15 ± 56.42	A caretenoid, no range set
Lutein (μg)	1,720.5 ± 2,283.5	None	1,720.5 ± 2,283.5	A caretenoid, no range set
Lucopene (μg)	2,154.3 ± 2,644.3	None	2,154.3 ± 2,644.3	A caretenoid, no range set
Retinol (μg)	287.38 ± 154.46	None	287.38 ± 154.46	<800-1,000 μg/day§

*Executive summary of the third report of the national cholesterol education program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III). JAMA 285:2486-2497, 2001.

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§Ono K, Waki Y, Takeda K: Hypervitaminosis A: a contributing factor to anemia in regular dialysis patients. Nephron 38:44-47, 1984.

¶Available at: http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/FoodLabelingNutrition/FoodLabelingGuide/ucm064928.htm.

Table 3. Dietary Intake of Patients With and Without Background History of Cardiac Disease

	Background History of Cardiac Disease	No Background History of Cardiac Disease	*P*-Value*
Total calories (cal)	1,618.2 ± 715.98	1,637.3 ± 618.92	
Calorie density (cal/kg)	22,034 ± 10,879	24,529 ± 12,500	
Total protein (g)	54.64 ± 24.27	55.01 ± 22.43	
Protein density (g/kg)	0.74 ± 0.36	0.82 ± 0.44	
Total fat (g)	69.66 ± 30.11	69.47 ± 30.68	
Carbohydrate (g)	198.98 ± 97.54	204.53 ± 81.87	
Cholesterol (mg)	211.51 ± 100.50	215.30 ± 108.38	
SFA (g)	19.53 ± 8.44	19.18 ± 8.35	
MUFA (g)	29.63 ± 14.16	28.84 ± 14.42	
PUFA (g)	14.51 ± 7.00	15.37 ± 7.71	
Vitamin A (IU)	448.78 ± 191.56	460.11 ± 324.6	
Vitamin D (μg)	84.49 ± 49.67	82.33 ± 61.81	
Thiamin (B1) (mg)	1.16 ± 0.56	1.17 ± 0.49	
Riboflavin (B2) (mg)	1.41 ± 0.57	1.36 ± 0.51	
Niacin (mg)	15.76 ± 7.53	15.60 ± 6.70	
Vitamin C (mg)	58.23 ± 35.22	79.97 ± 72.07	
Vitamin B6 (mg)	1.15 ± 0.72	1.14 ± 0.66	
Vitamin B12 (mg)	2.98 ± 1.45	3.07 ± 1.94	
Folate (μg)	124.10 ± 54.09	159.38 ± 108.49	
Calcium (mg)	490.90 ± 212.64	483.56 ± 211.08	
Phosphorus (mg)	839.50 ± 348.97	843.67 ± 331.59	
Iron (mg)	10.67 ± 4.98	10.79 ± 4.42	
Zinc (mg)	7.34 ± 3.72	7.11 ± 3.28	
Magnesium (mg)	167.76 ± 71.85	179.69 ± 79.34	
Fiber (g)	10.09 ± 5.02	11.73 ± 6.88	

SFA, saturated fatty acid; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid.
*All non-significant.

The average intake of sodium was 2,502.0 ± 1,094.7 mg, potassium was 1,695.1 ± 701.55 mg, and phosphorus was 841.23 ± 339.44 mg. The average total fiber intake was 10.77 ± 5.87 g per day, and saturated fat was 19.38 ± 8.34 g per day. The daily intake of calcium was less than 2 g/day. Vitamin B1, niacin, vitamin C, and selenium were within recommended range without supplementation, and exceeded the range with supplementation. Riboflavin intake exceeded recommendations even without supplementation. Folate and copper did not meet the recommendation range even with supplementation. Vitamin B6 and zinc intake did not meet the recommendation range without supplementation, and were within range with supplementation. Vitamins E and B12 were within range without supplementation, and exceeded range with supplementation.

Table 3 compares the group with known history of cardiac disease to those without, and none of the intake values are statistically different in the 2 groups.

Table 4 shows the proportion of total patients who met the AHA dietary guidelines for cardiovascular risk reduction for various dietary variables, as well as the percentage of those in each group who meet the guidelines. Once again, there was no difference between those with baseline cardiac disease as compared with those without the disease. Overall, only 7.1% met the guideline for the daily total fat intake (TFI), 31.4% for saturated fatty acid (SFA) intake, 91.4% for unsaturated fatty acid intake (UFA) intake, 31.4% for protein intake, and 48.6% for sodium intake. A maximum of 78.6% met the guideline for cholesterol intake and 94.3% for carbohydrate intake. Only 2.7% met the guideline for fiber intake, and it is notable that nobody in the baseline cardiac disease group met this guideline.

Discussion

Examining the dietary intake of MHD patients through FFQ in a community dialysis center, we found that their dietary energy intake is similar

Table 4. The AHA Recommendation for Dietary Intake

AHA Recommendation	Total	Background History of Cardiac Disease	No Background History of Cardiac Disease	*P*
Total fat <30% of dietary energy	5/70 (7.1%)	2/41 (4.9%)	3/29 (10.3%)	.25
SFA <10% of dietary energy	22/70 (31.4%)	12/41 (29.3%)	10/29 (34.5%)	.79
UFA ≤30% of dietary energy	64/70 (91.4%)	37/41 (90.2%)	27/29 (93.1%)	1.0
Cholesterol <300 mg/day	55/70 (78.6%)	32/41 (78.0%)	23/29 (79.3%)	1.0
Protein ≥15% of dietary energy	22/70 (31.4%)	14/41 (34.2%)	8/29 (27.6%)	.61
Carbohydrate <60% of dietary energy	66/70 (94.3%)	39/41 (95.1%)	16/29 (93.1%)	1.0
Salt <2,400 mg/day	34/70 (48.6%)	24/41 (58.5%)	10/29 (34.5%)	.06
Fiber >25 g/day	2/70 (2.9%)	0/41 (0%)	2/29 (6.9%)	.17

SFA, saturated fatty acid; UFA, unsaturated fatty acid.

to the dietary intake described in previous studies using the FFQ.[10,14] The dietary energy intake remains significantly lower than that recommended by the NKF (K/DOQI) for MHD (35 kcal/kg/day for patients who are <60 years of age and 30 kcal/kg for patients ≥60 years of age; Table 2).[15] Low body weights are associated with increased morbidity and mortality in HD.[15,16] Clinical factors like old age, presence of clinical CAD, and DM have been reported to predict malnutrition.[17] Other important contributing factors are anorexia from uremic toxicity in underdialyzed patients, acidemia, and comorbid illnesses.[15,18] The recommended dietary protein intake in MHD patients is at least 1.2 g/kg. Our data shows that MHD patients do not meet these recommendations. A similar observation was observed previously by Kalantar-Zadeh et al. using an older version of the FFQ[10] Protein–calorie malnutrition, also known as PEW, is an important factor predicting mortality in patients with end-stage renal disease on MHD.[4,19] Patients undergoing MHD are advised to eat a high protein diet to avoid loss of muscle mass and hypoalbuminemia, which is associated with an increased mortality in this population.[3,4] For this reason, a diet rich in protein but not in saturated fat or cholesterol is recommended.[19,20]

Our data indicate that the majority of patients undergoing MHD consume an atherogenic diet. There is currently no consensus on the optimal dietary lipid composition in patients undergoing MHD. Several studies support limiting the TFI to 35% and the SFA to 7% of the total calorie intake in dialysis patients (Table 2).[21,22] The high prevalence of atherosclerotic disease in dialysis patients might be partly because of a diet rich in SFA (the principle dietary determinant of LDL cholesterol levels).[23] However, there is no prospective study proving that dietary modifications have any benefit for MHD patients. The AHA strongly recommends limiting the TFI to 30% and the SFA to 10% or even 7% of the total calorie intake in patients with high LDL levels or CAD (Table 4).[19,24] Only 7% and 31% of our patients met the AHA recommendations for TFI and SFA respectively. The AHA and nutrition experts advise substituting UFA for SFA, with a 30% upper limit of UFA of the total energy intake.[19] In the vast majority of our patients, UFA intake was less than that range, which makes this option feasible (Table 4). Almost all our patients met the AHA and the national dietary recommendation of carbohydrate and cholesterol intake in patients undergoing MHD (Tables 2 and 4).[19]

Patients undergoing MHD frequently have hypertriglyceridemia and low serum HDL, which are more common than hypercholesterolemia.[25–27] Although reduction of LDL cholesterol levels can be achieved by substituting carbohydrates for SFA, this can further worsen triglyceride and HDL levels.[19] Substituting UFA or soluble fiber for SFA improves LDL cholesterol levels without negative effects on other lipid parameters.[19] This is feasible in our patients because most ingest less than the upper recommended limit for UFA. Dietary counseling can be directed to increase fiber intake by adding low potassium whole grains, fruits, and vegetables.

The mean daily dietary vitamin C intake in our studied population exceeds the minimum recommended for dialysis patients. A study performed by Kalantar et al. using the older version of the FFQ concluded that the daily intake of vitamin C is lower in MHD patients compared with control group. This was suggested as a potential atherogenic factor in this population. The older FFQ version used in that study did not have the ability

to quantify the additional intake from the vitamin supplements. Adding the supplements to the dietary intake clearly shows that our patients consumed high levels of vitamin C, which might be cardioprotective and beneficial in promoting intestinal iron absorption and reducing iron deficiency anemia[28] (Table 2).

Riboflavin, thiamin, and niacin serum levels are usually normal in MHD patients, although case reports have linked niacin deficiency to Wernicke's encephalopathy.[29] The average total intake exceeds that recommended for this group (Table 2). Vitamin B6, which helps in the metabolism of homocysteine, is usually removed with hemodialyis; thus, supplementing this vitamin is advised in this population.[30,31] With supplementation, our patients met the daily requirement of vitamin B6 (Table 2).

The levels of vitamin B12, folate, and vitamin E of our patients exceed the levels recommended by the K/DOQI clinical practice guidelines. Vitamin B12 deficiency, through rapid metabolism of homocysteine and increased cysteine levels, could constitute a risk factor for CAD.[32] Although the role of vitamin E in atherogenesis has not yet been entirely studied in human beings, a small study showed its benefits as an antioxidant in animals.[33] Currently, the AHA believes that there are insufficient data to justify the use of vitamin E supplements in CAD prevention.[19] Vitamin D supplements are routinely used in MHD patients to prevent or treat hyperparathyroidism or improve calcium homeostasis. Animal studies showed that phosphate loading and the severity of uremia play an important role in controlling arterial medial calcification in mice.[34] Despite this interesting observation, studies in human beings are currently lacking. The phosphorus intake of our patient was within the current recommendation of less than 1,000 mg/day. Serum magnesium level has also been related to noncardiovascular mortality in HD patients.[35] The recommended intake is 300 to 400 mg/day and the average in our patient is only 225 mg/day.

The daily sodium intake of our patient was 2.5 g. Despite the recommendations of AHA and the K/DOQI of less than 2 g of sodium for patients with cardiovascular disease, it is still a difficult goal to achieve. Hyperkalemia in HD patients is a risk factor for arrhythmia, whereas hypokalemia can be a major contributing factor to sudden cardiac death.[36]

The intake of potassium by our patients is well within the range recommended by Kopple and Coburn in their studies.[37] Our study showed that daily fiber intake is lower than that recommended by the K/DOQI and the AHA. Our results are similar to those reported by Kalantar-Zadech et al.[10] Besides its effect on lowering cholesterol level and reducing the risk of cancer, several studies have shown a causative relation between low dietary fiber and atherosclerosis.[38] Major efforts and education are required to stimulate MHD patients to increase their fiber intake.

Vitamin A intake (including alpha, beta carotene, and cryptoxanthin) is still a controversial topic. Although our patients' intake of vitamin A exceeded the recommendations, this may not be beneficial. A recent study showed that vitamin A acts as an oxidant and pro-oxidant.[39]

In addition to the traditional risk factors for CAD, nontraditional factors related to malnutrition and inflammation are increasingly being studied in this population. The syndrome, known as the MIA syndrome, is an association between malnutrition, inflammation, and accelerated atherosclerosis. Malnutrition and inflammation are commonly found in uremic patients, with a potential interplay between the 2 conditions.[40,41] Moreover, markers of inflammation and malnutrition were linked to long-term mortality in few studies.[42]

Analysis of the dietary intake shows similarity in those with history of cardiac disease at baseline compared with those without. A study performed on peritoneal dialysis patients found few differences in dietary daily intake between the 2 groups without drawing a major conclusion from their findings.[14] The relatively small sample size in our study might explain the inability to detect any difference between the 2 groups.

Our study has several limitations. It is a single-center study and might not reflect the dietary intake in different dialysis populations. We did not have a control group for comparison, as did several other studies. We aimed to determine whether the dietary intake in MHD patients meets the AHA, K/DOQI, and other MHD nutrition guidelines. In addition, we aim to repeat the FFQ after counseling our patients to improve their diet and determine whether this simple measure can help improve compliance with the current guidelines. Although it is a well-validated questionnaire, the FFQ can potentially underestimate intake, as MHD patients tend to underreport their daily

intake. We did not validate the current version of the FFQ, for example, by performing 3-day food records or 24-hour diet recalls and comparing that with the results we obtained. The main strength of our study is that we used the most updated version of the FFQ; this was developed specifically to assess dietary intake in the dialysis population. This fact makes our data more consistent and comparable with the current dietary recommendations than previous reports.

Conclusion

CAD is present in more than 40% of patients at the onset of dialysis.[6] Although dietary factors can play an important role in atherogenesis in MHD, several other conventional and nonconventional risk factors can contribute to CAD in patients undergoing MHD.[8,9] The analysis of dietary intake in our patients indicates that the majority did not meet the AHA, N/DOQI, and other MHD dietary guidelines for reducing the risk of cardiovascular disease. This fact is evident when comparing the total fat, SFA, and fiber intake. The low caloric intake raises awareness about the prevalence of malnutrition in dialysis patients. Increasing the protein intake is necessary to avoid loss of muscle mass and hypoalbuminemia, which is associated with increased mortality in this population. Although the dietary intake of a few vitamins is lower than recommended, appropriate levels are achieved, and sometimes exceeded with supplementation. Considering our findings, studies should be performed to see whether targeted counseling can improve the nutritional intake and overall cardiovascular outcomes of MHD patients.

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