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Nutritional Intake in Adult Hemodialysis Patients

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Abstract

Background—Research pertaining to the nutritional intake of hemodialysis patients is limited.

Purpose—Describe the nutritional quality of foods consumed by hemodialysis patients and variation by day of the week.

Methods—Dietary recalls were obtained from 22 hemodialysis patients and analyzed using the Nutrition Data System for Research.

Results—Few statistically significant differences were found by day of the week, but several dietary deficits were noted.

Conclusion—The data suggest poor intake of calories, protein, and several vitamins and minerals, as well as excess sodium consumption, but little variation by day of the week. Additional research is needed.

Keywords

renal dialysis; sodium; dietary; cross-sectional studies; nutritional deficits

Introduction

Significant lifestyle changes are required of thrice weekly in-center hemodialysis (HD) patients, including self-administration of numerous medications, fluid and dietary restrictions, and regular attendance at dialysis sessions. One of the most challenging components of dialysis treatment is the need to adhere to a complicated and fairly restrictive dietary regimen.^{1–5}

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Controlling sodium and fluid intake are important components of the HD diet. Extra-cellular volume expansion (which is controlled primarily by limiting dietary intake of sodium) is the main pathophysiologic determinant of hypertension in HD patients.⁶ Hypertension occurs in an estimated 72–90% of dialysis patients^{7–9} and is an important predictor of survival.¹⁰ In addition to the cardiovascular effects of fluid volume overload, patients with substantial interdialytic weight gains require increased ultrafiltration during dialysis, which has been shown to cause intradialytic hypotension and post-dialysis symptoms.¹¹

Hyperphosphatemia is an important factor in the development of cardiovascular calcification, cardiac disease, and death in patients with chronic renal failure,¹² and a major factor contributing to renal osteodystrophy.¹³ Phosphates are not adequately removed by dialysis, and must be controlled through either oral intake of phosphorus binders, reduced dietary phosphorus intake, or both. The intake of binders is difficult for many patients because of the large number of capsules or tablets that must be taken with every meal or snack. Thus, a combination of dietary restriction and phosphorus binders is critical to control hyperphosphatemia.

In addition, as glomerular filtration falls, patients must limit their intake of some fresh fruits and vegetables to prevent hyperkalemia between dialysis treatments. This is particularly critical in patients on intermittent, three times weekly HD. About 10% of patients on HD exhibit serious hyperkalemia.¹⁴ Hyperkalemia is responsible for 24% of emergency dialysis treatments¹⁵ and is likely one cause of sudden death in HD patients.

As kidney disease progresses many patients develop a decreased desire for food which often persists after they begin dialysis treatments. In the face of multiple dietary restrictions and less than optimal appetite, HD patients are predisposed to protein-energy malnutrition. Maintaining adequate nutritional intake is a key counseling concern for renal dietitians. Recent reports suggest that reduced protein energy intake is related to inappropriate dietary restrictions, disruption of meals by the dialysis schedule, fatigue, anorexia, taste alterations, and decreased appetite.^{16–19} Three studies have shown greater dietary energy deficits on dialysis treatment days compared to nondialysis treatment days.^{17,19–20} The most comprehensive of these studies involved 1,901 participants of the Hemodialysis Study prospective multicenter clinical trial. In this trial, dietary energy intake was 1.02 kcal/kg/day less ($p<0.001$), and dietary protein intake was 0.06 g/kg/day less ($p<0.001$), on dialysis treatment days than on nondialysis treatment days.¹⁷ To our knowledge, no studies have compared the nutritional quality of food consumed on dialysis treatment days to that on nondialysis treatment days. Finally, while diminished appetite may result in reduced food intake on dialysis days, because HD treatments are time consuming and many patients experience fatigue following treatment, we surmised that on dialysis days they would consume a greater number of convenience foods having lower nutritional quality and higher concentrations of sodium. To our knowledge, no studies have examined the sodium concentration of foods consumed on dialysis days (e.g. the proportion of grams of sodium to total grams of food consumed).

The purpose of the current report is to describe the nutritional quality of foods consumed and the variation of nutritional intake by type of day (weekday or weekend, and whether or not it is a dialysis treatment day) in a cohort of maintenance HD patients.

Methods

BalanceWise-HD is a randomized clinical trial designed to develop and pilot test an intervention to reduce dietary sodium intake in maintenance HD patients.²¹ Personal digital assistant (PDA)-based dietary self-monitoring with BalanceLog® software was used to target problematic foods, with participants counseled to make dietary changes using concepts based in Social Cognitive Theory.²² The intervention is described elsewhere.²¹ The relevant baseline measures obtained from the participants in this pilot study are summarized in the current report.

Design

Participants were recruited from two dialysis centers located in Southwestern Pennsylvania. Only patients who were at least 18 years or older who had been receiving intermittent maintenance HD for at least 3 months were included. A 3-month minimum duration of HD prior to recruitment allowed for initial treatment stabilization and adjustment to the HD regimen. Patients were approached on the dialysis unit during regularly scheduled treatments by a dialysis center nurse, dietitian, or social worker, to solicit their interest in the study and obtain a HIPAA authorization. Those who signed the HIPAA authorization were further screened to exclude individuals who were (1) scheduled to receive a living donor transplant during the study period, (2) unwilling or unable to speak 1–2 times per week with a study dietitian about their diet, or (3) unwilling to record, on a regular basis, foods that they consumed. Participants were also screened to verify that they could (4) turn on the PDA used in the intervention, (5) see the PDA screen, and (6) use the stylus to navigate the PDA. Patients meeting the study inclusion criteria were administered the informed consent. Additional information was gathered to assure that the participant was (7) not considered by nursing staff to be terminally ill. Finally, (8) a Mini-Mental Status Exam was administered and patients with a score below 17 were excluded.²³ The study protocol was approved by the IRB of the University of Pittsburgh.

Measures

Dietary intake was assessed via three unscheduled recalls during a two-week window prior to randomization. Unscheduled recalls can mitigate the potential for desirability response bias and/or actual changes in dietary patterns that could result from participants' anticipation of a scheduled recall. To assess day-to-day variation in dietary intake, recalls were obtained on 3 types of days [one weekday dialysis day (WeekdayDD), one weekday nondialysis day (WeekdayNDD), and one weekend nondialysis day (WeekendNDD)]. To minimize burden, the investigators chose not to collect face-to-face recalls on nondialysis days (to avoid requiring participants to travel to a central study location), and chose not to collect telephone recalls on dialysis days (to avoid further burdening patients who commonly experience post-dialysis fatigue). Consequently recalls for the WeekdayNDDs and WeekendNDDs were collected face-to-face during regularly scheduled dialysis treatments, and WeekdayDD

recalls were collected the day after dialysis via telephone. Recalls were structured using the Nutrition Data System for Research [NDSR] dietary analysis software program, described below.²⁴ Recalls employed two-passes (i.e., a quick list with queries on commonly forgotten foods that appeared as prompts in NDSR, such as condiments, sweeteners, salt, seasonings, and added fats). Portion size was estimated using standard visual cues (e.g. 3 ounces of meat is equivalent in size to a deck of cards).

Recalls were entered into the NDSR dietary analysis software program.²⁴ NDSR is comprehensive nutrient calculation software maintained by the Nutrition Coordinating Center at the University of Minnesota. It contains over 18,000 foods, 8,000 brand name products and a number of ethnic foods. Nutrient values are reported per 100 grams for each of 156 nutrients, nutrient ratios, and food components contained in the database. Additional health and sociodemographic data were obtained from a review of medical records and a sociodemographic questionnaire.

Analysis

Study participants were described in terms of health and sociodemographic characteristics. Calorie and protein intake were normalized to edema-free adjusted body weight (aBW_{ef}) as follows:²⁵

$$aBW_{ef} = BW_{ef} + [(SBW - BW_{ef}) * 0.25]$$

where BW_{ef} = baseline dry weight (in kg) and SBW = standard body weight from NHANES II for gender, height and body frame size.

Dietary intake was described by day of the week and dialysis treatment (WeekdayNDDs, WeekendNDDs, and WeekdayDD) in terms of total grams (gms) of food, vitamin and mineral content, calories, protein, and the proportion of sodium gms to total gms of food consumed. Nutrient values were compared by type of day using exact Friedman aligned rank tests, which standardize the within-participant comparisons across days. The association between total dietary sodium and total gms of food consumed was summarized using Spearman's rank correlation coefficient. Concentration of dietary sodium (Na^+) was defined as the ratio of total dietary sodium to total gms of food consumed during the day. P values of < 0.5 were considered statistically significant. Analyses were done using StatXact version 8.²⁶

Results

Twenty-two individuals consented to the study and completed the baseline dietary assessment. Demographic and health characteristics of participants are shown in Table 1. Participants were middle-aged, predominantly minority and male, with a median duration of dialysis of 3.9 years and a median aBW_{ef} of 78.7 kg. Hypertension was the etiology of ESRD for 36.4% of participants.

Energy intake and protein are summarized by treatment and day of the week in Table 2. Participants consumed less food (a mean of 1,378.7 gms) on WeekdayDDs, compared to

1,614.4 gms on WeekdayNDDs and 1,560.4 gms on WeekendNDDs ($p=0.19$). Although no significant differences were seen by type of day, participants consumed at most 75% of the energy and protein recommended by the National Kidney Foundation for HD patients on all types of days.²⁵

The concentration of sodium in foods consumed was similar on WeekdayNDDs (1.7 mgs/gm/day), WeekdayDDs (1.6 mgs/gm/day) and WeekendNDDs (1.5 mgs/gm/day), $p=0.74$; Table 2. Total dietary sodium was positively associated with total gms of food consumed on WeekdayDDs ($\rho = 0.44$, $p = 0.04$) and WeekendNDDs ($\rho = 0.73$, $p < 0.01$; Figure 1).

Micronutrient intake is summarized in relationship to treatment and day of the week in Table 3. Mean consumption of vitamin E differed significantly by type of day ($p=0.03$), and was highest (12.1 mg/day) on WeekdayNDDs. Mean vitamin intake was below the recommended minimum for Vitamins D, E, and pantothenic acid on all days, Vitamin C on WeekdayDDs, and folic acid on WeekdayDDs and WeekendNDDs.

Calcium and sodium consumption differed by type of day ($p=0.05$ for each), with relatively lower mean consumption of these minerals on WeekdayDDs (Table 3). On all three types of days, mean sodium levels exceeded 2,000 mg, and intake of zinc was below the recommended level of 15 mg/day. On Weekday DDs and Weekend NDDs, magnesium intake was below the recommended amount of 200–300 mg/day.

Discussion

Intake of calories and protein was considerably less than the recommended levels for hemodialysis patients while sodium intake was high in this small sample of in-center HD patients. In addition, several vitamins and zinc was less than the recommended dietary intake for adults. Given the small sample and the large standard deviations observed, the lack of significance differences across treatment and day of the week is not surprising. These data suggest some patterns that merit further investigation.

Although the findings of low energy and protein intake in this study are not significantly different there is a trend of lower intake on dialysis days. These findings are consistent with those of other investigations of HD^{17–20,27–28} and peritoneal dialysis.²⁹ That food volume, energy and protein intake were lowest on dialysis treatment days is consistent with the findings of Dassanayake et al.¹⁹ and Burrowes et al.¹⁷ Lower intake on dialysis days may be the result of a disrupted meal schedule.¹⁶ The dialysis units from which we recruited participants for this pilot study, by routine, did not permit patients to eat during treatments. Given that many hemodialysis patients are likely to have an inadequate dietary intake on dialysis days and the prevalence of malnutrition in this population, interventions to promote improved intake on these days should be explored.

Dietary protein has long been the cornerstone of the renal diet. During the early years of hemodialysis, protein was restricted in order to minimize the accumulation of urea between dialysis treatments. From 1960 through the late 1970's recommendations for protein intake ranged from 0.5–0.8 gm/kg. As it became evident that dialysis patients with a restricted

protein intake were at greater risk of malnutrition, the recommended protein intake increased in the early 1980's to 1.0 gm/kg and in 2000 to the current 1.2 gm/kg.^{25,30–33} In 1990, Lowrie and Lew showed that inadequate protein intake, reflected in, a low nPCR and low serum albumin levels, was associated with an increased relative risk of death.³⁴ Consequently, more attention has been paid in recent years to assuring the adequacy of dietary protein, and the consumption of nutritionally dense foods. Although an increased dietary protein intake is recommended for patients on hemodialysis, an increased protein intake may also result in an increased intake of phosphorus and consequent vascular calcification. Therefore, patients who are counseled to increase protein intake should be counseled on adherence to binders as well. Data from the Dialysis Outcomes and Practice Patterns Study indicate that less than half of dialysis patients meet target values for serum phosphorus levels, and nonadherence to phosphate binders is likely to be partially responsible.³⁵ In a recent small study, Lindberg and Lindberg identified the following barriers to phosphate binder adherence: objectionable taste, the large size of the pills, nausea after ingestion, forgetfulness, the need to take numerous other medications, and ignorance regarding the importance of taking binders with each meal. Lindberg and Lindberg suggest addressing nonadherence with patient education, routine assessment of the acceptability of the prescribed binder, and trials of alternative binders when possible.³⁶ When phosphatemia is not controlled through dietary restriction, counseling to enhance adherence to phosphorus binders will be necessary. Longer or more frequent HD also may be helpful, although this option is not always available or well received by many patients.

In spite of consuming a lower volume of food on WeekdayDDs than either WeekdayNDDs or WeekendNDDs, participants still consumed a significant amount of sodium. Our clinical experience suggests that, due to the need to accommodate lengthy treatments and the fatigue often experienced after dialysis, HD patients often rely on higher sodium fast foods and convenience foods. Because participants consumed the least amount of food, calories, and protein on dialysis days, we expected that poorer appetite on dialysis days would result in participants consuming higher total Na⁺ and foods with higher Na⁺ concentrations (i.e., evidence of consuming snack foods rather than regular meals). Although the difference was not statistically significant, we were surprised that the highest concentration of Na⁺ actually was consumed on WeekdayNDDs and the least concentration consumed on WeekdayDDs. It is possible that the physiologic response to dialysis resulted in Na⁺ seeking behavior on WeekdayNDDs. Additional research with a larger sample would be needed to confirm these observations.

For the vitamin and mineral deficits noted in our study, Table 4 lists the common sources of those nutrients and the reasons that they are restricted in HD patients. Given the limited nature of the HD diet, the deficits in vitamin and mineral intake should not be surprising. Of interest is the low dietary intake of pantothenic acid, a vitamin which is widely distributed in foods. Rich sources of pantothenic acid include liver, egg yolk, chicken, yogurt, milk legumes, broccoli, avocado, and sweet potatoes. Most of these foods are high in potassium and phosphorus and therefore limited on a renal diet which may explain in part the low pantothenic acid levels. In addition, some good sources of pantothenic acid are also sources of high biological protein of which many patients do not consume enough.

Several of the deficits suggested by our data are of particular importance in the HD patient population. Investigators have recently demonstrated wash-out of water-soluble B vitamins with hemodialysis.³⁷ Loss of appetite, nausea, vomiting, and/or diarrhea have been associated with deficits in folate³⁸ and zinc.³⁹ Fatigue and muscle weakness, common complaints voiced by HD patients,^{40–41} are associated with deficits in vitamins C⁴² and D.⁴³ Problems with cognitive function and mental clarity are more common in HD patients than in the normal population who are not on dialysis,⁴⁴ and may be influenced by dietary intake of folate^{45–46} and zinc.⁴⁷ HD patients are prone to defective bone mineralization, which also is associated with vitamin D deficiency.⁴⁸ Uncontrolled hypertension may be influenced by vitamin D.⁴⁹ The primary cause of death in HD patients is cardiovascular disease,⁵⁰ which may be associated with deficits in pantothenic acid and vitamin C.^{46,51} Reduced vitamin C, E, and folate have been associated with chronic inflammation,^{52–54} which is another significant problem in HD patients.⁵⁵ The response of dialysis patients to erythropoietin is diminished when anemia is accompanied by a folate deficiency.⁵⁶ Although intake low intake of magnesium observed in this study is not desirable HD patients typically have a positive magnesium balance⁵⁷ and magnesium supplements are usually not recommended.

As discussed below, caution must be used in drawing firm conclusions about dietary deficits from these data. Prior to taking any action to address dietary deficits, it is important to consider the extent to which biochemical and physical assessments confirm the manifestation of mineral and vitamin deficiencies, as well as the extent to which the patient is prescribed appropriate dietary supplements. Where clear deficits exist, there are a few practical steps that could be taken to address them. Although dialysis patients cannot consume them in unlimited quantities, green peppers, cauliflower, cabbage, watermelon, strawberries, raspberries, blueberries, cranberries, and pineapples all are good sources of Vitamin C (and also contain limited amounts of potassium). Fatty fishes such as salmon, mackerel, and tuna are a good source of vitamin D, and eggs and meat are good sources of pantothenic acid. Protein-rich foods such as beef, lamb, pork, crabmeat, turkey, chicken, lobster, clams and salmon are the best sources of zinc. Again, patients who are encouraged to consume greater quantities of these high phosphorus foods should also be encouraged to take their binders.

HD patients typically are prescribed several nutritional supplements, including active vitamin D and iron (both often given intravenously), vitamins with B and C content, and sometimes protein supplements. However, supplementation with 25 OH vitamin D and zinc is not standard practice, and future research is needed to evaluate their benefits in HD patients. In the meantime, the healthcare team may wish to consider measuring zinc and 25 OH vitamin D levels in HD patients to assess the need for replacement.

With the new Medicare reimbursement guidelines, programs are likely to move away from administration of medications intravenously on HD, and move toward oral prescriptions. However, adherence to oral medication regimens is poor,^{59–61} and inversely associated with the regimen complexity that is typical of the HD medication regimen.^{62–64} Furthermore, adherence of chronically ill people to their medication regimen drops dramatically after 6 months.⁶⁵ We found no evidence from the literature to suggest that adherence to nutritional

supplements is better than adherence to conventional medications. Intervention approaches that are modestly effective in enhancing medication adherence may be useful for encouraging patients to take nutritional supplements. In particular, using pillboxes, involving family caregivers, pairing nutritional supplements with habitual behaviors (such as brushing teeth), cuing (e.g. use of alarms, and placing supplements in a visible location), positive reinforcement, and didactic education may facilitate adherence.^{65–67}

Because of the pilot nature of the study, there are several limitations that preclude firm clinical or research implications. In particular the the results reported here were derived from statistical analyses of numerical data derived from the NDS-R. Additional qualitative research would be useful for characterizing the nature of dietary intake and developing specific dietary counseling approaches. Also, the data were derived from a small sample which is likely to be underpowered to detect differences in intake by day of the week for many of the nutrients evaluated. The sample was drawn from 2 dialysis centers in the Pittsburgh area, limiting generalizability of the findings.

Additionally, with the goals of minimizing measurement burden and retaining this sample through a 16-week intervention study, the investigators used a measurement protocol that could compromise the precision of nutritional estimates. Other researchers have found that more than three recalls are required to adequately capture dietary variability.^{68–69} To minimize memory bias, dietary recalls using a 5-step (rather than 2-step) multiple pass system are recommended.⁷⁰ To minimize measurement error, the collection of recalls using the same approach (rather than a combination of face-to-face and telephone) would be advised.

Conclusion

Data from this small pilot study found few differences in nutritional intake by dialysis treatment day and day of the week. The data suggest poor intake of calories, protein, and several vitamins and minerals, as well as excess sodium consumption. However, because of sampling and measurement limitations, caution must be used in drawing conclusions about the nature of the diet consumed by hemodialysis patients. Additional research is needed.

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Figure 1.
Scatter Plots of Total Dietary Sodium and Total gms of Food consumed, by Day of the Week and Dialysis Treatment Status

Table 1

Characteristics of Participants

	Median (Q1–Q3)
Age (years)	55 (37–60)
Duration of dialysis (years) (n=21) *	3.9 (2.0–8.3)
aBW _{ef} (kg)(n=21) *	78.7 (68.1–92.3)
	N (%)
Male	13 (59.1)
Minority race	17 (77.3)
Etiology of ESRD	
Hypertension	8 (36.4)
Diabetes	5 (22.7)
Glomerulonephritis	4 (18.2)
Other	4 (18.2)
Unknown	1 (4.6)

* Denominators other than 22 (due to missing data) are noted.

Table 2
Volume, Energy, and Sodium Concentration by Day of the Week and Dialysis Treatment Status

Standardized calorie, protein, and sodium intake (recommended)	Weekday Nondialysis Day (n=22)		Weekday Dialysis Day (n=21)		Weekend Nondialysis Day (n=21)		P-value
	Mean (%) *	SD	Mean (%) *	SD	Mean (%) *	SD	
Total grams of food consumed	1614.4	591.8	1378.7	544.7	1560.4	585.7	0.19
Calories kcal/ kg edema-free adjusted body weight/day	21.0	6.8	19.0	8.5	22.3	11.3	0.66
% of recommended calorie intake (30–35 kcal/kg/day) *	(70.0)		(63.3)		(74.3)		
Protein gm/ kg edema-free adjusted body weight/day	0.9	0.3	0.8	0.4	0.9	0.5	0.38
% of recommended protein intake (>1.2 g/kg/day) *	(75.0)		(66.6)		(75.0)		
Sodium concentration of foods consumed (mgs Na ⁺ /Total grams/day)	1.7	0.7	1.6	0.7	1.5	0.8	0.74

* Based on nutritional recommendations established by K/DOQI. [5]

Based on 2 df exact Friedman aligned rank test

Table 3

Vitamin and Mineral Intake by Day of the Week and Dialysis Treatment Status

Vitamins and minerals (recommended)	Weekday Nondialysis Day (n=22)		Weekday Dialysis Day (n=21)		Weekend Nondialysis Day (n=21)		P-value [†]
	Mean	SD	Mean	SD	Mean	SD	
Vitamins							
Vitamin A (700–900 mcg/day) [*]	2118.7	4341.5	1616.6	1957.6	2385.1	2508.0	0.10
Vitamin D (5–15 mcg/day) [*]	3.4	2.6	3.2	3.4	3.4	3.3	0.85
Vitamin E (15 mg/day) [*]	12.1	15.4	8.8	14.9	7.4	7.9	0.03
Vitamin K (90–120 mcg/day) [*]	178.1	398.6	124.5	241.9	218.2	390.7	0.47
Vitamin C (75–90 mg/day) [*]	83.7	129.1	61.5	71.5	83.2	66.6	0.35
Thiamin (1.1–1.2 mg/day) [*]	1.4	0.7	1.2	0.6	1.4	0.8	0.30
Riboflavin (1.1–1.3 mg/day) [*]	1.6	0.7	1.4	0.8	1.7	1.1	0.65
Niacin (14–16 mg/day) [*]	19.7	9.3	16.5	7.8	18.0	9.8	0.40
Pantothenic acid (5 mg/day) [*]	4.4	2.3	3.3	1.9	3.5	1.7	0.08
Vitamin B6 (1.3–1.7 mg/day) [*]	1.6	0.8	1.3	0.8	1.4	0.8	0.39
Folic acid (400 mcg/day) [*]	410.5	383.4	320.1	212.5	347.4	185.3	0.48
Vitamin B12 (2.4 mcg/day) [*]	3.6	2.2	3.6	2.4	4.2	3.7	0.78
Minerals							
Calcium (<2,000 mg/day including binders) ^{***}	737.3	624.7	589.8	449.2	773.3	569.3	0.05
Phosphorus (<1,000 mg/day) ^{***}	891.2	269.8	761.9	385.6	977.9	588.9	0.45
Iron (8–18 mg/day) [*]	13.5	7.2	11.8	7.0	14.1	8.0	0.30
Potassium (2000–3000mg/day) ^{**}	1927.3	839.0	1643.6	967.2	1777.8	947.9	0.59
Magnesium (200–300 mg/day) ^{***}	201.0	80.6	173.2	96.5	195.4	103.5	0.40
Zinc (15 mg/day) ^{**}	11.2	5.8	8.7	5.0	9.8	7.4	0.65
Selenium (55 mcg/day) [*]	102.2	36.9	76.5	36.3	99.7	61.2	0.09

Vitamins and minerals (recommended)	Weekday Nondialysis Day (n=22)		Weekday Dialysis Day (n=21)		Weekend Nondialysis Day (n=21)		P-value [‡]
	Mean	SD	Mean	SD	Mean	SD	
Sodium (<2,000 mg/day) ⁺	2632.8	985.8	2052.9	1010.4	2608.4	1355.4	0.05

* Based on the Dietary Reference Intakes established by the National Academy of Sciences, Institute of Medicine, Food and Nutrition Board [71]

** From Kopple JD and Massry SG. [72]

*** From NKD KDOQI Clinical Practice Guidelines [1]

+ From NKF KDOQI Clinical Practice Guidelines [4]

[‡] Based on 2 df exact Friedman aligned rank test

Table 4

Possible Reasons for Dietary Deficits in Hemodialysis Patients

Deficits noted	Dietary sources commonly used to address deficits [*]	Rationale for limiting these foods in HD	
		High Potassium ^{**}	High Phosphorus ^{**}
Vitamin D	Dairy products	X	X
Vitamin E	Milk, nuts, seeds,	X	X
	Whole grains		X
	Leafy green vegetables	X	
Vitamin C	Oranges and orange juice, tomatoes, broccoli, brussel sprouts, leafy greens, winter squash, sweet and white potatoes,	X	
Pantothenic acid	Whole grains		X
	Legumes	X	X
Folic acid	Leafy green vegetables	X	
	Legumes, sunflower seeds	X	X
Magnesium	Green vegetables	X	
	Legumes	X	X
	Dairy products	X	X
Zinc	Dairy products, peanuts, beans, and pumpkin seeds	X	X
	Whole grains		X
	Potatoes	X	

^{*} United States Department of Agriculture. Agricultural Research Service. National Nutrient Database for Standard Reference, Release 22 [73]

^{**} National Renal Diet. A Healthy Food Guide for People on Dialysis/Renal Dietitians Dietetic Practice Group of the American Dietetic Association 2nd ed. [74]