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Examining the Dietary Intake of Hemodialysis Patients on Treatment Days and Nontreatment Days

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Abstract

Previous literature has shown that hemodialysis patients have impaired dietary intakes on dialysis days (DDs), which may contribute to malnutrition and poor outcomes. In this study, we examined dietary intakes of 140 hemodialysis patients based on 3 nonconsecutive days food records (collected on 1 DD and 2 non-DDs). Patients had lower energy intake and other key nutrient intake on DDs; however, upon adjusting for energy intake, nutrient differences were no longer significant. None of the patient characteristics examined were associated with impaired intakes on DDs ($P > .05$).

Keywords

diet; energy intake; food habits; hemodialysis; kidney failure; malnutrition; protein-energy

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NEARLY 120 000 new patients are diagnosed with end-stage renal disease each year in the United States, the vast majority of whom are treated with hemodialysis (HD).[1] Hemodialysis treatment improves the health and survival of patients with end-stage renal disease; however, prolonged maintenance of HD therapy may promote malnutrition, in particular, protein-energy wasting, which is associated with higher morbidity and mortality in HD patients.[2] Impaired dietary intake contributes to protein-energy wasting in HD patients[3,4] and is, therefore, a key modifiable behavior that may improve nutritional status and clinical outcomes in this population.

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Several studies conducted in various HD populations have found that reported dietary intakes of energy and key nutrients are lower on dialysis days (DDs) than on nonDDs.[5–7] However, it is unclear whether certain patient characteristics (eg, age, gender, race/ethnicity) are associated with a higher likelihood of having impaired intake on DDs, or whether relatively low intake on DDs is associated with clinical outcomes (eg, serum albumin concentration, interdialytic weight gain). Moreover, these studies primarily considered absolute intakes of energy and nutrients, and it is unknown whether food and beverage choices on DDs differ from non-DDs.

Thus, we examined the reported dietary intakes of HD patients on DDs versus non-DDs among those who participated in the BalanceWise study, a technology-supported behavioral intervention to lower sodium intake in maintenance of HD patients.[8] In particular, we sought to identify potential determinants and consequences of impaired intake on DDs and to compare dietary nutrient densities on DDs versus non-DDs.

METHODS

Participant selection

Data for this cross-sectional study were collected during the baseline visit of the patient for the study. BalanceWise participants were recruited from 17 outpatient clinics of 3 companies that provide dialysis services in Pennsylvania: DaVita Health Care Partners, Inc., Dialysis Clinic, Inc., and Fresenius Medical Care North America. Only noninstitutionalized adults (more than 18 years of age) receiving thrice-weekly HD for at least 3 months were considered eligible for recruitment. Patients were excluded if they were deemed by the dialysis center staff to be inappropriate for a 16-week intervention due to changes in care (eg, pending renal transplant) or anticipated life expectancy of less than 12 months (to avoid overburdening the patient). In addition, those who were unable to use the hand-held personal computer or software being used in the intervention due to language, physical, or cognitive barriers were excluded. Of the 848 HD patients in our target population, 257 were deemed eligible and 190 consented to participate. Our analysis consisted of 140 participants who had completed all 3 dietary recalls at baseline. Although included and excluded participants were similar in race and dialysis vintage ($P > .05$), those included in the study were more likely to be female (48% vs 25%, $P = .01$) and older (62 ± 13 vs 54 ± 15 years of age, $P = .001$) than the participants who were excluded. The Institutional Review Board of the University of Pittsburgh approved the study.

Study measurements

To help account for day-to-day variability in dietary intake, and limit reporting/recording bias, dietary intake was collected using a 2-pass, 24-hour recall method on 3 nonconsecutive days in a 2-week period, including 2 weekdays (1 DD, 1 non-DD) and 1 weekend non-DD. The first 2 dietary recalls were collected in person, and the final recall was collected by telephone. Nutrient intakes on the 3 days were determined by transcribing food recalls into the Nutrition Data Software for Research (NDSR; Nutrition Coordinating Center at the University of Minnesota, Minneapolis, Minnesota).[9] In addition to absolute intakes, nutrient densities were calculated for protein (% of kcal), and minerals (mg per 1000 kcal).

Questionnaires, physical examinations, blood tests, and medical charts were used to obtain other study variables. Demographic characteristics including age, gender, and race were self-reported. Similarly, as part of a questionnaire on factors that may have led to dietary nonadherence, participants reported the extent to which they felt "washed out" on DDs in the past 2 months on a Likert scale ranging from "not a problem at all" (1) to "a very important problem for me" (5). "Washed out" is a commonly used phrase to describe the physical and/or emotional feelings of being drained or fatigued following HD treatment. Because most participants reported not having problems with feeling washed out, responses were collapsed into 2 categories: not a problem (1) or a problem (2–5).[10] Body weight was measured before and after dialysis treatment and converted into edema-free adjusted body weight as previously described,[11] which was used to calculate the participants' body mass index (in kg/m^2) using height data from the patients' medical charts. In addition, edema-free adjusted body weights were used to calculate interdialytic weight gain as the average daily change in body weight between 3 dialysis treatments. Predialysis blood samples were analyzed for serum albumin concentrations, and dialysis vintage was obtained from the participants' medical charts.

Statistical analysis

Reported dietary intakes on weekday DDs, weekday non-DDs, and weekend non-DDs were summarized as median and interquartile ranges and compared across days using the Kruskal-Wallis test. When significant differences were detected, reported dietary intakes were compared across record days using Wilcoxon rank sum tests.

On the basis of prior studies,[5–7] we hypothesized that there would be lower intake on DDs than on non-DDs in our cohort. To explore the potential determinants and consequences of poor intake on DDs, participants were categorized as having impaired and nonimpaired intake on DDs, using the 85th percentile of non-DD energy intake as a cutoff. For example, someone reporting 1500 kcal/d on DDs and 2000 kcal/d on non-DDs consumed 75% of non-DD energy intake on DDs, and would be categorized as having impaired intake on DDs, whereas someone consuming 1800 kcal/d on DDs and 2000 kcal/d on non-DDs consumed 90% of non-DD energy intake on DDs and would be categorized as having nonimpaired intake on DDs. For this categorization, the weekday and weekend non-DD energy intakes were averaged.

The associations of poor intake on DDs (impaired vs nonimpaired intake) with other study variables were assessed using independent 2-sample *t* tests for normally distributed continuous variables (age, body mass index, serum albumin, interdialytic weight gain), Wilcoxon rank sum tests for nonnormally distributed continuous variables (energy intake, dialysis vintage), and χ^2 tests for categorical variables (gender, race, feeling washed out on DD). Normality of study variables was determined using Shapiro-Wilks test and by examining frequency distribution graphs.

RESULTS

Participants

Of the 140 participants included in this analysis, 73 (52%) were male and 56 (40%) were African Americans. The mean ± SD age of the participants was 62 ± 13 years, and participants had received HD for a median (interquartile range) duration of 35 (15–67) months.

As outlined in Table 1, the reported energy intake on DDs was lower than weekday and weekend non-DDs ($P < .05$). There was a corresponding lower intake of sodium, potassium, and phosphorus on DDs; however, differences were no longer present after controlling for energy intake (Table 2). Absolute protein intake (g/d) tended to be higher on non-DDs, whereas relative protein intake (% kcal) tended to be lower on non-DDs. However, neither absolute nor relative protein intakes significantly differed by day of dietary recall ($P = .09$ for each, Table 2).

Participants classified as having impaired dietary intake on DDs (n = 73) reported a median (interquartile range) energy intake on DDs that was approximately 521 (342, 747) kcal/d less than the energy intake on non-DDs (Table 2). Although this was a significantly greater energy deficit on DDs than the nonimpaired intake participants ($P < .0001$), the 3-day energy intake did not differ between the impaired and nonimpaired intake groups ($P = .19$), which was due, in part, to greater energy intake on non-DDs in the impaired intake group ($P = .003$) (Table 2). None of the other study variables were significantly associated with impaired intake on DDs, but female participants tended to report more impaired intake on DDs than male participants (52% vs 45%, $P = .09$) (Table 2).

DISCUSSION

In this cross-sectional analysis of 140 HD patients, we confirmed earlier findings of lower intakes on DDs than on non-DDs. Although our sample consisted of a diverse cross section of white and African American men and women who were 18 years of age or older, we were unable to identify significant determinants and consequences of poor intake on DDs, except a trend toward more impaired intake on DDs among female participants. We did, however, demonstrate that the reported intakes of key nutrients do not differ between DDs and non-DDs when energy intake is adjusted. These findings suggest that impaired energy intake on DDs, rather than differences in dietary choices, are key considerations when examining dietary intake in HD patients.

As mentioned, our results support previous findings that HD patients report consuming less on days when they receive dialysis treatment.[5–7,11] In the BalanceWise pilot study, which used the same dietary recall method in 22 HD patients (1 DD, 2 non-DD), the reported intakes of food (in grams), energy, protein, and most micronutrients tended to be lower, albeit nonsignificantly, on DDs.[11] In another larger cohort of 1901 HD patients who completed 2-day food records (1 DD, 1 non-DD) as part of the baseline assessment of the Hemodialysis (HEMO) study, reported energy and protein intakes were significantly lower on DDs.[5] Reported energy and protein intakes were also lower on DDs in a cohort of 106 HD patients in India who completed several 24-hour dietary recalls (600 DD, 623 non-DD).[6] Finally, reported intakes of energy and most macronutrients and micronutrients were significantly lower on DDs among 54 elderly HD patients in Brazil who completed 3-day food records (1 DD, 2 non-DD).[7] The consistency of these findings across studies is particularly noteworthy given the limited number of dialysis and nondialysis dietary assessment days in most studies and the well-recognized error in estimating absolute dietary intake.[12,13]

To help address the issue of reduced intake on treatment days, we attempted to identify HD patient characteristics that were related to lower relative intake on DDs versus non-DDs. However, impaired DD intake was not associated with any of the demographic and clinical variables we examined. In the HEMO study, females, African Americans, and patients with diabetes appeared to have lower relative mean energy intake on DDs, but these differences were not analyzed for statistical significance. In the study cohort, African Americans had a similar prevalence of impaired intake on DDs as whites, but females were more likely, albeit nonsignificantly, to report impaired intake on DDs. Importantly, these differences may be exaggerated because females reported lower overall energy intake than males, and impaired DD intake was defined on the basis of relative energy intakes. Another notable finding of the HEMO study was that HD patients who reported eating during dialysis (41% of the sample) had similar energy intake on DDs compared with non-DDs, suggesting that an impaired intake on DDs may be related to an inability to eat during treatment. The time of food and beverage consumption on DDs was not collected in this study, and so, we were unable to assess the relationship between eating during dialysis and relative intake on DDs. The lack of clinical outcomes (eg, serum albumin) related to impaired intakes on DDs in our study was surprising but may be due to compensatory increases in dietary intakes on non-DDs.

Although time spent at the dialysis center may contribute to an impaired intake on DDs—especially if food is not being consumed—the physical and psychological effects of the dialysis treatment itself may also be important. Clinically, we have observed that some HD patients self-restrict dietary intake prior to dialysis to avoid interruption of their HD treatment session due to the necessity of using the washroom. After dialysis, patients may have a decrease in appetite as a result of treatment symptoms, including fatigue, nausea, vomiting, and abnormal/uncomfortable bowel movements.[14,15] Adding to these symptoms, anxiety and depression, conditions that may contribute to anorexia,[16] are common in HD patients and may be exacerbated on DDs.[17,18] In this study, we were unable to link self-reported problems with feeling “washed out” to lower intakes on DDs, but this question may have been too non-specific to encompass the many potential side effects of HD treatment.

In addition to differences in the amount of food consumed, it has been suggested that dietary choices may differ on DDs compared with non-DDs (eg, salt-seeking on non-DDs due to sodium removal during HD treatment).[11] However, our findings do not support this theory, as the nutrient density of protein and key minerals were similar on DDs versus non-DDs. Because previous studies examining day-to-day variability in intake have focused on crude amounts of nutrients in the diet,[5–7,11] which are subject to confounding by energy intake, we cannot compare these results with that of other studies. Stark et al[11] did analyze sodium concentration of the diet (mg/g total food) and did not find a significant difference between

DDs and non-DDs. Consequently, although other studies have reported differences in crude nutrient intake between DDs and non-DDs,[5–7,11] this finding in our study may be explained by differences in the amount eaten rather than differences in food choices.

In terms of our study's strengths, our BalanceWise study provided a relatively large and diverse sample of HD patients for studying dietary variability. However, several limitations should be mentioned. Most notably, we had only 1 DD and 2 non-DDs of dietary data per patient for analysis that may have led to misclassification of participants. Indeed, participants in the nonimpaired intake group reported higher energy intakes on DDs, which occurred, in part, because participants who had lower intakes on this particular DD (due to normal day-to-day variability in dietary intakes) were truncated at the 85th percentile cutoff and classified as having impaired intakes. Therefore, although we were able to demonstrate lower dietary intake on DDs than on non-DDs, the statistical power may have been inadequate to identify factors associated with impaired intake.

Furthermore, because this study was not designed to compare dietary intakes on DDs and non-DDs, factors that may have explained these differences (eg, appetite on DDs) or confirmed variations in nutrition status (eg, subjective global assessment) were unavailable. In addition, our study sample was not fully representative of the HD population because it was restricted to patients who were eligible for and who volunteered to participate in a technology-supported behavioral intervention study. Adding to this, participants in our sample were more likely to be female and older than those who were excluded. Finally, none of the HD centers of the BalanceWise study permitted eating during dialysis, so we were unable to assess this potentially important determinant of impaired intake on DDs.[5]

CONCLUSION

Our study confirms previous findings that HD patients tend to have impaired intakes on days when they are receiving dialysis treatment. Given the high prevalence of protein-energy wasting in HD patients and its adverse impact on survival in this population, strategies to improve intakes on DDs are urgently needed. Unfortunately, we were unable to identify any demographic or clinical characteristics of HD patients that were associated with impaired intake on DDs. However, we did show for the first time that observed differences in nutrient intake between DDs and non-DDs are likely due to variations in impaired energy intake on DDs. Because dietary assessment methods are limited in their ability to assess energy intakes accurately, the identification of risk factors for impaired DD intake may require more dietary collection days than is feasible. Consequently, identifying effective strategies such as intradialytic feeding to improve dietary intake of HD patients on DDs may require clinical trials rather than observational methods.

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Table 1.

Reported Dietary Intake on Dialysis and Nondialysis Days

Dietary Variable	Weekday DD	Weekday Non-DD	Weekend Non-DD	*P*
Energy, kcal/d	1186 (860–1499)	1440 (1005–1790)	1357 (963–1776)	.004
Protein, g/d	50 (39–68)	58 (40–78)	56 (41–72)	.09
Sodium, mg/d	1871 (1142–2728)	2383 (1680–3195)	2144 (1479–3021)	.005
Potassium, mg/d	1289 (835–1730)	1382 (1009–2051)	1420 (1051–1840)	.05
Phosphorus, mg/d	673 (471–893)	792 (553–1002)	738 (514–980)	.02
Nutrient densities				
Protein, % kcal	18 (14–23)	17 (13–22)	16 (13–20)	.09
Sodium, mg/1000 kcal	1646 (1227–2186)	1653 (1326–2101)	1649 (1258–2015)	.78
Potassium, mg/1000 kcal	1092 (829–1434)	1041 (807–1296)	1108(828–1364)	.73
Phosphorus, mg/1000 kcal	555 (465–687)	582 (479–712)	550 (457–658)	.33

Abbreviations: DD, dialysis day, non-DD, nondialysis day.

Values are presented as median (interquartile range), and differences between days were assessed using Kruskal-Wallis test (P values). When significant differences were found, groups were compared with one another using Wilcoxon rank sum test (values with different superscript letters are significantly different, $P < .05$).

Table 2.

Comparison of Participants With and Without Impaired Intake on Dialysis Day[a]

Variable	Relative Energy Intake on DD: ≤85% of Non-DD[b]	Relative Energy Intake on DD: >85% of Non-DD[b]	*P*
n	73	67	
$Energy_{DD}$ — $Energy_{NDD}$, kcal/d	−521 (−747 to −342)	111 (−11 to 469)	<.0001[c]
Energy intake, kcal/d	1285 (1125–1584)	1290 (1076–1642)	.80
Non-DD, kcal/d	1490 (1306–1847)	1207 (988–1607)	.003[c]
DD, kcal/d	926 (676–1266)	1498 (1107–1903)	<.0001[c]
Age, y	61.5 ± 12.5	61.7 ± 12.9	.19
Gender, male	33 (45%)	40 (60%)	.09
Race, African American	30 (41%)	26 (39%)	.84
Body mass index[d], kg/m^2	29.6 ± 7.2	30.9 ± 8.2	.30
Serum albumin, g/dL	3.9 ± 0.3	4.0 ± 0.3	.09
Interdialytic weight gain, kg/d[e]	1.3 ± 0.6	1.2 ± 0.5	.32
Dialysis vintage, mo[e]	27 (13–63)	44 (17–71)	.13
Feel washed out on DD, yes	37 (51%)	31 (46%)	.60

Abbreviations: DD, dialysis day, non-DD, nondialysis day.

[a]Values are presented as mean + SD for normally distributed continuous variables (age, body mass index, interdialytic weight gain), median (interquartile range) for nonnormally distributed continuous variables (energy intake, energy difference [$energy_{DD}$ − $energy_{non\text{-}DD}$], dialysis vintage), and number (percent) for categorical variables (gender, race, feel washed out on DD). Differences between participants with impaired intake on DD (≤85% of non-DD) and nonimpaired intake on DD (≤85% of non-DD) were assessed using independent 2 sample *t* test, Wilcoxon rank sum test, or χ^2 test, as appropriate.

[b]Non-DD energy intake: the average of reported energy intake on a nondialysis weekday and weekend day.

[c]*P* ≤ .05.

[d]Body mass index was calculated using the edema-free adjusted body weight, as per Stark et al.[11]

[e]Data were available on a subset of participants for interdialytic weight gain (n = 133) and dialysis duration (n = 128).