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Adherence to Hemodialysis Dietary Sodium Recommendations: Influence of Patient Characteristics, Self-Efficacy and Perceived Barriers

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Abstract

Objective—To identify characteristics of hemodialysis patients most likely to experience difficulty adhering to sodium restrictions associated with their dietary regimen.

Design—Secondary analysis using baseline data from an ongoing randomized clinical trial examining the effects of a technology-supported behavioral intervention on dietary sodium intake in hemodialysis patients.

Setting—13 dialysis centers in southwestern Pennsylvania.

Subjects—122 participants (61% women, 48% African American) aged 61 ± 14 years receiving maintenance, intermittent hemodialysis for end stage renal disease.

Main outcome measure—Normalized dietary sodium intake, adjusted interdialytic weight gain, perceived problems and self-efficacy for restricting dietary sodium.

Results—Younger participants were more likely to report problems managing their hemodialysis diet and low self-efficacy for restricting sodium intake. Consistent with these findings, younger participants had a higher median sodium intake and higher average adjusted interdialytic weight gain. Females reported more problems managing their diet. Race, time on dialysis and perceived income adequacy did not appear to influence outcome measures.

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Conclusion—Our findings suggest patients who are younger and female encounter more difficulty adhering to the hemodialysis regimen. Hence, there may be a need to individualize counseling and interventions for these individuals. Further investigation is needed to understand the independent effects of age and gender on adherence to hemodialysis dietary recommendations and perceived self-efficacy.

Keywords

dietary sodium; hemodialysis; self-efficacy; behavioral research; health care disparities

Introduction

Currently, over 590,000 patients in the United States have end stage renal disease (ESRD)¹. Caucasians comprise the majority of ESRD patients, however, ethnic minorities and, in particular, African Americans are disproportionately represented². Statistics indicate ESRD prevalence is 3.4 times greater for African Americans compared to Caucasians¹. Additionally, low socioeconomic status (SES) has been associated with a greater likelihood of being diagnosed with ESRD^{3, 4}. The vast majority of patients with ESRD are treated with intermittent (2-3 days per week) hemodialysis to remove kidney wastes and fluid volume. Because fluid elimination is intermittent, rather than continuous, patients are at high risk for fluid volume overload between treatments.

Studies have shown that large fluctuations in interdialytic weight gain (IDWG) result in extracellular volume expansion and elevated blood pressure, placing increased strain on the cardiovascular system⁵. IDWG is the product of water accumulation in the body from metabolism and dietary and fluid intake. Thirst, prompted by the osmotic stimulus that results from excess dietary sodium intake and dialysate sodium, also plays a significant role in IDWG. To minimize IDWG, hemodialysis patients are advised to restrict their free fluid intake and minimize dietary sodium intake^{6, 7}. The literature overwhelmingly demonstrates that, while these lifestyle modifications are essential to the well-being, and survival of hemodialysis patients, adherence is poor⁸⁻¹⁴.

In the non-ESRD population, research has shown diet to be highly variable, and to be a function of cultural, psychological, geographical, and lifestyle factors, including food trends; and daily routines^{15, 16}. Diet-related decisions are influenced by multiple factors, including taste, financial constraints, individual preferences, social status, education level, societal norms, health, relationships, trust in food sources, and convenience¹⁵⁻¹⁸. Dietary preferences and behaviors are highly individual. Consequently, when counseling ESRD patients regarding the dietary regimen, it is unlikely a single approach will be generalizable to all. Some tailoring may be required to address dietary preferences and habits. Unfortunately, current literature offers limited guidance for clinicians who wish to develop targeted dietary counseling plans.

Prior to developing targeted interventions, it is necessary to identify characteristics of those most likely to experience difficulty adhering to hemodialysis dietary restrictions. In this report we describe hemodialysis patients' dietary sodium intake and weight gain between treatments, confidence in their ability to adhere to dietary sodium restrictions, and reported barriers to dietary adherence. Additionally, we explore associations between variations in adherence to dietary sodium restrictions, average weight gain, perceived problems, and self-confidence and the sociodemographic and economic characteristics of study participants.

Methods

Design

This study was a secondary data analysis of baseline data from an ongoing randomized clinical trial (R01 NR010135) evaluating a behavioral intervention to reduce dietary sodium intake in hemodialysis patients. Our analysis used data obtained prior to randomization. This study was approved by the Institutional Review Board of the University of Pittsburgh. Signed informed consent was obtained from all participants.

Sample

Participants were recruited from 13 dialysis centers in southwestern Pennsylvania. Individuals were eligible to enroll in the parent study if they were 18 years of age or older and had received maintenance hemodialysis for at least 3 months. They were excluded if they: (1) could not read, write, or speak English, (2) planned to move out of the area or change dialysis centers within the next 4 months, (3) had a terminal illness and life expectancy of less than 12 months per clinical evaluation of dialysis center staff, or (4) resided with another participant of the study. Because the parent study required use of a hand-held computer, individuals were excluded if they: (5) could not see the screen of the hand-held computer or use the device's stylus to make dietary selections from the computer screen, or (6) were institutionalized (e.g., in a nursing home, personal care facility, or incarcerated) which limited control over their dietary intake. Baseline data from all participants (n=122) recruited between September 2009 and October 2011 were analyzed for the present report.

Measures

Sociodemographic and health data were abstracted from the medical record or collected via survey and included age, gender, race, marital status, etiology and duration of ESRD. Income adequacy was evaluated with a single item asking participants (yes or no) if their financial resources were adequate for meeting their basic living needs.

Dietary sodium intake was assessed via three unannounced dietary recall interviews conducted by telephone; calls were placed during a two-week window prior to randomization. To account for day-to-day variation in dietary intake with the hemodialysis treatment schedule, three recalls were obtained including one dialysis weekday, one non-dialysis weekday, and one non-dialysis weekend day. These data were averaged and used for analysis. To maintain consistency, recalls were structured using the Nutrition Data System Research (NDS-R)¹⁹, a comprehensive nutrient calculation software program maintained by the Nutrition Coordinating Center at the University of Minnesota. The NDS-R database contains over 18,000 foods, 8000 brand name products and a number of ethnic foods. The research team members who conducted the calls were either renal dieticians or trained in NDS-R use by renal dieticians, and standard prompts were used when collecting dietary data. To account for variation in dietary intake by the amount of food consumed, dietary sodium intake was normalized to caloric intake (e.g. mgs sodium/1000 kcals consumed).

Pre- and post-dialysis weights were abstracted from the medical record for four hemodialysis treatments immediately preceding randomization (e.g., Monday, Wednesday, Friday, and Monday). Three IDWGs were calculated from these weights by subtracting the post-dialysis weight for the prior hemodialysis treatment from the more recent pre-dialysis weight and dividing by the number of days since last treatment (which ranged from 2-3 days) to yield average daily IDWGs or IDWG_A. The mean of these three IDWG_As was used in our analysis.

The Problems with the Hemodialysis Diet Survey (hereafter referred to as the “Problems Survey”) was an investigator-developed tool that was adapted from “the Barriers to Healthy Eating Scale²⁰,” and contained 34-items and 5 subscales describing various problems hemodialysis patients encountered in trying to follow the diet. The subscales evaluated dietary problems related to the participant's physical condition (e.g. Because I feel ‘washed out’ after dialysis, it is hard to eat healthy on dialysis days), resource adequacy (e.g. *Appropriate foods are not available in my home*), social network (e.g. People in my life do not support my efforts to eat a healthy diet), behavioral factors (e.g. It is difficult to motivate myself to eat the right foods), and technical difficulties (e.g. I have trouble keeping track of the amount of the different nutrients that I eat from meal to meal). Participants responded to each item using a 5-point visual numeric scale (VNS) on which 1= “not a problem at all for me” to 5= “a very important problem for me.”

The Self-Efficacy in Restricting Dietary Sodium in Hemodialysis Scale (hereafter referred to as the “Self-Efficacy Survey”) was an investigator-developed instrument adapted from the “Cholesterol-Lowering Diet Self-Efficacy Scale^{21, 22}.” The 15-item visual numeric scale (VNS) (0= “not confident at all” to 100= “very confident”) consisted of items designed to capture confidence regarding one's ability to follow the general hemodialysis diet and, in particular, limit foods high in sodium (e.g. How confident are you that in the next month, you will be able to control the amount of salt that you eat?), limit fluid intake (e.g. How confident are you that in the next month you will be able to limit the amount of fluids you drink?), keep their IDWG under control (e.g. How confident are you that in the next month, you will be able to limit the amount of weight you gain from fluid between dialysis sessions?), and resist food temptations (e.g. How confident are you that in the next month, you will be able to limit the number of times each week you eat at fast food restaurants?).

Data Analysis

Data were analyzed using IBM SPSS (version 20, International Business Machines, Corp. Armonk, NY). A descriptive analysis of all baseline variables was performed to assess data accuracy; evaluate distributions; and describe participant characteristics, sodium intake, IDWG_A, dietary problems, and self-efficacy. Univariate logistic regression analysis was used to explore associations between participant characteristics, normalized dietary sodium, IDWG_A, and scores on the Problems and Self-Efficacy Surveys. To examine associations between participant characteristics and dietary sodium intake, we dichotomized mean normalized sodium intake using the median value as the cut point. To examine associations between participant characteristics and fluid gain between hemodialysis treatments, we dichotomized IDWG_A according to whether the mean value was less than 1.0 kg (a commonly used ceiling recommended to patients in the participating dialysis units).

Preliminary analyses of the Problems and the Self-Efficacy Surveys revealed positively skewed response distributions on both. Consequently, item responses were dichotomized. For the Problems Survey, a response of a “very important problem for me” was assigned a value of “1” and all other responses assigned a value of “0”. For the Self-Efficacy Survey, scores were dichotomized into a mean score of 80 or greater versus less than 80.

To identify those individuals at greatest risk for non-adherence multivariate logistic regression was used with a forward entry method on those independent variables found to be associated with increased normalized dietary sodium intake, increased IDWG_A, more perceived problems and decreased self-efficacy in terms of dietary sodium restriction. The effects of interaction terms created from participant characteristics were also explored.

Results

Participants were primarily older, white, unemployed, married males, with a high school education or less (Table 1). Nearly one-third reported their income to be inadequate for meeting their basic living requirements. On average, participants had been receiving treatment for ESRD for over 4 years. Mean daily dietary sodium intake for the entire sample was 2,346 mg (SD=904). The mean normalized dietary sodium intake average was 1.7 mg per 1,000 kcals consumed. The mean IDWG_A was 1.23 kilograms (SD=0.54). Most (57%) participants reported they were “very confident” in their ability to restrict their dietary sodium intake. However, almost half (41%) reported experiencing problems on one or more of the items tested.

Younger aged participants were more likely to have a normalized dietary sodium intake that exceeded the median for the sample (Table 2). Younger adults (< 65 years of age) also were found to be more likely, than their older aged counterparts, to have an IDWG_A greater than 1.0 kg (Table 3). Male participants were found to be more likely than their female counterparts to have an IDWG_A greater than 1.0 kg, although this result was only marginally significant.

To further explain age- and gender-related differences, we explored subscale scores for the Problems and Self-Efficacy Surveys. Younger aged participants and females were more likely to report problems managing the hemodialysis diet (Table 4). Also, younger aged participants were more likely to report low self-efficacy for restricting dietary sodium intake (Table 5). Older aged participants reported more confidence on subscales measuring their ability to limit common sources of sodium ($p=.024$), adhere to sodium restrictions on different days of the week ($p=.010$), and adhere to sodium restrictions when feeling “blue” or experiencing poor appetite ($p=.035$).

The multivariate logistic regression analyses were conducted by entering the participant characteristics found to be associated with dietary sodium intake, IDWG_A, perceived problems, and self-efficacy into the model. Only age was associated with increased normalized dietary sodium intake ($p=0.18$) and self-efficacy ($p=0.001$). Similarly, interaction effects between participant characteristics were not significant.

Discussion

The major findings of this study were: 1) Younger adults were more likely to exhibit higher dietary sodium intake, have larger IDWG_As, report more problems when navigating the hemodialysis diet, and express lower self-efficacy in their ability to restrict dietary sodium. 2) Females were more likely to report problems adhering to the hemodialysis diet, but they did not have larger dietary sodium intake or IDWG_As. 3) Race and income adequacy were not associated with normalized dietary sodium intake, IDWG_A, perceived problems or self-efficacy.

Contrary to expectations neither race nor income adequacy were found to be associated with any of the outcome variables examined in this report. Some studies in non-hemodialysis populations have demonstrated that dietary behaviors are closely related to social status and culture¹⁵⁻¹⁸ and ethnic minorities and individuals of lower SES tend to consume more dietary sodium²³. Our study was unable to replicate these results. Most (57%) study participants reported consuming 2,400mg or less of dietary sodium per day as recommended by the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI) guidelines²⁴ and limited variability in dietary sodium intake was observed. Our study results are similar to that of Morales-Lopez and colleagues²⁵ who reported no differences between 17 Hispanic and 17 age and gender matched non-Hispanic hemodialysis

patients in regard to dietary compliance. Accordingly, our findings do not support the need for tailored interventions specific to race and SES, although the literature suggests otherwise²⁶⁻²⁸.

Prior studies in other populations have demonstrated positive associations between older age and greater adherence to exercise regimens and medication taking²⁹⁻³². Six international studies that addressed the relationship of age with adherence to the hemodialysis dietary regimen reported largely consistent findings. A study of 160 Korean hemodialysis patients³³ found that older participants were more compliant with phosphorus, sodium, and fluid restrictions, compared to younger counterparts, despite lower education and knowledge. In a study that recruited more than 7,000 hemodialysis patients from Japan, the US, and five European countries, older hemodialysis patients were found to be more compliant with dietary and fluid restrictions⁹. In a cross-sectional study of 188 Malaysian hemodialysis patients, Chan and colleagues³⁴ found positive correlations between older age and adherence to dietary and medication regimen. Conversely, those participants who were younger, male, employed and had longer time on hemodialysis were more likely to be non-compliant. Kugler and colleagues³⁵ found that younger male hemodialysis patients in Germany and Belgium were at highest risk for dietary and fluid non-adherence. However, in a study of 107 Hungarian hemodialysis patients³⁶ and one of 200 Iranian hemodialysis patients³⁷, no correlation existed between age and dietary adherence.

Our findings that older patients consumed less sodium, had lower IDWG_A, reported fewer problems and better self-efficacy are consistent with the Korean³³, DOPPs⁹; Malaysian³⁴ and, German/Belgium³⁵ studies, although definitions of dietary adherence varied. Older hemodialysis patients may fare better due to a longer duration of ESRD and more experience working through the challenges of following the hemodialysis diet and having adjusted to the demands of the regimen. In addition, older adults tend to consume less food, which could contribute to lower sodium intake and weight gain between treatments^{38, 39}. Lower dietary sodium and IDWG_A also may indicate inadequate dietary intake, which is common in those with long-standing ESRD. Finally, younger patients may be more active outside the home³⁵ with larger social networks and therefore experience a greater number of barriers and temptations than older patients.

The fact that the gender of study participants was not associated with dietary sodium intake is incongruent with the findings of Chan and colleagues³⁴. They demonstrated that male hemodialysis patients were more likely than females to be non-compliant with dietary restrictions. Similarly, as previously discussed, younger male German and Belgian hemodialysis patients were at highest risk for dietary and fluid non-adherence³⁵. This discrepancy may be due to the fact that we normalized dietary sodium by calorie intake (to account for the fact that sodium intake will increase proportionate to the volume of food consumed). Our results do however agree with those of Rambod and colleagues³⁷.

Although of borderline significance, our finding that male participants were more likely than female participants to have an IDWG_A greater than 1.0kg is consistent with findings reported by both Chan and colleagues³⁴ and Takaki and Yano⁴⁰. Kugler and colleagues⁴¹ also found an association between male gender and increased frequency of fluid non-adherence in a sample of German and US hemodialysis patients. These results should not be surprising given that males generally have higher caloric requirements, and do not necessarily reflect poor self-management. Our results however contradict those results found by Saran et al⁹ that female gender increased the odds of non-adherence to IDWG recommendations.

Our finding of no gender differences with respect to self-efficacy differs from that of Zrinyi and colleagues³⁶, who showed that higher dietary self-efficacy was associated with lower IDWGs, and that female participants reported higher dietary self-efficacy scores. The fact that female participants reported more problems with the diet than males could reflect domestic norms. Women tend to bear greater responsibility for food purchasing and preparation⁴² and, therefore, may perceive more problems related to dietary choices. The fatigue and physical health problems commonly associated with dialysis could be more problematic for those responsible for purchasing and preparing food.

Limitations and Strengths

Similar to the USRDS 2012¹ statistics, participants in our study were primarily white and older aged, suggesting our results would likely be generalizable to the ESRD patient population. However, generalization may be limited by the fact that all participants were volunteers for a dietary intervention study, with moderate IDWG_{As} and dietary sodium intake.

There are also a few measurement limitations to consider. Due to a large amount of missing data, self-reported income adequacy was used in place of household income or other commonly used indicators of economic resources. A single, dichotomous item on income adequacy may not have been sensitive to differences in economic resources we sought to detect. Additionally, while 24-hour dietary recall is used quite often in behavioral and nutritional research, self-report is often biased and measurement reliability is a concern. Dietary recalls were structured using the NDS-R¹⁹. This software program, although comprehensive, may have under or over estimated sodium intake. Also, to minimize respondent burden, we limited recalls to 3 days, which may not adequately capture dietary variability. Future studies may want to explore other means to better assess dietary sodium intake.

Finally, IDWG_{As} and dietary sodium intake in this sample were lower than expected with limited variability. Self-selection bias may have resulted in a highly adherent sample, which, in turn, limited our ability to detect factors contributing to excessive dietary sodium intake or excessive IDWG_{As}.

Practical and Research Implications

Our study suggested the need to tailor dietary sodium restriction counseling to hemodialysis patients, although not as originally expected. Development of age-specific and gender-specific dietary restriction interventions, rather than those targeting issues related to race and income, may prove more helpful to improve dietary sodium restriction compliance and mitigate barriers. Prior to undertaking this step, additional research is needed to confirm our findings for this patient population. Considering that the vast majority of research on this topic has been conducted in international settings, findings may not be applicable to US population secondary to departures in cultural norms. Future researchers may wish to target a more diverse sample, and employ better methods to capture economic resources and dietary behavior.

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Table 1**Participant Characteristics (N=122)**

Variable	n (%)
Race	
Caucasian	64 (52.5)
African American	58 (47.5)
Age	
< 65 years	75 (62.5)
65 years	45 (37.5)
Gender	
Male	74 (60.7)
Female	48 (39.3)
Marital Status	
Single	58 (47.5)
Married, or Coupled	64 (52.5)
Income Adequacy	
Income Adequate	79 (64.8)
Income Inadequate	38 (31.1)
Education	
High School	73 (59.8)
> High School	49 (40.2)
Employment Status	
Employed	19 (15.6)
Unemployed	103 (84.4)
History of CVD	64 (52.5)

Variable	Mean (SD)
Mean age, years	60.7 (14)
Duration of ESRD (months)	51.3 (56)
Average Dietary Sodium intake (mgs/day)	2346 (904)
Average Normalized Dietary Sodium intake (mg/kcals consumed)	1.74 (4.3)
Average Interdialytic Weight Gain (ADWG, avg kg)	1.23 (.54)

N, total sample; n, number within the sample; CVD, cardiovascular disease; SD, standard deviation; ESRD, end stage renal disease; mgs, milligrams; kcals, kilocalories; avg kg, average kilograms

Table 2

Univariate Logistic Regression of Participant Characteristics with Normalized Sodium Intake

Variable		B	P-Value	OR	95% CI	
Race	African American	-.472	.200	.624	.303	1.28
	Caucasian (Reference Group)					
Age	Older Aged	-.931	.018*	.394	.182	.855
	Younger Aged (Reference Group)					
Gender	Female	-.371	.327	.690	.329	1.45
	Male (Reference Group)					
Marital Status	Single, Not Married	-.608	.100	.545	.264	1.12
	Married, Cohabiting (Reference Group)					
Income Adequacy	Inadequate	-.238	.555	.788	.358	1.74
	Adequate (Reference Group)					
Time on HEMODIALYSIS (LG10)	(Continuous)	.005	.176	1.01	.998	1.01

B, Beta; OR, Odds Ratio; CI, Confidence Interval

* significant P-Value <0.05; LG10, log 10

Table 3

Univariate Logistic Regression of Participant Characteristics with Average Daily Weight Gain

Variable		B	P-Value	OR	95% CI	
Race	African American	-.103	.792	.902	.421	1.94
	Caucasian (Reference Group)					
Age	Older Aged	-.935	.020 **	.393	.178	.865
	Younger Aged (Reference Group)					
Gender	Female	-.751	.059 *	.472	.216	1.03
	Male (Reference Group)					
Marital Status	Single, Not Married	.508	.198	1.66	.767	3.60
	Married, Living as Married (Reference Group)					
Income Adequacy	Inadequate	-.261	.546	.770	.330	1.80
	Adequate (Reference Group)					
Time on HEMODIALYSIS (LG10)	(Continuous)	-.002	.528	.998	.991	1.01

B, Beta; OR, Odds Ratio; CI, Confidence Interval

LG10, log 10

** significant P-Value <0.05

* borderline significant P-Value <0.05

Table 4

Univariate Logistic Regression of Participant Characteristics with “Problems with Hemodialysis Diet Questionnaire” Scores

Variable		B	P-Value	OR	95% CI	
Race	African American	.541	.147	1.72	.826	3.57
	Caucasian (Reference Group)					
Age	Older Aged	-.789	.050 *	0.45	.206	1.00
	Younger Aged (Reference Group)					
Gender	Female	1.09	.005 **	2.98	1.40	6.36
	Male (Reference Group)					
Marital Status	Single, Not Married	.126	.734	1.14	.548	2.35
	Married, Living as Married (Reference Group)					
Income Adequacy	Inadequate	-.546	.177	.580	.262	1.28
	Adequate (Reference Group)					
Time on HEMODIALYSIS (LG10)	(Continuous)	.003	.415	1.00	.996	1.01

B, Beta; OR, Odds Ratio; CI, Confidence Interval

LG10, log 10

* significant P-Value <0.05

** significant P-Value <0.01

Table 5

Univariate Logistic Regression of Participant Characteristics “Self-Efficacy Restricting Dietary Salt in Hemodialysis Scale” Scores

Variable		B	P-Value	OR	95% CI
Race	African American	-.038	.919	.963	.464 1.99
	Caucasian (Reference Group)				
Age	Older Aged	-1.39	.001**	.249	.108 .577
	Younger Aged (Reference Group)				
Gender	Female	.201	.596	1.22	.582 2.57
	Adequate (Reference Group)				
Marital Status	Single, Not Married	.018	.960	1.02	.491 2.11
	Adequate (Reference Group)				
Income Adequacy	Inadequate	-.033	.935	.967	.463 2.15
	Adequate (Reference Group)				
Time on HEMODIALYSIS (LG10)	(Continuous)	-.004	.291	1.00	.997 1.01

B, Beta; OR, Odds Ratio; CI, Confidence Interval

LG10, log 10

**
significant P-Value <0.01