

Macro and Micronutrients Deficiencies within Hemodialysis Patient's Dietary Intake, Should we Re-Consider our Recommendations?

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ARTICLE INFO

Article history:

Received: 05 January 2022

Accepted: 28 January 2022

Published: 31 January 2022

Keywords:

Chronic kidney disease;
Hemodialysis;
End stage renal disease;
Macronutrients;
Micronutrients;
Medical nutrition therapy

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SL Nutr Metab

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Citation this article: Barakat R, Haviv YS, Geva D, Vardi H, Shahar DR. Macro and Micronutrients Deficiencies within Hemodialysis Patient's Dietary Intake, Should we Re-Consider our Recommendations?. SL Nutr Metab. 2022; 2(1):115.

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ABSTRACT

Background: End Stage Renal Disease (ESRD) patients are at increased risk for impaired nutritional status and dietary deficiencies due to the complexity and severity of the disease.

Study aim: Evaluating Hemodialysis (HD) patient's dietary intake, on days on and off dialysis using 24 hour recall (24HR) questionnaires compared with ESRD requirements.

Methods: A cross-sectional study on dietary intake for HD patients was held in a single HD center. A convenience sample was taken, based on the number of patients in the HD units (n=74). Data were obtained from computerized medical records and a 24HR questionnaire interview was performed by a clinical dietitian.

Results: The mean caloric intake for HD patients was 1683.9 ± 546.9 Kcal/day deviating almost 20% below the Kidney Disease Outcomes Quality Initiative (KDOQI) guideline recommendations for HD patients. Subjects consumed 25% less carbohydrates than recommended while micronutrients intake was similar to the recommended dose due to intake of nutritional supplements.

When the results were analyzed according to the day of the week, patients' mean energy intake was the highest on a dialysis day (1766 ± 745.4 Kcal/day), and the lowest on the day after dialysis treatment (1651.5 ± 624.6 Kcal/day).

Conclusion: In our study of HD patient's carbohydrate consumption was less than recommended because they were found to eat less on the day after the HD session, raising the potential for nutritional intervention on that day.

Introduction

CKD is an increasing worldwide public health problem. In Israel and according to the Ministry of Health (MOH) annual report from 2015, around 6,400 patients undergo dialysis treatments each year, 94% (6,000 patients) do Hemodialysis (HD) and around 6% (400 patients), undergo peritoneal (PD) [1,2]. The prevalence of ESRD is increasing [3],

and it should be noted that, the rising prevalence of treated ESRD can be attributed primarily to the increase in the number of patients who start renal Replacement Therapy (RRT) each year rather than to increased survival of patients with ESRD [4,5]. Changes in the demographics of the population, differences in disease burden among racial groups, and under-recognition of earlier stages of CKD and of risk factors for CKD may partially explain this annual growth.

Moreover, our ESRD patients consume a disproportionate share of healthcare resources. A cost in which the nutritional status of these patients play an important role in predicting and treating partially, starting with the complications, increased hospitalization rate, hospital days and mortality [6]. Both assessing and optimizing nutritional status is important to improve patient's Quality Of Life (QOL), improve clinical outcomes, and help control these care costs for the benefit of the whole population.

The dietary aspect in this field (CKD- ESRD) is one of the most challenging for professionals and especially nutritionists, because of the restricted diet and the multiple macro- and micronutrient limitations. Therefore, one of the main goals of the Medical Nutrition Therapy (MNT) is to prevent malnutrition in these patients, in order to maintain their QOF and avoid serious health complications as mentioned before [7,8]. Moreover, in the nutritional domain the main challenges are attaining adequate energy intake in order to maintain a reasonable body weight and improving the overall health through appropriate food choices both on a "regular" day (off dialysis) or on a dialysis day (usually 3-4 times/week).

In this paper, the main objective is to describe dietary intake of HD patients versus requirements and to determine the association between the quality of the patients' diet and the nutritional status indicators, so as to understand this field more and prevent malnutrition among these patients.

Methods

1. Study setting/Participants

A cross sectional study was performed among prevalent HD patients. The study took place in a single center, Hadassah Medical Center, Jerusalem, Israel (N=105). Patients fed through Total Parenteral Nutrition (TPN) or other internal feeding methods were excluded, leaving a total of N=74 participants who agreed to participate. Data were collected from December 2012 to September 2013. The study was approved by the hospital's ethics committee and all participants signed an informed consent.

Study Tools

1. Data collection

Personal, demographic and medical data were retrieved from the medical records and stored in a format of an excel file.

Dietary intake and diet quality were collected using a modified U.S. Department of Agriculture (USDA) 24-hour recall in an adapted method described elsewhere [9]. The questionnaire comprised food intake for three consecutive days- the day before dialysis, the day of dialysis and the day after dialysis, it has to be explained that the day before and the day after, are not similar, cause the weekend is 2 consecutive days and during the week the difference between the treatments is shorter, so the day after is not exactly the day before; an issue that should be studied in the near future.

The 24-hour recall data was collected during an interview or completed independently by the patients at home based on formal dietitian guidance.

In order to maximize accuracy the "Food Guide and Quantities, Second Edition" of the Israeli Ministry of Health (MOH) (2009) was used.

For data entry purposes the computerized "Nutrition Analysis program of S. Daniel Abraham International Center for Health and Nutrition" was updated, by adding medical nutritional supplements that are recommended for HD patients [10], and nutritional values for the patients' intake of macro- and micronutrients were calculated, both per day and as an average of the 3 consecutive days.

All results were compared to the nutritional recommendations for HD patients [11,12].

2. Statistical Analysis

All datasets were merged into one combined excel file that was converted into an SPSS file. The merged data set was cleaned and checked for missing, illogical and exceptional values. Data was analyzed using SPSS 17th version, to provide a description of the study population including its personal, demographic, health and nutritional characteristics.

Continuous variables were presented as averages/medians and standard deviations, and qualitative variables were presented as percentages. T-test or Chi square X^2 were used where indicated to compare between groups.

Socio demographic (Mean± SD)	
Age (years)	63.35±13.3 (74)
Male gender, % (n)	63.5 (47)
Religion % (n) Jewish	62.2 (46)
Non Jewish*	37.8 (28)
Education (years)	11.88 ± 5.5
Caregiver's help, yes, % (n)	25.7 (19)
Country of birth, Israel, % (n)	70.3 (52)
Marital status, % (n) [Married]	75.7 (56)
Clinical (Mean± SD)	
Smoking/ current, yes, % (n)	10.8 (8)
BMI (kg/m ²) (median)	26.3 ± 4.9 (26)
Cardiovascular disease, no % (n)	52.7(39)
Diabetes, no % (n)	55.4 (41)
HTN, no % (n)	31.1 (23)
Duration of dialysis (number of years) (Median)	4.45 ± 4.76 (3)

* Non Jewish refers to all other participants; Muslims, Christians...etc.

Results

1. Characteristics of the study population

A total of 74 HD patients participated in the study with a mean age of 63 ± 13.3 (with a range of 20-85) years. Forty-seven participants (63.5%) were men, 46 (62%) of them were Jews and 56 (76%) were married. In terms of the main clinical characteristics collected, 38 (51.4%) of the patients had a Body Mass Index (BMI) > 25 and only 3 (4.1 %) patients had a BMI <19. Thirty-

three patients (44.6%) were diabetic, 51 (68.9 %) had hypertension (HTN), 35 (52.7%) had Cardiovascular Disease (CVD) and the mean average of dialysis vintage (years on dialysis), was 4.5 ± 4.76 years (Table 1).

The average values of the patients' blood test results were close to target levels. The main variables of interest from a nutritional point of view, such as Albumin (38.6 ± 4.4 g/l) and Total Protein (TP) (71.5 ± 6), indicate a well-nourished population as well as a treated and compliant population.

2. Dietary intake

2.1. The average intake: The mean daily dietary intake for 3 consecutive days was calculated and compared with the recommendations for HD patients. The results are shown in (Table 2). The study patients' mean intake was almost 20% lower than the mean daily intake recommended for carbohydrates, protein and overall energy. The macronutrient showing the least deviation from the general recommendation was fat with a mean intake of 11.5% among study participants.

As for the micronutrients studied, a bimodal distribution of the micronutrients intake was performed, showing either much more or much less than recommended for HD patients (Table 3).

2.2. The intake per days: According to the results shown in (Table 4), the actual intake was always lower than the recommendations, with no differences in results between individual days and the average of the three days together. The highest deviation from the recommendations was seen in the patients' carbohydrate intake (25%) while the fat intake (11.5%) deviated the least from the recommendations.

The micronutrients intake by day is presented (Table 5). The actual intake is not reported because results are confounded by the amount of supplements taken during the treatment.

Discussion

In this cross sectional study among 74 ESRD patients on HD, we evaluated dietary intake of the patients using 3 * 24h recalls in order to capture daily differences in dietary intake by collecting data extending over 3

Table 2: Macronutrient intake of the HD patients in comparison with dietary recommendations.

Macronutrient	Dietary Recommendations for HD patients	Mean Dietary Recommendations* (Mean \pm SD)	Mean intake of our HD patients (Mean \pm SD)	% deviation
Energy kcal	30- 35 Kcal/ Kg/ day	2118.7 \pm 377.9	1683.9 \pm 546.9	- 20%
Carbohydrate (g)	50% from total calories	264.8	198.6 \pm 72	- 25%
Protein (g)	1.2 – 1.3 g / Kg/ day (20% of total calorie intake) HBV** >50%	105.9	85.4 \pm 27.9	- 19 %
Fat (g)	30 % of total calorie intake	70.6	62.5 \pm 24.7	- 11.5%
Saturated fats (g)	33.3 % of total fat	23.5	22.3 \pm 10.2	5.11%
MUFA*** (g)	33.3% of total fat	23.5	23.8 \pm 10.8	1.3%
PUFA*** (g)	33.3 % of total fat	23.5	11.7 \pm 6.6	- 50.2%

*The mean dietary recommendations were calculated according to an average weight of 65 Kg, as clinically accepted.

** HBV- is a High Biological Value Protein.

***M/PUFA- mono/ poly unsaturated fatty acids.

Table 3: Micronutrient intakes for HD participants in comparison to recommendations for daily intake (Mean mg \pm SD is presented unless indicated otherwise).

Micronutrient	Recommendations for HD patients (mg)	HD Patient mean intake	% Deviation from recommendations*
Calcium (Ca)	2000	635.4 \pm 563.8	- 68 %
Phosphorus (P)	800	1169 \pm 407.6	+ 46%
Potassium (K)	1600-2000	2233 \pm 717.6	+ 11.7%
Iron (Fe)	8 for men	14.5 \pm 13.1	+ 44.8%
	18 for women	10.5 \pm 6	- 41.7%
Magnesium (Mg)	420 for men	255.9 \pm 94.7	- 39%
	320 for women	201 \pm 61.9	-37.2%
Sodium (Na)	2000-3000	2825.5 \pm 1012	Normal
Vitamin D(ng/ml)	Individual	72 \pm 61	---
Vitamin B12 (μ g)	6	8.1 \pm 16.4	+ 25.9%
Folic acid	>1	67.2 \pm 84.5	+ 98.5%

* Nutrients and Vitamins which don't have a daily recommendation were equated to the RDA – the recommended daily allowance for healthy people.

Table 4: Macronutrients Intake by days

Intake Macro	Daily Intake Dialysis day (Mean g \pm SD)	Daily Intake Day before dialysis (Mean g \pm SD)	Daily Intake Day after dialysis (Mean g \pm SD)	Mean intake (g \pm SD)	Mean dietary recommendations for HD patients (Mean g \pm SD)	% Deviation from recommendations
Energy (kcal)	1766 \pm 745.4	1661.5 \pm 628.2	1651.5 \pm 624.6	1683.9 \pm 546.9	2118.7 \pm 377.9	- 20%
Carbohydrates (50% of calories)	193 \pm 40.5	212.8 \pm 79.7	191.8 \pm 81	198.6 \pm 72	264.8	- 25%
Protein (20 % of calories)	89.9 \pm 46.1	86.7 \pm 41.1	82.6 \pm 31.5	85.4 \pm 27.9	105.9	- 19 %
Fat (30% of calories)	63.5 \pm 58.9	61.6 \pm 29.87	63 \pm 51.6	62.5 \pm 24.7	70.6	- 11.5%
Saturated Fats	22 \pm 11.6	22.4 \pm 14	22.7 \pm 13.8	22.3 \pm 10.2	23.5	6.8%
MUFA	23.9 \pm 14.8	23.5 \pm 12.7	24.3 \pm 16.3	23.8 \pm 10.8	23.5	- 1.7%
PUFA	12.9 \pm 11.7	10.9 \pm 5.8	13 \pm 12	11.7 \pm 6.6	23.5	82.2%

days, off and on dialysis. We found that HD patients are at high risk for nutritional deficiencies compared to the KDOQI recommendation for HD patients. Our results indicate that energy intake was significantly lower than the daily recommendation for energy intake along with lower than recommended intake of carbohydrates. Similar results were reported by Delgado C et al [13],

findings that support the known paradox about HD patients who suffer from obesity but high percentages of PEW- Protein Energy Waste, an issue that was mentioned in many studies concluding that obese patients are not necessarily in a good nutritional status. In obese CKD patients, there is a loss of muscle mass, which is a condition known as sarcopenic obesity [14,15],

Table 5: Micronutrient (minerals and vitamins) intake according to day (before, during, and after dialysis)

Intake Micro / Minerals (mg)	Daily intake Dialysis day (Mean ± SD)	Daily intake Day before dialysis (Mean ± SD)	Daily intake Day after dialysis (Mean ± SD)	Mean intake (Mean ± SD)	Mean dietary Recommendation for HD patients	% Deviation from RDA
Ca	691 ± 654	604 ± 543	613 ± 527	635.4 ± 563.8	2000	- 68 %
P	1224.2 ± 581.1	1192 ± 534.3	1119.2 ± 498.3	1169 ± 407.6	800	46%
K	2345 ± 166	2241.4 ± 863.6	2153 ± 914.3	2233 ± 717.6	1600-2000	11.7%
FE (µg)	14.7 ± 28.3	12.3 ± 8.8	11.6 ± 9.6	12.6 ± 10.9	8 men 18 women	+ 36.5% - 29.4%
Mg	255.7 ± 147	231.4 ± 105	221.4 ± 135.5	235.3 ± 87.6	420 men 320 women	+ 43.9 - 26.5
Na	3022.1 ± 1517.5	2785.7 ± 1247	2779 ± 1392	2825.5 ± 1012	2000-3000	0%
Micronutrients/ Vitamins						
Vitamin D (ng/ml)	72 ± 61	74.7 ± 85.7	64.9 ± 76.5	78.8 ± 99	Individual	----
Vitamin B12 (µg)	8.1 ± 16.4	4.5 ± 5.4	12.3 ± 33.5	8.1 ± 20.5	6 µg	+ 35%
Folic acid	67.2 ± 84.5	59.3 ± 64	59.6 ± 87.2	85 ± 202	>1	+ 84%

which is considered as one of the major risk factors correlated with morbidity and mortality in dialysis patients in particular. Moreover they showed that, energy and macronutrient estimates by Brief- Food Frequency Questionnaire (FFQ) are lower than estimates from 3-day food diaries. Of the 3 days studied, the highest intake was on the day of dialysis the same as our findings suggest. When looking at differences between days, energy and carbohydrate intakes showed the greatest deviation from recommendations on the day after the dialysis session, (least mean intake 1651.5 ± 624.6 Kcal /day, 191.8 ± 81 g/day) compared to the dialysis day (1766 ± 745.4 Kcal/day, 193 ± 104.5 g/day) and the day before the dialysis (1661.5 ± 628.2 Kcal/ day, 212.8 ± 79.7 g/day). This seems to be a new finding as to the best of our knowledge no studies have been so far reported. However, micronutrient intake also deviated from the recommendations, and showed the higher average on the day of the dialysis. These finding may be important for future nutritional intervention among HD patients. The day after dialysis has the potential for improving dietary and improve nutritional status. The results of this study are comparable with previous studies suggesting that HD patients are at high risk for malnutrition [16], because of the low intake of the macro- and micronutrients. Our study findings suggest that the day of the non- dialysis could be the potential day for a good intervention program so as to improve

these patients' nutritional intake. Interestingly, macronutrients intake was the highest on the dialysis day compared with the non- dialysis days, with no significant differences found between the three days. It is important to clarify that the day after the dialysis is actually the same day as the day before the dialysis, because the treatment is done every other day, unless it's a weekend, in which case the amount of time between treatments is longer. In this study, these differences were not taken into consideration. Future studies should investigate the differences between a weekend and a regular weekday. Additionally, an intervention trial on the day of the non- dialysis should be tested to improve nutritional status of ESRD patients. Our study suffers from some limitations that need to be addressed. The first is the low sample size, although comparable to groups in previous studies [17]. Additionally, we used 24h recall which is more prone to information bias as well as social desirability bias. In order to overcome this limitation, the dietitian who performed the assessment for the study is the one taking care of these patients and aware of patient's true dietary intake for years. We believe that despite the potential information bias, the design and the conduct of the study led to satisfying methodology and relatively accurate nutritional data. In conclusion, the results of this study showed that HD patients were consuming close to 25% less than the recommended carbohydrate intake this population. Furthermore, the study showed that patients eat less on the day after the

HD session, suggesting that intervention should be focused on increasing dietary intake of low protein carbohydrates as an energy source on the day after the HD session.

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