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Chronic hemodialysis patients: A comparison of clinical, laboratory and nutritional parameters among elderly and non-elderly patients

Pacientes en hemodiálisis crónica: Comparación de parámetros clínicos, de laboratorio y nutricionales entre pacientes ancianos y no ancianos

Tássia Ney Portantiolo¹. <https://orcid.org/0000-0003-3707-8066>
Alessandra Doumid Borges Pretto¹. <https://orcid.org/0000-0002-3913-0676>
Gabriela de Lemos Uliano¹. <https://orcid.org/0000-0003-3687-7288>
Camila Irigónhé Ramos^{2*}. <https://orcid.org/0000-0001-8593-1397>
Sandra Costa Valle¹. <https://orcid.org/0000-0003-1176-7402>

1. Faculdade de Nutrição, Universidade Federal de Pelotas, Pelotas, Rio Grande do Sul, Brasil.
2. Faculdade de Enfermagem, Universidade Federal de Pelotas, Pelotas, Rio Grande do Sul, Brasil.

*Corresponding author: Camila Irigónhé Ramos.
Faculdade de Enfermagem, Universidade Federal de Pelotas, Pelotas, Rio Grande do Sul, Brasil.
E-mail: mila85@gmail.com

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ABSTRACT

Aim: To compare nutritional, clinical and laboratory parameters data among elderly and non-elderly patients on hemodialysis. **Methods:** It is a cross-sectional study, with a sample of 34 patients (17 non-elderly participants between 18 to 59 years of age, and 17 elderly participants aged 60 years or older), from the Nephrology Unit, Hospital Santa Casa de Misericórdia, Pelotas/RS/BR. Demographic, socioeconomic, clinical, laboratory, anthropometric data and information on food consumption were collected. **Results:** Most elderly and non-elderly patients had low income and education. Among elderly participants, weight values, pre and post-dialysis, interdialytic weight gain, median diastolic blood pressure pre and post-dialysis and urea, were higher than among the non-elderly. About 65% of the non-elderly and 70.6% of the elderly subjects had inadequate caloric intake. The same occurred with protein intake, for which 58.8% of the non-elderly and 82.3% of the elderly patients presented inadequate protein intake. **Conclusion:** There was a tendency of weight gain in the elderly, which may increase the risks of treatment. Evidence indicates an association between the intake of energy and protein in the diet of patients on hemodialysis, requiring an adequate diet and dialysis, in order to avoid complications related to kidney disease. **Keywords:** Elderly; Hemodialysis Units; Hospital; Malnutrition; Obesity.

RESUMEN

Objetivos: Comparar parámetros nutricionales, clínicos y de laboratorio de pacientes ancianos y no ancianos sometidos a

hemodiálisis. Métodos: Estudio transversal, realizado con una muestra de 34 pacientes, de los cuales 17 eran no ancianos de 18 años y más y menos de 60 años y 17 ancianos de 60 años y más, de la Unidad de Nefrología del Hospital Santa Casa. de Misericórdia de Pelotas / RS / BR. Se recopilaron datos demográficos, socioeconómicos, clínicos, de laboratorio, antropométricos y de consumo de alimentos. Resultados: La mayoría de los pacientes ancianos y no ancianos eran de bajos ingresos y educación. En los ancianos, se encontraron valores de peso, pre y posdiálisis, aumento de peso interdialítico, mediana de la presión arterial diastólica pre y posdiálisis y urea más alta en comparación con los no ancianos. Aproximadamente el 65% de las personas no ancianas y el 70,6% de las personas mayores presentaban una ingesta calórica inadecuada, lo mismo ocurrió con la ingesta proteica, donde el 58,8% de las personas no ancianas y el 82,3% de las personas mayores presentaban una ingesta proteica inadecuada. Conclusión: Hubo una tendencia al aumento de peso en los ancianos, lo que puede traer riesgos al tratamiento. La evidencia indica una asociación entre la ingesta energética y proteica en la dieta de pacientes en hemodiálisis, requiriendo adaptación de la dieta y diálisis para evitar complicaciones relacionadas con la enfermedad renal.

Palabras clave: Anciano; Desnutrición; Obesidad; Unidades Hospitalarias de Hemodiálisis.

INTRODUCTION

The increase in the number of patients with chronic non-communicable diseases (CNCD) such as obesity, hypertension and diabetes mellitus, besides the increase in life expectancy of the population, is associated with a high prevalence of chronic kidney disease (CKD)¹. The aging process and the consequent decline in bodily functions and physiological reserves may cause the individual to be more prone to chronic conditions^{1,2}. It should also be considered that functional changes are typical of the natural aging process, being empowered by the presence of CNCD³.

Hemodialysis (HD) is one of the treatments for kidney failure with replacement therapy (KFRT) currently and widely used. KFRT is increasing in Brazil^{4,5}. The Brazilian Society of Nephrology (SBN), performed a census in 2012 and recorded a prevalence of 97,586 patients on dialysis, with 651 dialysis units in the country. In Brazil, in 2012, 31.9% of dialysis patients were 65 years old or older⁶. The treatment for HD causes limitations, mainly physical, which worsen with advancing age. In addition, the elderly are more likely to have multiple comorbidities³.

Kidney disease progression and HD therapy causes restrictions and damages in physical, mental and functional health, general well-being, social interaction and satisfaction of patients³. The limitations of HD patients, especially physical, tend to increase with the advancing age due to the fragility of the aging process, as well as the changes characterized by progressive weight gain and changes in body composition, with fat redistribution and lean body mass reduction⁷. In addition, there is a basal metabolism decrease, body mass redistribution and increased susceptibility to nutrient deficiency. All these aspects affect nutritional status and increase the susceptibility of multiple co-morbidities⁷.

Individualized nutrition assistance helps with the prevention and the control of clinical complications related to inadequate nutritional status. Studies show a reduction in morbidity and mortality in HD patients associated with values of body mass index (BMI) between 23 and 25 kg/m² and age-appropriate intake of energy and protein^{8,9}. There are no potential risks or harms associated with the application of BMI guidelines.

Indeed, the standard weight status categories that have been defined by the World Health Organization (WHO) according to BMI ranges for adults should be used in the CKD population. To ensure the accuracy of BMI, height should be measured periodically¹⁰.

Nonetheless, BMI is not an ideal marker of obesity because it cannot differentiate between higher weights due to increased adiposity versus muscularity and it cannot identify visceral adiposity, which has negative metabolic effects¹⁰. For the nutritional assessment and diagnosis of HD patients it is necessary to employ various clinical, dietary, biochemical and anthropometric methods, aiming to overcome limitations presented by each method when used separately¹⁰.

Evidence shows poor intake of energy and protein associated with the development of protein energy malnutrition (PEM) in dialysis patients. PEM is strongly associated with increased morbidity and mortality, higher rates of hospitalization and decreased quality of life in HD patients⁹. However, nowadays, there is great heterogeneity in the nutritional profile of dialysis patients, with obesity being one of the comorbidities present in a significant part of the population of HD patients.

Regarding obesity, one should consider that besides energy storage, adipose tissue is an endocrine organ complexly regulated, with broad endocrine and metabolic actions, secreting several adipokines, including TNF- α , IL-6, plasminogen activator inhibitor-1 (PAI-1), PCR, resistin and acylation-stimulating protein. Moreover, a direct relationship between obesity and survival persists with wide variation in body weight among HD patients^{9,10}. However, obesity, in addition to aggravating the inflammatory state and increasing the risk and severity of cardiovascular and metabolic diseases, contributes to clinical instability in HD patients, particularly the elderly, due to increased physiological vulnerability^{9,10,11}.

Considering previous studies, this work postulated that elderly regular HD therapy patients will have higher body weight, lower caloric and protein intake, resulting in greater difficulty in the control of clinical parameters. Thus, the aim of this study was to compare clinical, laboratory and

nutritional parameters between elderly and non-elderly patients, undergoing constant HD.

METHODS

A cross-sectional study was performed in the Nephrology Unit of Santa Casa de Misericórdia de Pelotas/RS. The sample size was calculated based on the difference between averages of blood pressure levels, weight and caloric consumption, considering data from similar studies. We used a 95% confidence interval, maximum tolerable error of five percentage points and 80% power. The calculation was increased by 20% to account for losses and refusals and to control for confounding factors, requiring a final sample of 68 subjects.

Among the 102 registered patients of Chronic Kidney Disease Grade 5 treated with dialysis (CKD G5D), 43 met eligibility criteria; there were eight refusals and one death. Thus, the sample consisted of 34 patients. The study included patients over 18 years of both genders, non-hospitalized, who had spent more than three months on HD before data collection. Individuals who had infections, neoplasia, who have lived anytime as a renal transplanted and did not to understand the items in the instrument used for the assessment of the nutritional intake were excluded from the study.

In an interview with the patients, demographic and socioeconomic variables were collected, such as gender, age (years), education (years) and family income (minimum wage). To classify the age group, individuals from 18 to 59 years old were considered non-elderly; the ones aged 60 or older were considered elderly.

Data such as the etiology of the renal disease, HD duration (years), presence of comorbidities, blood pressure levels (mmHg), pre and post-dialysis dry weight (kg), rate-efficiency dialysis Kt/V (Daugirdas II) and plasma levels of albumin (g/dL measured by bromocresol green), hemoglobin (g/dL), urea (mg/dL), creatinine (mg/dL), phosphorus (mg/dL), both analyzed by the colorimetric and potassium methods (mg/dL), dosed by selective ion, were abstracted from the computerized records of the unit, in the period from July to September 2013. The percentage of interdialytic weight gain (IDWG) was estimated based on the difference of the current pre-dialysis weight and the previous post-dialysis weight¹².

Laboratory data, with the exception of post-dialysis urea, were collected immediately before the dialysis session, performed by the same laboratory, and corresponded to the average of three sessions held between July and September 2011.

Anthropometric measurements were performed by a trained technician and considered weight, pre and post-dialysis, measured on a WELMI digital balance, class II, with 150kg-capacity and 100g-accuracy. Height was measured using the reverse measurement technique with the aid of an inextensible measuring tape. The average of the values was used. BMI, according to the World Health Organization (WHO), was calculated as the ratio between dry weight average, estimated by experienced personnel, and squared

stature¹³. Energy and protein intake were estimated from the current weight. To determine the ideal weight for elderly and non-elderly patients, average BMI (22 kg/m²) was used¹².

A nutritional record was used to collect dietary data. In order to fill it in, patients and/or family members received instructions about measures (portion sizes), by means of illustrative figures and serving utensils. Furthermore, they were instructed to detail the type and amount of each food ingested and the time of ingestion. The food record was performed on three different days: Sunday, one day in the interdialytic period and another on dialysis. Data records were analyzed separately using the ADSNutri[®] software for the calculation of nutritional intake, which uses the Brazilian Table of Food Composition-TACO-UNICAMP and, for foods not in TACO, information was obtained from food labels.

Calorie, protein, sodium, potassium, phosphorus and calcium consumption were compared with the recommendations of the Kidney Disease Outcome Quality Initiative (KDOQI)¹⁰, considering the following daily reference amounts: calories for <60 years of 35 Kcal/kg and for >60 years of 30 Kcal/kg, protein 1.2 g/kg, sodium 1.5 g, potassium 1.5 g, phosphorus 1.0 g, and calcium 1.0 g. The protein intake in g/kg/day was also estimated by calculating the Protein Equivalent of Total Nitrogen Appearance (PNA) at midweek. To estimate this midweek PNA, the serum urea nitrogen-SUN- was initially calculated, from the serum urea values of pre-dialysis. For the patients with residual function the pre-dialysis SUN was adjusted¹².

The evaluation of nutritional parameters, as well as their deviations, took into consideration the adequacy of the BMI <22 kg/m², albumin level <3.8 g/dL, caloric intake of 35 kcal/kg/ideal body weight (IBW) for the non-elderly and of 30 kcal/kg/IBW for the elderly, protein intake for both age groups of 1.2 g/kg/IBW and PNA <1.2 g/kg/IBW¹². Despite the limitations in the use of BMI in HD patients, it was used as an additional parameter for clinical evaluation because of its easy application.

The study was approved by the Ethics Committee in Research from Universidade Federal de Pelotas, protocol n.150/2011. Informed Consent, contained information about the research, was read and signed by the individuals who agreed to participate. Those who did not sign were considered refusals.

Results are presented as mean±standard deviation, median and extreme values (minimum and maximum). Data normality was tested using the Shapiro Wilk test. Comparisons between groups was performed using the Mann Whiteny U test. To compare the frequencies of clinical, nutritional and laboratory parameters between the groups we used the Fisher's exact test. A p value of p<0.05 was considered a statistically significant difference. We used the BioEstat 5.3 program (free Software, Mamirauá Institute).

RESULTS

In the resulting sample, most were male 61.8% (n= 21) and the prevalence of non-elderly subjects (<60

years) and elderly (≥ 60 years) was similar, 50% ($n = 17$) in both groups. Demographic, socioeconomic, clinical and laboratory data are presented in table 1. The median age of the non-elderly patients was 51 years; as for the elderly, it was 65. It is observed that most individuals of both age groups had low income, education and number of adults in the family. The dialysis duration was higher in the non-elderly group, 4.4 years on average, due to a longer discovery of the disease and an earlier beginning of the treatment. As for the elderly, the dialysis duration was of 1.3 years.

Pre-dialysis weight in non-elderly patients resulted in a median value of 60.3 kg and the post-dialysis weight was 59.1 kg. The IDWG was 2.4%. No difference between median diastolic blood pressure (DBP), pre-dialysis and post-dialysis, was observed. Serum creatinine and urea levels were 7 mg/dL and 41 mg/dL, respectively (Table 1).

Among elderly patients, a median pre-dialysis weight of 73.8 kg was observed, 71.7 kg post-dialysis, and an IDWG of 3%. In the evaluation of DBP, pre-dialysis and post-dialysis, values of 90 mmHg, 83.3 mmHg, respectively,

and serum urea of 46.6 mg/dL and creatinine of 9.6 mg/dL were observed (Table 1).

Comparisons of clinical and nutritional parameters of patients are presented in table 2. In the non-elderly, there was the same percentage of malnutrition and obesity, observing the occurrence in 11.7% of subjects. Regarding caloric intake below 30 kcal/kg, it occurred in 64.7% of subjects; less than 1.2 g/kg of daily protein intake in 58.8% and less than 0.8 g/kg of protein in 17.6%. Albumin lower than 3.8 g/dL was observed in 52.9% of patients of this age group. Transferrin saturation of less than 20% and pre-dialysis SBP (Systolic Blood Pressure) greater than 160 mmHg were verified in 29.4%. Post-dialysis SBP greater than 160 mmHg was observed in 35.2% and Kt/V of Urea lower than 1.2 in 29.4% of subjects.

In elderly patients, malnutrition was not found, but obesity was observed in 23.5%. Caloric and protein intake showed significant inadequacy in relation to the recommendations for the age. A caloric intake inferior to 30 kcal/kg was observed in 70.6% of patients and 82.3% presented protein intake less than 1.2 g/kg and PNA smaller than 1.2 g/kg in 100%.

Table 1. Demographic, socioeconomic and clinical data of non-elderly and elderly patients on hemodialysis. Median (Min-Max).

	Non-elderly n= 17	Elderly n= 17	p value ***
Age (years)	51 (20-59)	65 (60-83)	< 0,01
Income (MW)	2 (0-10)	2 (0-5)	0,16
Education (years)	5 (0-11)	3 (0-11)	0,04
Number of people at home	3 (1-6)	2 (1-6)	0,15
Dialysis Duration (years)	4,4 (0,7-8,4)	1,3 (0,3-8,1)	0,09
BMI (Kg/m ²)	22,6 (16,6-34,5)	24,3 (18,5-41,4)	0,11
Pre-dialysis Weight (Kg)	60,3 (41,0-114,1)	73,8 (59,0-111,5)	< 0,01
Post-dialysis Weight (Kg)	59,1 (40,0-106,9)	71,7 (56,2-108,1)	< 0,01
GPI%	2,4 (1,0-4,2)	3,0 (0,9-3,7)	0,59
Blood pressure levels (mmHg)			
Pre-dialysis			
SBP**	146 (113-173)	153 (117-180)	0,66
DBP**	87 (77-103)	87 (70-100)	0,82
Post-dialysis			
SBP**	136,6 (110-160)	153,3 (116-180)	0,12
DBP**	87 (77-100)	83 (67-153)	0,30
Urea (mg/dL)	41,0 (24,6-72,3)	9,6 (0,0-16,0)	0,20
Creatinine (mg/dL)	7,0 (0-14,0)	7,0 (0-14,0)	0,46

* Values are expressed as median, minimum and maximum.

** DBP: diastolic blood pressure, SBP: Systolic Blood Pressure.

*** Mann-Whitney Test, $p < 0,01$.

Table 2. Comparison of clinical and nutritional parameters between elderly and non-elderly patients on hemodialysis (n= 34).

Parameters	Criteria	Non-elderly %	N	Elderly	N	p value
Malnutrition	BMI<18,5 Kg/m ²	11,7	2	0,0	0	0,48
Obesity	BMI>30,0 Kg/m ²	11,7	2	23,5	4	0,65
Inadequate caloric intake	<30 ou 35Kcal/Kg	64,7	11	70,6	12	1,00
Protein intake						
Inadequate oral ingestion	<1,2g/Kg	58,8	10	82,3	14	0,26
Inadequate PNA	<1,2 g/Kg	94,1	16	100,0	17	1,00
Hipoalbuminemia	<3,8g/dL	52,9	9	35,3	6	0,33
Low Transferrin Saturation	<20%	29,4	5	29,4	5	1,00
Inadequate Dialysis	KTv<1,2	5,0	0	82,3	14	0,00

Fischer's Exact Test *According to the World Health Organization (WHO).

** PNA: Protein Equivalent of Total Nitrogen Appearance.

DISCUSSION

The present study had limitations, an evident constraint is the number of studied patients. The study design envisaged sufficient statistical power regarding clinical and nutritional changes, but difficulties to obtain a sample keeping the exclusion criteria may have left the study underpowered to confirm the differences. This should be borne in mind when interpreting the non-significant changes recorded in these parameters. The presence of infection and not understanding the items in the instrument used for the assessment of the nutritional intake were the main problems for the exclusion of the subjects in this study. In the present study, it was possible to observe the association of HD therapy with higher weight, higher SBP after the dialysis session and inadequate dialysis rate among elderly compared to non-elderly participants.

In Brazil, in 2013, the Census of the Brazilian Society of Nephrology reported that 62.6% of the population of HD patients was younger than 65 years⁶. The elderly population aged up to 80 years was 26.7%. Moreover, an increase in the prevalence of HD patients with advanced age was observed and 4.7% were older than 81⁶.

The number of patients on dialysis has been increasing worldwide. In developing countries, epidemiological data on the population of HD patients may present limitations related to difficulties in accessing the population who use the public health system for specialized services. In addition, in elderly patients, dialysis is often postponed due to clinical instability caused by multiple comorbidities³.

Family support is a factor that contributes to the management and improvement of CKD complications, of

hemodialysis and comorbidities, particularly in the elderly, especially in situations similar to the ones encountered in this study, in which the majority lived with their families and had low income and education¹⁴. Dietary intervention aims to control the complications of CKD, of uremic symptoms and electrolyte disturbances, but also operates in correlated diseases like hyperthyroidism, in protein-energy malnutrition and in the several metabolic changes that such patients present, in order to improve nutritional status¹⁴.

This study investigated exposure to nutritional and clinical factors associated with the increase of morbidity and mortality in elderly and non-elderly patients on HD. With regard to nutritional parameters, malnutrition prevailed in approximately 11.7% of the total sample. Obesity was present in 23.5% of the elderly patients, similar to the findings of Cabral et al.¹⁵ who found a prevalence of overweight of 18.9% and to the study of Silva et al.¹⁶ which showed that 29% patients who were undergoing HD treatment were overweight and 16% were obese. Obesity is another factor that is increasingly recognized as a cause of CKD, being independently associated with excess load and excretion. Progressive weight gain is accompanied by a period of hyperinsulinemia without hyperglycemia. Subsequently, insulin levels decrease and hyperglycemia becomes evident. In obesity, the first clinical evidence of renal disease is proteinuria, which can be investigated in obese patients¹⁷.

In this study, it was also observed that malnutrition was only found among non-elderly subjects. In addition, obesity prevailed in the same proportion as malnutrition in them, but was twice as prevalent in the elderly. The study by Oliveira et al.¹⁸ with 575 patients from Belo Horizonte

also found a significantly higher prevalence of malnutrition in elderly patients.

The time that the patient remains on dialysis is another factor that negatively influences weight and body composition¹⁵. Many risk factors are being studied for the occurrence of malnutrition in patients on HD. In this study, non-elderly patients presented more malnutrition than the elderly, a different finding from the one of Movilli et al.¹⁹ who observed a higher prevalence of malnutrition in elderly patients, mainly the ones older than 75 years. Contrasting with what was found in this population, many studies show a high prevalence of malnutrition in non-elderly participants. Morais et al.²⁰ found 61.4% of patients with mild malnutrition, 29.6% moderately malnourished and 2.3% severely malnourished. A finding similar to that of Calado et al.²¹ in which 61% of the studied population had malnutrition.

In the population studied, caloric intake below the recommended levels was found in 64.7% and 70.5% of the non-elderly and elderly patients, respectively, showing deficient consumption. However, among patients with KFRT receiving HD, there are several factors that may influence energy expenditure beyond the traditional determinants, such as hyperparathyroidism, hyperglycemia, chronic inflammation, infections, and other intercurrent illnesses that should be considered in the overall energy prescription¹⁰. Energy needs will vary depending on the health status of the patient. In the present study, the low rate of malnutrition in the elderly and non-elderly sample may indicate that their energy needs are met with lower levels of energy intake compared to overall recommendations¹⁰.

In general, the designated caloric intake for weight maintenance and neutral nitrogen balance in hemodialysis patients is 30 or 35 kcal/kg, and 30 kcal/day for those older than 60 because of a lower energy expenditure^{10,22}. A study evaluating the energy requirements in HD in a research center, with 4-hour sessions, three times a week²², found ingestion of different amounts of kilocalories (25.35 or 45 kcal/kg/day), with constant protein intake (1.13 g/kg/day). It was found that nitrogen balance was negative when the intake was 25 kcal/kg, but neutral or positive, if intake was between 35 and 45 kcal/kg²³.

In the sample, 58.8% of non-elderly and 82.3% of elderly participants presented protein intake <1.2 g/kg, which means that a negative nitrogen balance may occur. This is an important factor in determining the nutritional status of this population, since these patients require further recommendations for protein intake, due to the losses of amino acids, peptides and protein catabolism caused by the uremia³. PNA lower than 1.2 g/kg was found in 94.1% of non-elderly and in 100% of elderly subjects, which may also demonstrate inadequate caloric intake, leading to negative nitrogen balance²¹. On the other hand, the observed protein intake when analyzed together with energy intake, BMI, and albumin level may indicate an adequate support for this nutrient, in spite of being lower

than overall recommended levels for patients with KFRT receiving HD.

In addition to the catabolic factors inherent to CKD and to the dialysis methods, the presence of malnutrition is commonly associated with low food intake, especially energy intake¹⁴. Prevalence of protein-calorie malnutrition in dialysis patients is very high, with 23% to 76% in patients on HD²⁴. Peters et al.²⁵ correlated the duration of HD and patient BMI and observed that the lowest BMI scores are associated with longer HD (10.0±2.2 years), concluding that it can interfere energetically in patient nutritional state. Rebeca et al.²⁶ showed a direct association between obesity and family history of an end-stage renal disease among incident dialysis patients. The association was strongly connected with the most severe degrees of obesity and persisted after the adjustment for other characteristics of the patient, including history of SBP and diabetes mellitus (DM).

As for creatinine, in patients younger than 60 years average of serum levels were 7.0 and 9.6 in patients aged 60 or older. Serum creatinine values, when lower than expected for patients on dialysis (10 mg/dl), reflect a decrease in the muscle mass and/or a deficient protein intake, besides being associated with a higher mortality rate^{25,26,27}. However, the usefulness of this test is reduced by several factors such as kidney failure, liver function, use of medications like diuretics, the amount of protein in the diet, and metabolic stress¹⁰.

Serum albumin is another factor that can be used for nutritional assessment in CRF patients^{28,29}. A mean value of albumin <3.8 g/dL was present in 52.9% of non-elderly and 35.3% of elderly participants. In the study by Calado et al. it was found that a serum level below 4.0 g/dL in 67% of patients²⁰. Hypoalbuminemia has an important role in terms of dialysis patients' conditions because it is a strong factor independently associated with mortality (2,298). Studies show that the risk of death increases sharply when serum albumin levels decline to less than 4g/dL^{21,22}. Inadequate dialysis can cause changes in patient appetite, as it is associated with clinical manifestations related to uremia²⁵. In this study, 29.4% of non-elderly patients presented the value of Kt/V below the recommended value of 1.2, and in elderly patients, there was an even higher percentage, 82.3%. However, a major problem in the use of Kt/V is the improper collection of urea, pre and post-dialysis, which may lead to unreliable results²⁰.

In the present work, high risks of future complications in CKD were observed, because the pre-dialysis PAD, urea and creatine suffer major changes especially in the elderly. Caloric and protein intake also performed with greater disability in this group, due to a lower caloric intake and decreased protein intake when compared with the non-elderly. Moreover, an association between energy-protein intake in the diet of patients on HD was observed. We highlight the importance of controlling these nutrients in the diet together with adequate dialysis to avoid complications that may further aggravate the clinical condition of patients with renal disease^{29,30}.

Thus, this study emphasized the need for daily analysis of clinical and nutritional parameters in HD patients, and the control of factors that can interfere in the treatment and quality of life of these patients. Finally, we highlight the need for nutritional assistance geared to specific needs, for nutritional status maintenance and for preventing possible complications in HD patients.

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