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Protein intake and its influence on the lipid and anthropometric profiles of patients with chronic kidney disease

La ingesta de proteínas y su influencia en los perfiles lipídicos y antropométricos de pacientes con enfermedad renal crónica

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ABSTRACT

Introduction: Recent studies highlight Chronic Kidney Disease (CKD) as responsible for severe damage to clinical-nutritional status and for changes in the lipid profile of its patients, which, together, contribute to the increase in deaths and hospitalization time for these patients. Therefore, this study aimed to determine the protein intake and its association with the lipid and anthropometric profile of chronic renal patients. **Methods:** Data came from a cross-sectional survey conducted with 95 patients with CKD on dialysis treated at Renal Therapy Centers in the State of Piauí. Anthropometric variables were determined. Protein consumption was obtained by applying two 24hr dietary recalls. Lipid fractions were determined according to the calorimetric enzymatic method and specific calculations. Data were analyzed with Stata[®], v.12 software (Statacorp, College Station, Texas, USA), with significance level set at $p < 0.05$. The research received ethical approval, n° 2.527.329. **Results:** The final sample consisted of 95 patients, with a predominance of male participants (67.4%) and the average age of the total population was 40.8 ± 10.7 years. There was no association between protein consumption and anthropometric variables. However, there was a significant, but negative, correlation between protein intake and total cholesterol concentrations ($p = 0.017$) and LDL-c ($p = 0.025$). **Conclusion:** The mean protein intake identified, 1.30 ± 0.83 g/kg/day, despite meeting the recommendation for chronic renal patients did not appear to influence the anthropometric status, but had significant effects on specific lipid parameters of patients with CKD of this study.

Keywords: Anthropometry; Nutrients; Lipids; Renal Dialysis; Renal Insufficiency Chronic.

RESUMEN

Introducción: Estudios recientes destacan a la enfermedad renal crónica (ERC) como responsable del daño severo en el estado clínico-nutricional y de cambios en el perfil lipídico de sus pacientes, que, en conjunto, contribuyen al aumento del tiempo de hospitalización y mortalidad de estos pacientes. Por tanto, este estudio tuvo como objetivo determinar la ingesta proteica y su asociación con el perfil lipídico y antropométrico de pacientes renales crónicos. **Métodos:** Se analizaron los datos de la encuesta transversal realizada a 95 pacientes con ERC en diálisis tratados en Centros de Terapia Renal del Estado de Piauí. Se determinaron variables antropométricas. El consumo de proteínas se obtuvo aplicando dos encuestas de alimentación 24HR. Las fracciones lipídicas se determinaron según el método enzimático calorimétrico y cálculos específicos. Los datos se analizaron en Software Stata 12, y se adoptaron como nivel de significancia $p < 0.05$. La investigación recibió la aprobación ética, bajo la opinión del número 2.527.329. **Resultados:** La muestra final estuvo conformada por 95 pacientes, con predominio de varones (67,4%) y la edad promedio de la población total fue de $40,8 \pm 10,7$ años. No hubo asociación entre el consumo de proteínas y las variables antropométricas de los pacientes. Sin embargo, hubo una correlación significativa, pero negativa, entre la ingesta de proteínas y las concentraciones de CT ($p = 0.017$) y LDL-c ($p = 0.025$). **Conclusión:** Se concluyó que la ingesta media de proteínas identificada, $1,30 \pm 0,83$ g/kg/día, a pesar de cumplir con la recomendación para pacientes renales crónicos, no pareció influir en el estado antropométrico, pero tuvo efectos significativos sobre parámetros lipídicos específicos de pacientes con ERC de este estudio.

Keywords: Antropometría; Diálisis renal; Insuficiencia Renal Crónica; Nutrientes; Lípidos.

INTRODUCTION

Chronic kidney disease (CKD) is still a serious global public health problem, and currently ranks 12th among the leading causes of death in the world¹. In Brazil, according to the Latin American Society of Nephrology and Hypertension (LASNH), the prevalence of CKD was above the established target of 700 pmp (per million of the population) from 2017 to 2019, with values close to 1000/pmp in the Southeast and South regions, and average values higher than 157 pmp for CKD cases in the Brazilian Northeast^{2,3}.

By definition, kidney disease is characterized by the presence of kidney damage that implies impaired renal function for three months or more and is sometimes irreversible. The classic repercussions include the decrease of glomerular filtration rate, hydroelectrolytic imbalance, alterations in metabolic processes, and hormonal disorders⁴.

The disease etiology is heterogeneous, with a greater or lesser prevalence of combined (modifiable) and non-modifiable environmental factors. Among the modifiable risk factors are the Western diet patterns, which is characterized by a high consumption of saturated fat and a low consumption of fruits and vegetables, obesity, physical inactivity and smoking. Non-modifiable characteristics, on the other hand, include older age, male sex, ethnicity and genetics^{5,6}.

The various metabolic events observed due to CKD and its complications have a negative impact on the clinical and general status of patients with the disease. CKD is associated with elevation in levels of inflammatory markers: Interleukin-6 (IL-6), Tumor Necrosis Factor Alpha (TNF- α) and Protein-C-Reactive (PCR). It is also related to insulin resistance, inhibition of protein synthesis and even changes in the release of ghrelin and leptin, appetite regulators. All of these dysfunctions favor muscle loss, increased protein catabolism, decreased protein synthesis, which in turn compromises the maintenance of a neutral or slightly positive nitrogen balance, and good nutritional status^{7,8}.

Currently, studies addressing deregulation in protein

metabolism demonstrate, in detail, that CKD is associated with an increase in lipid profile changes, corresponding to increased triglyceride levels, reduction of High Density Lipoprotein (HDL-c) and accumulation of Low Density Lipoprotein (LDL-c), which contribute jointly to the occurrence of Cardiovascular Diseases (CVD), the main cause of death and hospitalization in patients with CKD^{9,10}.

Among the nutritional interventions proposed for the treatment of patients with CKD, the hypoproteic diet in the pre-dialysis phase is effective, considering that a high protein load can cause damage to the glomerular structure and aggravate the pathological condition. Nevertheless, there is controversy as to the renoprotective effect and possible repercussions on the nutritional state^{11,12}, which demonstrates that the quality and quantity of dietary protein seem to have repercussions both on lipid levels and on the anthropometric parameters of these patients¹³.

Patients undergoing dialysis treatment, in turn, tend to present high energy-protein waste due to increased protein degradation associated with decreased series synthesis. In addition, disorders such as inflammation, metabolic acidosis, and resistance to anabolic activity of hormones such as insulin or growth hormone are conditions also generated by hemodialysis that intensify the risk of systemic disorders and nutritional status¹⁴. Thus, at this stage of treatment the protein quota should be increased in order to avoid losses, and should be between 1.2-1.4 grams per kilogram of body weight per day, with more than 50% of this composed of proteins of high biological value¹⁵.

Based on the above, this study aimed to investigate protein intake and its association with the lipid and anthropometric profile of patients with CKD on hemodialysis.

METHODS

Study Protocol and Research Subjects

This multicenter, cross-sectional and quantitative study followed the Guidelines of the Declaration of Helsinki and

Resolution N° 466/2012 of the National Health Council, and received ethical approval under the opinion n° 2.527.329, issued by the Ethics and Research Committee of the Federal University of Piauí (CEP-UFPI).

This is a section of the data from the project entitled “Cardiovascular Risk and its Association with Metabolic Syndrome in Patients with Chronic Kidney Disease in Hemodialysis Therapy”, linked to the Graduate Program in Food and Nutrition of the Federal University of Piauí-PPGAN/UFPI.

This research was conducted with 95 patients diagnosed with CKD, determined by the occurrence of impaired renal function for three months or more, who underwent dialysis therapy. Participants were recruited from three health centers: Hospital Getúlio Vargas (HGV), Nefrocenter and Nephrological Clinic of Piauí, which serve, on average, 48.3% of patients with the disease in the state of Piauí, and are located in the capital. The sample size was calculated considering a 95% confidence interval and relative error of 5%, which resulted in a sample of 112 patients, and finally, 10% was added for possible losses. However, after evaluating the proposed eligibility criteria, inappropriate participants were removed, leaving 95 participants.

The dependent variable of the study was protein intake in the diet, and the independent variables were: lipid profile and anthropometric profile. The patients were identified through the form number, in which they contained spaces intended to compile data such as: age, marital status, level of formal education, profession and/or occupation, monthly family income, lifestyle habits including: smoking, alcohol consumption and physical activity.

Eligibility Criteria

The eligibility criteria were: a) Age over 18 years and under 60 years, without distinction of sex and race; b) Absence of recent infections (less than three months ago); c) Preserved cognitive ability; d) Absence of diagnoses of Cancer, Tuberculosis, Acquired Immunodeficiency Syndrome, Chronic Obstructive Pulmonary Disease, Severe Cardiovascular Disease, Cerebrovascular Disease and Symptomatic Heart Failure (SHF); e) Absence of pathological conditions or conditions that would prevent anthropometric evaluation, such as: Advanced Bone Diseases, Sequelae of Stroke, Physical Disabilities or Amputations. Pregnant and lactating participants were considered ineligible for the study.

Clinical and Anthropometric Characterization of Nutritional Status

For anthropometric evaluation, weight and height were measured to calculate Body Mass Index (BMI). Dry weight, that is, that measured after the hemodialysis session, was measured on a digital scale (Camry®, model EB9013), with a maximum capacity of 150 kg, graduated in 100 grams, with the participants standing barefoot. Height was measured with an anthropometer (Welmy®, model R-110), graduated in centimeters and with a fixed vertical bar for positioning

on the head. Participants were measured standing, barefoot, with arms extended by their sides, feet together, head up and looking at a fixed point at eye level.

The values of weight (kg) and height (m) were applied in the formula to obtain BMI (kg/m^2), which was classified according to cutoff points proposed by the World Health Organization¹⁶.

Waist circumference (WC) was measured using a flexible, non-extensible measuring tape with an accuracy of 0.1 centimeters, surrounding the natural line of the waist, in the narrowest region between the thorax and hip, at the midpoint between the last rib and the iliac crest. Participants assumed an upright position, with a relaxed abdomen, arms extended along the body and parallel legs slightly apart¹⁷. The reference values for WC that predict Cardiovascular Risk (CVR) were adopted according to the WHO¹⁸. Then, the Hip circumference (HC) was measured, which was evaluated around the hip, in the maximum extension of the buttocks. WC and HC values made it possible to obtain the Waist-hip ratio (WHR) value.

For the classification of CVR, the cutoff points suggested by Lean et al.¹⁹ and Pereira et al.²⁰ for WC and WHR, respectively, were used. Subjects were classified with elevated CVR when: WC ≥ 94 cm for men and ≥ 80 cm for women; WHR ≥ 0.95 for males and ≥ 0.80 for females.

To measure neck circumference (NC), an inelastic measuring tape was placed at the height of the cricoid cartilage. In men with prominence, NC was measured below it. They were classified as having high CVR when NC ≥ 37 cm for men and ≥ 34 cm for women, according to a study by BenNoun and Laor²¹.

Lipid Profile Determination

The concentrations of total cholesterol (TC), HDL-c and triglyceride (TG) were determined according to the calorimetric enzymatic method. The LDL-c fraction was calculated according to the formula of Friedwald et al.²²: $\text{LDL-c} = \text{CT} - \text{HDL-c} - \text{TG}/5$, valid for TG values below 400mg/dL. The cutoff values used as a reference for serum lipids were the Update of the Brazilian Guidelines on Dyslipidemia and Prevention of Atherosclerosis²³.

Food Consumption Assessment

Food intake was evaluated according to the 24-Hour Recall Technique (24HR). Two 24HR were performed; the first applied to all study participants and the second with 40% of the randomly selected population^{24,25}. The performance of the second, 60 days after the first, is justified by the need to correct the data by the intrapersonal variability of food consumption using statistical methods. The choice of reapplication rate was based on the study by Verly-Jr et al.²⁵. The 24HR was applied according to the five steps of the Multiple Pass Method²⁶.

Portion sizes were standardized using conventional homemade measures of the mentioned foods²⁷. The conversion of the amount of food in a homemade measure to weight

(gram) or volume (milliliter) was made based on the tables by Bombem et al.²⁸ and Moreira²⁹, in this sequence, for further analysis of energy and nutrient.

Dietary Data Analysis

The intake of energy and macronutrients was calculated with the Dietbox Software® and the results were adjusted by intrapersonal and interpersonal variability, corrected by statistical modeling techniques incorporated in the online platform Multiple Source Method - MSM (version 1.0.1). The assessment of the usual amount of food consumed was after 24HR, after which a simple regression was made, considering the predictive covariates (sex and age) for food intake. Subsequently, the usual daily intake of nutrients per participant was estimated, based on the multiplication between the probability of consumption and the usual amount of intake^{30,31}.

The adequacy of the percentage of macronutrients in relation to Total Energy Value (TEV) was based on the Acceptable Macronutrient Distribution Intervals (AMDR), which considers acceptable, for adult individuals (>18 years), the following values: 45–65% of carbohydrates; 10–35% of proteins and 20–35% for lipids. The recommended protein quota is 1.2 to 1.4 g/kg/day.

Statistical analysis

Statistical analyses were conducted in the Statistical Package for the Social Sciences (SPSS) version 20.0. The variables were evaluated by the Shapiro-Wilk test to verify adherence to the normal distribution. Continuous variables were presented in the form of mean and standard deviation. To verify the differences in means of numerical variables, the Student's t-test was used for the parametric variables and the Mann-Whitney test for the nonparametric variables. The correlation between dietary protein intake

and lipid profile and anthropometric data was investigated through Spearman correlation. The significance level was set at $p < 0.05$.

RESULTS

A total of 114 patients were selected, 19 of whom did not meet the proposed eligibility criteria, leaving 95 participants. More than half of the sample consisted of males (66.3%), and the mean age was 40.8 ± 10.7 years.

The means and standard deviations of anthropometric parameters were compiled in table 1. A statistical difference was observed between all variables ($p < 0.05$), with the exception of HC. In addition, the mean values of weight, height, BMI, WC, NC, WHR were statistically higher in males ($p < 0.001$).

Table 2 below shows the anthropometric variables that evaluated nutritional status and cardiovascular risk in the sample. According to BMI, more than half (57.9%) of the total number of participants was eutrophic. However, it was found that males presented a higher percentage of overweight (25.4%), in relation to females. In addition, it was observed that 20.6% and 25.0% of male and female patients, in this order, presented high risk for CVD, according to WC.

Table 3 compiles the values obtained from the lipid fractions determined in the study. It was verified that the mean values of TG, TC, LDL-c were within the desirable ranges. In particular, TC and LDL-c were statistically higher in females ($p = 0.014$).

Table 4 presents the quantitative characterization of the overall diet of patients. The usual food intake pointed to a high probability of inadequate energy and macronutrients, with emphasis on the lipid intake that was high, considering the recommended values for this population.

Table 1. Dispersion measures of anthropometric variables in patients with CKD on hemodialysis, according to sex. Teresina, 2020.

Parameters	Sex			p
	Total (n= 95) Mean±SD	Female (n= 32) Mean±SD	Male (n= 63) Mean±SD	
Weight (kg)	63.03±14.6	54.98±11.4	67.12±14.4	<0.001*
Height (m)	1.63±0.09	1.56±0.06	1.66±0.09	<0.001*
BMI (kg/m ²)	23.57±4.4	22.27±3.9	24.23±4.5	0.040
WC (cm)	86.05±13.9	78.34±12.7	89.96±12.9	<0.001*
NC (cm)	36.16±4.1	33.18±3.4	37.68±3.6	<0.001*
HC (cm)	93.73±8.4	91.79±9.8	94.71±7.5	0.111
WHR (cm)	0.912±0.09	0.849±0.08	0.944±0.08	<0.001*

SD (Standard Deviation); BMI (Body Mass Index); WC (Waist Circumference); NC (Neck Circumference); HC (Hip Circumference); WHR (Waist-To-Hip Ratio). Student t test with significant association ($p < 0.05$). Source: Research Data.

Table 2. Classification of nutritional status and cardiovascular risk according to the body mass index and waist circumference of the participants. Teresina, 2020.

Classification	Total Frequency	%	Sex			
			Male		Female	
			Frequency	%	Frequency	%
BMI						
Grade 3 Thinness	0	0	0	0	0	0
Grade 2 Thinness	4	4.2	1	1.6	3	9.4
Grade 1 Thinness	6	6.3	3	4.8	3	9.4
Eutrophy	55	57.9	36	57.1	19	59.4
Pre-Obesity	22	23.2	16	25.4	6	18.8
Grade 1 Obesity	6	6.3	5	7.9	1	3.1
Grade 2 Obesity	2	2.1	2	3.2	0	0
Grade 3 Obesity	0	0	0	0	0	0
WC						
Suitable	57	60	39	61.9	18	56.3
High Risk	21	22.1	13	20.6	8	25
Very High Risk	17	17.9	11	17.5	6	18.7

BMI (Body Mass Index); WC (Waist Circumference)¹⁸. Source: Research Data.

Table 3. Means and standard deviations of the lipid fractions of chronic kidney patients allocated according to sex. Teresina, 2020.

Parameters	Total (n= 95) Mean±SD	Sex		p
		Female (n= 32)	Male (n= 63)	
		Mean±SD	Mean±SD	
TC (mg/dL)	136±36	149±41	129±33	0.014
LDL-c (mg/dL)	80.7±36.2	90.7±39.9	75.6±33.3	0.055
HDL-c (mg/dL)	34.4±8.7	35.2±8.6	33.9±8.8	0.485
TG (mg/Dl)	148±92	161±104	141±85	0.321

Reference values: CT<190; LDL-c:<130 for down risk; <100 for intermediated risk; <70 for high risk; <50 for very high risk; HDL-c>40; TG<150 (WHO, 2000). SD (Standard Deviation); TC (Total Cholesterol); LDL (Low Density Lipoprotein); HDL (High Density Lipoprotein); TG (Triglycerides). Student t test with significant association (p <0.05). Source: Research Data.

Table 4. Estimated food intake of patients with CKD undergoing hemodialysis. Teresina, 2020.

Parameters	Total (n= 95)		
	Mean±SD	Kcal	%
Total Caloric Value (Kcal/kg/dia)	25.15±10.18	1585.4	100
Carbohydrate (g/kg/dia)	2.91±1.23	735.2	46.4
Lipids (g/kg/dia)	0.902±0.41	513.9	32.5
Protein (g/kg/dia)	1.30±0.83	329.6	20.9

SD (Standard Deviation). Source: Research Data.

Table 5 shows the simple linear correlation between dietary proteins and anthropometric parameters. The results show the absence of correlations between protein intake and anthropometric variables.

Table 5. Correlation between protein intake and anthropometric parameters of patients with CKD. Teresina, 2020.

Variables	Proteins (g)	
	R	P
BMI	0.087	0.404
Waist Circumference (cm)	0.055	0.597
Neck Circumference (cm)	0.150	0.147
Hip Circumference (cm)	0.130	0.210
Waist-To-Hip Ratio	-0.023	0.823

*Significant Spearman correlation ($p < 0.05$). BMI (Body Mass Index). Source: Research Data.

DISCUSSION

This study explored the association between dietary protein intake of patients with CKD on hemodialysis and lipid fractions, without significant influences on the anthropometric profile. At first, considering the functional and progressive complications generated by the characteristic picture of CKD, the finding on the nutritional status of the patients was expected, which reflects nutritional imbalances and metabolic dysregulations.

In this study, 31.6% of the patients were overweight, similar to the studies by Bousquet-Santos, et al.³², Koehnlein, et al.³³, and Bernardo et al.³⁴ which were overweight in approximately 40% of their samples. Although it was not the prevalent classification, it is worth mentioning because physiological damage and the adoption of inadequate habits contributed to negative health impacts.

Obesity generates conditions that favor the impairment of renal function. Insulin resistance, for example, is the cause of diabetic nephropathy, while hypertensive nephrosclerosis and focal and segmental glomerulosclerosis may result from hypertension conditioned by obesity, because in turn it leads to increased renal tubular sodium resorption, impairing pressure natriuresis and resulting in volume expansion due to activation of the sympathetic nervous system, especially in the presence of visceral obesity, by promoting renal compression³⁶.

In particular, the adoption of a Western Diet, characterized by a high consumption of ultra-processed foods, rich in saturated fat with high caloric density, may be a determining aspect for overweight in the population of this study^{37,38}.

Moreover, the controversy related to BMI as an

Table 6 shows the simple linear correlation between protein intake and lipid profile of participants. It was observed that there was a negative correlation ($p < 0.05$) between protein consumption and the values of TC and LDL-c.

Table 6. Correlation between protein intake and lipid profile of patients. Teresina, 2020.

Variables	Proteins (g)	
	R	p
TC (mg/dL)	-0.244	0.017*
LDL-c (mg/dL)	-0.230	0.025*
HDL-c (mg/dL)	0.002	0.988
TG (mg/DL)	-0.039	0.713

*Significant Correlation ($p < 0.05$). TC (Total Cholesterol); LDL (Low Density Lipoprotein); HDL (High Density Lipoprotein); TG (Triglycerides). Source: Research Data.

independent risk factor for CKD deserves to be considered, because some literature has shown that high values of this index may be associated with favorable outcomes^{33,34,35,38}. The study by Evans et al.³⁹, for example, showed that BMI greater than 30 kg/m² reduced the risk of mortality in 920 patients with advanced CKD.

It is emphasized that because it is a parameter of low sensitivity and, therefore, nonspecific with regard to the distribution of body fat, BMI should be evaluated in association with other more specific variables⁴⁰. In this study, we considered the measurement of WC, NC, and calculation of WHR, whose mean values were statistically higher in males ($p < 0.05$). Of these, only NC was higher than the reference values, which pointed to the accumulation of abdominal fat, and signaled a greater susceptibility to cardiometabolic events in these patients. Similarly, Yoon et al.⁴¹ showed mean values of 36.3 ± 3.0 and 32.4 ± 0.9 , for males and females, respectively, reported as increased in patients with CKD.

In relation to WC and WHR, in the present study, mean values were not significantly related to cardiometabolic risk, which is consistent with the results of a study by Macek et al.³⁸, which also showed these variables within normal limits.

Nevertheless, it is mentioned that WC pointed to the existence of high and very high risk for CVD, in discrete percentages of the sample (22.1% and 17.9%, respectively), but that they identified a certain degree of exposure to atherosclerotic events in both sexes. This parameter, in turn, also evaluates the adiposity of individuals, which is a predictor of metabolic complications related to lipid profile, development of dyslipidemias and occurrence of CVD⁴².

Other metabolic complications may be associated with high WC values, as observed in the study by Sanches et al.⁴³ who found mean sums of the desired levels for this parameter among chronic renal patients, which were associated with hypertriglyceridemia and inflammation in this population.

In the present study, most of the lipid fractions evaluated were within the normal range, especially for the concentrations of TC and LDL-c that were statistically higher in females. In agreement, the results of Da Silva et al.⁴⁴, Fontes et al.⁴⁵, Rizzetto et al.⁴⁶ showed similar values when evaluating the lipid profile of renal dialysis patients.

Regarding habitual food intake, inadequacies were identified in terms of energy and carbohydrate consumption. The average caloric value found of 25 kcal/day classified the caloric intake of the participants as hypocaloric, which reveals a negative aspect for weight maintenance and prevention of energy-protein malnutrition⁴⁷. According to the European Society of Clinical Nutrition and Metabolism (ESPEN) energy intake should be 35 kcal per kilogram of body weight per day during dialysis treatment, given the hypercatabolic condition promoted by the same⁴⁴.

Current studies mention that caloric intake from norm to hypercaloric can support weight maintenance strategies and prevent or correct any protein-energy malnutrition conditions, sometimes seen in renal patients undergoing prolonged dialysis^{38,48,49}. In addition, it is worth mentioning that other factors, such as uremic symptoms, drug interactions, associated comorbidities, as well as endocrine-metabolic changes, catabolism and significant loss of nutrients by dialysis treatment, aggravate malnutrition.

Regarding protein intake, mean weight of the population was 63.0 kg and average protein intake was 1.3 g/kg/day, which is equivalent to a contribution of 20.9% in the total caloric value, which signifies hyperprotein intake among study participants. These findings are similar to those of Machado et al.⁵⁰, which through an observational survey conducted in the state of São Paulo identified energy consumption of 25 Kcal/kg/day and 1.1 g/kg/day of protein. In this study, 90.01% of the participants had high protein intake and 66.1% consumed energy below the recommended level.

In contrast, the cross-sectional study by Vaz et al.⁵¹, conducted with 118 patients with CKD undergoing dialysis treatment treated in the city of Goiânia, showed percentages of macronutrient contributions of 55% carbohydrates, 30% lipids and 15% proteins, with intake of 1.18 g/kg/day, and 31.20 Kcal/kg/day, expressing adequacy, since the expected values for patients at this stage of treatment is that caloric and protein intake be increased.

Within this context, it is worth mentioning that dialysis treatment of these patients can cause representative damage to the pool of proteins and amino acids, imposing the need for increased protein intake. In this sense, it is believed that observing adequate values reflects that the sample was assisted and nutritionally oriented.

It is worth noting that difficulties are observed regarding adherence to nutritional recommendations in the face of

impaired renal function, attributed not only to appetite alteration and taste acuity, which induce a reduction in food intake, but also to the eating habits of the Brazilian population themselves^{50,52}.

In healthy people, increased protein intake can contribute to metabolic control, reduced liver fat without risk of metabolic decompensation and to the preservation of lean body mass. Protein confers satiety, promotes the body's energy expenditure or calorie burning, and helps change body composition in favor of lower body mass. It is important to consider that, in patients with CKD on hemodialysis, dietary proteins have the main objective of resuming losses through the dialysis process and minimizing the effects of common protein catabolism in this pathology, therefore, the fact that there was no correlation between dietary protein and anthropometric parameters in this study is supported in the environment of metabolic dysregulation of the pathological condition.

Regarding the influence of protein intake on the lipid profile, as shown in table 6, there was a slight negative correlation, but was significant between TC, LDL-c and protein intake. These findings indicate that patients with CKD with higher protein intake had lower values of TC and LDL-c. A study by Fontes et al.⁴⁵ among CKD patients conducted an intervention consisting of changing the usual hyperprotein diet (1.4g/kg) to a hypoprotein diet (0.8 g/kg) for a period of 6 months. After this period, the authors found a significant reduction in the values of TC and LDL-c in 12% and 16%, respectively, so protein intake showed a significant positive association ($p < 0.05$) with these variables. This was observed in a similar study conducted by Noce et al.⁵³ in which the authors observed statistically significant reductions in TC and LDL-c for participants who consumed a hypoprotein diets.

Cross-sectional studies involving patients with hemodialysis CKD found diets with high protein load was associated with BMI values classified as eutrophic. Also with chronic renal patients on dialysis, Alcântara et al.⁵⁴ evaluated food intake and found no statistical association between diet proteins and BMI, as well as for the other anthropometric parameters evaluated. In the same study, the average protein intake was 16% of the TEV (54.9±24.9 g).

Dietary protein sources have a direct influence on lipid profile and body composition. Studies show that diets with reduced intake in foods of animal origin and rich in protein sources of plant origin, such as legumes, fruits and whole grains, promote the reduction of LDL-c, total cholesterol and lipids, and elevation of HDL-c^{55,56}.

In CKD patients, plant-based diets may be beneficial considering total protein intake, since a higher proportion from plant sources is associated with lower mortality among CKD patients, which is largely due to the reduction in levels of atherogenic lipoproteins and TC^{57,58}. A cross-sectional study by Liu et al.⁵⁹ compared the diet of patients with strict or non-vegetarian CKD (consuming eggs or milk) and omnivores. The authors noted that omnivores had a

significantly higher prevalence of abdominal obesity, in addition to significantly higher levels of TC and TG.

Although all participants of the present study were characterized as omnivores, that is, they did not present restrictions regarding the consumption of foods of animal origin, with the most endorsed protein sources being: chicken, beef, pork and egg. Participants also reported a low consumption of milk powder, together with coffee and insufficient consumption of fruits and vegetables compared to recommendations^{5,60}. A negative correlation was observed between dietary protein with TC and LDL-c. This finding can be explained by the important consumption of plant protein sources and by the contribution of other macronutrients in the diet, carbohydrates and lipids, which in turn exert influence on both anthropometric and lipid parameters.

In an experimental study conducted by Laurentius et al.⁶¹, the effect of a high-fat diet on the lipid profile and renal function of mice was evaluated, the results of which showed significant differences between the groups for LDL-c and triglycerides ($p < 0.05$), with an increase of 16% and 41%, respectively, for the group with a high-fat diet, in addition to a non-significant increase in TC for the same group. These findings allow us to infer that the high lipid intake found among the participants of the present study, with a contribution of 32.5% of TEV may have influenced weight, body composition and lipid parameters evaluated, with emphasis on TC and LDL-c.

It is important to consider that several factors may contribute to variations in the profile of food consumption of different populations, even if under similar clinical conditions, such as cultural characteristics, socioeconomic status, educational level, specialized professional association, as well as the adhering to the prescribed recommendations⁴⁴. Socioeconomic status is an impediment for patients with CKD to comply with the nutritional guidelines provided for nutritional treatment. Purchasing power is associated with a reduction in the acquisition of healthier foods such as fruits and vegetables, which tend to be more expensive than highly processed foods.

It was also observed the consumption of ultra-processed foods among some patients, such as soft drinks, sausages and stuffed cookies. These foods are high in sugar, saturated fat and trans-fat and all these food components are associated with increases in serum levels of total cholesterol and LDL-c, as well as promote the reduction of HDL-c⁶². It is known that the high consumption of foods rich in simple carbohydrates promotes lipogenesis, forming triglycerides that deposit in adipose tissue as well as promote the elevation of TG⁶³. Trans fatty acids promote the increase of plasma LDL-c concentration through mechanisms that reduce plasma concentrations of HDL-c, which, in turn, acts in reverse transport of cholesterol in order to be metabolized and its concentrations to be decreased⁶⁴. Through this information we can assume that the lack of correlation between the protein and anthropometric profile and the negative correlation with the lipid profile may be due to the eating habits adopted

by the participants of the present study.

Some limitations were observed. Because it is a cross-sectional study, it was not possible to establish a causal relationship, but we provide evidence by associations between the variables studied. In addition, the absence of data on markers that confirm the conditions of influence of protein intake on the metabolic profile as well as statistical data on the food profile, make it impossible to deepen further understanding of the investigated relationships. The determination of habitual consumption using 24 hr dietary recall, despite being a practical and low-cost method, is subject to patients' memory, which may result in underestimation of foods and amounts mentioned.

Final Considerations

We conclude that the results found in this study reinforce the importance of implementing frequent nutritional follow-up to patients with CKD, since dietary protein can generate repercussions on the lipid profile of patients with CKD, although without effects on anthropometric parameters.

In addition, the negative correlation between dietary proteins and parameters of the lipid profile (i.e., TC and LDL-c) suggests the indispensability of the intake of plant proteins in the diets of participants, without deserving the influence of other macronutrients components. In this, it is observed the establishment of dietary treatment as essential and decisive for the control of disease advancement.

Finally, it is important to carry out further studies to assess the influence of protein intake on lipid and anthropometric profiles in different populations of CKD patients, assessed according to the time of hemodialysis and from the perspective of interventions.

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