Revista Brasileira em Promoção da Saúde
e-ISSN:1806-1230
Original Article
DOI: 10.5020/18061230.2021.11271

Analysis of factors associated with nutritional risk of patients on hemodialysis

Análise dos fatores associados ao risco nutricional de pacientes em hemodiálise

Análisis de los factores asociados con el riesgo nutricional de pacientes de hemodiálisis

Jéssica Almeida Leite
Federal University of Mato Grosso (*Universidade Federal de Mato Grosso*) - Cuiabá (MT) - Brazil

Priscila de Oliveira Sousa
Federal University of Mato Grosso (*Universidade Federal de Mato Grosso*) - Cuiabá (MT) - Brazil

Michelle Yasmine Borges
Federal University of Mato Grosso (*Universidade Federal de Mato Grosso*) - Cuiabá (MT) - Brazil

Paulo Rogério Melo Rodrigues
Federal University of Mato Grosso (*Universidade Federal de Mato Grosso*) - Cuiabá (MT) - Brazil

Bruna Teles Soares Beserra
Federal University of Mato Grosso (*Universidade Federal de Mato Grosso*) - Cuiabá (MT) - Brazil

Gabriela Dalcin Durante
Federal University of Mato Grosso (*Universidade Federal de Mato Grosso*) - Cuiabá (MT) - Brazil

ABSTRACT

Objective: To analyze the frequency and factors associated with nutritional risk (NR) in patients with Chronic Kidney Disease (CKD) undergoing hemodialysis. **Methods:** An analytical cross-sectional study was carried out with 110 individuals aged ≥ 20 years undergoing hemodialysis in two clinics in Cuiabá, Mato Grosso, Brazil, from June to October 2018. Data were collected through interviews, measurements, and consultation on medical records. Associations between the outcome score on the Malnutrition Inflammation Score (MIS) and socioeconomic, demographic and clinical variables and health-related risk behaviors and nutritional status (NS) were assessed. Bivariate analysis was performed using Pearson's chi-squared test and crude and adjusted binary logistic regression were performed considering significant p≤0.05. **Results:** There was a high percentage of individuals with high NR (n=73; 66.36%), with higher rates among patients with dialysis duration ≥ 4 years, 24-hour urine volume < 500 ml, hyperkalemia, hyperphosphatemia, smokers, those with increased waist circumference, low calf circumference and who did not practice physical exercises. In the adjusted multiple analysis, longer dialysis duration (p=0.02) and physical inactivity (p=0.04) remained associated with high NR. **Conclusion:** There was a high frequency of patients with high NR, with sedentary patients and those with longer hemodialysis treatment being at a higher risk. There is a need for these patients to be observed more carefully by health professionals working in hemodialysis clinics in order to promote better quality of life and prevent potential complications and changes in nutritional status.

Descriptors: Renal Insufficiency, Chronic; Renal Dialysis; Nutritional Status.

RESUMO

Objetivo: *Analisar a frequência e os fatores associados ao risco nutricional (RN) de pacientes com doença renal crônica (DRC) submetidos à hemodiálise.* ***Métodos:*** *Estudo de corte transversal, analítico, realizado com 110 indivíduos com idade ≥ 20 anos, em tratamento hemodialítico em duas clínicas de Cuiabá, Mato Grosso, Brasil, no período de junho a outubro de 2018. Os dados foram coletados por meio de entrevista, aferições e consulta ao prontuário clínico. Avaliou-se a associação entre o desfecho pontuação do Malnutrition Inflammation Score (MIS) e as variáveis socioeconômicas, demográficas, clínicas, de comportamentos de risco relacionados à saúde e de estado nutricional. Realizou-se análise bivariada pelo teste de qui-quadrado de Pearson e regressão logística binária bruta e ajustada, considerando significativo p≤0,05.* ***Resultados:*** *Foi observada elevada frequência de indivíduos com alto RN (n=73; 66,36%), sendo maior entre os pacientes com tempo de diálise ≥ 4 anos, volume de urina/24h <500ml, hiperpotassemia, hiperfosfatemia, fumantes, com elevada circunferência da cintura, baixa circunferência da panturrilha*

Received on: *07/06/2020*
Accepted on: *03/04/2021*

e que não praticavam exercício físico. Na análise múltipla ajustada permaneceram associados ao alto RN o maior tempo de diálise (p=0,02) e o sedentarismo (p=0,04). ***Conclusão:*** *Observou-se elevada frequência de pacientes com alto RN, sendo que pacientes sedentários e com mais tempo de tratamento hemodialítico compuseram grupo em maior risco. Destaca-se a necessidade desses pacientes serem observados mais atentamente pelos profissionais de saúde que atuam nas clínicas de hemodiálise, a fim de promover melhor qualidade de vida e prevenir potenciais complicações e alterações do estado nutricional.*

Descritores: *Insuficiência Renal Crônica; Diálise Renal; Estado Nutricional.*

RESUMEN

Objetivo: *Analizar la frecuencia y los factores asociados con el riesgo nutricional (RN) de pacientes con enfermedad renal crónica (ERC) sometidos a hemodiálisis.* **Métodos:** *Estudio de corte transversal y analítico realizado con 110 individuos de edad ≥ 20 años, en tratamiento de hemodiálisis en dos clínicas de Cuiabá, Mato Grosso, Brasil, en el periodo entre junio y octubre de 2018. Se ha recogido los datos a través de entrevista, mediciones y consulta al historial clínico. Se evaluó la asociación entre el resultado de puntuación del Malnutrition Inflammation Score (MIS) y las variables socioeconómicas, demográficas, clínicas, de conductas de riesgo relacionadas con la salud y del estado nutricional. Se realizó un análisis bivariado con la prueba de chi-cuadrado de Pearson y la regresión logística binaria bruta y ajustada considerando significativo p≤0,05.* **Resultados:** *Se observó elevada frecuencia de individuos con alto RN (n=73; 66,36%) que ha sido mayor entre los pacientes con el tiempo de diálisis ≥4 años, el volumen de orina/24h <500ml, con hiperpotasemia y hiperfosfatemia, fumadores, con elevada circunferencia de la cintura, baja circunferencia de los gemelos y que no practicaban ejercicio físico. Más tiempo de diálisis (p=0,02) y el sedentarismo (p=0,04) se han asociado con el alto RN por el análisis múltiple ajustado.* **Conclusión:** *Se observó elevada frecuencia de pacientes con alto RN y los pacientes sedentarios y con más tiempo de tratamiento de hemodiálisis han estado en el grupo de más riesgo. Se destaca la necesidad de los profesionales sanitarios que trabajan en las clínicas de hemodiálisis de observar a los pacientes más atentamente con el objetivo de promocionar mejor calidad de vida y la prevención de potenciales complicaciones y alteraciones del estado nutricional.*

Descriptores: *Insuficiencia Renal Crónica; Diálisis Renal; Estado Nutricional.*

INTRODUCTION

The global epidemiological profile has undergone changes resulting from the combination of the reduction in the total number of deaths from infectious diseases and the increase in the occurrence of mortality from non-communicable diseases (NCDs)[1]. Among NCDs, chronic kidney disease (CKD) has a great epidemiological impact and is considered a public health problem[2]. In 2019, CKD stood out among the top ten causes of disability-adjusted life years (DALY) in older age groups[2].

The incidence and prevalence of CKD requiring renal replacement therapy (RRT) has increased significantly over the years[2]. According to data from the Brazilian Dialysis Census[3], the estimated global prevalence of patients on chronic dialysis increased from 405 per million population (pmp) in 2009 to 640 pmp in 2018, corresponding to an absolute increase of 58%, with an average increase of 6.4% per year. The estimated number of new dialysis patients in 2018 was 42,546, an increase of 54.1% compared to 2009[3].

The main underlying diseases that result in CKD in Brazil are arterial hypertension (AH) and diabetes mellitus (DM), which together account for 60 to 70% of CKD cases[3]. These three NCDs share common risk factors considered modifiable, such as excess weight, physical inactivity and inadequate nutrition. An adequate and healthy diet, physical practices and physical activity are priority axes of the National Health Promotion Policy that have a direct impact on the prevention of the occurrence of AH, DM and, as a consequence, CKD[4]. CKD is characterized by the presence of renal damage or reduction in renal function for a period equal to or greater than three months regardless of its etiology, and hemodialysis is one of the most used treatment alternatives for individuals who need RRT[5].

The reduction in renal function and the RRT itself are responsible for causing changes in food consumption and electrolyte, hormonal and metabolic disturbances, which can lead to changes in the nutritional profile, mainly resulting in depletion of body fat and muscle tissue[5,6]. Malnutrition has a great impact on the progress of patients, as it is associated with a greater number of complications, greater frequency and duration of hospital admissions, as well as higher mortality[7].

Paradoxically, an increase in the prevalence of overweight and obesity has been observed in patients with CKD[5]. Although overweight is identified as an important cause of kidney disease, due to its close association with DM and SAH, and is associated with a worse quality of life for these patients, as it is considered a risk factor for many

diseases, it has been considered a protective factor in dialysis patients. This may be due to the fact that malnutrition in this group is associated with higher mortality when compared to obese individuals[8].

The nutritional status (NS) of chronic kidney patients has a great impact on their quality of life and survival[5,6], which makes periodic monitoring essential so as to better understand the possible nutritional and metabolic changes presented and to promote, maintain or recover the health of these individuals, thus minimizing their damage[9,10]. Among the compound methods of assessment, the Malnutrition Inflammation Score (MIS)[11] has stood out for the population with CKD as it is the only tool that integrates all NS assessment methods: clinical history, physical examination, anthropometry and laboratory tests. Currently, the MIS is an advance in relation to individual measures in the assessment of NS and has been considered a clinical marker of nutritional risk in the dialysis population[12].

Thus, the aim of this study is to analyze the frequency and factors associated with nutritional risk in patients with chronic kidney disease undergoing hemodialysis.

METHODS

This is an observational analytical cross-sectional study of a non-probability sample of 110 chronic kidney patients undergoing hemodialysis treatment at two specialized clinics in the municipality of Cuiabá, Mato Grosso, Brazil, from June to October 2018. The hemodialysis clinics were private, but mostly served patients from the Unified Health System (*Sistema Único de Saúde – SUS*) through an agreement.

All patients with CKD on hemodialysis who accepted and signed the Informed Consent Form, of both genders, aged 20 years or over, on hemodialysis for at least three months, not hospitalized in the past three months, clinically stable and with a prescription for hemodialysis three or more times a week, participated in the study. Pregnant and lactating patients, those who were unable to measure their weight and/or height, and patients diagnosed with cognitive and/or hearing impairment that could prevent data collection were excluded from the study.

An interview was conducted using a specific questionnaire to obtain information related to socioeconomic, demographic and health-related risk behavior characteristics, with data on clinical variables obtained from the patient's clinical record. The following demographic variables were considered: gender (male and female); age, in full years, categorized into two age groups: 20-59 years (adults) and ≥60 years (older adults); race/color, self-reported as White, Black, *Pardo* (mixed-race Brazilians), Yellow or Red and categorized as White (White + Yellow), Black (Black) and *Pardo* (*Pardo* + Red) due to the low frequency of individuals with eastern and indigenous ancestry.

The socioeconomic variables of the study were: education, collected as the period attended and categorized into: "up to complete primary education" (including individuals who reported being illiterate or having attended up to incomplete secondary education), "complete secondary education and incomplete higher education" and "complete higher education or more" (including those with a higher education degree and/or any graduate level); marital status, collected as single, legally married, in a common-law marriage, widowed, separated or divorced and dichotomized into "with a partner" or "without a partner" [single, widowed or separated/divorced]; individual monthly income, collected as the number of individual monthly minimum wages and categorized into "up to two minimum wages", "three or more minimum wages"; and current working condition, categorized into "no job" (unemployed), "working" (including self-employed, civil servant, or private company worker) and "with income, but no job" (including those who receive sick pay and retired by disability, length of service or age).

The clinical variables, self-reported or collected from the medical record, were: urine volume in 24 hours, collected in milliliters and categorized into "less than 500 ml" and "equal to or greater than 500 ml"; dialysis duration in months, transformed to years and dichotomized into "less than four years" and "four years or more". DM, AH and dyslipidemia comorbidities were dichotomous variables (yes/no).

The results of laboratory tests were obtained from the medical record, considering the results of the most current tests in relation to the day of data collection. The threshold values for classification of test results were: pre-dialysis urea ≥150mg/dl (expected value)[6], phosphorus and potassium <5.5mg/dl (expected values)[6].

Regarding health-related risk behavior variables, the following variables were considered: current smoker, a dichotomous variable (yes/no), being considered current smoker the individual who answered positively to the question: "Are you currently a smoker?", regardless of the number of cigarettes, frequency and duration of smoking; alcohol consumption, a dichotomous variable (yes/no), in response to the question: "Do you drink any type of alcoholic beverage?", regardless of the frequency of consumption, type and amount of alcoholic beverage consumed; and practice of physical activity in the three months prior to the interview, a dichotomous variable (yes/no), in response

to the question: “In the last three months, did you practice any type of physical exercise or sport?”, regardless of the type, frequency and duration of physical exercise or sport performed.

Anthropometric and physical examination data were collected at the end of the hemodialysis session to reduce interference from the individual’s hydration status. To complete MIS, a physical examination[10] was performed through observation of apparent loss of adipose tissue (classified as: mild, moderate, severe, very severe or not applicable; observed in the following regions: biceps, triceps , chest, below the eyes) and muscle (classified as: mild, moderate, severe, very severe or not applicable), observed in the following regions: temple, clavicle, acromion, scapula, ribs, interosseous muscle of the hand, quadriceps, knee and calf).

The measurement of anthropometric measurements followed standardized techniques, considering: dry weight (weight after dialysis)[13], height[13], waist circumference (WC)[14], calf circumference (CC)[14] and adductor pollicis muscle thickness (APMT)[15]. For each measurement, two measurements were taken in sequence, considering the average of the two measurements as the final measurement.

The measurement of dry weight was carried out using a digital Ellegance (Mondial®) scale with a capacity of 150kg. The individuals were barefoot, wearing as little clothing as possible and their arms were extended along the body[13]. To measure height, a compact Sanny® stadiometer was used, with a total length of 210cm, and the participants were in an upright position, with their head up, eyes looking at a horizontal plane according to the Frankfurt horizontal plane, with the spine and heels against the wall, knees straight, feet together and arms outstretched[13].

The dry weight and height were used to calculate the Body Mass Index (BMI), which was classified according to age – adults or older adults[13]. At the end, the weight was categorized as “no excess weight” (including all those adults and older adults classified as being underweight and at normal weight) or “excess weight”.

To measure CC and WC, a measuring tape (Sanny®, with a total length of 150cm and 1mm precision) was used. CC was measured at the point of greatest circumference on the calf, and measurement was standardized on the left leg[14]. For the measurement, the participant remained in an orthostatic position or sitting on a chair with the leg flexed at 90º. For CC, individuals were classified as “nutritional risk”, when CC<31cm, or “adequate”, when CC≥31cm[14].

To measure WC, the participant remained in an orthostatic position, with arms extended and slightly apart from the body and the abdomen relaxed. It was agreed to standardize the measurement at the level of the umbilical scar[14]. For WC, individuals were classified as “low risk” or “increased risk”, considering the WC threshold values associated with the development of complications related to obesity according to gender[14].

aqui

APMT measurement was performed with the patient seated, the arm flexed at approximately 90°, and the forearm and hand resting on the knee[15]. A Cescorf® plicometer was used, with continuous pressure of 10g/mm^2, to clamp the adductor muscle at the apex of an imaginary triangle formed by the extension of the thumb and index finger. The procedure was performed in the hand, opposite the arteriovenous fistula[16]. As for APMT measurement, individuals were classified according to mean APMT values for patients undergoing hemodialysis[16] according to gender as “adequate” or at “nutritional risk”.

At the end of anthropometric data collection, the MIS was completed. The instrument contains 10 components, with severity levels scored from 0 to 3. The components evaluated are: clinical history (change in weight, appetite and food intake, gastrointestinal symptoms, functional capacity and presence of comorbidities), physical examination (fat and muscle reserves, and functional capacity), anthropometry (BMI) and laboratory tests (albumin and total iron/transferrin binding capacity)[10]. The sum of all components can range from 0 to 30. The classification of nutritional risk, according to the MIS, consisted of low (<6 points) or high (≥6 points) nutritional risk[17].

The data, entered in duplicate in EpiInfo version 7.2, underwent consistency analysis by comparing the entries to eliminate possible errors, being stored in an Excel database and then analyzed using the SPSS statistical package version 23.0 (SPSS Inc. Chicago IL, USA).

To check the consistency of the data and define the categories of the variables, the absolute and relative frequencies of the variables were estimated. Pearson’s chi-squared test was used for bivariate analysis and, when necessary, Fisher’s exact test was also used. Independent variables that presented p≤0.10 were included in the bivariate analysis using the Pearson test in the crude binary logistic regression model and mutually adjusted for all the variables in the model. In the adjusted analysis, all analyzed covariates were used, with the less informative covariates being successively removed from the model in a backward elimination based on the Akaike information criterion. Those independent variables that remained with p≤0.05 were considered associated with the MIS outcome variable and kept in the final multiple model.

This study was approved by the board of directors of the clinics where the study was carried out and by the Human Research Ethics Committee of the Federal University of Mato Grosso (Approval No. 2.658.607).

RESULTS

In all, 110 patients participated in the study, with a mean age of 51.8 years (standard deviation =12.8). The majority of the population was male (n=68; 61.82%), with a predominance of adult individuals (between 20 and 59 years old) (n=75; 68.19%), self-reported *Pardo* race/color (n=60; 54.54%), and individuals living with a partner (n=59; 53.64%). As for education, 47.22% (n=51) of the patients had only completed primary school. Most participants are beneficiaries of social security (n=90; 82.57%) and the mean individual income was up to two minimum wages (n=78; 70.91%) (Table I).

Of the total number of patients evaluated, 66.36% (n=73) had an MIS equal to or greater than 6 points, with the mean score presented by the patients in this study being 6.99 (standard deviation =2.97). There were no statistically significant differences between socioeconomic and demographic variables according to the MIS categories (Table I).

Table I - Socioeconomic and demographic characteristics and bivariate analysis of associations between the Malnutrition Inflammation Score (MIS) categories and socioeconomic and demographic variables of patients undergoing hemodialysis at two clinics. Cuiabá, Mato Grosso, Brazil, 2018.

Variables	Total (n=110)		MIS				p-value
			Low risk (<6 points)		High risk (≥6 points)		
	n	%	n	%	n	%	
Total	110	100	37	33.64	73	66.36	
Sex							0.96[a]
Female	42	38.18	14	33.33	28	66.67	
Male	68	61.82	23	33.82	45	66.18	
Age group							0.23[a]
Adult	75	68.19	28	37.33	47	62.67	
Older adult	35	31.81	9	25.71	26	74.29	
Race/color							0.58[a]
White	23	20.91	9	39.13	14	60.87	
Black	27	24.55	7	25.93	20	74.07	
Pardo (mixed-race)	60	54.54	21	35.00	39	65.00	
Education							0.16[a]
Up to primary education	51	47.22	13	25.49	38	74.51	
Complete secondary education and incomplete higher education	41	37.96	15	36.59	26	63.41	
Complete higher education or above	16	14.82	8	50.00	8	50.00	
Marital status							0.38[a]
Without a partner	51	46.36	15	29.41	36	70.59	
With a partner	59	53.64	22	37.29	37	62.71	
Individual monthly income							0.32[a]
Up to two minimum wages	78	70.91	24	30.77	54	69.23	
Three or more wages	32	29.09	13	40.63	19	59.37	
Working status							0.67[b]
Unemployed	8	7.34	3	37.50	5	62.50	
Employed	11	10.09	5	45.45	6	54.55	
With income, but no job	90	82.57	29	32.22	61	67.78	

[a]: Pearson's chi-squared test; [b]: Fisher's exact test; p≤0.05

The most frequent presumptive etiologies of CKD were: hypertensive nephrosclerosis (n=54; 49.09%), unknown or undiagnosed causes (n=25; 22.73%) and diabetic nephropathy (CKD caused by diabetes mellitus) (n=12; 10.91%) (data not shown in table). The clinical characteristics of the patients are shown in Table II, as well as the bivariate analysis of associations between these variables and the MIS categories.

Regarding the presence of comorbidities, AH (n=83; 75.45%) and DM (n=26; 23.64%) were frequent in this population. As for the duration of dialysis, the mean, in years, was 4.86 (standard deviation = 4.65), and most patients had a treatment duration of less than four years (n=63; 57.27%).

In the bivariate analysis of associations between the MIS variables and the clinical variables, it was observed that, for the duration of dialysis, the proportion of individuals at high risk was higher among those with a treatment of four years or more compared to those with less than four years of hemodialysis treatment (n=38; 80.85% versus n=35; 55.56%; p=0.01). Most patients had a residual volume of diuresis less than 500 ml within 24 hours (n=84; 76.36%), thus being called anuric and/or oliguric, and this category was associated with greater nutritional risk (n=61; 72.62%; p=0.01).

Table II - Clinical characteristics and bivariate analysis of associations between Malnutrition Inflammation Score (MIS) categories and clinical variables of patients undergoing treatment. Cuiabá, Mato Grosso, Brazil, 2018.

Variables	Total (n=110)		MIS				p-value
			Low risk (<6 points)		High risk (≥6 points)		
	n	%	n	%	n	%	
Diabetes							0.41[a]
Yes	26	23.64	7	26.92	19	73.08	
No	84	76.36	30	35.71	54	64.29	
Arterial hypertension							0.67[a]
Yes	83	75.45	27	32.53	56	67.47	
No	27	24.55	10	37.04	17	62.96	
Dyslipidemia							0.73[b]
Yes	10	9.09	4	40.00	6	60.00	
No	100	90.91	33	33.00	67	67.00	
Dialysis duration							0.01[a*]
Less than four years	63	57.27	28	44.44	35	55.56	
Four years or more	47	42.73	9	19.15	38	80.85	
Urine volume/24h							0.01[a*]
<500 ml	84	76.36	23	27.38	61	72.62	
≥500 ml	26	23.64	14	53.85	12	46.15	
Pre-dialysis urea							0.06[a]
Below expected value	70	63.64	28	40.00	42	60.00	
Expected value	40	36.36	9	22.50	31	77.50	
Potassium							0.09[a]
Expected value	78	70.91	30	38.46	48	61.54	
Above expected value	32	29.09	7	21.88	25	78.12	
Phosphorus							0.07[a]
Expected value	77	70.00	30	39.00	47	61.00	
Above expected value	33	30.00	7	21.21	26	78.79	

[a]: Pearson's chi-squared test; [b]: Fisher's exact test; p≤0.05

The risk behaviors related to health and nutritional status of hemodialysis patients, according to the MIS categories, are described in Table III. Smoking is not a frequent behavior in the population analyzed (n=7; 6.36%), but 19.27%

(n=21) reported consuming alcoholic beverages. Of the total number of patients, 62.73% (n=69) were sedentary, and among the patients who reported practicing some type of physical exercise (n=41; 37.27%) in the last three months prior to the interview, walking was the most reported (n=27; 66.36%).

Regarding the nutritional status of patients, we found that 45.45% (n=50) had some degree of excess weight according to BMI, and the majority (n=73; 66.36%) had an increased risk of cardiovascular diseases (CVD) according to the WC measurement. As for muscle mass indicators, most patients had adequate values for CC (n=91; 82.73%) and similar frequencies for the APMT categories “adequate” and “nutritional risk” (n=55; 50.00 %). In the bivariate analysis, a greater proportion of individuals at nutritional risk according to CC was observed among those at high risk according to the MIS (n=17; 89.47%; p=0.02) (Table III) .

Table IV shows the results of the crude and adjusted multiple analysis, demonstrating that sedentary lifestyle (p=0.02) and longer dialysis duration (p=0.04) were associated with high nutritional risk (MIS ≥6 points). Regarding the practice of physical exercise in the three months prior to the interview, those individuals who reported not practicing any physical exercise were 3.25 times more likely to have greater nutritional risk when compared to individuals who reported practicing some physical exercise. As for the duration of dialysis, individuals with four years or more of treatment were 3.03 times more likely to have greater nutritional risk compared to individuals with less than four years of hemodialysis.

Table III - Characteristics of risk behaviors related to health and nutritional status of patients and bivariate analysis of associations between the categories of the Malnutrition Inflammation Score (MIS) and variables of risk behaviors related to health and nutritional status of patients undergoing treatment. Cuiabá, Mato Grosso, Brazil, 2018.

Variables	Total (n=110)		MIS				p-value
			Low risk (<6 points)		High risk (≥6 points)		
	n	%	n	%	n	%	
Current smoker							0.09[b]
Yes	7	6.36	0	0.00	7	100.00	
No	103	93.64	37	35.92	66	64.08	
Drinking							0.65[a]
No	21	19.27	8	38.10	13	61.90	
Yes	88	80.73	29	32.95	59	67.05	
Physical exercise							0.08[a]
Yes	41	37.27	18	43.90	23	56.10	
No	69	62.73	19	27.54	50	72.46	
Weight status							0.20[a]
No excess weight	60	54.55	17	28.33	43	71.67	
Excess weight	50	45.45	20	40.00	30	60.00	
Waist circumference							0.06[a]
Low risk	37	33.64	8	21.62	29	78.38	
Increased risk	73	66.36	29	39.73	44	60.27	
Calf circumference							0.02[a*]
Nutritional risk	19	17.27	2	10.53	17	89.47	
Adequate	91	82.73	35	38.46	56	61.54	
APMT							0.07[a]
Nutritional risk	55	50.00	14	25.45	41	74.55	
Adequate	55	50.00	23	41.82	32	58.18	

APMT: Adductor pollicis muscle thickness; [a]: Pearson’s chi-squared test; [b]: Fisher’s exact test; p≤0.05

Table IV - Crude and adjusted binary logistic regression of associations between the Malnutrition Inflammation Score (MIS) and independent variables of patients undergoing treatment. Cuiabá, Mato Grosso, Brazil, 2018.

Variables	MIS					
	Crude analysis			Adjusted analysis*		
	OR	(95%CI)	p-value	OR	(95%CI)	p-value
Physical exercise			0.08			0.02**
No	2.06	0.91;4.64		3.25	1.23;8.73	
Yes	1.00			1.00		
Waist circumference			0.06			-
Low risk	2.39	0.96;5.95		-	-	
Increased risk	1.00			-	-	
Calf circumference			0.03**			
Nutritional risk	5.31	1.16;24.41		-	-	
Adequate	1.00			-	-	
APMT			0.07			-
Nutritional risk	2.10	0.94;4.73		-	-	
Adequate	1.00			-	-	
Dialysis duration			0.01**			0.04**
Less than four years	1.00			1.00		
Four years or more	3.38	1.40;8.15		3.03	1.03;8.90	
Urine volume/24h			0.01**			-
<500 ml	3.09	1.25;7.67		-	-	
≥500 ml	1.00			-	-	
Pre-dialysis urea			0.06			-
Below expected value	0.44	0.18;1.05		-	-	
Expected value	1.00			-	-	
Potassium			0.10			-
Expected value	0.45	0.17;1.16		-	-	
Above expected value	1.00			-	-	
Phosphorus			0.08			-
Expected value	0.42	0.16;1.09		-	-	
Above expected value	1.00			-	-	

OR: Odds ratio; 95% CI: 95% Confidence interval; APMT: Adductor pollicis muscle thickness; *Analysis mutually adjusted for all the variables in the model; **p<0.05

DISCUSSION

In the present study, the factors associated with nutritional risk in patients undergoing hemodialysis were evaluated and we found a high frequency of individuals at high nutritional risk, the highest being found among patients with dialysis duration ≥4 years, urine volume/24h <500ml, hyperkalemia, hyperphosphatemia, smokers, patients with increased waist circumference, low calf circumference and those who did not exercise. In the adjusted multiple analysis, those individuals who were sedentary and who had been on dialysis for longer had a higher nutritional risk, as measured by the MIS, when compared to those who practiced physical exercise and had less time on HD.

The socioeconomic and demographic characteristics of the participants evaluated in the current study were similar to those found in other national studies in which most patients with CKD are male[18,19], *Pardo*[18,19], live with a partner[20], and are of low socioeconomic status[19,20] and education[18,19]. As for the most frequent presumptive etiologies of CKD, we found that hypertensive nephrosclerosis and diabetic nephropathy together accounted for more than half of the cases found. In addition, AH and DM were the most frequent comorbidities in this population.

In Brazil, AH and DM are the most frequent underlying diseases and comorbidities associated with CKD[4]. The occurrence of these NCDs follows the current trend of the general profile of the world population, in which there is an increase in NCDs and their common modifiable risk factors, such as unhealthy diet, physical inactivity, smoking, harmful consumption of alcoholic beverages and excess weight[2,21]. These risk factors are part of the 2011-2022 NCD Action Plan[21], and their control has a direct impact on the incidence and prevalence of CKD.

The assessment of NS using MIS does not yet have a consolidated cutoff value for patients on hemodialysis. Furthermore, in studies carried out with this population, different cutoff values have been used to classify higher nutritional risk[22,23]. In the present study, participants with a score equal to or greater than six points on MIS were classified as having worse nutritional status. The mean score observed for MIS was similar to the values found in other studies carried out with chronic renal patients around the world[18,23].

Most patients were considered anuric or oliguric in the current study, and this condition is associated with a greater nutritional risk according to MIS because the residual volume of diuresis helps in the clearance of low and medium molecular weight substances, thus allowing greater fluid removal and improvement in NS[24]. In addition, the residual volume determines how much the patient must restrict their food and fluid intake[24]. It can be implied that patients with lower urinary volume have greater dietary restrictions and, thus, NS can be negatively affected[25].

Most patients in the current study had increased serum levels of phosphorus and potassium, and this condition is associated with greater nutritional risk, since hyperphosphatemia contributes to secondary hyperparathyroidism, resistance to vitamin D and hypocalcemia in addition to being responsible for causing bone damage and increased risk for CVD[6]. Moreover, hyperkalemia can lead to cardiac arrhythmia and sudden death, particularly in patients on hemodialysis[5].

As for the nutritional status of the population analyzed in this study, we found that around 45% of the participants had some degree of excess weight as measured by BMI and most had an increased risk of developing CVD according to WC. These data follow the current trend of the general population and the chronic kidney disease population[8]. In chronic kidney disease patients, it has been reported that high BMI is, paradoxically, associated with better survival in these patients, a phenomenon referred to as reverse epidemiology, perhaps because, in this same group, malnutrition is associated with higher mortality when compared to obese individuals[8]. However, even in dialysis patients, visceral obesity is associated with increased cardiovascular risk, especially the risk of coronary calcifications and other adverse cardiovascular events[8].

It was also observed in the present study that most individuals with a thinner adductor pollicis muscle (considered nutritional risk) also presented higher scores on MIS (high risk), thus emonstrating that this measure can be an indicator of reduced muscle mass and changes in body composition, although the reference values used to categorize APMT measures are not unanimous among publications on the chronic kidney disease population[16,26].

It should be noted that, in the multiple analysis, sedentary lifestyle and longer duration of hemodialysis treatment of the participants analyzed in the current study remained associated with high nutritional risk. Regarding the practice of physical exercise, sedentary individuals were 225% more likely to have greater nutritional risk when compared to those who engage in physical exercise. Studies that analyzed the association between physical exercise and MIS were not found in the literature, but sedentary lifestyle has been observed among patients with CKD, and this can be associated with increased mortality, morbidity and the risk factors that drive progression of CKD[27]. As a result, sedentary lifestyle among chronic kidney disease patients can result in reduced muscle mass (sarcopenia), reduced skeletal strength and the accumulation of adipose tissue, a situation that is aggravated by changes in body composition caused by CKD and RRT, which can lead to malnutrition and a decline in the functional capacity of these patients[25,27,28].

Physical exercise has several benefits, such as blood glucose control and blood pressure reduction, with additional effects on weight control, lipid profile improvement, bone and skeletal muscle strengthening, nutritional status improvement and, consequently, improved quality of life[25,27,28]. As for the general population, individuals with CKD benefit from the actions of the National Health Promotion Policy[4], which lists, among its priority themes, body practices and physical activities, as even in lower intensity training, physical exercise can result in the control and reversal of muscle loss and in the improvement of the functional capacity of chronic renal patients[27].

As for the duration of dialysis, we found in the current study that individuals with four years or more of hemodialysis treatment were 203% times more likely to have greater nutritional risk compared to those with less than four years of treatment. In line with this finding, other publications suggest that the longer the time on hemodialysis treatment, the higher the MIS score, thus indicating a worse nutritional status[22,29]. The association between the length of hemodialysis treatment and MIS can be explained by the subclinical inflammation and reduced protein synthesis,

by the reduction in muscle mass and change in body composition in response to the progression of CKD, and by the metabolic changes caused by the RRT itself[22,24,29].

In order to minimize the impact of CKD and its treatment on the nutritional status of the patient, it is recommended that routine nutritional assessments be carried out[9,10]. It is known that there is no single method that can predict malnutrition in hemodialysis and also that the most accurate indication is the use of multiple methods applied simultaneously[10,16]. MIS has stood out as a compound instrument for assessing the NS of patients on hemodialysis and as an important clinical marker in this population[12], being able to diagnose early changes in nutritional status. In addition, actions to promote healthy lifestyle habits, such as adequate and healthy eating, physical practices and physical activities, and cessation of smoking and alcohol consumption[4], contribute in the short, medium and long term to the improvement of the nutritional status and quality of life of hemodialysis patients.

A limitation of the present study is the fact that laboratory tests were collected in two different clinics and with data collected from the patients' medical records, so that there was no standardization of collection dates and analysis laboratories. However, we sought to collect the most current data available in the medical records. In addition, the physical examination contained in the MIS instrument is based on a subjective assessment of decreased body and subcutaneous fat reserve, as well as signs of reduced muscle mass, and this assessment may differ between examiners. To minimize this error, training for data collection and standardization of the assessment carried out by the researcher who performed this analysis was adopted as a procedure.

CONCLUSION

There was a high frequency of patients with high NR, with sedentary patients and those with longer hemodialysis treatment comprising the group with the highest nutritional risk measured by the MIS instrument. The need for these patients to be observed more closely by health professionals who work in hemodialysis clinics should be highlighted in order to promote a better quality of life and prevent potential complications and changes in nutritional status.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS

Jéssica Almeida Leite, Priscila Oliveira Sousa, Michelle Yasmine Borges and Gabriela Dalcin Durante participated in all stages of the research, with substantial contributions to the study conception and design; collection, analysis and interpretation of data; and writing and critical review of the manuscript. **Bruna Teles Soares Beserra** participated in the analysis and interpretation of data; and in the critical review of the manuscript. **Paulo Rogério Melo Rodrigues** contributed to the statistical analysis and interpretation of data, as well as to the critical review of the manuscript. All the authors approved the final version submitted for review.

REFERENCES

1. World Health Organization. World Health Statistics 2018: monitoring health for the SDGs, sustainable development goals. Geneva: World Health Organization; 2018.
2. Global Burden of Disease 2016 Causes of Death Collaborators. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet [Internet]. 2017 [accessed on 2020 Nov 12];390(10100):1151-210. doi: https://doi.org/10.1016/S0140-6736(17)32152-9
3. Neves PDMM, Sesso RCC, Thomé FS, Lugon JR, Nascimento MM. Censo Brasileiro de Diálise: análise dos dados da década de 2009-2018. J Bras Nefrol [Internet]. 2020 [accessed on 2020 Nov 12];42(2):191-200. doi: 10.1590/2175-8239-JBN-2019-0234
4. Brasil. Ministério da Saúde. Portaria nº 2.446, de 11 de novembro de 2014. Redefine a Política Nacional de Promoção da Saúde (PNPS). Diário Oficial da União; 2014.
5. Avesani CM, Pereira AML, Cuppari L. Doença renal crônica. In: Cuppari L. Nutrição nas doenças crônicas não transmissíveis. Barueri: Manole; 2009. p. 267-330.

6. Martins C. Avaliação e diagnóstico do estado nutricional de pacientes renais. In: Riella MC, Martins C. Nutrição e o rim. Rio de Janeiro: Guanabara Koogan; 2013. p. 93-109.
7. Bousquet-Santos K, Costa LG, Andrade JML. Estado nutricional de portadores de doença renal crônica em hemodiálise no Sistema Único de Saúde. Ciênc Saúde Colet [Internet]. 2019 [accessed on 2020 Nov 12];(3):1189-99. doi: 10.1590/1413-81232018243.11192017
8. Silva GB Jr, Bentes ACSN, Daher EF, Matos SMA. Obesidade e doença renal. J Bras Nefrol [Internet]. 2017 [accessed on 2020 Nov 12];39(1):65-69. doi:10.5935/0101-2800.20170011
9. Silva AMD, Souto TCM, Freitas FF, Moraes CN, Sousa BS. Estado nutricional de pacientes renais crônicos submetidos a tratamento hemodialítico em um hospital de referência de Pernambuco. Nutr Clín Diet Hosp [Internet]. 2017 [accessed on 2020 Nov 12];37(3):58-65. doi: 10.12873/373brunosoares
10. Ikizler TA, Burrowes JD, Byham-Gray LD, Campbell KL, Carrero JJ, Chan W, et al. KDOQI Clinical Practice Guidelines for Nutrition in Chronic Kidney Disease: 2019 Update. Am J Kidney Dis [Internet]. 2020 [accessed on 2020 Nov 12];76(3, Suppl 1):S1-S107. doi: https://doi.org/10.1053/j.ajkd.2020.05.006
11. Kalantar-Zadeh K, Kleiner M, Dunne E, Lee GH, Luft FC. A modified quantitative subjective global assessment of nutrition for dialysis patients. Nephrol Dial Transplant [Internet]. 1999 [accessed on 2020 Nov 12];14(7):1732-8. doi: 10.1093/ndt/14.7.1732
12. Kamimura MA, Avesani CM. Métodos compostos de avaliação nutricional. In: Cuppari L, Avesani CM, Kamimura MA. Nutrição na Doença Renal Crônica. Barueri: Manole; 2013. p.199-212.
13. World Health Organization. Physical Status: the use and interpretation of anthropometry. WHO Technical Report Series nº 854. Geneva, Swi: World Health Organization; 1995.
14. Callaway CW, Chumlea WC, Bouchard C, Himes JH, Lohman TG, Martin AD, et al. Circumference. In: Lohman TG, Roche AF, Martorel R. Anthropometrics standartization reference manual. Champaign: Human Kinetics Books; 1988.
15. Harrison GG, Buskirk ER, Carter JEL, Johnston FE, LohmanTG, Pollock MR, et al. Skinfold thicknesses and measurement technique. In: Lohman TG, Roche AF, Martorel R. Anthropometrics standartization reference manual. Champaign: Human Kinetics Books; 1988.
16. Oliveira CMC, Kubrusly M, Mota RS, Choukroun G, Brandão JB Neto, Silva CABS. Adductor Pollicis Muscle Thickness: a promising anthropometric parameter for patients with chronic renal failure. J Ren Nutr [Internet]. 2012 [accessed on 2020 Nov 12];22(3):307-16. doi: 10.1053/j.jrn.2011.07.006
17. Lopes MB, Silva LF, Lopes GB, Penalva MA, Matos CM, Robinson BM, et al. Additional contribution of the Malnutrition-Inflammation Score to predict mortality and patient-reported outcomes as compared with its components in a cohort of African descent hemodialysis patients. J Ren Nutr [Internet]. 2017 [accessed on 2020 Nov 12];27(1):45-52. doi: 10.1053/j.jrn.2016.08.006
18. Sampaio GC, Brito ACD, Barros AJF, Hortegal EV, Dias RSC. Inflamação e associação com parâmetros clínicos e nutricionais de pacientes em hemodiálise. Ciênc Saúde [Internet]. 2017 [accessed on 2020 Nov 12];10(2):71-76. doi: 10.15448/1983-652X.2017.2.24244.
19. Castro AS, Pessoa PP, Barroso CF, Araújo GN, Sousa MP, Oliveira DL, et al. Zinco e risco cardiovascular de pacientes nefropatas em tratamento de hemodiálise. Rev Bras Promoç Saúde [Internet]. 2018 [accessed on 2020 Nov 12];31(1):1-7. doi: 10.5020/18061230.2018.5803
20. Lemos LB, Moraes GS, Lemos GS, Nery AA. Automedicação em pacientes renais crônicos hemodialíticos. Rev Bras Promoç Saúde [Internet]. 2020 [accessed on 2020 Nov 12];33:9906. doi: 10.5020/18061230.2020.9906
21. Ministério da Saúde (BR), Secretaria de Vigilância em Saúde, Departamento de Análise de Situação de Saúde. Plano de ações estratégicas para o enfrentamento das doenças crônicas não transmissíveis (DCNT) no Brasil 2011-2022. Brasília: Ministério da Saúde; 2011.
22. Bandeira SBC, Cansanção K, Paula TP, Peres WAF. Evaluation of the prognostic significance of the malnutrition inflammation score in hemodialysis patients. Clin Nutr ESPEN [Internet]. 2020 [accessed on 2020 Nov 12];35:109-115. doi: 10.1016/j.clnesp.2019.10.019

23. Rambod M, Bross R, Zitterkoph J, Benner D, Pithia J, Colman S, et al. Association of Malnutrition-Inflammation Score with quality of life and mortality in hemodialysis patients: a 5-year prospective cohort study. Am J Kidney Dis [Internet]. 2009 [accessed on 2020 Nov 12];53(2):298-309. doi: 10.1053/j.ajkd.2008.09.018

24. Alvarenga LA, Andrade BD, Moreira MA, Nascimento RP, Macedo ID, Aguiar AS. Análise do perfil nutricional de pacientes renais crônicos em hemodiálise em relação ao tempo de tratamento. J Bras Nefrol [Internet]. 2017 [accessed on 2020 Nov 12];39(3):283-6. doi: 10.5935/0101-2800.20170052

25. Moorthi RN, Avin KG. Clinical relevance of sarcopenia in chronic kidney disease. Curr Opin Nephrol Hypertens [Internet]. 2017 [accessed on 2020 Nov 12];26(3):219-28. doi: 10.1097/MNH.0000000000000318

26. Machado AD, Rissotto CM, Martins CTB, Bazanelli AP. Associação entre o consumo energético e proteico e a espessura do músculo adutor do polegar em pacientes em hemodiálise. Ciênc Saúde [Internet]. 2017 [accessed on 2020 Nov 12];10(1):3-9. doi: 10.15448/1983-652X.2017.1.24111

27. Howden EJ, Coombes JS, Isbel NM. The role of exercise training in the management of chronic kidney disease. Curr Opin Nephrol Hypertens [Internet]. 2015 [accessed on 2020 Nov 12];24(6):480-7. doi:10.1097/MNH.0000000000000165

28. Huang M, Lv A, Wang J, Xu N, Ma G, Zhai Z. Exercise Training and Outcomes in Hemodialysis Patients: Systematic Review and Meta-Analysis. Am J Nephrol [Internet]. 2019 [accessed on 2020 Nov 12];50(4):240-54. doi: 10.1159/000502447

29. Martins ECV, Pereira VFS, Sales OS, Pereira PAL. Tempo de hemodiálise e o estado nutricional em pacientes com doença renal crônica. Braspen J. 2017;32(1):54-57.

First author's address:
Jéssica Almeida Leite
Faculdade de Nutrição - Departamento de Alimentos e Nutrição
Universidade Federal de Mato Grosso
Av. Fernando Corrêa da Costa, 2367, Bloco CCBSI
Bairro Boa Esperança
CEP: 78060-900 - Cuiabá - MT - Brasil
E-mail: jessica_leite96@hotmail.com

Mailing address:
Gabriela Dalcin Durante
Faculdade de Nutrição - Departamento de Alimentos e Nutrição
Universidade Federal de Mato Grosso
Av. Fernando Corrêa da Costa, 2367, Bloco CCBSI
Bairro Boa Esperança
CEP: 78060-900 - Cuiabá - MT - Brasil
E-mail: gabrielad.durante@gmail.com

How to cite: Leite JA, Sousa PO, Borges MY, Rodrigues PRM, Beserra BTS, Durante GD. Analysis of factors associated with nutritional risk of patients on hemodialysis. Rev Bras Promoç Saúde. 2021;34:11271.