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Prevalence of malnutrition and associated factors in hemodialysis patients[1]

Prevalência de desnutrição e fatores associados em pacientes em hemodiálise

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A B S T R A C T

Objective

To assess the prevalence of malnutrition and associated factors in hemodialysis patients.

Methods

This is a cross-sectional study of 344 hemodialysis patients from *Goiânia*, *Goiás* aged 18 years or more. The dependent variable, malnutrition, was investigated by the Subjective Global Assessment. The independent variables included socioeconomic, demographic, and lifestyle data, clinical history, and energy and protein intakes. The patients underwent anthropometric measurements and laboratory tests. Multiple Poisson regression determined the associated factors ($p<0.05$).

Results

Mild or moderate malnutrition was found in 22.4% of the patients. Malnourished patients had lower body mass index, mid-arm muscle circumference, percentage of body fat, serum creatinine ($p<0.001$), and normalized protein nitrogen appearance ($p=0.001$). Multivariate analysis identified the following factors associated with malnutrition: age between 19 and 29 years (PR=1.23, 95%CI=1.06-1.43), family income less than 2 minimum salaries (PR=1.13, 95%CI=1.01-1.27), hemodialysis vintage ≥60 months (PR=1.08, 95%CI=1.01-1.16), Kt/V≥1.2 (RP=1.12, 95%CI=1.03-1.22), calorie intake <35 kcal/kg/day (PR=1.22, 95%CI=1.10-1.34), and normalized protein nitrogen appearance <1.0 g/kg/day (PR=1.13, 95%CI=1.05-1.21).

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Conclusion

The prevalence of malnutrition in this population was high, corroborating the literature. The prevalence was higher in patients aged less than 29 years and those with low family income, longer hemodialysis vintage, higher Kt/V, and inadequate protein and calorie intakes. Strategies to reverse this situation should include more nutritional care.

Indexing terms: Malnutrition. Nutrition assessment. Renal dialysis.

RESUMO

Objetivo

Avaliar a prevalência e os fatores associados à desnutrição em pacientes em hemodiálise.

Métodos

Estudo transversal com 344 pacientes maiores de 18 anos em hemodiálise em Goiânia, Goiás. A variável dependente, desnutrição, foi obtida por meio da avaliação subjetiva global. As variáveis independentes envolveram aspectos socioeconômicos, demográficos, estilo de vida, história clínica, ingestão energética e proteica. Realizaram-se antropometria e exames laboratoriais. A análise dos fatores associados foi realizada por regressão de Poisson múltipla (p<0,05).

Resultados

A prevalência de desnutrição leve ou moderada foi constatada em 22,4% dos pacientes. Os pacientes desnutridos apresentaram menor índice de massa corporal, menor circunferência muscular do braço, menor porcentagem de gordura corporal, menor valor de creatinina sérica (p<0,001) e nPNA (p=0,001).O resultado final da análise multivariada identificou os fatores associados à desnutrição: idade de 19 a 29 anos (RP=1,23; IC95%=1,06-1,43), renda familiar <2 salários-mínimos (RP=1,13; IC95%=1,01-1,27), tempo em HD ≥60 meses (RP=1,08; IC95%=1,01-1,16), Kt/V ≥1,2 (RP=1,12; IC95%=1,03-1,22), ingestão calórica inferior a 35 kcal/kg/dia (RP=1,22; IC95%=1,10-1,34) e nPNA <1,0 g/kg/dia (RP=1,13; IC95%=1,05-1,21).

Conclusão

Observou-se alta prevalência de desnutrição na população estudada em acordo com o encontrado na literatura. A prevalência foi maior entre os pacientes com idade inferior a 29 anos, renda familiar baixa, maior tempo em hemodiálise, maior Kt/V e ingestão calórica e proteica inadequadas. Estratégias para reverter esta situação devem envolver maior atenção nutricional.

Termos de indexação*: Desnutrição. Avaliação nutricional. Diálise renal.*

INTRODUCTION

With a prevalence of 10 to 60%[1], malnutrition continues to be a problem in Chronic Renal Failure (CRF) patients on Hemodialysis (HD), increasing their morbidity and mortality[1,2-5].

Factors that discourage food intake and promote hypercatabolism can lead to malnutrition. Among them are anorexia due to uremia, gastrointestinal disorders, psychological factors, severe dietary restrictions, social problems, comorbidities, inflammatory processes, and hypercatabolism due to nutrient losses during dialysis and metabolic changes[6,7].

Detecting malnutrition in CRF patients is a challenge[2]. There is no single objective method capable of diagnosing malnutrition accurately in HD patients[5]. Biochemical and anthropometric indicators can be influenced by comorbidities, inflammatory status, hydration status, observer experience, and absence of reference standards for HD individuals[8].

In this context, the Subjective Global Assessment (SGA) has been used to assess the nutrition status of HD patients[9]. This technique relates objective and subjective aspects of the clinical history and physical examination[2]. The SGA is inexpensive, quickly administered, requires little interviewer training, and has good reproductibility[4,10], being recommended by the National Kidney Foundation-Kidney Disease Outcomes Quality Initiative (NKF-K/DOQI)[10]. Multicentric and longitudinal studies have claimed that the SGA is associated with morbidity, mortality, and hositalization[1,2], and correlates well with anthropometric measurements[4].

In addition to diagnosing nutritional status, identifying clinically controllable risk factors that promote nutritional deficits is very important for planning specific interventions[9]. However, given the multicausality of malnutrition in CRF[6,7], one should consider the relationships between its determinants when implementing prevention, diagnostic, and control strategies.

Considering this logic, the magnitude of CRF in Brazil, its impacts on nutritional status, and the absence of data on the prevalence of malnutrition in HD patients in the Brazilian Midwest Region, especially *Goiás*, this study aimed to estimate the prevalence of malnutrition in an HD population and establish the determinants of malnutrition.

METHODS

This cross-sectional study with a proportional, stratified sample from ten centers representative of the HD population of the city of *Goiânia* (GO) collected data from May 2009 to March 2010.

The sample size was given by the number of municipal HD patients aged 18 years or more (n=1,400), the prevalence of malnutrition, which varies from 10 to 60% in HD patients[3-5], sample maximization to 50%, confidence interval of 95%, and error of 5%. Hence, the estimated sample size was 302 patients. An extra 20% was included to compensate for losses and refusals, totaling 362 individuals, of which 344 remained in the study. The remainder (n=18) either dropped out or did not provide all the required information.

Considering the total number of patients in each clinic, the sample was selected by simple random sampling and consisted of clinically stable, not institutionalized males and females aged 18 years or more who had been undergoing hemodialysis for at least three months.

The exclusion criteria were: infections in the last three months, cancer, tuberculosis, acquired immunodeficiency syndrome, severe chronic obstructive pulmonary disease, severe cardiovascular disease, cerebrovascular disease, symptomatic heart failure classes III and IV, pregnancy, venous catheter dialysis, and diseases or situations that prevented anthropometric and food intake assessments, such as advanced bone diseases, stroke sequelae, physical disabilities, or amputated limbs.

The study collected socioeconomic, demographic, lifestyle, and anthropometric data, clinical history, and energy intake; administered the SGA; and performed laboratory tests. Four dieticians trained specifically for this study collected the data mentioned above using standard forms, pretested in a pilot study.

Nutritional status was classified according to the SGA, as recommended by the NKF-KDOQI[10] and validated by Steiber *et al.*[2] for HD patients. This protocol uses a 7-point scale to measure each one of the six SGA items (changes in body weight, energy intake, gastrointestinal symptoms, functional capacity, diseases and comorbidities that affect nutritional requirements, and physical examination to investigate subcutaneous fat loss, muscle mass loss, and presence of edema or ascites). The present study used the cutoff points recommended by the KDOQI, which classifies patients as nourished when the scores 6 or 7 prevail; mildly or moderately malnourished when the scores 3, 4, or 5 prevail; and severely malnourished when the scores 1 or 2 prevail[10].

The study socioeconomic and demographic data included gender, age in full years divided into age groups, marital status (living with or without a partner), education level (no education, elementary grades 1-4, elementary grades 5-8,

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high school, and higher education); and family income according to number of minimum salaries (<2, 2-5, and >5).

Lifestyle data included smoking status (nonsmoker, smoker, ex-smoker - those who had not smoked in at least six months), alcohol intake (regardless of beverage type or amount), physical activity during leisure time (yes or no), at home (performs or not physically-demanding chores), at work (has or does not have physically-demanding tasks), and physical activity commuting (inactive if the patient uses a vehicle, or walks or bicycles for less than ten minutes)[11]. Individuals inactive in all four categories above were considered inactive, and those active in at least one category above were considered active.

The clinical history data taken from the patients' medical records and confirmed with their physicians included CRF etiology, presence of comorbidities, and HD vintage.

Six 24-hour dietary recalls, three of HD days and three of non-HD days, excluding Sundays, collected dietary data. A program based mainly on the Brazilian Food Composition Table developed specifically for this study (www.dbcheckout.com.br/nutri) calculated the mean energy intake for those six days. Protein intake was estimated by calculating the Protein equivalent of total Nitrogen Appearance (PNA) of the midweek dialysis[10] as follows: PNA (g/day): pre-dialysis BUN/{[25.8+(1.15÷Kt/V)]+(56.4÷Kt/V)}+0.168, where BUN, Blood Urea Nitrogen in mg/dL= blood urea (mg/dL)÷2.14. The result was normalized to the ideal weight as recommended by NKF-KDOQI[10] and European Best Practice Guidelines (EBPG)[12]. A normalized PNA (nPNA) >1.0 g/kg was considered adequate[12].

Two dieticians took the anthropometric measurements after the midweek dialysis as recommended by Lohman *et al.*[13] and standardized the data as recommended by Habicht[14]. The measurements included weight, height, Mid-Arm Circumference (MAC), and Triceps (TST), Subscapular (SST), Biceps (BST), and Suprailiac Skinfold Thicknesses (SIST).

Body Mass Index (BMI) was given by the dry weight-to-height squared ratio, and nutritional status was classified as recommended by the World Health Organization (WHO)[15]. Mid-Arm Muscle Circumference (MAMC) was given by the equation MAMC=MAC(cm)-{3.14x[TST(mm)÷10]}, and the result by gender was compared with the reference standards proposed by Frisancho[16] and classified as recommended by Blackburn & Harvey[17].

Body fat was estimated by adding the four skinfold thicknesses (TST, SST, BST, and SIST) using the body density equations proposed by Durnin & Womersley[18]. The percentage of body fat was given by the equation proposed by Siri[19]. Since no ideal percentage of body fat has been established for HD patients, the cutoff points used by the present study were up to 25 and 32% of males' and females' body weight, respectively[20].

The biochemical tests included serum albumin (colorimetric method using bromocresol green) before dialysis, creatinine, and urea (kinetic method) before and after dialysis. All tests were performed by the clinical analysis laboratory of the *Hospital das Clínicas* of the *Universidade Federal de Goiás* (HC/UFG). Serum albumin >4 g/dL and creatinine ≥10 mg/dL were considered normal[12]. Dialysis was considered adequate when the patient's Kt/V index ≥1.2[21].

The data were entered twice in the program Epi Info 6.0 to check for consistency and analyzed by the statistical package Stata 8.0. The categorical variables were expressed as frequencies and percentages, and the continuous variables as mean and standard deviation after the Kolmogorov Smirnov test checked data normality ($p \geq 0.05$).

The prevalence of malnutrition was calculated for each study variable. Simple Poisson regression investigated which factors, if any, were associated with malnutrition. Variables with a statistical significance ≤0.20 were tested in multivariate analysis by Poisson regression with robust variance estimate, and the Wald test assessed statistical significance. The variables with $p<0.05$ remained in the final model.

The project was approved by the Research Ethics Committee of HC/UFG (nº 011/2009) and of the *Santa Casa de Misericórdia* of *Goiânia* (nº 046/2009), and all participants signed an Informed Consent Form. The entire sample was being followed regularly by dieticians.

RESULTS

Table 1 describes the demographic, clinical, and nutritional characteristics of the study sample (n=344). The prevalence of malnutrition according to the SGA was 22.40%. Malnutrition was either mild or moderate, regardless of gender (p=0.92). Most malnourished individuals were males (59.30%) with a mean age of 49.33 ± 13.76 years; the main etiologies were hypertensive nephropathy (37.70%) followed by glomerulonephritis (19.50%) and diabetic nephropathy (15.70%). High blood pressure was the most common comorbidity (66.40%). The median BMI and serum albumin were appropriate,

Table 1. Demographic, clinical, and nutritional characteristics of hemodialysis patients according to their nutritional status classified by the subjective global assessment. *Goiânia* (GO), Brasil, 2010.

Variables	Total	Nourished n=267 (77.60%)	Malnourished n=77 (22.40%)	p^*
Gender				0.929*
Males (n/%)	204 (59.30)	158 (77.45)	46 (22.55)	
Females (n/%)	140 (40.70)	109 (77.86)	31 (22.14)	
Age (years)	49.33 ± 13.76	50.07 ± 12.94	46.75 ± 16.09	0.062*
HD vintage (months)	43 (24.00 - 78.75)	42 (24 - 72)	48 (25 - 97.5)	0.092**
Kt/V	1.59 ± 0.39	1.55 ± 0.38	1.73 ± 0.38	<0.001*
CRF etiology (n/%)				0.741*
Hypertensive nephropathy	130 (37.70)	100 (37.45)	30 (38.96)	
Glomerulonephritis	67 (19.50)	55 (20.60)	12 (15.58)	
Diabetic nephropathy	54 (15.70)	39 (14.61)	15 (19.48)	
Not determined	26 (7.60)	22 (8.24)	4 (5.19)	
APKD	24 (7.00)	19 (7.12)	5 (6.49)	
Others	43 (12.50)	32 (11.99)	11 (14.29)	
Comorbidities (n/%)				0.427*
High blood pressure	228 (66.40)	177 (66.29)	51 (66.23)	
Diabetes	12 (3.60)	8 (3.00)	4 (5.19)	
High blood pressure + DM	40 (11.70)	28 (10.49)	12 (15.58)	
Others	13 (3.40)	1(4.12)	2 (2.60)	
Inexistent	51 (14.90)	43 (16.10)	8 (10.39)	
Weight (kg)	64.04 ± 12.85	67.25 ± 12.28	52.91 ± 7.46	<0.001*
BMI (kg/m²)	23.19 (20.72-26.03)	24.72 ± 3.90	20.00 ± 2.55	<0.001*
MAMC				<0.001*
<5th percentile	82 (23.80)	37 (13.90)	45 (58.40)	
≥5th percentile	262 (76.20)	230 (86.10)	32 (41.60)	
Body fat (%)	29.60 ± 8.80	31.55 ± 7.93	22.83 ± 8.35	<0.001*
LBM (kg)	44.73 ± 8.84	45.85 ± 8.95	40.84 ± 7.25	<0.001*
Serum albumin (g/dL)	4.01 (4.0 - 4.3)	4.13 ± 0.27	4.12 ± 2.69	0.642*
Pre-HD urea (mg/dL)	110.84 ± 27.52	112.13 ± 28.09	106.38 ± 25.14	0.106*
Serum creatinine (mg/dL)	9.50 ± 2.62	9.77 ± 2.60	8.57 ± 2.53	<0.001*
Energy intake (kcal/kg IW)	26.05 ± 6.64	26.25 ± 6.86	25.33 ± 5.80	0.282*
nPNA (g/Kg IW)	1.03 ± 0.27	1.05 ± 0.27	0.94 ± 0.22	0.001*

Note: *t test or Pearson's Chi-square test; **Mann Whitney test.

HD: Hemodialysis; Kt/V: Dialysis Adequacy Index; CRF: Chronic Renal Failure; APKD: Autosomal Polycystic Kidney Disease; DM: Diabetes *Mellitus*; BMI: Body Mass Index; MAMC: Mid-Arm Muscle Circumference; LBM: Lean Body Mass; IW: Ideal Weight; nPNA: normalized Protein Nitrogen Appearance.

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but mean serum creatinine was low (9.50 ± 2.62 mg/dL). Based on BMI, 8.72% of the patients were underweight, 59.01% were normal weight, and 32.27% were overweight. Most patients had appropriate serum albumin (77.91%) and low serum creatinine (58.72%).

In comparison with nourished patients (SGA), malnourished patients have smaller anthropometric parameters, namely body weight, BMI, % of body fat, MAMC, and lean body mass ($p<0.001$); higher Kt/V ($p<0.001$); and lower serum creatinine ($p<0.001$) and nPNA ($p=0.001$) (Table 1).

The prevalence of malnutrition was significantly higher in patients aged 19 to 29 years (50.00%) and in those with family income below

Table 2. Sample distribution, prevalence of malnutrition according to the subjective global assessment, and prevalence ratio of hemodialysis patients according to demographic, socioeconomic, and clinical variables, energy intake, and nPNA. *Goiânia* (GO), Brazil, 2010.

Variables	Sample distribution		Prevalence		Crude PR	*p*-value*
	n	%	n	%	(95%CI)	
Age (years)						0.030
19 to 29	24	6.98	12	50.00	1.24 (1.06 - 1.44)	
30 to 39	62	18.02	14	22.58	1.01 (0.91 - 1.13)	
40 to 49	88	25.58	17	19.32	0.98 (0.89 - 1.09)	
50 to 59	84	24.42	16	19.05	0.98 (0.89 - 1.09)	
>60	86	25.00	18	20.93	1	
Education level						0.050
No education	7	2.03	1	14.29	0.94 (0.73 -1.20)	
Elementary grades 1-4	117	34.01	33	28.21	1.05 (0.92 - 1.19)	
Elementary grades 5-8	104	30.23	14	13.46	0.93 (0.82 - 1.05)	
High school	79	22.97	21	26.58	1.04 (0.91 - 1.19)	
Higher education	37	10.76	8	21.62	1	
Marital status						0.093
Has partner	203	59.01	39	19.21	1.00	
No partner	141	40.99	38	26.95	1.06 (0.99-1.14)	
Family income						0.070
<2 MS	161	46.80	44	27.33	1.12 (1.01 - 1.25)	
2-5 MS	146	42.44	28	19.18	1.05 (0.94 - 1.17)	
>5 MS	37	10.76	5	13.51	1	
HD vintage						0.094
≥60 months	128	37.21	35	27.34	1.00 (0.99 - 1.15)	
<60 months	216	62.79	42	19.44	1	
Kt/V						0.005
≥1.2	288	83.72	71	24.65	1.12 (1.03 - 1.22)	
<1.2	56	16.28	6	10.71	1	
kcal/kg IW						0.002
≥35	29	8.43	2	6.90	1	
<35	315	91.57	75	23.81	1.15 (1.05 - 1.27)	
nPNA (g/kg IW)						>0.001
Adequate (≥1 g)	173	50.29	26	15.03	1	
Inadequate (<1 g)	171	49.71	51	29.82	1.12 (1.05 - 1.21)	

Note: *Wald test.
PR: Prevalence Ratio; 95%CI: Confidence Interval of 95%; nPNA: normalized Protein Nitrogen Appearance; MS: Minimum Salary; HD: Hemodialysis; Kt/V: Dialysis Adequacy Index; IW: Ideal Weight.

two minimum salaries (27.33%), whose prevalence was 1.12 times higher than that of patients with family income above five minimum salaries. Malnutrition was also associated with Kt/V above 1.2 (24.65%). An energy intake below 35 kcal/kg/day (23.81%) and nPNA below 1.0 g/kg (29.82%) increased the prevalence of malnutrition by 1.15 and 1.12 times, respectively (Table 2). The variables gender, physical activity, smoking status, alcohol intake, comorbidities, and etiology were not associated with malnutrition and were not tested in the final multivariate analysis model (p>0.20).

Multivariate analysis included the following variables: age, education level, marital status, family income, HD vintage, Kt/V, energy intake, and nPNA. In the final multivariate analysis model, the following factors remained associated with malnutrition: age between 19 and 29 years (PR=1.23; 95%CI=1.06-1.43), family income below two minimum salaries (PR=1.13; 95%CI=1.01-1.20), longer HD vintage (PR=1.08; 95%CI= 1.01-1.16), energy intake below 35 kcal/kg/day (PR=1.22; 95%CI=1.10-1.34), and inappropriate nPNA (PR=1.13; 95%CI=1.05-1.21) (Table 3).

Table 3. Final multivariate analysis model of malnutrition in hemodialysis patients. *Goiânia* (GO), Brazil, 2010.

Variables	Adjusted PR	95%CI	p-value*
Age (years)			
19 to 29	1.23	1.06-1.43	0.006
30 to 39	1.00	0.90-1.12	0.929
40 to 49	0.98	0.89-1.08	0.713
50 to 59	0.96	0.87-1.07	0.485
>60	1	-	-
Family income			
<2 MS	1.13	1.01-1.27	0.020
2-5 MS	1.05	0.94-1.17	0.356
>5 MS	1	-	-
HD vintage			
<60 months	1		
≥60 months	1.08	1.01-1.16	0.035
Kt/V			
≥1.2	1.12	1.03-1.22	0.010
<1.2	1	-	-
kcal/kg IW			
≥35	1	-	
<35	1.22	1.10- 1.34	<0.001
nPNA (g/kg IW)			
Adequate (≥1 g)	1	-	
Inadequate (<1 g)	1.13	1.05-1.21	0.001

Note: *Wald test.
PR: Prevalence Ratio; CI: Confidence Interval of 95%; nPNA: normalized Protein Nitrogen Appearance; MS: Minimum Salary; HD: Hemodialysis; IW: Ideal Weight; Kt/V: Dialysis Adequacy Index.

DISCUSSION

The prevalence of mild and moderate malnutrition in the study sample was 22.40% according to the SGA. This prevalence was lower than that found by Steiber *et al.*[2], who found a prevalence of moderate malnutrition of 29.00% in 156 HD patients, and higher than that found by the multicentric contrast study[3], which used the same diagnostic method (SGA <6) and found a prevalence of moderate malnutrition of 17.00% in 560 patients. On the other hand, the percentage of malnourished patients in the present study was similar to that reported by the Netherlands Co-operative Study Adequacy of Dialysis II (NECOSAD-II), where 23.00% (n=1,601) of the patients were moderately malnourished[1]. Severe malnutrition defined by an SGA score of 1 or 2 also was not found by other studies[2,3].

The prevalence of mild and moderate malnutrition found by earlier Brazilian studies varied from 39.7 to 80.0%[22-24]. However, comparison with such studies is inconclusive because they either used other SGA classification methods[22,23] or small sample sizes[24].

Malnutrition in HD patients has complex etiology, possibly resulting from disease- and treatment-related factors that further reduce food intake and increase protein catabolism, such as age, poor dialysis, psychosocial problems, hormonal imbalances, comorbidities, metabolic acidosis, inflammatory processes, and HD-related nutrient losses. Early detection of nutritional changes is critical since severe malnutrition is harder to treat[25]. In the present study, the risk factors that determined nutritional inadequacies were age, family income, HD vintage, dialysis adequacy, energy intake, and nPNA.

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The younger individuals in the study sample were at greater risk of malnutrition, contrary to Burrowes *et al*.[26], who found that older patients had worse nutritional status. Our younger patients had lower weight, BMI, percentage of body fat, and lean body mass, and the main etiology was glomerulonephritis (data not shown). The factors that possibly worsened the nutritional status of these younger adults were inadequate protein intake along with higher energy expenditure secondary to age and dialysis-related catabolism[6,7]. In these cases the principal recommendations for correcting nutritional status are greater surveillance, proper food intake and more physical activity to increase body weight, especially lean body mass[5,6,9].

The inverse relationship between malnutrition and family income reinforces the influence of the latter on nutritional status, exposing the individual to food insecurity and violating one of the principles of a healthy diet, which is guaranteed physical and financial access to appropriate food[27]. Poor access to appropriate food worsens nutritional status, decreases adherence to treatment, increases mortality, and reduces survival[28].

Patients with HD vintage longer than five years were more likely to be malnourished, corroborating Chumlea *et al.*[29], who found a direct association between long HD vintage and poor nutritional parameters. Additionally, hemodialysis is highly catabolic, promoting significant loss of essential nutrients, such as amino acids, proteins, vitamins, and glucose[7]. If these nutrients are not adequately replenished, nutritional status may worsen over time. Bohé & Rennie[6] claim that individuals on dialysis three times a week lose 2 kg of lean body mass a year.

The prevalence of malnutrition was also higher in study individuals with adequate dialysis according to the Kt/V index. Since malnourished individuals have smaller body volumes, they are susceptible to an increase in Kt/V, so the possibility of malnutrition exists even when dialysis is efficient[10]. However, inadequate dialysis may indirectly compromise nutritional status, since underdialyzed patients with Kt/V below 1.2[21] can experience less hunger because of the accumulation of uremic toxins[25]. Nevertheless, some studies did not find associations between Kt/V and nutritional status or survival, and shorter HD sessions (<3 hours/session) were associated with higher mortality, regardless of Kt/V[30,31]. The Hemo study (n=1,846) found that random patients receiving a high dialysis dose (Kt/V 1.65) did not consume more energy and proteins than random patients receiving the standard dose (Kt/V 1.25); moreover, both groups experienced similar weight loss and serum albumin reduction[32].

The factors mentioned earlier, namely age, income, and HD vintage, lead to low energy and protein intakes, which directly impact nutritional status. Inadequate food intake, which generally begins before the introduction of renal replacement therapy[12], is one of the main determinants of worse clinical outcomes in these patients, promoting weight loss, decreasing survival, and increasing morbidity and mortality[10,12].

Patients with inadequate energy and protein intakes had higher prevalence of malnutrition, suggesting that energy and protein deficits play an important role in malnutrition in dialysis patients. Low protein and especially energy intakes have been observed in HD patients[24].

The vast majority of the study sample (91.57%) ingested fewer than 35 kcal/kg/day; of these, 47.97% ingested fewer than 25 kcal/kg/day, and the nPNA of 49.71% was below 1.0 g/kg/day. This is concerning because, according to the classical study by Slomowitz *et al.*[25], 35-45 kcal/kg/day are necessary to revert a negative nitrogen balance in individuals consuming fewer than 25 kcal/kg/day. At least 1.0 g of protein/kg/day is necessary to replenish the nutrients lost in hemodialysis and achieve positive nitrogen balance in clinically stable patients[12]. Additionally, adequate energy intake prevents the use of protein for energy[25].

Malnutrition has an objective repercussion on anthropometric and laboratory parameters, resulting in low body weight, fat store depletion, body protein loss, and low serum albumin and creatinine in HD patients[9,25]. These parameters were lower in the malnourished study patients, except for serum albumin. This indicates the importance of HD patients gaining body weight, especially lean body mass, because weight gain would imply better functional and immune statuses, greater independence, and lower malnutrition-related morbidity and mortality[6].

One of the study limitations was the impossibility of analyzing an inflammatory marker capable of distinguishing between malnutrition and inflammation-induced malnutrition. Only eleven (14.29%) of the malnourished study patients had serum albumin below 3.8 g/dL, suggestive of malnutrition and inflammation[2], a prevalence lower than the 18% found by Steiber *et al.*[2]. Since most of the study population had serum albumin above 4 g/dL and were not malnourished, inflammation probably had at most a small influence on their nutritional status. Another limitation is not having analyzed the residual diuresis of 27 patients to calculate PNA. However, PNA remained associated with malnutrition even when these patients' data were excluded from data analysis.

Another limitation is the use of the 24-hour recall to investigate food intake since this instrument is subject to the interviewee's memory and collaboration, and to underreporting and overreporting. However, the use of six dietary recalls improved the accuracy of the food intake data because it reduced the intrapersonal daily intake variability[33]. The study strengths are the use of a sample representative of the HD population of *Goiânia* (GO) and analysis of the isolated effect of many factors that can impact the nutritional status of these patients.

CONCLUSION

The prevalence of malnutrition in the study population was high, corroborating the literature. The prevalence was greater in patients aged less than 29 years and in those with low family income, longer hemodialysis vintage, higher Kt/V, and inadequate calorie and protein intakes. Strategies to revert this situation should include greater nutritional care.

CONTRIBUTORS

ATVS FREITAS, IMF VAZ, and SF FERRAZ helped to conceive the study; collect, analyze, and interpret the data; and write the manuscript. MRG PEIXOTO helped to analyze and interpret the results and to write the manuscript. MIVM CAMPOS helped to interpret the data. All authors reviewed the manuscript.

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