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Prevalence of hyperphosphatemia and phosphorus intake in patients with chronic renal disease undergoing hemodialysis in a medium-sized Brazilian municipality

Prevalência de hiperfosfatemia e consumo de fósforo em portadores de doença renal crônica em tratamento hemodialítico em um município brasileiro de médio porte

Abstract

Objective: To estimate the prevalence of hyperphosphatemia and its correlation with dietary phosphorus intake in individuals undergoing hemodialysis in a medium-sized Brazilian municipality. ***Methods:*** This is a cross-sectional study with adult and elderly patients of both sexes undergoing treatment at a dialysis center in a medium-sized Brazilian municipality. Data were collected through a structured questionnaire containing sociodemographic questions, biochemical examination, and three 24-hour dietary recall interviews. ***Results:*** The final sample consisted of 75 participants, the majority of which were male (54.7%) and in the 36–59 years age group (56%). The prevalence of hyperphosphatemia was 45.9%, and 21.3% of participants had a dietary phosphorus intake above the recommended limits. However, there was a negative and significant correlation (P = 0.01) between phosphorus intake and serum phosphorus concentration. ***Conclusion:*** The prevalence of hyperphosphatemia in the studied sample of hemodialysis patients was high but showed a low correlation with dietary phosphorus intake, suggesting that it may be associated with nondietary factors such as ineffective hemodialysis or low adherence to phosphate binder therapy.

Keywords: Food consumption. Chronic kidney disease. Hyperphosphatemia.

Resumo

Objetivo: Estimar a prevalência de hiperfosfatemia e sua correlação com o consumo alimentar de fósforo em indivíduos submetidos ao tratamento de hemodiálise em um município brasileiro de médio porte. ***Métodos:*** Estudo transversal, realizado com pacientes adultos e idosos, de ambos os sexos, cadastrados em uma unidade hemodialítica de um município brasileiro de médio porte. Foi aplicado um questionário estruturado que continha questões relativas a variáveis sociodemográficas, exame bioquímico e um inquérito dietético por meio de três recordatórios alimentares de 24h. ***Resultados:*** O estudo foi realizado com 75 participantes, de ambos os sexos, sendo a maioria do sexo masculino (54,7%), predominantemente na faixa etária de 36-59 anos (56%). A prevalência de hiperfosfatemia na amostra foi de 45,9%, e 21,3% dos participantes apresentaram consumo alimentar de fósforo acima das recomendações nutricionais. Entretanto, verificou-se correlação negativa e significativa (p = 0,01) entre o consumo de fósforo e a concentração sérica deste nutriente. ***Conclusão:*** Pode-se concluir que a prevalência de hiperfosfatemia nesses pacientes em hemodiálise foi alta, porém com baixa correlação com a ingestão alimentar do nutriente, podendo estar associada a fatores

não dietéticos como ineficácia do tratamento de hemodiálise e baixa adesão ao uso de quelantes.

Palavras-chave: Consumo alimentar. Doença renal crônica. Hiperfosfatemia.

INTRODUCTION

Chronic kidney disease (CKD) is a worldwide public health problem affecting countries of different economic levels. Its occurrence is associated with the widespread increase in the prevalence of diabetes and hypertension, risk factors for CKD.[1] Hemodialysis is the main treatment option to improve the quality of life of individuals with end-stage kidney disease.[1-3]

Dietary habits directly interfere with life quality, which is why nutritional monitoring becomes essential at this stage.[4] CKD patients must limit the intake of certain foods, particularly those rich in phosphorus, as high phosphorus levels can induce bone complications and increase mortality rates.[5]

Hyperphosphatemia (i.e., high serum phosphorusconcentration) is associated with increased CKD progression, mortality risk, and rate of cardiovascular events.[6] The disorder may arise from ineffective treatment and substantially increase the risk of comorbidities.[5,7] Simple strategies can be applied to control hyperphosphatemia, such as balanced nutrition, use of phosphate binders, and routine hemodialysis sessions.[8] Nevertheless, the prevalence of hyperphosphatemia is high among CKD patients. Nerbass et al.[5] found that 62 and 28% of hemodialysis patients in Santa Catarina and Tocantins, Brazil, respectively, were affected by the disorder.

The present study aimed to estimate the prevalence of hyperphosphatemia in CKD patients attending a dialysis center in a medium-sized Brazilian municipality and correlate dietary phosphorus intake with serum phosphorus levels.

MATERIAL AND METHODS

This is a cross-sectional study conducted with adult and elderly patients of both sexes undergoing hemodialysis in a dialysis center in a medium-sized Brazilian municipality. The research is part of a larger study entitled "*Perfilsociodemográfico, comportamental, clínico, antropométrico e dietético de pacientessubmetidos à hemodiálise do município de Barreiras-BA*" (Sociodemographic, behavioral, clinical, anthropometric, and dietary profile of patients undergoing hemodialysis in Barreiras, Bahia, Brazil). The sample included patients older than 18 years who attended the selected healthcare facility and signed an informed consent form. Pregnant women and patients who were unable to answer the questionnaire were excluded from the study. All patients who met the inclusion criteria were invited to participate. This research was approved by the Human Research Ethics Committee of the*UniversidadeFederal do Oeste da Bahia* (Federal University of Western Bahia, protocol no. 83803418.3.0000.8060).

Data were collected from June to December 2018 using a structured questionnaire, medical records, and 24-hour dietary recall (24HR) interviews. The structured questionnaire contained questions about sociodemographic characteristics, including sex (dichotomized into female and male), age (recorded in completed years and categorized into the age groups 20–35, 36–59, and ≥60 years), and socioeconomic level (classified into A and B, C, and D and E, according to the *AssociaçãoBrasileira de Empresas de Pesquisa*[9], (Brazilian Association of Research Companies).

Biochemical data (serum phosphorus levels) were obtained from the patients' medical records and used to identify the presence of hyperphosphatemia, defined as serum phosphorus concentrations above 5.5 mg/dL.[10]

Three 24HR interviews were conducted on alternate days using the automated multiple-pass method developed by the United States Department of Agriculture. The approach consists of five steps (quick list, forgotten food list, time and occasion list, detail cycle, and general review) that are applied according to a

standardized process[11] to improve the recall of dietary information. We used the food photo album of Monteiro and Chiarello[12] to assist the participants in specifying and quantifying foods.Food quantities were reported in household measures and converted to grams or milliliters based on the reference table of Pinheiro et al.[13] Subsequently, the data were transcribed into the Brasil-NUTRI®software, developed by the*Instituto Brasileiro de Geografia e Estatística* (Brazilian Institute of Geography and Statistics) for the 2008–2009 Family Budget Survey.[14,15] Energy and protein intakes were calculated and expressed per kilogram of body weight (BW), in agreement with Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines, which recommend a daily energy intake of 30 to 35 kcal/kg BW and a daily protein intake of 1.2 g/kg BW.[16,17] A daily phosphorus intake between 800 and 1000 mg/day was considered adequate, in line with the European Best Practice Guidelines (EBPG).[18]

Statistical analysis

Statistical analyses were performed using Stata version 13.1. Continuous variables are presented as mean, median, and interquartile range and categorical variables as frequency. The normality of data distribution was assessed by the Shapiro–Wilk test. Nondichotomous variables were subjected to Student's *t*-test or Mann–Whitney *U*-test ($P \leq 0.05$), depending on their distribution. Spearman's test was used to investigate linear correlations between dietary phosphorus intake and serum phosphorus levels.

RESULTS

During the course of the study, the dialysis center attended 90 CKD patients. Pregnant women or individuals under the age of 18 years ($n = 6$), patients who refused to participate ($n = 2$), individuals with cognitive deficit ($n = 1$), and individuals who were discharged or died ($n = 6$) were not included in the study. Thus, the final sample consisted of 75 patients, the majority of which were male (54.7%), aged 36–59 years (56%), and of an intermediate socioeconomic level (45.3%) (data not shown).

The mean and median energy intake was 1312.52 ± 554.25 kcal/day and 1292.09 kcal/day (P25 = 1056.10, P75 = 1624.79), respectively, corresponding to 21.96 ± 8.43 kcal/kg BW/day. Macro- and micronutrient analyses revealed that the mean protein intake was 67.45 ± 32.17 g/day; and the median intake, 67.46 g/day (P25 = 50.46, P75 = 83.81) or 1.12 ± 0.49 g/kg BW/day. The median phosphorus intake was 604.17 mg/day (P25 = 496.88, P75 = 784.24). Dietary energy ($P = 0.02$) and carbohydrate ($P = 0.01$) intakeswere higher in men than in women (Table 1).

Table 1. Energy and macronutrient intake of female and male patients on hemodialysis in a dialysis center in western Bahia, Brazil, 2018.

Variable	Total		Female patients		Male patients		*P*-value
	Mean (SD)	Median (P25–P75)	Mean (SD)	Median (P25–P75)	Mean (SD)	Median (P25–P75)	
Energy (kcal)	1312.52 (554.25)	1292.09 (1056.10–1624.79)	1210.85 (388.87)	1242.74 (960.09–1493.48)	1442.18 (472.21)	1354.68 (1131.45–1743.52)	0.02*
Carbohydrate (g)	137.27 (71.29)	166.00 (126.94–217.46)	151.95 (52.26)	147.26 (112.13–183.58)	188.40 (73.58)	171.96 (104.25–227.75)	0.01**
Protein (g)	67.45 (32.17)	67.46 (50.27–83.81)	62.99 (25.47)	59.60 (44.79–78.96)	73.15 (28.11)	70.63 (55.61–83.81)	0.10*
Fat (g)	37.96 (22.64)	39.21 (29.16–52.29)	38.33 (16.50)	34.84 (26.10–52.29)	69.47 (17.04)	41.48 (31.53–51.31)	0.15**
Phosphorus (mg)	654.55 (269.02)	604.17 (496.88–784.24)	583.93 (204.32)	577.23 (412.25–699.88)	713.12 (302.80)	652.53 (498.51–922.00)	0.03*

Abbreviations: SD, standard deviation; P25–P75, 25th to 75th percentile.
* Student's *t*-test.

** Mann–Whitney *U*-testPhosphorus intake was higher than the recommended for CKD patients in 21.3% of cases. The mean duration of hemodialysis treatment was 40.9 months, and the prevalence of hyperphosphatemia was 45.9% (*n* = 34). Hyperphosphatemia prevalence was highest among men (61.76%; *P* = 0.012), patients aged 36–59 years (47.06%), and individuals with a low socioeconomic level (50.00%). Among CKD patients with hyperphosphatemia, only 5.88% had an adequate phosphorus intake, and 26.47% had a protein intake higher than the recommended (Table 2).

Table 2. Sociodemographic characteristics of hemodialysis patients attending a dialysis center in western Bahia, Brazil, 2018, stratified by presence of hyperphosphatemia.

Variable	Hyperphosphatemia		*P*-value
	Yes (%)	No (%)	
Sex			0.012
Female	61.76	32.50	
Male	38.24	67.50	
Age group (years)			0.445
18–35	32.35	17.50	
36–59	47.06	65.00	
≥60	20.59	17.50	
Socioeconomic level			0.380
High (A and B)	8.82	12.50	
Intermediate (C)	41.18	47.50	
Low (D and E)	50.00	40.00	
Protein intake			0.167
Below the recommended	64.71	50.00	
Adequate	8.82	7.50	
Above the recommended	26.47	42.50	
Phosphorus intake			0.179
Below the recommended	85.29	70.00	
Adequate	5.88	25.00	
Above the recommended	8.82	5.00	

We observed a negative and significant correlation (*P* = 0.01, *r* = −0.87) between phosphorus intake and serum concentration. After stratifying by sex, weak and negative correlations were observed between the variables (male, *P* = 0.27 and *r* = −0.17; female, *P* = 0.24, r = −0.20). These results are shown in Figure 1.

Insert Figure 1

DISCUSSION

The results of the present study showed that 45.9% of hemodialysis patients had hyperphosphatemia and 21.3% had a dietary phosphorus intake above the recommended for CKD patients on hemodialysis. Despite these findings, a negative significant correlation (*P* = 0.01) was observed between phosphorus intake and serum phosphorus concentration.

In contrast to the results of Hill et al.,[19] the majority of CKD patients in the present study were male (54.7%). On a global level, females are more affected by CKF than males.[19] However, reports from Brazil show that the majority of CKD patients are male. The Brazilian Census of Nutrition in Hemodialysis[20] found that

58.4% of the interviewed individuals undergoing hemodialysis were male and aged less than 60 years (63.1%). In Brasília, Souza et al.[21] observed that 61.5% of CKD patients attending a public hospital were male.

The prevalence of hyperphosphatemia was high (45.9%) in the current study, in agreement with the findings of Abrita et al.,[22] who observed that 35.8% of patients from 11 dialysis centers of the*Associação de Centros de Nefrologia do Estado de Minas Gerais* (Association of Nephrology Centers of the State of Minas Gerais, AMICEN) had serum phosphorus levels above 5.5 mg/dL. These results are a cause for concern, as long-term hyperphosphatemia can exert negative health effects and increase mortality rates.[8]

The study participants had a low energy intake and an adequate protein intake, according to K/DOQI recommendations. K/DOQI guidelines state that patients on hemodialysis should have daily energy and protein intakes of 30–35 kcal/kg BW and 1.2 g/kg BW, respectively. At least 50% of the protein intake should be derived from high biological value proteins.[16,17] Machado et al.,[23] in a study conducted with 34 patients on hemodialysis in São Paulo State, identified a mean energy consumption of 19.0 kcal/kg BW, similar to our results. However, the protein intake (0.9 g/kg BW)[23] was lower than that found here.

Nutrient intake is an important indicator of quality of life in CKD patients. For instance, low energy and protein intakes are closely associated with malnutrition and impaired ability to carry out daily activities resulting from fatigue and pain.[4] Santos et al.[4] emphasized that individualized nutritional monitoring is of great importance to improve the patient's diet quality, nutritional status, and quality of life.

The mean dietary phosphorus intake was 654.55 mg/day. Most participants had a low intake of the nutrient, according to EBPGrecommendations. We also observed a negative correlation between phosphorus intake and serum levels. Such results agree with those of Machado et al.,[23] who reported that CKD patients on hemodialysis had a phosphorus intake of 612.5 mg/day and that intake was negatively correlated with serum phosphorus levels. Thus, it is possible to conclude that increased serum phosphorus concentrations may be associated with nondietary factors, such as low adherence to phosphate binder therapy or ineffective hemodialysis treatment.[8]

The method used to estimate daily food intake can be considered a limitation, as dietary data may have been under- or overestimated and do not reliably reflect the individual's eating habits. We sought to minimize this bias by conducting three 24HRinterviews on alternate daysusing a food photo album. The strength of this research lies in the fact that few studies have been carried out to correlate hyperphosphatemia and dietary phosphorus intake in CKD patients in Brazil.

CONCLUSION

We observed a high prevalence of hyperphosphatemia in CKD patients on hemodialysis in western Bahia, Brazil. The occurrence ofhyperphosphatemia was not correlated with nutrient intake, indicating that nondietary factors, such as ineffective hemodialysis treatment and low adherence to phosphate binder therapy, are associated with the disorder. Therefore, nutritional monitoring and educational actions should be carried out frequently to reduce the risk of morbidity andmortality in patients on hemodialysis. Future studies should investigate the prevalence and factors associated with hyperphosphatemia for an increased understanding of this disorder.

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Contributors

Silva DCG and Cunha MSB contributed to the study conception and design, data analysis and interpretation, and approval of the final version of the manuscript. Souza MKVA, Almeida JNMA, and Santos TC contributed to data collection, database development, and revision of the final version of the manuscript.

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