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Association of nutritional status with handgrip strength in patients with chronic kidney disease

Associação do estado nutricional com a força de preensão palmar em pacientes com doença renal crônica

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ABSTRACT

Objective
Evaluation of handgrip strength with indicators of nutritional status in chronic kidney disease patients.

Methods
This is a cross-sectional, descriptive study, with an analytical approach conducted at Hospital das Clínicas de Pernambuco, Recife, Brazil, between May and September 2022. Demographic, clinical, anthropometric and biochemical variables were evaluated. Individuals, males and females, were classified with low or high handgrip strength. The upper left or right limb was assessed, based on a national reference standard.

Results
A total of 81 patients of both genders were included in the investigation. Their mean age was 54.69±16.03 years. According to the muscle mass index, 12.3% and 18.7% of adult and elderly patients were classified as malnourished respectively. Regarding handgrip strength (HGS), 92.4% of the participants were classified as low handgrip strength patients. These had a higher mean age (55.81±15.91), lower mean height (1.61±0.09) and reduced arm muscle circumference (23.48±4 .24), showing a statistical significance of p=0.025; 0.045 and 0.022 respectively.

Conclusion
It can be concluded that low handgrip strength is associated with patients' reduced muscle mass and older age, and it is suggested that handgrip strength can be used routinely in the clinical practice as a predictor of loss of lean mass in chronic kidney disease patients.

Keywords: Kidney disease. Muscle strength. Nutrition. Nutritional assessment.

RESUMO

Objetivo
Avaliar a associação da força de preensão palmar com indicadores do estado nutricional em doentes renais crônicos.

Métodos
Trata-se de um estudo transversal, descritivo, com abordagem analítica. Realizado entre maio e setembro de 2022, no Hospital das Clínicas de Pernambuco, Recife, Brasil. Foram avaliadas variáveis demográficas, clínicas, antropométricas e bioquímicas. Os indivíduos foram classificados como baixa ou alta força de preensão palmar, segundo o sexo e o membro superior avaliado, a partir de um padrão de referência nacional.

Resultados
Foram incluídos 81 pacientes de ambos os sexos, com uma média de idade entre 54,69±16,03 anos. Segundo o índice de massa muscular 12,3% e 18,7% dos pacientes adultos e idosos respectivamente estavam classificados como desnutridos. Quanto à força de preensão palmar, 92,4% dos pacientes foram classificados como baixa força. Os pacientes com baixa força de preensão palmar, tinham uma maior média de idade (55,81±15,91), menor média de altura (1,61±0,09) e circunferência muscular do braço reduzida (23,48±4,24), mostrando uma significância estatística de p=0,025; 0,045 e 0,022 respectivamente.

Conclusão
Pode-se concluir que a baixa força de preensão palmar está associada a massa muscular reduzida e a idade elevada dos pacientes e sugere-se que a força de preensão palmar possa ser utilizada de rotina na prática clínica como preditor de perda de massa magra em pacientes com doença renal crônica.

Palavras-chave: *Doença renal. Força muscular. Nutrição. Avaliação nutricional.*

INTRODUCTION

Chronic Kidney Disease (CKD) is defined as a decrease in Glomerular Filtration Rate (GFR) to less than 60 ml/min/1.73 m^2 measured on at least two separate occasions within a 90-day period, with or without markers of kidney injury [1]. CKD is considered a public health problem and is associated with high rates of morbidity and mortality, with serious socioeconomic impact being a challenge for public health worldwide [2].

In Brazil, it is estimated that within a population of approximately 200 million inhabitants, 11 to 22 million adults have some kind of kidney problem. In 2017, more than 690 million new cases of CKD at different stages were registered worldwide. Thus, it can be said that the global prevalence is 9.1% [3]. The regions of the country have different incidences; however, in general it is believed that 8% to 10% of the population has some degree of kidney impairment [4].

Patients with CKD often present with dynapenia (age-related progressive loss of muscle strength) which is a consequence of increased catabolism related to high production of inflammatory cytokines, metabolic acidosis, hormonal changes, dietary restrictions, aging, and comorbidities such as diabetes and infections [5]. Dynapenia can result in disability, increased falls and fractures, decreased quality of life, and increased cardiovascular disease [6].

Although there is no universal marker of nutritional status, the assessment of anthropometric parameters (weight, height, arm circumference, calf circumference and triceps skinfold), arm muscle circumference, body mass index, handgrip strength and biochemical tests are widely recommended to help establish a more accurate nutritional diagnosis [7].

Handgrip Strength (HGS) is a method used in the clinical practice, especially in patients with CKD, as it is a simple and safe procedure that translates the muscle function and its combination with lean mass as well as with nutritional and inflammatory status. HGS is also considered a prognostic marker for CKD patients [8]. Through this instrument, we can monitor patients who have experienced a considerable deterioration of their nutritional status before the manifestations of any other health intercurrences. Thus, dynamometry has shown to be a practical nutritional screening tool that can be used for kidney patients [9].

Sarcopenia is a chronic condition associated with the physiological aging process characterized by muscle mass, strength and function reduction. This condition is also found in kidney patients associated with progressive and cumulative loss of muscle mass known as uremic sarcopenia, and may be present in all stages of CKD; however, the more severe the loss of kidney function, the greater the risk of sarcopenia in these patients [10]

Therefore, continuous monitoring of the nutritional status of patients with CKD, through a close and complete nutritional assessment, is extremely important for an early diagnosis of nutritional problems [11]. Thus, the objective of this study was to evaluate the association of handgrip strength with other nutritional status parameters in chronic kidney patients.

METHODS

This is a cross-sectional, descriptive study with an analytical approach carried out at the *Hospital das Clínicas de* Pernambuco, Recife, Brazil, between May and September 2022. The sample was for convenience, and patients of both genders, aged over 20 years, admitted to the hospital with a diagnosis of CKD, undergoing dialysis treatment or not, and who did not meet previously established exclusion criteria were invited to participate in the study.

The study excluded pregnant or nursing patients, those diagnosed with malignant diseases, chronic infections (HIV/AIDS, Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome, arthritis and tuberculosis), edema of the lower and upper limbs, in addition to severe liver failure and those who had physical limitations (paralysis or amputation of the lower or upper limbs) or cognitive limitations (cerebral palsy, Alzheimer's, Down syndrome and autism) that could interfere with the nutritional assessment or diagnosis due to a limitation in the use of the method and/or a change in reference values, such as the group of pregnant women.

Sociodemographic data were collected through a bedside interview with the patient. The variables collected were age, gender, education, occupation, marital status, self-reported race, comorbidities (diabetes and hypertension), and stage of kidney disease. Weight and height were measured for the anthropometric assessment, and the Body Mass Index (BMI) was subsequently calculated, classified according to the World Health Organization (WHO) [12] for adults and to Lipschitz [13] for the elderly.

The averages obtained for Arm Circumference (AC) and Triceps Skinfold (TSF) were calculated according to the techniques of Lohman, Roche, and Martorell [14], and the percentiles were according to the Frisancho classification [15]. Next, the calculation of the Arm Muscle Circumference (AMC) was performed according to the equation, AMC (cm) = AC (cm) – [0.314 × TSF (mm)] and classified according to Blackburn and Thornton [16].

Calf Circumference (CC) was also assessed, with a cutoff point of eutrophy equal to or greater than 31 cm, according to Lohman, Roche and Martorell [14]. A Jamar® hydraulic hand dynamometer was used to measure HGS. Patients were instructed to hold the dynamometer with maximum force in the orthostatic position with the arm at a right angle and the elbow at the side of the body, forming a 90° angle [8]. Three measurements were collected on the non-dominant arm with a one-minute rest interval between them, and the highest value obtained from the three measurements was used for HGS. Individuals were classified according to their gender and the upper limb measurement was considered low in the following cases: for males, handgrip strength <42.8 kg for the right hand and <40.9kg for the left hand, and for females <25.3kg and <24.0kg respectively according to the national reference [17].

To assess the risk of malnutrition in hospitalized patients, the malnutrition screening tool known as MST (Malnutrition Screening Tool) was used. Patients with scores greater than two were classified as at risk of malnutrition and less than two as without risk of malnutrition. To assess the biochemical parameters the following exams which are routine in the patients' hospital monitoring procedures were performed: serum levels of urea, creatinine, hemoglobin, hematocrit, Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), C-Reactive Protein (CRP) and serum albumin.

The results were collected from the patients' electronic medical record and recorded in specific monitoring spreadsheets. The glomerular filtration rate was also calculated using the patient's creatinine and age using the eGRF application, which uses the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) creatinine equation, 2021. This measurement, called creatinine clearance, allows a more accurate assessment of the patient's renal function.

The IBM®SPSS® program (version 20) was used for statistical calculations. Continuous variables were tested for normal distribution using the Kolmogorov–Smirnov test [18]. The variables presented a normal distribution and were therefore expressed as mean and standard deviation. Regarding data analysis, the Chi-square test was used to assess the association between categorical variables and the Student's *t*-test to compare means with normal distribution. Values of $p<0.05$ were considered significant.

The study was approved by the ethics committee of the *Hospital das Clínicas* of the Federal University of Pernambuco under CAAE: 55155422.8.0000.8807 and number 5,284,961. All participants signed the Free and Informed Consent Form to participate in the study.

RESULTS

Eighty-one patients were evaluated, 60.5% of whom were adults and 39.5% were older adults, with a mean age of 54.69±16.03 years. Out of these, 50.6% were female. Regarding education, 30.9% had completed high school and 51.9% had low education. It was reported that 58% of the patients evaluated had a partner and 49.4% were unemployed at the time of the interview (Table 1).

According to the Glomerular Filtration Rate (GFR), the majority (50.6% of the patients) were in stage 5 of the disease and were already undergoing dialysis treatment, and 30.9% were in stage 4, undergoing conservative renal treatment (Table 1).

Table 1 – Sociodemographic and clinical characteristics of patients with chronic kidney disease. Recife (Brazil), 2022.

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Variables	n	%
Age		
Adults (22-59 years)	49	60.5
Older adults (≥60 years)	32	39.5
Gender		
Male	40	49.4
Female	41	50.6
Ethnicity		
White	14	17.3
Yellow	3	3.7
Brown	41	50.6
Black	23	28.4

Table 1 – Sociodemographic and clinical characteristics of patients with chronic kidney disease. Recife (Brazil), 2022.

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Variables	n	%
Education		
Elementary School I	16	19.8
Elementary School II	24	29.6
High School	25	30.9
Higher Education	14	17.3
Illiterate	2	2.5
Occupation		
Retired	23	28.4
Unemployed	40	49.4
Self-employed	8	9.9
Employed or civil servants	10	12.3
Marital Status		
With a partner	47	58.0
Without a partner	34	42.0
Diabetes		
Yes	28	34.6
No	53	65.4
Hypertension		
Yes	58	71.6
No	23	28.4
Glomerular Filtration Rate		
Grade 01	2	2.5
Grade 02	3	3.7
Grade 03	10	12.3
Grade 04	25	30.9
Grade 05	41	50.6
Causes of Chronic Kidney Disease		
Primary glomerulopathies	3	3.7
Genetic diseases	2	2.5
Metabolic diseases	3	3.7
Systemic diseases	10	12.3
Others	63	77.8

The main causes of CKD found in the study were those of undetermined origin, caused by nephrectomy, lithiasis and medication, classified as "others" (77.8%). The majority of the patients studied had a diagnosis of hypertension (71.6%) (Table 1).

Regarding BMI, 12.3% and 18.7% of adult and elderly patients, were classified as malnourished respectively. On the other hand, it was found that 30.5% (adults) and 31.2% (elderly) patients were diagnosed as being overweight. Regarding AC and TSF, most patients were classified as malnourished (44.4% and 54.2%) (Table 2).

The AMC showed that 38.3% of the patients had a diagnosis of malnutrition. It was also found that most patients (59.3%) had hypoalbuminemia and 81.5% had anemia. As to HGS, 92.4% of patients were below average and only 7.4% had normal or high HGS (Table 2).

In Table 3, a significant association was observed between the nutritional variables AC, TSF, AMC, CC and MST with BMI (p<0.001), which was not observed with HGS (p=0.561).

In Table 4, it is reported that patients with low HGS had a higher mean age (55.81±15.91), lower mean height (1.61±0.09) and a reduced CMB (23.48 ±4.24), showing a statistical significance of p=0.025; 0.045 and 0.022 respectively.

Table 2 – Nutritional and clinical characteristics of chronic kidney disease patients. Recife (Brazil), 2022.

Variables	n	%
BMI (Adult)		
Malnutrition	6	12.3
Eutrophy	28	57.1
Overweight	15	30.5
BMI (Older adult)		
Thinness	6	18.7
Eutrophy	16	50.0
Overweight	10	31.3
AC		
Thinness	36	44.4
Eutrophy	35	43.2
Overweight	10	12.4
TSF		
Thinness	44	54.2
Eutrophy	16	19.8
Overweight	21	26.0
AMC		
Malnutrition	31	38.3
Eutrophy	50	61.7
MST		
Risk	14	17.3
No risk	67	82.7
hgs		
High	6	7.4
Low	75	92.4
Anemia		
Yes	66	81.5
No	15	18.5
Hypoalbuminemia		
Yes	48	59.3
No	33	40.7

Note: HGS: Handgrip Strength (mean undesired value: <40.9 kg for men and <24 kg for women); BMI: Body Mass Index classified according to World Health Organization [12]; (Adult) and Lipschitz, 1994 [13] (Elderly); AC (upper arm circumference) and TSF (triceps skinfold), Frisancho classification [15]; AMC (upper arm muscle circumference), Blackburn and Thornton classification [16]; MST (malnutrition screening tool), Lawson et al. [19]; Anemia (Men: hemoglobin <13.5 g/dL; Women: hemoglobin <12 g/dL), Hypoalbuminemia (<3.5 mg/dL).

Table 3 – Association of nutritional parameters according to the body mass index classification in chronic kidney disease patients. Recife (Brazil), 2022.

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Nutritional parameters	BMI						p^*
	Malnutrition		Eutrophy		Overweight		
	n	%	n	%	n	%	
AC							
Malnutrition	11	91.7	20	45.5	4	16	<0.001
Eutrophy	1	8.3	22	50	13	52	
Overweight	0	0	2	4.5	8	32	
TSF							
Malnutrition	11	91.7	25	56.8	8	32	0.001
Eutrophy	0	0	12	27.3	4	16	
Overweight	1	8.3	7	15.9	13	52	
AMC							
Malnutrition	11	91.7	17	38.6	3	12	<0.001
Eutrophy	1	8.3	27	61.4	22	88	
CC							
Malnutrition	10	83.3	12	27.3	1	4	<0.001
Eutrophy	2	16.7	32	72.7	24	96	

Table 3 – Association of nutritional parameters according to the body mass index classification in chronic kidney disease patients. Recife (Brazil), 2022.

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Nutritional parameters	BMI						p^*
	Malnutrition		Eutrophy		Overweight		
	n	%	n	%	n	%	
MST							
Risk	7	58.3	6	13.6	1	4	<0.001
No Risk	5	41.7	38	86.4	24	96	
HGS							
High	0	0	4	9.1	2	8	0.561
Low	12	100	40	90.9	23	92	

Note: p^*: Pearson's chi-square; BMI: Body Mass Index (World Health Organization [12] and Lipschitz [13]); AC: Mid-Upper Arm Circumference (Lohman et al. [14]); TSF: Triceps Skinfold (Lohman et al. [14]); AMC: Mid-Upper Arm Muscle Circumference (Blackburn & Thornton [16]); CC: Calf Circumference (Lohman et al. [14]); HGS: Handgrip Strength (Schlüssel [17]); MST: Malnutrition Screening Tool (Lawson et al. [19]).

Table 4 – Correlation of clinical and nutritional parameters with handgrip strength in chronic kidney patients. Recife (Brazil), 2022.

Clinical and nutritional parameters	Handgrip strength		p^*
	Normal n=6	Low n=75	
	Mean (SD)	Mean (SD)	
Age	40.67±10.61	55.81±15.91	0.025
Weight	74.62±21.04	63.55±17.22	0.140
Height	1.69±0.47	1.61±0.09	0.045
Body mass index	26.24±8.03	24.51±5.61	0.486
Mid-arm circumference	32.0±6.49	28.37±5.45	0.126
Triceps skinfold	13.52±9.41	15.33±7.46	0.575
Mid-arm muscle circumference	27.71±4.65	23.48±4.24	0.022
Calf circumference	35.17±4.08	33.52±5.26	0.458
Glomerular filtration rate	18.67±7.63	20.93±20.60	0.790
Hemoglobin	10.68±3.34	9.78±2.21	0.359
Hematocrit	32.55±9.76	30.09±6.83	0.413
Mean corpuscular volume	89.20±2.08	89.22±11.55	0.996
Mean corpuscular hemoglobin	29.15±1.14	29.57±3.05	0.738
C-reactive protein	1.18±1.89	3.69±5.67	0.287
Urea	88.67±14.5	102.99±42.32	0.414
Creatinine	4.67±2.10	4.68±2.66	0.994

Note: $^*p$: *t*-test.

DISCUSSION

The renal patients' low education level observed in this study corroborates the data of Santos et al. [20], who indicated a prevalence of 62.5% of patients with low education. It is important to emphasize that both studies were conducted in public institutions of the *Sistema Único de Saúde* (SUS, Unified Health System) that cares for a low-income population. The most prevalent comorbidities associated with the underlying disease in the present study were hypertension and DM; similar data were also found in other studies [9,21,22].

When reviewing a study with dialysis patients under 59 years of age and another study that included adults and older adults, a dominance of overweight and obesity (49.1%) [21] and (43.4%) [20], respectively, was reported among the different nutritional health problems. These data corroborate the present study and can be justified by the nutritional transition, known as "reverse epidemiology", that has been occurring in the Brazilian population [23].

In another study with patients undergoing conservative treatment, with the same patient profile as in this study, it was observed that excess weight was more significant (34%) [24]; similar data were also observed in the study by Amorim, Moura and Santos (61.4%) [25] which corroborate this study. The presence of overweight and obesity is more common in stages 2 and 3 of CKD, as eating habits and a sedentary lifestyle contribute to increased kidney damage and decreased glomerular filtration rate [26].

However, other anthropometric parameters such as AC and TSF indicated a high prevalence of malnutrition, data that corroborate other studies [11,17,27]. Low weight may be more evident in patients undergoing dialysis treatment, due to dietary restrictions, electrolyte changes and loss of muscle mass [28].

When analyzing the significant association of BMI with AC, TSF, AMC, CC and nutritional screening (MST), we observed agreement of the main nutritional parameters that are used in the clinical practice, as well as the importance of using several methods to define the nutritional diagnosis, since there is no gold standard or a single indicator to assess kidney disease patients' nutritional status, which is in line with the data available in the literature [19,28,29].

In the study by Lima et al. [30], it was shown that AMC is the marker that diagnosed eutrophy with the highest prevalence in patients with CKD, also observed in other studies [22,27,31] and in the present investigation.

Regarding HGS, a high frequency of reduced HGS patients was observed compared with a healthy reference population (both gender adults over 19 years of age) conducted in the city of Rio de Janeiro [17]. In two other studies with both genders patients over 20 years of age, undergoing conservative treatment, with the same reference standard used in this study, prevalence values of 31.4% [8] and 51% [32] were observed for low muscle strength, respectively.

The type of treatment (dialysis or conservative) can interfere with kidney patients' nutritional status and cause the reduction of muscle mass and strength, which may be associated with the different metabolic, hormonal and nutritional disorders characteristic of CKD and its treatments, in addition to muscle changes resulting from the accumulation of nitrogen compounds [33,34].

In another study with 53 hemodialysis patients from a hospital in the Northeast of Brazil, with adults up to 59 years of age, of both genders, a high prevalence of patients with reduced handgrip strength (88.7%) was observed [11]. It is important to highlight that few studies in the literature have evaluated the adequacy of HGS use in patients on hemodialysis and patients in conservative treatment.

When comparing the results of the present study with those of other investigators, we faced the need to standardize the method used to measure HGS, and to define the reference standard to be used for renal patients on conservative treatment and dialysis which is of utmost importance. The use of HGS has been increasingly suggested in the clinical practice, especially in CKD patients, because it is a simple and reliable method that assesses muscle strength in association with lean mass; besides it is a good marker of clinical prognosis for those patients [35,36].

Low muscle strength, associated with low muscle quantity and quality that cause poor physical performance, in addition to advanced age, low socioeconomic status, low macronutrient intake and a sedentary lifestyle, together with a diagnosis of high blood pressure and insulin resistance, show that there is an association between sarcopenia and CKD [37].

In the study by Gomes et al. [8] with renal patients undergoing conservative treatment and in the study by Bertoni et al. [38], with renal patients undergoing hemodialysis, both showed that older individuals exhibited low muscle strength, confirming the results of the present study. In the aging process, a reduction in muscle mass is expected, but in elderly individuals there is a faster reduction in muscle strength than in muscle mass, that is, muscle quality is more compromised and mass lost cannot predict the decline in muscle strength in these patients [39,40].

It is clear that the presence of sarcopenia leads to greater impairment of the renal function, especially when the kidney has not been functioning fully for a long time [41]. Thus, both CKD can increase the risk of sarcopenia, as well as sarcopenia can further aggravate the clinical condition of patients with CKD, increasing the likelihood of a poor prognosis [42].

There are several etiological factors that can cause muscle disorders, consequently leading to a loss of muscle mass, which are related to kidney diseases, the dialysis system and low-grade chronic inflammation present in patients with CKD, with increased protein degradation, as well as decreased protein synthesis, leading to a negative protein balance [34].

Therefore, being aware and knowing how to diagnose nutritional status is extremely important to prevent malnutrition and thus ensure intervention for those patients at nutritional risk or malnourished, since individual monitoring and suggestions for appropriate and effective dietary interventions are essential for this group of patients [30]. In addition, it is important to emphasize that HGS is considered a good predictor tool of muscle mass in patients with CKD [8].

However, limitations of this study include the size of the sample used, and the lack of definition of a reference standard for HGS in patients with CKD, since there are few studies with patients undergoing conservative treatment, and those with dialysis patients require different methodologies making analysis and comparison with other studies difficult.

CONCLUSION

Through this study, we can conclude that low HGS is associated with reduced muscle mass and advanced age in patients with CKD. We suggest that HGS be used routinely in the clinical practice as a predictor of lean mass loss in patients with CKD.

However, it is of great importance that further investigations be carried out to define a reference classification for renal patients, adults and older adults of both genders, undergoing conservative treatment and dialysis, as well as to create a consensus on the assessment of HGS for those patients. Thus, we can assist in the early diagnosis and treatment of renal patients, improving their prognosis and quality of life.

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