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Association between handgrip strength and nutritional indicators in patients undergoing hemodialysis

Associação entre força de preensão manual e indicadores nutricionais em pacientes em tratamento hemodialítico

Abstract

Objective: To assess the association between handgrip strength (HGS) and nutritional indicators in patients undergoing hemodialysis in western Bahia State, Brazil. ***Methods:*** This is a cross-sectional study conducted with adult and elderly patients attending a hemodialysis unit in western Bahia. A structured questionnaire containing sociodemographic questions was administered, and anthropometric, body composition, clinical, and biochemical variables were analyzed. HGS was measured on the non-fistula side using a Saehan® hydraulic dynamometer. Data analysis was performed using Stata version 13.1. ***Results:*** A total of 113 patients were evaluated, most of whom were male (60.55%) and aged between 35 and 59 years (57.52%). Positive associations were found between height and HGS; the higher the patient height, the higher the HGS (p = 0.020). Higher post-dialysis body weight was also associated with higher HGS (p = 0.002). Triceps skinfold thickness was inversely associated (p = 0.007) with HGS, whereas phase angle showed a positive association (p = 0.018). ***Conclusion:*** HGS was positively associated with height, post-dialysis body weight, and phase angle but negatively associated with triceps skinfold thickness.

Keywords: Chronic renal disease. Hand-held dynamometer. Anthropometry. Hemodialysis.

Resumo

Objetivo: Verificar a associação entre a força de preensão manual (FPM) e indicadores nutricionais em pacientes em tratamento hemodialítico do Oeste da Bahia. ***Métodos:*** Trata-se de um estudo transversal, realizado com pacientes adultos e idosos, cadastrados em uma unidade de hemodiálise do Oeste da Bahia. Foi aplicado questionário estruturado com questões referentes às condições sociodemográficas e realizada análise das variáveis antropométricas, de composição corporal, clínicas e bioquímicas. A FPM foi medida do lado não fistuloso com um dinamômetro hidráulico da marca SAEHAN® (Saehan corporation – SH5001). A análise dos dados foi realizada com o auxílio do *software* Stata 13.1. ***Resultados:*** Foram avaliados 113 pacientes, com predominância do sexo masculino (60,55%) e faixa etária de 35 a 59 anos (57,52%). Foram encontradas associações positivas entre a altura e a FPM, sendo que quanto maior a altura, maior é a força (p = 0,020). O maior peso corporal após sessão de hemodiálise também se apresentou associado à maior FPM (p = 0,002). A medida da prega cutânea tricipital mostrou associação inversa (p = 0,007) e o ângulo de fase foi positivamente associado à FPM (p = 0,018). ***Conclusão:*** A força de preensão manual foi associada positivamente a altura, peso corporal após sessão de hemodiálise e ângulo de fase. Em contrapartida, a FPM associou-se negativamente à prega cutânea tricipital.

Palavras-chave: Doença Renal Crônica. Dinamômetro de Força Muscular. Antropometria. Hemodiálise.

INTRODUCTION

Adequate nutrition is of utmost importance for patients on hemodialysis,[1] given the high frequency of nutritional disorders in this patient group. Reduced physical performance[2] and sarcopenia are common problems in chronic kidney disease (CKD)[3] that contribute to increased morbidity and mortality.[4,5]

Patients with CKD frequently display muscle atrophy, metabolic acidosis, persistent inflammation, endocrine dysfunctions, and increased resting energy expenditure—conditions that need to be well understood for a more effective treatment.[6]

Handgrip strength is a useful tool for assessing muscle loss and predicting prognosis. Several studies have demonstrated a relationship between low handgrip strength and increased mortality in patients undergoing hemodialysis.[7-9] This simple, fast, and non-invasive method[10] is performed using a hand-held dynamometer. Handgrip strength can also be used to evaluate the nutritional status of patients, as individuals with malnutrition often show lean mass depletion and low muscle strength.[11]

The relevance of handgrip strength in clinical and epidemiological settings has increased because of its numerous applications, including, for instance, its use as a diagnostic tool for sarcopenia.[12] This study aimed to investigate the association between handgrip strength and nutritional indicators in patients undergoing hemodialysis in western Bahia State, Brazil.

METHODS

This cross-sectional study was conducted as part of a larger research project entitled "Sociodemographic, behavioral, clinical, anthropometric and dietary profile of patients undergoing hemodialysis in the municipality of Barreiras, Bahia."

All patients who met the inclusion criteria—namely, age ≥18 years, being registered in the hemodialysis unit, and signing the informed consent form—were included in the study. Patients who were unable to answer the questionnaire or perform anthropometric measurements were excluded. This study was approved by the Research Ethics Committee of the Federal University of Western Bahia, Brazil (protocol no. 83803418.3.0000.8060).

Data collection took place between July 2018 and November 2019. Sociodemographic data were collected using a structured questionnaire. Anthropometric measurements and body composition analysis were performed. Clinical data were obtained from medical records. All stages of data collection were carried out by trained individuals to ensure the reliability of results.

Determination of handgrip strength

Handgrip strength was measured on the non-fistula side (non-catheterized arm) after a dialysis session using a hydraulic dynamometer (model SH5001, Saehan Corporation, Korea). Patients were instructed to hold the dynamometer comfortably in order to obtain the best grip performance. At the time of measurement, patients remained seated, with the arm adduced and the elbow flexed to 90° degrees without support.[13] The highest measured value was used as handgrip strength.

Anthropometric assessment and body composition analysis

Body mass was measured by using a wireless wheelchair scale with a maximum capacity of 300 kg and graduation of 100 g (SECA-665®, USA). Standing height was measured using a compact stadiometer (WISO®, Brazil). For patients unable to stand, height was estimated from half arm span values.[14]

A skin caliper (Cescorf, Brazil) was used to measure biceps, triceps, suprailiac, and subscapular skinfold thickness. Arm circumference, waist circumference, and neck circumference measurements were obtained using a non-elastic measuring tape (Cescorf, Brazil). All body measurements were performed on the limb contralateral to the vascular access.

Phase angle, lean body mass, and fat mass were determined using a bioimpedance device (model A-310, Biodynamics Corporation, USA) and four plethysmograph electrodes attached to the patient's skin. The patient was asked to remain in a horizontal position during measurements. Anthropometric and body composition measurements were obtained after hemodialysis.

Sociodemographic, clinical, and biochemical variables

A structured questionnaire was administered to collect information on sex (dichotomized as female and male), age group, level of education (illiterate, primary, and secondary/vocational/post-secondary education), marital status (single, married/partnered, and divorced/separated/widowed), and socioeconomic status (high, classes A and B; intermediate, class C; and low, classes D and E).[15]

Data on hemodialysis duration, hemoglobin, and serum albumin levels were collected from medical records.

Statistical analysis

Statistical analysis was performed using Stata version 13.1. The normality of data distribution was assessed by the Shapiro–Wilk test. Results are presented as absolute and relative frequencies, mean, standard deviation, and range. Values of handgrip strength were classified according to Schlüssel et al.[10] Correlations between handgrip strength and anthropometric, body composition, clinical, and biochemical variables were analyzed using Pearson's or Spearman's test. Associations between independent variables and handgrip strength were examined using simple and multiple linear regression analysis. The level of significance was set at $p < 0.05$.

RESULTS

At the time of the study, 156 patients attended the hemodialysis unit, 140 of whom were eligible to participate in the research. However, after exclusion of discharges and deaths, the total sample comprised 113 patients.

The majority of patients were male (60.55%), married/partnered (62.83%), aged 35–59 years (57.52%), with primary education (53.98%) and low socioeconomic status (81.41%). These data are presented in Table 1. Of note, six patients had a history of diabetes mellitus.

Table 1. Sociodemographic characteristics of hemodialysis patients (N = 113) attending a dialysis unit in western Bahia State, Brazil, in 2019.

Variable	*n*	%
Sex		
Female	43	39.45
Male	66	60.55
Marital status		
Married/partnered	71	62.83

Table 1. Sociodemographic characteristics of hemodialysis patients (N = 113) attending a dialysis unit in western Bahia State, Brazil, in 2019. (Continues).

Variable	*n*	%
Single	31	27.43
Divorced/separated/widowed	7	9.73
Age group (years)		
<35	26	23.01
≥35–59	65	57.52
≥60	22	19.47
Level of education		
Illiterate	8	7.08
Primary education	61	53.98
Secondary/vocational/post-secondary education	44	38.94
Socioeconomic status		
High (classes A and B)	9	7.95
Intermediate (class C)	12	10.62
Low (classes D and E)	92	81.41

The mean handgrip strength was 28.96 ± 17.93 kgf. Table 2 shows the mean, standard deviation, and percentiles of anthropometric, body composition, clinical, and biochemical data of study participants. The mean height was 167.79 ± 18.08 cm; post-dialysis weight, 66.35 ± 14.70 kg; triceps skinfold thickness, 15.11 ± 8.78 mm; and phase angle, 6.90 ± 2.0°.

Table 2. Anthropometric, body composition, clinical, and biochemical characteristics of chronic kidney disease patients (N = 113) undergoing hemodialysis in western Bahia State, Brazil, in 2019.

Variable	Mean	Standard deviation	P25, P75
Height (cm)	163.79	18.08	158.5, 172.0
Post-dialysis body weight (kg)	66.35	14.70	57.5, 73.3
Triceps skinfold thickness (mm)	15.11	8.78	9, 20
Subscapular skinfold thickness (mm)	16.30	8.34	10, 20
Arm circumference (cm)	29.29	5.27	25, 33
Neck circumference (cm)	36.23	3.91	34, 38
Waist circumference (cm)	88.09	13.08	78.25, 97.25
Lean mass (kg)	49.10	11.85	41.5, 55.4
Fat mass (kg)	17.56	9.36	10.9, 23.3
Phase angle (°)	6.90	2.0	5.7, 7.6
Hemodialysis duration (months)	27.80	39.68	7, 35
Albumin (mg/dL)	3.53	0.56	3.25, 3.91
Hemoglobin (g/dL)	9.50	12.34	7.9, 10.5

P25, 25th percentile; P75, 75th percentile

We observed that the handgrip strength values of 52.1% of patients were in the ≤10th percentile and only 9.73% of patients had values above the 50th percentile. Correlation analysis revealed a positive correlation of handgrip strength with height ($p < 0.001$, $r = 0.493$) and post-dialysis body weight ($p = 0.008$, $r = 0.245$) and a negative correlation of handgrip strength with triceps skinfold thickness ($p = 0.009$, $r = −0.241$) and subscapular skinfold thickness ($p = 0.080$, $r = −0.165$). Handgrip strength was also positively correlated with arm circumference ($p = 0.913$, $r = 0.103$), neck circumference ($p = 0.004$, $r = 0.270$), lean mass ($p = 0.001$, $r = 0.348$), phase angle ($p < 0.001$, $r = 0.385$), serum albumin ($p = 0.121$, $r = 0.149$), and hemoglobin ($p = 0.087$, $r = 0.163$). Negative correlations were observed between handgrip strength and waist circumference ($p = 0.967$, $r = −0.003$), fat mass ($p = 0.385$, $r = −0.082$), and hemodialysis duration ($p = 0.383$, $r = −0.082$).

Table 3 shows the determinants of handgrip strength, as assessed by simple and multiple linear regression. Positive associations were found between height and handgrip strength; the higher the height, the higher the strength ($p = 0.020$). Post-dialysis body weight was also positively associated with higher handgrip strength ($p = 0.002$). Triceps skinfold thickness showed an inverse relationship with handgrip strength ($p = 0.007$), and phase angle was positively associated with the variable ($p = 0.018$).

Table 3. Simple and multiple linear regression coefficients, 95% confidence intervals (CI), and *p*-values for handgrip strength in chronic kidney disease patients (*N* = 113) undergoing hemodialysis in western Bahia State, Brazil, in 2019.

Variable	β	95% CI	*p*	$β_A$	95% CI	*p*
Height (cm)	0.298	0.120, 0.476	0.001	0.202	0.032, 0.372	0.020
Post-dialysis body weight (kg)	0.299	0.077, 0.522	0.009	0.388	0.141, 0.636	0.002
Triceps skinfold thickness (mm)	−0.280	−0.661, 0.099	0.146	−0.560	−0.966, −0.154	0.007
Subscapular skinfold thickness (mm)	−0.093	−0.497, 0.310	0.646			
Arm circumference (cm)	0.035	−0.604, 0.674	0.914			
Neck circumference (cm)	1.212	0.387, 2.037	0.004			
Waist circumference (cm)	−0.005	−0.263, 0.253	0.967			
Lean mass (kg)	0.527	0.260, 0.793	<0.001			
Fat mass (kg)	−0.157	−0.516, 0.200	0.385			
Phase angle (°)	2.735	1.136, 4.334	0.001	1.860	0.324, 3.397	0.018
Hemodialysis duration (months)	−0.063	−0.148, 0.020	0.135			
Albumin (mg/dL)	2.044	−4.024, 8.113	0.506			
Hemoglobin (g/dL)	0.179	−0.780, 1.139	0.712			

β, simple linear regression coefficient; $β_A$, covariable-adjusted β value.

DISCUSSION

This study sought to investigate the associations between handgrip strength and anthropometric, body composition, clinical, and biochemical data of patients undergoing hemodialysis in western Bahia State, Brazil. We identified that height influenced handgrip strength. Taller individuals had greater strength, as did individuals with greater post-dialysis body weight. Low triceps skinfold thickness was associated with high handgrip strength, demonstrating that the lower the body adiposity, the greater the strength. Phase angle was positively associated with handgrip strength.

The positive relationship between height and handgrip strength observed here agrees with the results of Rodríguez-García et al.,[2] who evaluated 750 healthy subjects in Mexico. The authors identified significant associations between handgrip strength and height, the variable with the highest correlation in both sexes. The relationship between handgrip strength and height is likely based on the close association of height with lean body mass.[16] A study assessing 73 children with CKD also found a positive correlation between handgrip strength and height.[17] Hasheminejad et al.[18] evaluated 83 adults on hemodialysis in Iran and found that handgrip strength was positively associated with height and body weight.

In our study, we observed that the higher the body weight, the higher the handgrip strength. Grisin et al.,[19] in evaluating 37 adult subjects one year after hemodialysis treatment, observed a positive correlation of pre- and post-dialysis handgrip strength with high fat and lean mass, which may partially explain the correlation between handgrip strength and post-dialysis weight observed in the current study.

Triceps skinfold thickness, used in nutrition clinical practice as an indicator of body fat, had a negative correlation with handgrip strength. Leal et al.,[20] in a cross-sectional study with 43 patients on hemodialysis in Rio de Janeiro, Brazil, found a negative correlation between handgrip strength and body fat. In a study by Cordeiro et al.,[21] reduced handgrip strength was correlated with excess abdominal adiposity in patients undergoing hemodialysis. The findings suggest that a reduction in lean mass may occur even in individuals with high fat mass, probably because of inflammation caused by high fat deposition.[20]

Phase angle showed a positive association with handgrip strength ($p = 0.018$). Dos Reis et al.[22] assessed 129 liver transplant recipients and observed a positive association between phase angle and handgrip strength: patients with lower handgrip strength had a lower phase angle. The results of Rodríguez-García et al.[2] corroborate these data.

A limitation of the current study is its cross-sectional nature, which precludes analysis of cause and effect relationships. The strengths of the study include data collection by a trained team, minimizing inter-individual variability and increasing reliability. It should also be noted that this was the first study to associate handgrip strength with nutritional indicators in patients undergoing hemodialysis in the western region of Bahia State, Brazil.

CONCLUSION

Handgrip strength was positively correlated with height, post-dialysis body weight, and phase angle and negatively correlated with triceps skinfold thickness. It is essential to frequently evaluate anthropometric characteristics in this patient group to reduce the risk of mortality and associated comorbidities. Future studies should aim to determine cut-off values of handgrip strength in this population for improved prognostic prediction.

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Contributors

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