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Evaluation of respiratory muscle strength and pulmonary function of patients with chronic kidney disease submitted to hemodialysis

Evaluación de la fuerza muscular respiratoria y la función pulmonar de pacientes con enfermedad renal crónica sometidos a hemodiálises

Avaliação da força muscular respiratória e função pulmonar de pacientes com doença renal crônica submetidos à hemodiálise

ABSTRACT

Objective: To assess respiratory muscle strength (RMS) and lung function (PF) in patients with chronic kidney disease (CKD) undergoing hemodialysis (HD). Methods: Cross-sectional study with 41 participants. Maximum inspiratory and expiratory pressures (MIP; MEP), Forced Vital Capacity (FVC) and forced expiratory volume in the first second (FEV1) were checked. Results: There is no significant difference between men and women in relation to the percentage of the predicted achieved for MIP, but there is in relation to MEP (p = 0.082; p = 0.003). As for PF, it was found that there is a significant difference between men and women, for both variables FVC and FEV1 (p = 0.034 and p = 0.024). Conclusion: Regarding RMS, patients with chronic kidney disease on hemodialysis have respiratory muscle weakness, and when compared by gender, men had reduced inspiratory muscle strength compared to predict. As for PF, women have values below normal standards compared to men.
DESCRIPTORS: Chronic Kidney Disease; Hemodialysis; Respiratory Muscle Strength; Lung function.

RESUMEN

Objetivo: evaluar la fuerza de los músculos respiratorios (FMR) y la función pulmonar (FP) en pacientes con enfermedad renal crónica (ERC) sometidos a hemodiálisis (HD). Métodos: estudio transversal con 41 participantes. Se verificaron las presiones inspiratoria y espiratoria máxima (MIP; MEP), la Capacidad Vital Forzada (FVC) y el volumen espiratorio forzado en el primer segundo (FEV1). Resultados: No hay diferencia significativa entre hombres y mujeres en relación al porcentaje de lo esperado alcanzado para MIP, pero sí en relación a MEP (p = 0.082; p = 0.003). En cuanto al PF, se encontró que existe una diferencia significativa entre hombres y mujeres, para ambas variables FVC y FEV1 (p = 0.034 yp = 0.024). Conclusión: Con respecto a la FMR, los pacientes con enfermedad renal crónica en hemodiálisis tienen debilidad de los músculos respiratorios y, en comparación por sexo, los hombres tenían una fuerza de los músculos inspiratorios reducida en comparación con lo previsto. En cuanto a la FP, las mujeres tienen valores por debajo de los estándares normales en comparación con los hombres.
DESCRIPTORES: Enfermedad Renal Crónica; Hemodiálisis; Fuerza de los músculos respiratorios; Función pulmonar.

RESUMO

Objetivo: Avaliar a força muscular respiratória (FMR) e a função pulmonar (FP) de pacientes com doença renal crônica (DRC) submetidos à hemodiálise (HD). Métodos: Estudo transversal com 41 participantes. Foram verificadas as pressões inspiratória e expiratória máxima (PImáx; PEmáx), capacidade Vital Forçada (CVF) e volume expiratório forçado no primeiro segundo (VEF1). Resultados: Não há diferença significante entre homens e mulheres em relação ao percentual do previsto alcançado para PImáx, porém há em relação a PEmáx (p=0,082; p=0,003). Quanto a FP constatou-se que há diferença significativa entre homens e mulheres, para ambas as variáveis CVF e VEF1 (p=0,034 e p=0,024). Conclusão: Em relação à FMR, os pacientes com doença renal crônica em hemodiálise possuem fraqueza muscular respiratória, e quando comparados por gênero, os homens apresentaram força muscular inspiratória reduzida em relação ao previsto. Quanto a FP, as mulheres possuem valores abaixo dos padrões de normalidade comparada aos homens.
DESCRITORES: Doença Renal Crônica; Hemodiálise; Força Muscular Respiratória; Função Pulmonar.

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INTRODUCTION

Chronic kidney disease (CKD) is defined in the Kidney Disease Improving Global Outcomes (KDIGO) clinical practice guideline as abnormalities in kidney structure or function that have been present for more than three months and that have serious health implications. [1]

The number of patients with chronic kidney disease who needed dialysis grew from 42.000 in 2000 to 122.000 in 2016. Last year, 5.700 people had kidney transplants in the country, an amount that has been increasing, in average, 10% from one year to the next, according to the Brazilian Society of Nephrology (SBN - Sociedade Brasileira de Nefrologia).

It is a chronic disease that has a progressive and irreversible character that causes the loss of kidney function. The latter occurs gradually, which causes the individual to be asymptomatic and/or causes mild symptoms that can go unnoticed for a long time. [2,3]

CKD is classified into different stages that take into account the cause, the decrease in the glomerular filtration rate and albuminuria. In addition, the presence of one or more kidney injury markers - abnormalities of urine sediment, electrolytes and other abnormalities due to tubular disorders, abnormalities detected by histology, structural abnormalities detected by imaging and history of kidney transplantation - are also used to assist in the diagnosis and classification of the disease. [1]

Patients followed up with CKD in stage VI to V should be oriented to dialysis treatment, in an attempt to avoid the occurrence of serious complications that can lead to death. Hemodialysis (HD) is the most widely used treatment, which must be performed by CKD patients for life or even undergoing a successful kidney transplant. Despite promoting maintenance and prolonging life, renal replacement therapies do not offer a cure for the disease and, in the long run, end up damaging the patient's daily life and quality of life (QOL).[4]

Individuals with CKD, in general, develop the uremic syndrome that affects several body systems, including the respiratory system. Studies have shown that CKD is associated with several respiratory diseases, such as: pulmonary edema, pleural effusion, fibrosis, pulmonary parenchyma calcification and sleep apnea syndrome. In addition, HD can also negatively impact the respiratory muscle strength and lung function of the individual. [5,6]

As a result of these and other changes, these patients have reduced respiratory and peripheral muscle strength and function, as well as reduced cardiorespiratory fitness. Such complications limit participation in activities of daily living, consequently reducing QOL, in addition to increasing mortality in patients with the disease. [7]

This study aimed to assess respiratory muscle strength and lung function in patients with chronic kidney disease undergoing hemodialysis.

METHODS

Cross-sectional study with a quantitative approach conducted in a hemodialysis clinic in the city of Fortaleza-Ceará, northeastern Brazil. Participants were included with a clinical diagnosis of Chronic Kidney Disease, registered in the Hemodialysis Sector of the referred clinic, aged> 18 and <60 years; both genders; who were on dialysis treatment for more than three [3] months; with sufficient cognitive and physical capacity to perform the assessment procedures, not having a diagnosis of chronic obstructive pulmonary disease and accepting to participate in the research after having read, understood and signed the Free and Informed Consent Form - IC.

Exclusion criteria were those individuals with a history of acute myocardial infarction less than three months before the study, decompensated heart disease, an infectious process, who had participated or were participating in any study involving physical activity for less than six months.

The study was approved by the Research Ethics Committee of the Federal University of Ceará, opinion 1.113.278. CAEE: 43697715.0.0000.5054.

The assessment consisted of collecting personal data (age, gender, height, weight, body mass index (BMI), hemodialysis time, whether diabetic / hypertensive or not, tobacco use, causes of CKD, comorbidities and medications) through its own physiotherapeutic evaluation form. Height (meters) and weight (kilograms) were measured using a stadiometer (600–2,100-mm model, accuracy-1.5 mm) and an electronic scale model MRP200P (accuracy 0.1 kg), respectively. Participants during the above measurements were wearing light clothing and without shoes.

The evaluations were carried out by previously trained professionals. It is important to note that they were performed before the patient entered the HD session, on the second day of hemodialysis of that week, for weight control, because on the first day of the week, due to the weekend, the participant would have a greater change in this variable.

As a result of these and other changes, these patients have reduced respiratory and peripheral muscle strength and function, as well as reduced cardiorespiratory fitness.

The respiratory data evaluated were the pulmonary condition: measurements of maximum inspiratory and expiratory pressures (MIP and MEP) and measurement of lung volumes and capacities (Forced Vital Capacity - FVC; Forced Expiratory Volume in the first second - FEV1). The measurement of maximum respiratory pressures (MIP and MEP) was performed using the MR® manovacuometer and the volumes and capacities were assessed using the ONE FLOW RANGE portable spirometer (Clement Clarke International) and followed the guidelines of the Guidelines for Pulmonary Function Tests, described by the Brazilian Society of Pulmonology and Tisiology. To perform the test, the individual remained seated, head in a neutral position, without flexion of the cervical, using a nasal clip to prevent air leakage.

The data were tabulated using the Microsoft Excel 2010® program and later analyzed using the Statistical Package for the Social Sciences, version 17.0 (SPSS 17.0). The results of the studied variables were expressed as mean ± standard deviation for distributed continuous variables and frequency and percentage for categorical variables. For the calculation of the predicted values for MIP, MEP, FVC and FEV1, tables referring to the Brazilian population were used, based on the study by Pereira (2002). [8] To compare the means obtained for each variable of the different genders, the independent T test was used. Values of $p \leq 0.05$ were considered statistically significant.

RESULTS

41 patients with CKD undergoing hemodialysis from a population of 84 eligi-

Figure 1- Flowchart of the study sample design.

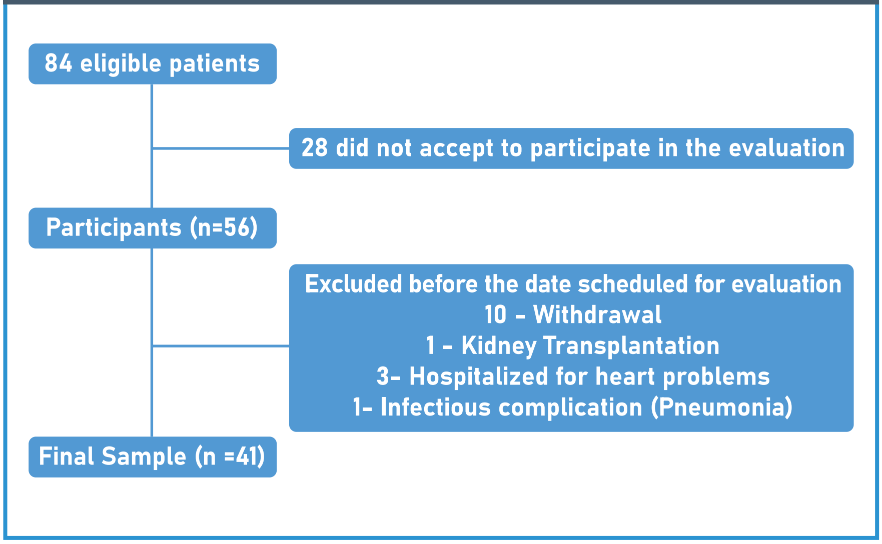

Table 1 – General demographic data of the study sample (Fortaleza-CE).

VARIABLE	MEAN ± STANDARD DEVIATION
Age (Years)	49,98 ± 13,40
Gender Male, n (%)	24(58,5)
Weight (Kg)	74,39 ± 17,68
BMI*	28,18 ± 6,16
Time of HD (months)	28,10 ± 20,80
Diabetics, n (%)	14(34,1)
Hypertensive, n (%)	41(100)
Tobacco use	
Already smoked n (%)	16(39,0)
Never smoked n (%)	25(61,0)
Causes of CKD	
Diabetes, n (%)	14(34,1)
Hypertension, n (%)	06(14,6)
Glomerulonephritis, n (%)	09(21,9)
Unspecified cause, n (%)	11(26,8)
Comorbidities	
Diabetes, n (%)	14(34,1)
Hypertension, n (%)	41(100)
Heart disease, n (%)	11(26,8)
Peripheral Vascular Disease, n (%)	11(26,8)
Antihypertensive drugs:	
ACE inhibitor**, n (%)	14(34,1)
Calcium channel blockers, n (%)	11(26,8)
Beta- Blockers, n (%)	10(24,3)

ble participants were included, however, 28 did not accept to participate in the study and 15 were previously excluded from the date scheduled for the evaluation (10 withdrawal; 01 kidney transplantation; 03 hospitalized for heart problems and 01 due to infectious complications-pneumonia) (Figure 1). The participants had an average age of 49,98 ± 13,40 years; weight of 74,39 ± 17,68 kg; BMI of 28,18 ± 6,16 Kg / m2 and HD time of 28,10 ± 20,80 months.

Among the evaluated patients, 24 (58,5%) were male, 14 (34,1%) diabetic and 16 (39,0%) smoked or used it. The most prevalent causes of CKD were: diabetes with 14 patients (34,1%), systemic arterial hypertension (SAH) in 06 (14,6%) and glomerulonephritis (GN) in 09 (21,6%). The most prevalent comorbidity was SAH present in all patients and the most used antihypertensive medication was the angiotensin-converting enzyme (ACE) inhibitor by 14 (34,1%). The parameters of pulmonary strength and function observed were MIP of 79,90 ± 24,39 cm/H_2O, MEP of 71,59 ± 23,58 cm/H_2O, FVC of 2,88 ± 1,00 l/min and FEV1 of 2,16 ± 0,79 l/min (Table 1).

When analyzing respiratory muscle strength, separated by gender, the following values were found: the mean MIP of women was 72,35 ± 25,37 cm/H_2O. With the predicted value of 84 cm/H_2O, it was found that 85% of this value was reached. As for male participants, the mean MIP was 85,25 ± 22,68 cm/H_2O, with a predicted value of 120 cm/H_2O, it was noticed that 70% of this value was reached.

In relation to MEP, the female gender had an average of 55,18 ± 13,71 cm/H_2O. The predicted value was 115 cm/H_2O, with 48% of that value being reached; and the mean of the MEP of the male gender was 83,21 ± 22,27 cm/H_2O with an expected value of 126 cm/H_2O, obtaining 65% of this value.

When comparing both variables in relation to the percentage of the predicted achieved for each gender, it was fou-

α_2 Adrenergic Agonist, n (%)	13(31,7)
Vasodilators, n (%)	10(24,3)
Pulmonary parameters	
MIP (cm/H_2O)	79,90 ± 24,39
MEP (cm/H^2O)	71,59 ± 23,58
FVC (l/min)	2,88 ± 1,00
FEV1(l/min)	2,16 ± 0,79
Hemoglobin (g/dL)	10.6±1.8
Serum Parathormone (pg/mL)	275±141
Serum Calcium (mg/dL)	8.7±1.0
Serum Phosphorus (mg/dL)	5.7±3.1

BMI- Body mass index, ACE - Angiotensin-converting enzyme , CKD - Chronic Kidney Disease , MIP - Maximum Inspiratory Pressure, MEP - Maximum Expiratory Pressure, FVC- Forced Vital Capacity, FEV- Forced Expiratory Volume HD - hemodialysis. Values expressed as mean ± standard deviation.

Table 2 - Values obtained from MIP and MEP when separating participants by gender, considering the predicted and the percentage of the predicted achieved.

RESPIRATORY MUSCLE STRENGTH				
VARIÁVEIS		PREDICTED (CM/H_2O)	% OF THE PREDICTED ACHIEVED	P VALUE
MIP- cm/ H_2O (W)	72,35 ± 25,37	84	85%	0,082
MIP cm/ H_2O (M)	85,25 ± 22,68	120	70%	
MEP- cm/ H_2O (W)	55,18 ± 13,71	115	48%	*0,003
MEP- cm/H_2O (M)	83,21 ± 22,27	126	65%	

(W) = Women ; (M) = Men . MIP - Maximum Inspiratory Pressure, MEP - Maximum Expiratory Pressure. Values expressed as mean ± standard deviation.
(*) There is a significant difference between men and women when compared to the predicted values reached for the MEP variable. Independent T test. Values of p≤0.05 were considered statistically significant.

Table 3 - Values obtained from FVC and FEV1 when separating participants by gender, considering the predicted and the percentage of the predicted achieved.

LUNG FUNCTION				
VARIABLES		PREDICTED	% OF THE PREDICTED ACHIEVED	P VALUE
VFC -L/min (W)	2,22 ± 0,65	3,19	69%	*0,034
VFC- L/min (M)	3,35 ± 0,95	3,57	93%	
FEV1 -L/min (W)	1,63 ± 0,57	2,47	65%	*0,024
FEV1-L/min (M)	2,53 ± 0,71	2,87	95%	

(M) = Women ; (H) = Men . CVF - Vital Forced Capacity, FEV- Forced Expiratory Volume, HD- hemodialysis. Values expressed as mean ± standard deviation.
(*) There is a significant difference between men and women when compared in relation to the predicted values reached for both variables. Independent T test. Values of p≤0.05 were considered statistically significant.

nd that there is no significant difference between men and women in relation to MIP, however it was significant in relation to MIP (p = 0,082, p = 0,003, respectively) (Table 2).

Regarding the analyzes of lung function separated by gender, the following was verified: the mean FVC of women was 2,22 ± 0,65 l/min. The forecast was 3,19 l/min, reaching 69% of that value. As for men, FVC was 3,35 ± 0,95 l/min, with a predicted value of 3,57 l/min, so 93% of the predicted value was obtained. When checking the FEV1 values; in women, the mean was 1,63 ± 0,57 l/min and the predicted 2,47 l/min; it was evidenced, therefore, that 65% of this value were contemplated. The average FEV1 for men was 2,53 ± 0,71 l/min, with a predicted 2,87 l/min, which reveals that 95% of this value was reached.

When these values were compared in relation to the percentage of the predicted achieved for each gender, it was found that there is a significant difference between men and women, for both variables FVC and FEV1 (p = 0,034 and p = 0.024, respectively), with p≤0,05 (table 3).

DISCUSSION

Several studies have documented that patients with CKD undergoing HD have reduced respiratory and peripheral muscle strength, low cardiorespiratory conditioning and reduced functional capacity that directly and negatively influence the performance of their activities of daily living, as well as quality of life. [6, 9, 10]

Impaired lung function may result directly from circulating uremic toxins or may result indirectly from fluid overload, anemia, immune suppression, extra-bone calcification, malnutrition, electrolyte disturbances and/or acid-base imbalances, which are common problems in patients with CKD hemodialysis. [2]

The respiratory system is affected by both the disease and by hemodialysis, thus, respiratory muscle strength and endurance are decreased in patients with CKD when compared to healthy individuals. [12] In the present study, when comparing the values obtained from MIP and MEP, with participants separated by gender and considering the predicted and the percentage of the predicted achieved, it was found that the MEP is more compromised than the MIP, corroborating the study by Cunha et al. (2009) [13], whose patients with CKD on HD had important changes in respiratory muscle strength, especially in expiratory strength, having levels much lower than predicted (42,8% of predicted) which may be associated with decreased skeletal muscle strength, characteristic of uremic myopathy.

Kovelis et al. (2008) [12] carried out the assessment of pulmonary function and respiratory muscle strength in 17 patients with hemodialysis CKD in order to correlate them with the weight variation linked to the performance of HD and also to verify the correlation between hemodialysis time and possible respiratory changes. As one of the main results, the study demonstrated a correlation between the loss of respiratory muscle strength and the time of treatment by hemodialysis, that is, the longest time on hemodialysis is associated with the decrease in respiratory muscle strength. In the present study, it was observed that patients have a little more than two years of hemodialysis treatment, and that men have 70% of the predicted for inspiratory muscle strength, which is according to Sousa (2002) [14], mild muscle weakness. Therefore, there is speculation about the possibility of a decrease in muscle strength with the evolution of the disease and an increase in the treatment period.

Given the above, it is clear that uremia and dialysis interfere with respiratory and mechanical stimulation, muscle function and gas exchange. HD will somehow, at some point, affect the respiratory system of patients undergoing this treatment. [15] The most common pulmonary alterations are airflow limitation, restrictive disorders, reduced pulmonary diffusion capacity, decreased endurance and respiratory muscle strength. [12, 16, 17]

A Study by Morais et al (2011) [18] assessed respiratory muscle strength in type 2 diabetic patients and a 31% prevalence of inspiratory muscle weakness was found in these individuals. In the present study, it was observed that DM and SAH were the main causes of CKD and this result agrees with the study by Posser et al., 2016 [9] who found similarity in the causes of the disease. In this case, it is suggested that DM may be an influencing factor for the decrease in respiratory muscle strength in the present study.

It is worth noting that when comparing women and men in relation to respiratory muscle strength, women show a significantly more marked reduction in MEP. These differences in the values of maximum expiratory pressure between genders can be related and also exacerbated, in addition to the clinical condition, by the inequality in the amount of lean mass, since, in general, men have a greater amount of muscle mass and, consequently, more force than women when forced expiratory force is required. [19]

The results found in the present research point to what some authors have already described when verifying the presence of reduced respiratory muscle strength and negative changes in lung function in hemodialysis patients. [20, 21] The consequence of this impairment in the respiratory musculature together with other pulmonary and systemic problems contributes to the decrease in lung capacity, due to the impairment in the function of this system. [22, 23]

This condition can be explained due to uremic myopathy, present in patients with CKD undergoing HD and characterized by a generalized weakness, which appears as an important factor for reducing the strength of the respiratory muscles. Due to this condition, the reductions and limitations of airflow, mainly of FEV1, found in the women of the present study, may be associated with the delay in the contraction of the muscle fiber due to the weakness of these muscles, especially the expiratory ones, which have a value of force much lower than expected. [24, 25]

The first reports on respiratory function in dialysis patients in Brazil started at the end of the last decade and were mostly aimed at studying lung function associated with HD time. [14, 29, 24] In one of the studies, Cury et al. (2010) [19]evaluated pulmonary function in these patients and it was possible to state that there was a decrease in forced vital capacity (FVC), in forced expired volume in the first second (FEV1) and in maximum voluntary ventilation (MVV), as indicated by spirometry.

When dealing with FVC and FEV1 in hemodialysis patients, authors propose that the main disorders that may be associated with low results of these two variables in this patient profile. In the case of women in the present study, they can be explained by subclinical conditions such as: decreased serum albumin with consequent fluid and protein imbalance in the microcirculation, interstitial fibrosis and calcifications of the pulmonary parenchyma and bronchial tree and or fibrosis by corticosteroid therapy, if the patient uses this. [21]

Another factor worth mentioning is that in addition to the respiratory muscle impairment that may explain the decrease in lung function, there is also the accumulation of interdialytic fluid that leads to increased hydrostatic pressure and changes the pulmonary capillary permeability, impairing lung volumes and capacities. [26]

In contrast, male participants, in relation to lung function, showed FVC and FEV1 values within the normal range and better than women. It is suggested that these values can be explained by the best expiratory muscle strength found in men.

The small number of participants who were evaluated, due to the need to be volunteers without any previous lung and/or heart disease and who had cognitive and physical conditions to perform the two tests used, was a limiting factor for this study. However, as a relevant point, the study encourages the routine implementation of physical therapy in the care of patients with chronic kidney disease undergoing hemodialysis, as it is already known about the impairment in respiratory muscle strength and lung function suffered by this group of patients.

CONCLUSION

As for respiratory muscle strength, men with hemodialysis CKD had reduced inspiratory muscle strength compared to predicted, characterizing mild muscle weakness. When comparing both variables (MIP and MEP) in relation to the percentage of the predicted achieved, for each gender, it was found that there is no significant difference between men and women in relation to MIP, however there is a difference in relation to MEP, obtaining the men a better result in this last variable, although still out of the normal range for both genders.

When lung function was analyzed, it was found that the male gender has pulmonary function related to the values of FVC and FEV1 within the normal range while the female gender has a reduction in lung function. When comparing the different genders in relation to the predicted percentage, it was found that there is a significant difference between men and women, for both variables mentioned above.■

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