Impact of cystic fibrosis on blood lactate level, respiratory muscle function, peripheral strength and nutritional status in children and adolescents

Impacto da fibrose cística no nível de lactato sanguíneo, função muscular respiratória, força periférica e estado nutricional em crianças e adolescentes

Impacto de la fibrosis quística en el nivel de lactato en sangre, la función muscular respiratoria, la fuerza periférica y el estado nutricional en niños y adolescentes

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ABSTRACT
Introduction: Individuals with cystic fibrosis (CF) have digestive, pulmonary and muscular system manifestations, resulting in functional and clinical repercussions, such as changes in the nutritional status, in the strength and endurance of the respiratory muscles and in the oxidative capacity. The objective of this study was to compare blood lactate level, respiratory muscle strength and endurance, peripheral strength and nutritional status among children and adolescents with CF and healthy ones, as well as to correlate the lactate level with respiratory and peripheral muscle forces and respiratory muscle endurance of children and adolescents with CF. Methods: In an observational, analytical and cross-sectional study, 22 children and adolescents (11 healthy and 11 with CF) were divided into two groups according to the diagnosis of CF. Blood lactate level, inspiratory and expiratory muscle strength, respiratory muscle endurance, peripheral muscle strength and nutritional status were evaluated. Data analysis was performed using Students t test, Mann-Whitney, Pearson and Spearman correlations, with SPSS (25.0), adopting a significance level of 5%. Results: Children and adolescents with CF presented high levels of blood lactate (p=0.000), decreased maximum inspiratory pressure (p=0.006), deterioration of nutritional status (p=0.000) and also they did not show any difference in peripheral strength (p=0.365) and respiratory endurance (p=0.716). Conclusions: Individuals with CF have high levels of blood lactate, with significant impairment of nutritional status and respiratory muscle function compared to healthy individuals. However, the high lactate levels are not related to respiratory and peripheral muscle strength and respiratory endurance.

Keywords: cystic fibrosis, lactate, muscle strength, nutritional status.
RESUMO
Introdução: Indivíduos com fibrose cística (FC) apresentam manifestações digestivas, pulmonares e musculares, resultando em repercussões funcionais e clínicas, como alterações no estado nutricional, na força e resistência dos músculos respiratórios e na capacidade oxidativa. O objetivo deste estudo foi comparar o nível de lactato sanguíneo, a força e resistência do músculo respiratório, a força periférica e o estado nutricional entre crianças e adolescentes com FC e os saudáveis, bem como correlacionar o nível de lactato com as forças musculares respiratórias e periféricas e a resistência do músculo respiratório de crianças e adolescentes com CF. Métodos: Num estudo observacional, analítico e transversal, 22 crianças e adolescentes (11 saudáveis e 11 com FC) foram divididos em dois grupos de acordo com o diagnóstico de FC. Foram avaliados o nível sanguíneo de lactato, a força inspiratória e expiratória do músculo, a resistência respiratória do músculo, a força do músculo periférico e o estado nutricional. A análise dos dados foi realizada utilizando-se o teste de Student t, correlações de Mann-Whitney, Pearson e Spearman, com SPSS (25,0), adotando um nível de significância de 5%. Resultados: Crianças e adolescentes com FC apresentaram níveis elevados de lactato sanguíneo (p=0,000), diminuição da pressão inspiratória máxima (p=0,006), deterioração do estado nutricional (p=0,000) e também não apresentaram diferença na força periférica (p=0,365) e resistência respiratória (p=0,716). Conclusões: Indivíduos com FC têm altos níveis de lactato sanguíneo, com comprometimento significativo do estado nutricional e da função muscular respiratória em comparação com indivíduos saudáveis. No entanto, os níveis elevados de lactato não estão relacionados com a força respiratória e muscular periférica e resistência respiratória.

Palavras-chave: fibrose cística, lactato, força muscular, estado nutricional.

RESUMEN
Introducción: Los individuos con fibrosis quística (FQ) presentan manifestaciones del sistema digestivo, pulmonar y muscular, dando como resultado repercusiones funcionales y clínicas, tales como cambios en el estado nutricional, en la fuerza y resistencia de los músculos respiratorios y en la capacidad oxidativa. El objetivo de este estudio fue comparar el nivel de lactato en la sangre, la fuerza y resistencia de los músculos respiratorios, la fuerza periférica y el estado nutricional entre los niños y adolescentes con FQ y los sanos, así como correlacionar el nivel de lactato con las fuerzas musculares respiratorias y periféricas y la resistencia de los músculos respiratorios de los niños y adolescentes con FQ. Métodos: En un estudio observacional, analítico y transversal, 22 niños y adolescentes (11 sanos y 11 con FQ) se dividieron en dos grupos según el diagnóstico de FQ. Se evaluó el nivel de lactato en sangre, la fuerza muscular inspiratoria y espiratoria, la resistencia muscular respiratoria, la fuerza muscular periférica y el estado nutricional. El análisis de los datos se realizó mediante la prueba t de Students, correlaciones de Mann-Whitney, Pearson y Spearman, con SPSS (25,0), adoptando un nivel de significancia del 5%. Resultados: Los niños y adolescentes con FQ presentaron altos niveles de
lactato sanguíneo \( (p=0.000) \), disminución de la presión inspiratoria máxima \( (p=0.006) \), deterioro del estado nutricional \( (p=0.000) \) y tampoco mostraron diferencia en la fuerza periférica \( (p=0.365) \) y resistencia respiratoria \( (p=0.716) \). Conclusiones: Las personas con FQ presentan niveles altos de lactato en sangre, con deterioro significativo del estado nutricional y de la función muscular respiratoria en comparación con las personas sanas. Sin embargo, los altos niveles de lactato no están relacionados con la fuerza muscular respiratoria y periférica y la resistencia respiratoria.

**Palabras clave:** fibrosis quística, lactato, fuerza muscular, estado nutricional.

### 1 INTRODUCTION

Genetic changes that characterize cystic fibrosis (CF) associated with unfavorable environmental factors can cause inflammation and infection of the respiratory tract, causing airflow obstruction that evolves with functional and structural decline of the organism. In individuals with CF, there are functional and clinical repercussions characterized mainly by impaired lung function, resulting in changes in the strength and resistance of the respiratory muscles, which act directly on ventilatory mechanics (Leroy et al., 2011). Other CF characteristics are limitations to physical exercise and reduced capacity to perform activities of daily living (ADLs), in addition to numerous manifestations related to the digestive system, which results in deterioration of nutritional status and generates a decrease in global development of the organism, including the muscular system and its oxidative capacity (Ziegler et al., 2007; Erickson et al., 2015). Deterioration of muscle function may also be related to a high level of blood lactate (Hoff et al., 2016). Lactate has been used as a marker of tissue hypoperfusion, a prognostic factor in severe disease situations and as an etiological diagnosis (Kliegel et al., 2004). To date, few studies Nikolaizik et al., (1998) and Bensel et al., (2011) has evaluated the blood lactate level in individuals with cystic fibrosis.

Thus, the aim of this study was to compare blood lactate level, respiratory muscle strength and endurance, peripheral muscle strength and nutritional status among CF healthy and healthy children and adolescents. As well as correlating the blood lactate level with the respiratory and peripheral muscle forces and the respiratory muscle endurance of children and adolescents with CF.
2 MATERIAL AND METHODS

2.1 STUDY DESIGN

An observational, analytical study with a cross-sectional design and quantitative approach, carried out at the Laboratory of Physiotherapy in Cardiorespiratory Research (LAFIPCARE), from September 2018 to December 2019. In accordance with the Declaration of Helsinki, it was approved by the local Ethics and Research Committee of the Health Sciences Center, under registration number 2,925,345.

2.2 SAMPLE CALCULATION

The sample size calculation was performed using *GraphPad StatMate* software, totaling 32 children divided into two groups. However, due to the rarity of the disease and the refusal of some patients to participate in the research, we evaluated only 22 individuals among children and adolescents. It is important to mention that most cases of cystic fibrosis in our state are concentrated in children under seven years of age.

2.3 VOLUNTEERS

Twenty-two children and adolescents of both sexes, aged between 7 and 17 years participated in the study. Eleven individuals were included in the healthy group (HG), composed of eutrophic individuals with preserved cognitive function and without respiratory, neurological or orthopedic changes that would hinder the execution of the tests. The cystic fibrosis Group (CFG) had 11 patients with a clinical diagnosis of CF confirmed with a sweat test, preserved cognitive function and who did not have musculoskeletal disorders that could limit the execution of the tests. Individuals who were unable to complete any stage of the evaluation process were excluded.

2.4 ASSESSMENT OF BLOOD LACTATE LEVEL

Blood lactate measurements were obtained by a drop of blood taken from the index finger, at the end of the evaluation, using the Accutrend Lactate plus®
lactate meter (Roche Diagnostics GmbH, Germany), validated by Pérez et al., (2008). The drop of blood was placed on the Accusport BM-Lactate® reagent strip (Roche Diagnostics GmbH, Germany), inserted in the device and analyzed.

2.5 RESPIRATORY MUSCLE ASSESSMENT

The strength of the inspiratory and expiratory muscles is represented by the measures of maximum inspiratory and expiratory pressure, MIP and MEP, respectively, according to the method proposed by Black and Hyatt (1969). The assessment of MIP and respiratory muscle endurance was determined using the PowerBreathe® device (KH2, PowerBreathe International Ltd, UK), its results were observed in real time using the Breathe-Link Medic software. For MEP measurements, a manovacuometer (GeRar®, São Paulo, Brazil) was used.

For the measurement of MIP, the participant was asked to exhale until the residual volume and, soon after, to inhale with the greatest possible force until his total lung capacity, with the mouth attached to the device. To measure the MEP value, the reverse procedure was requested. A minimum of 3 and a maximum of 9 maneuvers were performed. Thus, the highest recorded value was selected for analysis. To obtain the reference values, the equations cited by Heinzmann-Filho et al - MIP female were used: $-33.854 - (1.814 \times \text{age})$; Male MIP: $-27.020 - (4.132 \times \text{age})$; Female MEP: $17.066 + (7.22 \times \text{age})$; Male MEP: $7.619 + (7.806 \times \text{age})$ (Heinzmann-Filho et al., 2012).

After measuring the value of MIP and MEP, the incremental load test was performed. The volunteer was instructed to perform inspirations against a load of 30% of MIP for 2 minutes. Then, a minute of rest was given, and the load was increased by 10% of the MIP for a new round of the test. The load increase was repeated until fatigue. At the end of the test, MIP measurement was performed and to determine inspiratory muscle endurance, the fatigue resistance index was calculated ($IRF = \text{Final MIP}/\text{Initial MIP}$), being taken as a reference value of 0.88 for normality (Chang et al., 2005). For respiratory assessments, the participant used a disposable mouthpiece, along with a nose clip.
The following test discontinuation criteria were used: increase or decrease in heart rate (HR) of ± 20bpm, signs of respiratory muscle overload, evidenced by the excessive increase in respiratory work, presence of runs, respiratory rate above 35ipm and levels of saturation peripheral oxygen (SpO2) below 90%.

2.6 PERIPHERAL MUSCLE ASSESSMENT

Peripheral muscle strength of the upper limb was assessed using the Dynamometer® device (Jamar hand dynamometer, Patterson Medical, Warrenville, USA), through which three measurements were made on the dominant limb, with maximum handgrip effort, with the individual positioned according to the standards recommended by the American Society of Hand Therapists (ASHT). The largest measure of the three performed was used for analysis (American Society of Hand Therapists, 1992).

2.7 ASSESSMENT OF NUTRITIONAL STATUS

Anthropometric assessment was performed using measurements of weight (kilograms - kg) and height (centimeters - cm). To assess the nutritional status of children and adolescents, the WHO AnthroPlus software was used, which provides the growth curves of children and adolescents, as recommended by the World Health Organization (WHO), through the variable presented by the database software, z-score: body mass index (BMI) by age (BMI/A) (Brasil, 2007).

2.8 DATA PROCESSING AND ANALYSIS

The Shapiro-Wilk test was used to test the assumption of normality of the study variables. The Students t test was used to compare variables between groups with normal distribution and the Mann-Whitney test for non-normal variables. The correlation of the lactate level with muscle strength and endurance was analyzed through Pearson’s correlation coefficient, for variables with normal distribution, and Spearman’s, for variables with non-normal distribution. The
analyzes were performed using the SPSS statistical program (25.0), adopting a significance level of 5%.

3 RESULTS

The general characterization of the studied sample regarding age, weight, height, BMI and its classification, sex, physical activity and skin color is described in table 1. Differences between groups can be observed, in the variables BMI and weight.

Table 1: General characterization of the sample of the healthy group (HG) and cystic fibrosis (CFG)

<table>
<thead>
<tr>
<th></th>
<th>HG (n=11)</th>
<th>CFG (n=11)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Age (years)**¹</td>
<td>12,4 ± 3,0</td>
<td>12,8 ± 3,1</td>
<td>0,786</td>
</tr>
<tr>
<td>**Weight (kilos)**²</td>
<td>48,1 (45,0-53,2)</td>
<td>32,6 (26,3-42,4)</td>
<td>0,009</td>
</tr>
<tr>
<td>**Height(cm)**¹</td>
<td>155,6 ± 14,4</td>
<td>145,3 ± 15,4</td>
<td>0,119</td>
</tr>
<tr>
<td>**BMI (kg/m²)**¹</td>
<td>21,2 ± 3,1</td>
<td>15,5 ± 2,3</td>
<td>0,000</td>
</tr>
<tr>
<td>BMI classification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eutrophic</td>
<td>9 (81,8)</td>
<td>1 (9,1)</td>
<td></td>
</tr>
<tr>
<td>Low weight</td>
<td></td>
<td>10 (90,9)</td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>2 (18,2)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>7 (63,6)</td>
<td>4 (36,4)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4 (36,4)</td>
<td>7 (63,6)</td>
<td></td>
</tr>
<tr>
<td><strong>Physical activity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>They perform</td>
<td>7 (63,4)</td>
<td>3 (27,3)</td>
<td></td>
</tr>
<tr>
<td>Do not perform</td>
<td>4 (36,4)</td>
<td>8 (72,7)</td>
<td></td>
</tr>
<tr>
<td><strong>Color</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>7 (63,6)</td>
<td>4 (36,4)</td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>4 (36,4)</td>
<td>4 (36,4)</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>-</td>
<td>3 (27,3)</td>
<td></td>
</tr>
</tbody>
</table>

The nutritional status of children and adolescents in both groups is represented by the graphical analysis of the growth curve of the database (HG / CFG) provided to the WHO AnthroPlus program, in comparison with the normal WHO child growth pattern, observed in the figure 1.

Figure 1. A: Growth curve of children and adolescents in HG. B: Growth curve for children and adolescents in the CFG. Both represented by the BMI/A z-score.

Source: Prepared by the autor.
The analysis of blood lactate level, respiratory muscle strength and endurance, peripheral muscle strength and nutritional status, between HG and CFG, are shown in table 2.

Table 2: Comparative analysis of blood lactate level, muscle assessment and nutritional status between HG and CFG.

<table>
<thead>
<tr>
<th></th>
<th>HG</th>
<th>FCG</th>
<th>IC</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactate (mmol/L)¹</td>
<td>1,7 (1.2-2.0)</td>
<td>4,2 (3.3-4.9)</td>
<td>-</td>
<td>0.000</td>
</tr>
<tr>
<td>MIP (cmH₂O)²</td>
<td>90,9 ± 20,5</td>
<td>64,3 ± 19,9</td>
<td>8,708-44,630</td>
<td>0.006</td>
</tr>
<tr>
<td>MIP (%)²</td>
<td>82,6 ± 8,9</td>
<td>68,0 ± 17,8</td>
<td>2,082-27,143</td>
<td>0.025</td>
</tr>
<tr>
<td>MEP (cmH₂O)²</td>
<td>71,4 ± 15,5</td>
<td>60,8 ± 27,5</td>
<td>-9,301-30,392</td>
<td>0.281</td>
</tr>
<tr>
<td>MEP (%)²</td>
<td>57,6 ± 12,4</td>
<td>52,5 ± 18,9</td>
<td>-9,134-19,254</td>
<td>0.466</td>
</tr>
<tr>
<td>FRI²</td>
<td>1,12 ± 0,21</td>
<td>1,09 ± 0,18</td>
<td>-0,145-0,208</td>
<td>0.716</td>
</tr>
<tr>
<td>Peripheral force (kg/f)¹</td>
<td>16,0 (10,0-21,0)</td>
<td>12,0 (8,0-22,0)</td>
<td>-</td>
<td>0.365</td>
</tr>
<tr>
<td>Nutritional Status (BMI/A)²</td>
<td>0,8 ± 1,2</td>
<td>-1,9 ± 1,7</td>
<td>1,465-4,103</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Legend: 1. Variables represented by median and interquartile range values. 2. Variables represented by mean and standard deviation values; FRI: Fatigue Resistance Index. I: Initial; F: Final; L: Left; R: Right. BMI/A: Body Mass Index by Age. Source: Prepared by the autor.

The correlation of blood lactate level with muscle assessment (MIP, MEP, FRI and peripheral strength) is represented in the CFG. Through graphical and statistical analysis, it is observed that there was no relationship between these variables.
4 DISCUSSION

Blood lactate is a by-product of the anaerobic glycolytic system that has its concentration altered according to the metabolic demand of an effort, being associated with an increase in the recruitment of fast motor units, which generates an increase in strength for muscle contraction (Santos; de Assis Viegas, 2009). In our study, elevated lactate levels were observed in volunteers with CF when compared to healthy volunteers. Elevated lactate levels reflect predominantly anaerobic metabolism due to hypoxic conditions resulting from the presence of respiratory secretions in CF patients (Bensel et al., 2011).

This finding can be justified by the reduction of oxidative muscle capacity in individuals with CF at rest, during or after an exercise. This reduction occurs due to a microvascular dysfunction, which affects the transport and supply of...
oxygen to the muscles. This dysfunction may be related to oxidative stress, which may reduce the bioavailability of nitric oxide, predisposing to a decrease in maximum oxygen consumption and an increase in the level of blood lactate, as a product of anaerobic respiration in conditions in which there is no adequate oxygenation in the tissues (Rodriguez-Miguelez et al., 2016).

However, although individuals with CF have elevated blood lactate levels, they did not present an increase in muscle strength, which may justify the lack of a relationship between lactate and respiratory muscle strength and endurance or peripheral muscle strength. Thus, it is suggested that there is muscle contraction through anaerobic metabolism, since individuals with CF have chronic hypoxemia, but this muscle activity is not effective in generating strength.

Exercise capacity in people with CF is influenced by lung function, nutritional status and hypoxemia at rest. It is known that these individuals during exercise can reach the anaerobic threshold and develop metabolic acidosis at lower intensities. Therefore, the evaluation of the lactate level can be useful to establish an individual training program, since the anaerobic threshold indicates the intensity of exercise tolerated in prolonged training periods without increasing the oxygen output (Kliegel et al., 2004).

Assessing the blood lactate level is a simple measure and can be done during exercise. Thus, we suggest that new studies evaluate the exercise capacity based on the measurement of lactate and that they identify the ideal intensity of the exercise so as not to cause excessive lactate production and that it does not favor muscle wasting, metabolic acidosis and the interruption of exercise in patients who have increased lactate at rest. Our results can be useful to support these studies.

Monitoring nutritional status is essential for this population, since it is a predictor of survival and is indirectly associated with morbidity and mortality in individuals with CF (Salvatore et al., 2011). In our study, children and adolescents with CF showed a decrease in the z-score BMI/A in relation to the HG, suggesting that individuals with CF have a BMI below the expected for their age, according to the distribution normal WHO. This fact is corroborated by the study by Martins
et al., (2019), in which adolescent patients with CF had a mean BMI z-score significantly lower than healthy adolescents, as well as the average fat mass index (FMI) of adolescents with CF was lower than in healthy controls.

According to the WHO, the z-score <-2 of BMI/A refers to the nutritional diagnosis of low BMI for age. This cutoff point confirms that CF patients evaluated in this study have a greater tendency to underweight. Impaired energy balance is common in patients with CF. Energy loss, justified by poor digestion and intestinal bad absorption of macronutrients, causes loss of fat through feces and disturbances in the metabolism of proteins and amino acids, contributing to muscle atrophy (Engelen; Com; Deutz, 2014; Zemel et al., 2000).

The muscular evaluation of our study showed that individuals with CF have a decrease in MIP, as well as the percentage of MIP predicted for this population, when compared to HG, suggesting that patients with CF have a reduction in respiratory muscle strength. The decrease in strength is probably due to chronic systemic inflammation, oxidative stress, hypoxia, bad nutrition, electrolyte disturbance and recurrent inactivity in this population (Wood et al., 2001).

Another relevant factor contributing to the deficit in muscle strength, is the primary defect in cystic fibrosis transmembrane conductance regulator (CFTR), a protein present in skeletal muscle fibers. The mutation of this protein generates high amounts of calcium and inflammatory mediators in the muscle, which can limit exercise capacity early (Divangahi et al., 2009). Associated with this factor, the respiratory musculature also undergoes changes due to pulmonary hyperinflation caused by persistent pulmonary inflammation, the presence of inflammatory mediators in the vicinity of the diaphragm muscles and the use of corticosteroids, common in these patients (Dassios, 2015).

Andrade et al., (2018) observed that individuals with CF presented MIP and MEP below the reference value for this population, representing a greater tendency for respiratory muscle weakness, especially for females. However, it was found that there was no difference in the values of MEP and the MEP percentage predicted in individuals with CF when compared to HG.
The similarity of expiratory muscle strength between HG and CFG can be explained by the pathophysiology of this chronic and progressive disorder, which can present a thick and infected secretion resulting from a chronic inflammatory process. Thus, the mucus becomes dry, thick and viscous and causes airway obstruction, imposing greater resistance to breathing and coughing. Thus, patients perform greater strength at the time of cough, suggesting a form of muscle training, which makes the strength of expiratory muscles, represented by the MEP value, to be within normal values and to show no difference when compared to HG (Gershman et al., 2006).

It can also be observed that individuals with CF do not have changes in inspiratory muscle endurance, according to FRI values. This result is attributed to the adaptation of inspiratory muscles to chronic stress, after new functional requirements generated by airway obstruction, which results in an increase in the number of mitochondria and can provide an increase in the resistance capacity of these muscles (Keens et al., 1977). However, a study by Vendrusculo et al., (2016) revealed a different result, showing a decrease in endurance in children and adolescents with CF who had normal lung function and concludes that the increase in airway resistance over time generates greater muscle resistance, because ventilation with an increased load caused by airway obstruction can lead to resistance training.

Peripheral muscle dysfunction is an important systemic consequence of CF with important clinical implications, such as exercise intolerance, reduced quality of life and also represents one of the best prognostic and survival markers in CF (Hulzebos et al., 2014). Arikan et al., (2015) state that the peripheral muscle strength of the quadriceps, shoulder abductor and handgrip strength was lower in patients with CF compared to the control group, demonstrating a reduction in peripheral muscle strength in patients with CF.

However, in our study, the peripheral handgrip strength values of the GFC do not show any difference when compared to the HG. This result may be attributed to the probable decrease in muscle strength of the upper limb of both groups. Moura (2008) calculated the average handgrip strength for male children
and adolescents (42.09 kg/f) and for female (26.64 kg/f). Based on this result, we have that children and adolescents from both groups in our study have muscle weakness in the upper limbs. However, as Moura's study did not establish reference values, it was not possible to compare the results of our study with predicted values.

The urbanization process and the creation of new technologies, added to the violence in urban centers, have contributed to the inactivity and sedentarism of children and adolescents. According to Rocha; Rose; Schivinski (2014) the functional and physical activity level of child athletes was assessed and it was concluded that part of the children and adolescents did not meet the desirable criteria for a recommended physical fitness. This fact can also justify the values found in our study.

The study had limitations regarding the sample size. As it is a rare disease, the number of patients is restricted in our state. In addition, many patients were outside the age range included in the study. We can also consider as a limitation the existence of gaps in the literature regarding studies with reference parameters of handgrip strength in Brazilian children and adolescents, preventing a deeper analysis of the results.

5 CONCLUSIONS

Individuals with CF have high levels of blood lactate with significant impairment of nutritional status and respiratory muscle function compared to healthy individuals. However, the high lactate levels are not related to respiratory and peripheral muscle strength and respiratory endurance. The functional characteristics presented by children and adolescents with CF are essential to guide the creation of new physical therapy intervention strategies, enabling better assistance to these individuals, especially in the exercise prescription.
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