DOI: 10.1590/1809-2950/e24008324en

ORIGINAL RESEARCH

Respiratory system parameters and clinical markers in children with cystic fibrosis

Parâmetros do sistema respiratório e marcadores clínicos para crianças com fibrose cística

Parámetros del sistema respiratorio y marcadores clínicos para niños con fibrosis quística

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ABSTRACT | This study aimed to investigate the relationship between respiratory system parameters and clinical markers in individuals with cystic fibrosis (CF), as well as to compare individuals with altered oscillometric parameters to those with values within normal range. This cross-sectional analytical study involved children and adolescents with CF. Data collected included anthropometric measurements, disease severity, bacterial colonization, genetic mutations, and parameters from impulse oscillometry (IOS) and spirometry. A total of 115 evaluations were conducted. Correlation was found between respiratory system parameters and the association of total airway resistance (R5) and 5 Hz reactance (X5) with genetic mutations, BMI percentiles, and disease severity. Significant differences were observed between the TypicalX5 and AlteredX5 groups ($FEV_{1\%}$ and $FEF_{25-75\%}$, p<0.001) and the TypicalR5 and AlteredR5 groups ($FEV_{1\%}$ and $FEF_{25-75\%}$, p<0.001). Height, FEV_1 (L), and $FEF_{25-75\%}$ (L) explained 69.2% of variations in X5 (kPa), while height and FEV1 (L) together explained 68.2% of variations in R5. **Conclusion**: This study verified the relationship between spirometric and oscillometric parameters, and found that R5 and X5 are linked to genetic mutation, BMI percentile, and disease severity. Routine spirometry, as well as weight and height assessment, are essential in the management of lung disease.

Keywords | Adolescent; Cystic Fibrosis; Clinical Markers; Child; Pulmonary Function; Respiratory Mechanics.

RESUMO | Este estudo teve como objetivo investigar a relação entre parâmetros do sistema respiratório e marcadores clínicos em indivíduos com fibrose cística (FC), bem como comparar indivíduos com parâmetros oscilométricos alterados àqueles com valores dentro da faixa de normalidade. Trata-se de um estudo analítico transversal com crianças e adolescentes com FC. Foram coletados dados antropométricos, de gravidade da doença, colonização bacteriana, mutações genéticas e parâmetros obtidos por oscilometria de impulso (IOS) e espirometria. Foram realizadas 115 avaliações. Identificou-se correlação entre os parâmetros do sistema respiratório e a associação da resistência total das vias aéreas (R5) e da reactância a 5 Hz (X5) com mutações genéticas, percentis de IMC e gravidade da doença. Diferenças significativas foram observadas entre os grupos com X5 típico e X5 alterado ($VEF_{1\%}$ e $FEF_{25-75\%}$, p<0,001) e entre os grupos com R5 típico e R5 alterado ($VEF_{1\%}$ e $FEF_{25-75\%}$, p<0,001). A estatura, o VEF1 (L) e o $FEF_{25-75\%}$ (L) explicaram 69,2% das variações em X5 (kPa), enquanto a estatura e o VEF1 (L) juntos explicaram 68,2% das variações em R5. Este estudo verificou a relação entre os parâmetros espirométricos e oscilométricos, e identificou que R5 e X5 estão associados à mutação genética, ao percentil de IMC e à gravidade da doença. A espirometria de rotina, bem como a avaliação do peso e da estatura, são essenciais no manejo da doença pulmonar.

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Financing source: Fundação de Amparo à Pesquisa e Inovação do Estado de Santa Catarina and Coordination for the Improvement of Higher Education Personnel – Conflict of interests: Nothing to declare – Presentation: Aug. 6, 2024 – Accepted for publication: Oct. 19, 2024 – Approved by the Research Ethics Committee of the Universidade do Estado de Santa Catarina [Protocol No. 80800217.4.0000.5361]. Responsible editor: Sônia LP Pacheco de Toledo

Descritores | Adolescente; Fibrose Cística; Marcadores Clínicos; Criança; Função Pulmonar; Mecânica Respiratória.

RESUMEN | Este estudio tuvo como objetivo analizar la relación entre los parámetros del sistema respiratorio y los marcadores clínicos en individuos con fibrosis quística (FQ), así como comparar los individuos con parámetros oscilométricos alterados con aquellos con valores dentro del rango normal. Se trata de un estudio analítico transversal realizado con niños y adolescentes con FQ. Se recogieron datos antropométricos, sobre la gravedad de la enfermedad, la colonización bacteriana, las mutaciones genéticas y los parámetros obtenidos por oscilometría de impulso (IOS) y espirometría. Se realizaron 115 evaluaciones. Se identificó una correlación entre los parámetros del sistema respiratorio y la asociación de la resistencia total de las vías respiratorias (R5) y la reactancia a 5 Hz (X5) con mutaciones genéticas, percentiles del IMC y gravedad de la enfermedad. Se encontraron diferencias significativas entre los grupos con X5 típico y X5 alterado ($VEF_{1\%}$ y $FEF_{25-75\%}$, p<0,001) y entre los grupos con R5 típico y R5 alterado ($VEF_{1\%}$ y $FEF_{25-75\%}$, p<0,001). La altura, el VEF1 (L) y el $FEF_{25-75\%}$ (L) explican el 69,2% de las variaciones en X5 (kPa), mientras que la altura y el VEF1 (L) juntos ilustran el 68,2% de las variaciones en R5. Este estudio verificó la relación entre los parámetros espirométricos y oscilométricos, e identificó que R5 y X5 están asociados con la mutación genética, con el percentil del IMC y con la gravedad de la enfermedad. La espirometría de rutina, así como la evaluación del peso y la altura, son esenciales en el tratamiento de la enfermedad pulmonar.

Palabras clave | Adolescente; Fibrosis Quística; Marcadores Clínicos; Niño; Función Pulmonar; Mecánica Respiratoria.

INTRODUCTION

Cystic fibrosis (CF) is an autosomal recessive genetic disorder that affects multiple organs[1]. Given its progressive nature, close monitoring of clinical manifestations following diagnosis is essential[2]. In individuals with CF, disease severity is an important marker associated with different classes of genetic mutations, which contribute to clinical variability and may accelerate symptom onset[3,4]. Similarly, nutritional status and pathogen colonization are directly linked to the progression of lung disease—a significant clinical marker for this population[5,6].

Although CF is a multisystem disease, respiratory involvement is the leading cause of morbidity and mortality in affected individuals. Therefore, monitoring different respiratory system parameters is essential for disease management[1]. In this regard, it is recommended that the assessment of pulmonary function via spirometry begin in early childhood for individuals with CF. Among spirometry parameters, forced expiratory volume in one second (FEV_1) is considered one of the main indicators. It is used to monitor disease prognosis, detect early acute pulmonary exacerbations, guide lung transplantation decisions, and evaluate treatment response[2].

In addition to spirometry, the impulse oscillometry system (IOS) offers a complementary evaluation of the respiratory system. Although less commonly used than spirometry, IOS has proven to be a relevant method in assessing pulmonary mechanical properties and is routinely used in major CF reference centers[6]. In CF, IOS has been increasingly employed for early detection of airway abnormalities. This method can discriminate between resistive properties of the distal and proximal airways. It is a quick and safe procedure that requires only tidal breathing, making it easier to perform in younger children, as it does not depend on forced maneuvers or vigorous verbal commands[7].

Previous studies have shown an association between clinical markers in CF and reduced FEV_1 in spirometry[3-5]. However, the relationship between these markers and IOS parameters remains underexplored, despite IOS being considered a complementary tool to traditional pulmonary function tests. Therefore, this study aimed to investigate the relationship between respiratory system parameters and clinical markers in individuals with CF, as well as to compare individuals with altered oscillometric parameters to those with values within normal range.

METHODOLOGY

A cross-sectional analytical study was performed at the CF referral center of the Joana de Gusmão Children's Hospital – Florianópolis, Santa Catarina,. Assessments of respiratory system parameters were included for children and adolescents with CF aged five to 15 years, with diagnosis confirmed according to the Brazilian Guidelines for the Diagnosis and Treatment of Cystic Fibrosis[2]. Participants were selected via non-probabilistic convenience sampling. Evaluations performed from May

2017 to May 2018 in the referred hospital were considered. Examinations of individuals who were unable to perform any evaluation procedure and who manifested pulmonary exacerbation at the time of collection were excluded from the sample.

Anthropometric data on body mass and height were obtained, followed by the calculation of body mass index (BMI) and BMI percentiles[8]. Clinical stability was verified using the Cystic Fibrosis Clinical Score (CFCS)[9] and the Cystic Fibrosis Foundation Score (CFFS)[10]. The CFCS includes five common symptoms and five physical findings; a final score of 25 or higher indicates pulmonary exacerbation[9], as does the presence of four or more signs and symptoms on the CFFS[10]. Disease severity was determined using the Shwachman–Doershuk Score (SDS)[11], which was scored by a specialist from the referral center. Data on bacterial colonization and genetic mutation were obtained from medical records.

To evaluate respiratory system parameters, pulmonary function was analyzed using spirometry (Master Screen IOS, Jaeger®) following the American Thoracic Society (ATS) guidelines[12]. Respiratory mechanics was monitored using the IOS (Master Screen IOS, Jaeger®), also in accordance with ATS recommendations[13]. Spirometric parameters analyzed included forced expiratory volume in one second (FEV_1) and forced expiratory flow between 25% and 75% of forced vital capacity ($FEF_{25-75\%}$), expressed both in absolute values and percentages of the predicted values, according to Polgar et al.[14] and Knudson et al.[15]. Oscillometric parameters analyzed were 5 Hz impedance (Z5), total airway resistance (R5), central airway resistance (R20), 5 Hz reactance (X5), resonance frequency (ResF), and reactance area (AX), all reported in absolute values and percentages of predicted values according to the reference equations proposed by Assumpção et al.[16] for Brazilian children.

For IOS data analysis, individuals were divided into groups based on typical X5 (TypicalX5) and R5 values (TypicalR5), as well as those with altered values (AlteredX5 and AlteredR5). X5 and R5 values equal to or greater than 150% of the predicted ones were considered altered[17].

All statistical analyses were conducted using IBM SPSS® 20.0, with statistical significance set at $p<0.05$. Data normality was assessed using the Kolmogorov–Smirnov test. Mann–Whitney's *U* Test was used to compare differences between TypicalX5 and AlteredX5 groups, as well as between TypicalR5 and AlteredR5 groups. Spearman's correlation was used to analyze associations between SDS, respiratory system parameters, age, and anthropometry variables. Simple linear regression (SLR) and multiple linear regression (MLR) analyses were performed to determine the influence of predictors—body mass, height, age, SDS, FEV_1, and $FEF_{25-75\%}$ (absolute values)—on the dependent variables R5 and X5 (also in absolute values). Initially, outliers were identified in both dependent and predictor variables. Then, the adjustment of the dependent variables to the normal distribution was analyzed, with the need for logarithmic transformation (base 10) to R5 and exponential transformation to X5. Pearson's correlation coefficient was applied between the transformed dependent variables and the predictor variables, followed by the development of SLR and then MLR models. Stepwise selection was used. The probability of inclusion in the model of a predictor variable was $p\leq0.05$ and exclusion probability of $p\geq0.10$. To evaluate the model fit, residual analysis was used, which presented zero mean and normal distribution. The best model was chosen based on the adjusted determination coefficient (R2 adjusted) and the theoretical framework adopted by the authors.

RESULTS

In total, 118 evaluations were performed; however, three were excluded due to researchers not having access to the subjects' medical records hindering data collection. According to clinical stability criteria, 25 evaluations were excluded due to pulmonary exacerbations. Therefore, this study included 115 evaluations of children with CF, with a mean age of 9.84±2.80 years and a mean BMI of 16.29±2.35 kg/m^2.

Of the total assessments, 54.8% were girls, 75.7% were individuals colonized by bacteria, 82.6% had at least one ΔF508 mutation allele, and 83.5% were classified as having excellent to good severity according to SDS. No patient had a score of 40 or lower, which is considered severe by SDS.

Table 1 shows the means and standard deviations of FEV_1, $FEF_{25-75\%}$, Z5, R5, R20, X5, ResF, and AX parameters, both in absolute values and percentages of predicted values. Changes in the predicted percentage values of FEV_1, $FEF_{25-75\%}$, Z5, X5, and AX were observed. About 40% of the sample had FEV_1 values greater than or equal to 80% of the predicted and, among these, 43% had $FEF_{25-75\%}$ values below 70% of the predicted.

Table 1. Descriptive statistic of respiratory system parameters, spirometry, and IOS in the total sample, and of groups TypicalX5 and AlteredX5, and TypicalR5 and AlteredR5

	Total Sample (n=115)	AlteredX5 (n=72)	TypicalX5 (n=43)	AlteredR5 (n=19)	TypicalR5 (n=96)
Parameter			Mean±SD		
FEV_1 (L)	1.44±0.67	1.23±0.56	1.78±0.70	0.90±0.57	1.55±0.63
FEV_1%	70.90±26.85	58.80±23.66	91.16±18.40	46.06±27.81	75.81±23.88
$FEF_{25-75\%}$ (L/s)	1.34±1.09	0.97±0.69	1.96±1.34	0.60±0.50	1.49±1.12
$FEF_{25-75\%}$ %	52.45±35.14	37.77±26.60	77.02±34.18	26.21±21.63	57.64±35.05
Z5 (kPa/L/s)	0.79±0.32	0.87±0.33	0.64±0.22	1.23±0.32	0.69±0.23
Z5%	166.84±65.35	195.90±65.33	118.18±22.50	270.67±58.14	146.29±43.61
R5 (kPa/L/s)	0.72±0.29	0.78±0.30	0.61±0.22	1.10±0.31	0.64±0.21
R5%	112.23±36.30	125.89±37.26	89.34±19.32	174.21±30.76	99.95±21.94
R20 (kPa/L/s)	0.50±0.13	0.50±0.14	0.48±0.10	0.60±0.16	0.47±0.11
R20%	96.13±17.16	98.81±19.19	91.62±11.98	115.69±17.11	92.25±14.36
X5 (kPa/L/s)	-0.31±0.17	-0.37±0.17	-0.18±0.06	-0.52±0.21	-0.26±0.12
X5%	207.00±123.29	265.07±121.74	109.77±27.22	362.46±159.74	176.23±87.26
ResF (1/s)	21.46±6.62	23.73±6.15	17.65±5.60	30.16±4.84	19.73±5.47
ResF%	132.98±51.79	151.78±55.17	101.50±22.65	201.31±65.32	119.45±35.96
AX (kPa/L)	2.58±2.25	3.35±2.36	1.28±1.26	5.89±2.45	1.92±1.51
AX%	372.52±572.74	521.40±680.06	123.22±83.19	1096.33±10.55	229.26±239.1

(L): liters; kPa: kilopascal; %: percentage of predicted values; FEV_1: forced expiratory volume in one second; $FEF_{25-75\%}$: forced expiratory flow from 25% to 75% of the forced vital capacity; Z5: impedance at 5 Hz; R5: total airway resistance; R20: central airway resistance; X5: reactance at 5 Hz; ResF: resonance frequency; AX: reactance area expressed in kPa/L.

Correlation analysis showed a weak association between body mass, height, and age with X5 as a percentage of the predicted values. FEV_1% and $FEF_{25-75\%}$ presented moderate to strong correlations with all oscillometric parameters as a percentage of predicted values. Disease severity measured by SDS was correlated with all oscillometric parameters except R20%.

The TypicalX5 group included 43 evaluations, with a mean FEV_1 of 91.16±18.40% and $FEF_{25-75\%}$ of 77.02±34.18%. The AlteredX5 group comprised 72 evaluations, showing lower mean values for FEV_1 (58.80±23.66%) and $FEF_{25-75\%}$ (37.77±26.60%) compared to the TypicalX5 group ($p<0.001$). The comparison between the groups also showed a significant difference in the SDS scores ($p<0.001$), the TypicalX5 group mean score was 91.28±8.87 points and the AlteredX5 group mean was 82.99±14.62 points.

The TypicalR5 group comprised 96 evaluations, with a mean FEV_1 of 75.81±23.88% and a mean $FEF_{25-75\%}$ of 57.64±35.05%. The AlteredR5 group included 19 evaluations, with a mean FEV_1 of 46.06±27.81% and a mean $FEF_{25-75\%}$ of 26.21±21.63%. The TypicalR5 group showed higher values compared to AlteredR5 group.

Table 2 shows the data of SLR and MLR analysis for R5. The SDS score was not significantly correlated with the transformed R5 variable, so it was not included in the regression models. Height and FEV_1 together explained 68.2% of the variation in R5. Therefore, for each 1cm increase in height, a decrease of 0.334 kPa/L/s in R5 is expected, and for each 1L increase in FEV1, a decrease of 0.154 kPa/L/s in R5 is expected.

Table 2. Simple and multilinear regression results for R5 in absolute value, transformed into logarithm

p-value	R^2	Adjusted R^2		Model
SLR – Age (years old)	26.2%	25.6%	<0.001	Log(R5)=0.123–0.03×Age
SLR – Height (cm)	39.2%	38.7%	<0.001	Log(R5)=0.708–0.64×Height
SLR – Mass (kg)	34.9%	34.3%	<0.001	Log(R5)=0.131–0.10×Mass
SLR – FEV_1	60.7%	60.3%	<0.001	Log(R5)=0.102–0.193×FEV_1
SLR – $FEF_{25-75\%}$	43.0%	42.5%	<0.001	Log(R5)=-0.042–0.100×$FEF_{25-75\%}$
MLR*		68.2%	<0.001	Log(R5)=0.506–0.334×Height–0.154×FEV_1

R2: coefficient of determination; Adjusted R2: adjusted coefficient of determination; SLR: simple linear regression; MLR: multiple linear regression Log-log base 10; FEV_1: forced expiratory volume in one second; FEF25-75%: forced expiratory flow from 25% to 75% of forced vital capacity. (*) Log (R5)=a+b1×Height+b2×FEV_1.

Table 3 shows the SLR and MLR results for the X5 variable. Age did not show significant correlation with the transformed X5 variable, so it was not included in the regression models. Predictor variables—height, FEV_1, and $FEF_{25-75\%}$—together explained 69.2% of X5 variations. Therefore, for each 1cm increase in height, a 0.338 kPa/L/s decrease is predicted for X5. For each 1L increase in FEV_1, an 0.433 kPa/L/s increase in X5 is expected, and for each 1L/s increase in $FEF_{25-75\%}$, X5 is expected to increase by 0.076 kPa/L/s.

Table 3. SLR and MLR results for X5 in absolute value, transformed into exponential

p-value	R^2	Adjusted R^2		Model
SLR – Height(cm)	5.8%	5.0%	0.009	Exp(X5)=1.644+0.346×Height
SLR – Mass(kg)	9.1%	8.3%	0.001	Exp(X5)=1.901+0.007×Mass
SLR – SDS	14.6%	13.8%	<0.001	Exp(X5)=1.548–0.007×SDS
SLR – FEV_1	65.2%	64.9%	<0.001	Exp(X5)=1.716+0.280×FEV_1
SLR – $FEF_{25-75\%}$	50.2%	49.8%	<0.001	Exp(X5)=1.918–0.151×$FEF_{25-75\%}$
MLR*		69.2%	<0.001	Exp(X5)=2.062–0.338.Height+0.433× FEV_1 0.076×$FEF_{25-75\%}$

R2: coefficient of determination; Adjusted R2: adjusted coefficient of determination; SLR: simple linear regression; MLR: multiple linear regression; Exp: exponential; cm: centimeters; kg: kilogram; SDS: Shwachman–Doershuk score; FEV_1: forced expiratory volume in one second; $FEF_{25-75\%}$ forced expiratory flow from 25% to 75% of forced vital capacity. (*) Exp (X5)=a+b1×Height+b2× FEV_1+b3×$FEF_{25-75\%}$.

DISCUSSION

This study presents findings on the relationship between clinical markers and respiratory system parameters, a relevant aspect in CF. Its originality lies in the presentation of data on the interaction between these variables. To the best of our knowledge, this is the first study to show an association between oscillometric parameters and spirometry in individuals with CF.

Regarding the linear regression analysis, body mass, age, and SDS did not seem to be relevant to predict the R5 and X5 parameters, since it was not included in the regression model. However, height and FEV_1 were associated with both oscillometric parameters (R5 and X5), indicating that impairments in spirometric function leads to the worsening of R5 and X5. Also, $FEF_{25-75\%}$ was included in the regression model for X5, and since both parameters reflect small airway function,

this result supports the use of IOS as a complementary assessment tool to spirometry[18,19]. This analysis had not yet been conducted in other studies that correlated IOS with spirometry, and it encourages further research while reinforcing the importance of routine pulmonary function monitoring by spirometry and, based on these findings, the interpretation of possible repercussions on airway resistance and reactance.

Some studies have evaluated the correlation between oscillometric and spirometric parameters, with conflicting results[18,20]. Moreau et al. found a weak positive correlation between X5 and spirometric indexes in 30 individuals with CF aged four to 19[20]. Similarly, Raj et al.[18] studied 39 individuals with CF (34 children and five adults) and found no significant correlation between X5 and any spirometric parameter. Both studies had small sample sizes and included participants across a wide age range.

In spirometry, FEV_1 is typically within the normal range for most young individuals. Consequently, its sensitivity in detecting airway obstruction compared to FEF_{75} and $FEF_{25-75\%}$ has been a topic of discussion[21]. This is because the involvement of $FEF_{25-75\%}$ is precocious, and therefore it stands out as a parameter that may be altered even in asymptomatic individuals[21]. These findings are supported by König et al.[22], who analyzed 3,169 spirometry tests from individuals with CF. The authors found that among tests with FEV_1 above 80% of the predicted value, approximately 58% showed changes in FEF_{75}, 31% in $FEF_{25-75\%}$, and 72% in the FEV_1/FVC ratio. Reinforcing the findings by König et al.[22], this study showed that among individuals with FEV_1 above 80% of the predicted value, 43% had $FEF_{25-75\%}$ below 70% of the predicted value, with evident impairment of small-caliber airways. Although they present a low disease severity according to the SDS, this alteration in $FEF_{25-75\%}$ combined with elevated X5 values in most children reinforces early impairment of peripheral airways.

CF is characterized by early involvement of small-caliber airways, which causes increased surface tension, altering airway wall thickness, reduction of smooth muscle tone, among other alterations[23]. X5 reflects pulmonary elastic recoil and is altered in obstructive and small airway diseases, such as CF[19,24]. Another parameter indicative of peripheral airway impairment is resistance at 5 Hz (R5), which represents total airway resistance. Sakarya et al.[19] observed increased R5 and R20 values in individuals with CF compared to healthy individuals, with the increase being more evident in R5 than in R20. According to the authors, this finding demonstrates distal airway obstruction in CF rather than in central resistance (R20)[18]. This finding was also verified in this study, in which R5 values were numerically higher than R20, although the difference was not statistically significant. However, a relevant finding in this investigation, unaddressed by Sakarya et al.[19], was the X5 parameter, whose impairment enabled the development of an equation including anthropometric variables and spirometry parameters, similar to what was found with R5.

When comparing the TypicalR5 and AlteredR5 groups, differences were observed in FEV_1 and $FEF_{25-75\%}$ values, with the latter showing lower spirometric results. A similar pattern was found in the AlteredX5 group. This suggests that individuals with lower spirometric values present impaired respiratory mechanics, reinforcing the potential of IOS as a sensitive instrument to detect respiratory mechanics compromise in CF and supporting its use as a complement to spirometry[18]. However, one limitation of this study is the unequal sample size between subgroups (AlteredR5=19, TypicalR5=96), which highlights the need for further investigation. Although this study has provided valuable insights into the relationship between respiratory system parameters and clinical markers in children with CF, its retrospective design must be acknowledged as a limitation and taken into account when interpreting the results and their implications.

In any case, the X5 and R5 values (expressed as percentages of predicted values) were associated with BMI percentile, genetic mutation, and SDS, which attends to health teams the interaction between clinical markers and the IOS. Regarding these markers, particularly BMI percentile, an association with R5 and X5 was identified as a percentage of the predicted value, so that all individuals with a compromised BMI percentile also had X5 values above the predicted range. Individuals with nutritional impairment and stunted growth tend to exhibit reduced lung function, which can negatively impact respiratory mechanics parameters[25].

Higher disease severity and progression are also associated with genotype in CF, specifically the ΔF508 mutation[26], which is present in most of the sample. An association was found between this genotype and R5 and X5 (expressed as percentages of predicted values), with most children showing alterations in R5 and X5 carrying at least one ΔF508 allele. This mutation is the most common in the southern Brazil population and is classified as a type II mutation, which is linked to a more severe disease phenotype [26,27]— potentially explaining the changes in respiratory mechanics, especially in X5.

Disease severity in the studied sample was classified using the Shwachman-Doershuk score[11], which is known to correlate with pulmonary function, specifically with FEV_1[28]. A negative relationship was observed between the SDS and X5, suggesting that individuals with less severe disease may have a less altered pulmonary elastic recoil. Regarding anthropometry, regression models of both oscillometric variables included height as a predictor of changes in airway resistance and reactance. An increase in height was associated with improvements in R5 and X5. This result was expected, as older children theoretically have greater lung volumes and lower airway resistance[29]. These findings are consistent with those reported by other authors[16, 30], and reinforce the importance of promoting healthy growth in height and weight among children with CF.

CONCLUSION

This study identified a relationship between respiratory system parameters and clinical markers in children with CF, including BMI, genetic mutation, bacterial colonization, and disease severity. Associations were found between spirometric and oscillometric parameters, particularly R5 and X5, and clinical variables such as genetic mutation, BMI percentile, and disease severity. The regression model developed was able to predict R5 and X5 values based on spirometric measures (FEV_1 and $FEF_{25-75\%}$) and children's height. These findings reinforce the importance of clinical monitoring in CF and the need to investigate all factors in the evaluation of affected individuals. Routine spirometry, along with weight and height evaluation, are essential in the management of pulmonary disease in this population.

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