

# The Borg Scale Is Accurate in Children and Adolescents Older Than 9 Years With Cystic Fibrosis

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**OBJECTIVE:** To evaluate the accuracy of the modified Borg scale to estimate lung impairment, measured via FEV<sub>1</sub> in children and adolescents with cystic fibrosis. **METHODS:** This cross-sectional prospective study was conducted with cystic fibrosis patients, 6–18 y old. With the modified Borg scale we evaluated their subjective perceptions of dyspnea before and after submaximal exercises, and its correlation with lung function (spirometry), 6-min walk test (6MWT), and nutritional status according to body mass index. **RESULTS:** Forty-one patients (mean  $\pm$  SD age range 11.1  $\pm$  4.1 y), were included in the study. The median (and interquartile range) modified Borg scale score after 6MWT was 2 (1–3). The mean percent-of-predicted FEV<sub>1</sub> (FEV<sub>1</sub>%) was 97  $\pm$  32%. The Z score of the 6MWT distance (6MWTZ) for 61% of the patients was  $\leq$  -2. The modified Borg scale correlated weakly with the other variables when all patients in the sample were analyzed. There was a significantly greater correlation of the Borg-scale score with FEV<sub>1</sub>% ( $r = -0.59$ ,  $P = .003$ ) and with 6MWTZ ( $r = 0.46$ ,  $P = .03$ ) when patients older than 9 years were evaluated separately. The receiver operating characteristic curve analysis revealed that a modified-Borg-scale cut-off point of 2.5 generated an area of 0.80, a sensitivity of 80%, a specificity of 77%, and an accuracy of 0.78 to predict FEV<sub>1</sub>% lower than 80% in the group of patients older than 9 years. **CONCLUSIONS:** The modified Borg scale is accurate to assess the subjective perception of dyspnea of children older than 9 years and adolescents with cystic fibrosis. *Key words:* cystic fibrosis; modified Borg scale; lung function testing; 6-minute walk test; children; adolescents. [Respir Care 2010;55(6): 729–733. © 2010 Daedalus Enterprises]

## Introduction

Cystic fibrosis (CF) patients show intolerance to physical exercise, due to dynamic hyperinflation,<sup>1</sup> with a consequent decrease of ventilatory capacity, contributing to

the physical and aerobic limitation of these individuals, evidenced by symptoms reported during and after exercise, such as dyspnea, fatigue, and ventilatory limitation.<sup>2-5</sup> The progressive limitation of physical conditioning, allied to inactivity, begins a vicious cycle in which worsening of dyspnea is associated with a weaker physical performance, severely compromising the quality of life.<sup>6</sup>

Therefore, assessment of exercise tolerance and aptitude in children with CF is a useful measure of the impact of the disease on the patient. Moreover, measurement of activity level and exercise tolerance may be used to identify functional limitations and to quantify the effects of the disease on daily life activities and, therefore, quality of life.<sup>7</sup>

In this context, the 6-minute walk test (6MWT) has been used in pulmonary rehabilitation programs to assist in acquiring general information about the responses of several systems involved in exercise, including the cardiovascular and neuromuscular systems.<sup>8-10</sup> As an aid to ob-

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tain functional data, the modified Borg scale is a tool used with the 6MWT to verify the degree of ventilatory discomfort at rest and after exercise, being reproducible and valid in the subjective perception of dyspnea, at least in adults, providing directly an individual measurement of the intensity of exercise.<sup>11</sup>

Also, the knowledge of the intensity of the patient's dyspnea provides important data about the evolution of the clinical picture during treatment, because this measurement is fundamental in clinical practice, enabling the therapists to suit their conduct to achieve best therapeutic goals.<sup>12</sup> Studies with adults showed its applicability<sup>8,13,14</sup>; however, literature is scarce in relation to its use in children and adolescents. Subjectivity and the incapacity to understand the scale are possible limitations of this age group, which demands that further studies be carried out.

Thus, in this innovative study we intended to verify the applicability and accuracy of the modified Borg scale after exercise in estimating the pulmonary compromise measured via the FEV<sub>1</sub>, in children and adolescents with CF.

## Methods

This was a cross-sectional and prospective study in patients in the pediatric pulmonology out-patient clinic of Hospital São Lucas da Pontifícia, Universidade Federal do Rio Grande do Sul, and the adult pulmonology out-patient clinic of Hospital de Clínicas de Porto Alegre, Porto Alegre, Brazil.

The research protocol was started after approval by the Ethics in Research Committee of Pontifícia Universidade Católica do Rio Grande do Sul and the Scientific Commission and the Health Research and Ethics of Hospital de Clínicas de Porto Alegre, and written informed consent was obtained from all the patients, or family members of patients younger than 18 years of age.

Data collection took place from March 2006 to December 2007. The population studied consisted of patients with CF, ages 6–18 years, who were clinically stable and with the cognitive capacity to do the tests and understand the modified Borg scale. We excluded patients who had had exacerbation signs of the respiratory symptoms in the last 15 days,<sup>15</sup> hemodynamic instability, osteomuscular alterations, or cardiac diseases. All the patients invited agreed to participate. No patient was excluded.

## Measurements

The patients were submitted to clinical and interdisciplinary evaluations and, later, to the pulmonary function test, in accordance with the routine of ambulatory care. Next, they were sent to the rehabilitation center of Pontifícia Universidade Católica do Rio Grande do Sul located next to Hospital São Lucas. At their arrival at the rehabil-

itation center, they remained at rest sitting on a chair for 15 min, and, after that, they started the 6MWT with the application of the Borg scale. The patients enrolled at the Hospital de Clínicas de Porto Alegre were taken to the rehabilitation center of Pontifícia Universidade Católica do Rio Grande do Sul, with the aim of keeping the same procedure and location for the data collection.

## Spirometry

Spirometry was performed by a trained resident physician, using a hand-held spirometer (Koko, nSpire Health, Longmont, Colorado). Data evaluated were the forced vital capacity (FVC), the FEV<sub>1</sub>, and the Tiffeneau index (FEV<sub>1</sub>/FVC). Absolute values and the rates predicted for sex, age, and height were calculated according to Pereira and co-workers.<sup>16,17</sup>

## 6-Minute Walk Test

The 6MWT was conducted in accordance with the American Thoracic Society guidelines, in a closed corridor with a flat, hard surface of 30 m, marked every 3 m.<sup>18</sup> At rest and after the 6MWT we measured heart rate, peripheral oxygen saturation (S<sub>pO<sub>2</sub></sub>, with a portable wrist oximeter [PalmSAT 2500, Nonin Medical, Plymouth, Minnesota]), blood pressure (CE0050, Tycos/Welch Allyn, Skaneateles Falls, New York), respiratory rate (counted as chest wall excursions per minute), and the modified Borg scale score. Absolute values obtained for the distance walked in meters were normalized in accordance with the equations proposed by Geiger et al,<sup>19</sup> and are expressed in Z scores.

## Modified Borg Scale

The American Thoracic Society's 2002 guidelines suggest the modified Borg scale as an aid for the 6MWT, enabling the evaluation of the degree of respiratory discomfort in terms of determinations of subjective rates, according to the perception of the individual. This is a vertical scale quantified from 0 to 10, in which 0 represents no symptoms and 10 represents maximum symptoms, providing an individual measurement of the intensity of the exercise.<sup>11,18</sup> All the patients received instructions as to the purpose of the scale, how it would be applied, and had time to observe it and adapt to the scale's expressions and numbers. At the beginning and at the end of the 6MWT, the scale was shown to the patient, and the patient was asked to measure the perception of the intensity of the dyspnea (Fig. 1).<sup>18</sup>

## Anthropometric Variables

Body mass (weight) was obtained with the patient wearing as little clothing as possible and bare-footed.<sup>20</sup> Height

- 0 No Breathlessness
- 0.5 Very very slight (just noticeable)
- 1 Very slight
- 2 Slight breathlessness
- 3 Moderate
- 4 Somewhat severe
- 5 Severe breathlessness
- 6
- 7 Very severe breathlessness
- 8
- 9 Very very severe (almost maximum)
- 10 Maximum

Fig. 1. Modified Borg scale.

was measured using the stadiometer placed on the scale.<sup>20</sup> The variables used for classification of the nutritional status were distributed in percentile of body mass index (BMI).<sup>21</sup> The program Epi Info (version 4.3, United States Centers for Disease Control) was used to obtain the values of percentiles of BMI.

**Sample**

Sample size was calculated taking into consideration possible correlations between the severity of the obstructive disease (FEV<sub>1</sub>) and the limitation to submaximal exercise (Borg scale after exercise). For this study we estimated that we needed 41 children and adolescents with CF, considering an alpha error of 5%, a beta error of 20%, and a minimum coefficient of correlation of 0.35.

**Statistical Analysis**

The data were analyzed with the use of statistics software (SPSS version 14.0, SPSS, Chicago, Illinois). The results were described and expressed in mean and standard deviation when the distribution was symmetric, and median and interquartile range when the distribution was asymmetric. The categorical variables are presented in absolute frequencies and rates. The Pearson’s linear correlation test (r) was used to evaluate the associations between the quantitative variables. The receiver operating characteristic

Table 1. Characteristics of 41 Children and Adolescents With Cystic Fibrosis

Age (mean ± SD y)	11.2 ± 4.1
Male (n, %)	28 (68)
Weight (mean ± SD kg)	40.2 ± 16.8
Height (mean ± SD m)	1.42 ± 0.20
FEV <sub>1</sub> (mean ± SD % predicted)*	97 ± 32
FVC (mean ± SD % predicted)*	108 ± 2
FEV <sub>1</sub> /FVC (mean ± SD %)*	86 ± 18
Borg dyspnea score (median, interquartile range)	
Before 6MWT	0 (0–1)
After 6MWT	2 (1–3)
6MWT distance (mean ± SD m)	476 ± 105
Z score of 6MWT distance (mean ± SD)	-2.48 ± 1.55
S <sub>pO<sub>2</sub></sub> after 6MWT (mean ± SD)	96 ± 4
Heart rate after 6MWT (mean ± SD beats/min)	112 ± 18
Respiratory rate after 6MWT (mean ± SD breaths/min)	24 ± 5
Body mass index (mean ± SD kg/m <sup>2</sup> )	18.8 ± 3.4

\* Before 6-min walk test (6MWT).  
FVC = forced vital capacity

curve was used to determine the cut-off points for sensitivity and specificity of the modified Borg scale.

**Results**

Forty-one patients with CF were studied, 28 of them being male, and the mean age was 11.1 ± 4.1 years. Mean percent-of-predicted FEV<sub>1</sub> (FEV<sub>1</sub>%) was used as an outcome to evaluate the accuracy of the modified Borg scale. Pulmonary compromise, assessed via spirometry, was considered mild for most of the patients, and 68% presented FEV<sub>1</sub>% higher than 80%, and only 15% lower than 60% of predicted values. Table 1 describes the general characteristics of these patients.

In this sample, the median of the modified Borg scale values after 6MWT was 2 (interquartile range 1–3). There was a statistically significant negative correlation of the modified Borg scale with FEV<sub>1</sub>% (r = -0.35, P = .02) and 6MWTZ (r = -0.4, P = .009) (Fig. 2). FEV<sub>1</sub>% also correlated with 6MWTZ (r = 0.5, P = .001) and with S<sub>pO<sub>2</sub></sub> (r = 0.53, P < .001). Sixty-one percent of the patients presented 6MWTZ ≤ -2. There was no significant correlation of the modified Borg scale with the BMI (r = -0.04, P = .77).

The possibility that the age or the degree of pulmonary compromise might influence the performance of the modified Borg scale was considered, and additional analysis with different subsets of patients according to the age and the FEV<sub>1</sub>% were done.

Using the receiver operating characteristic curve analysis in patients older than 8 years, the greatest area of the

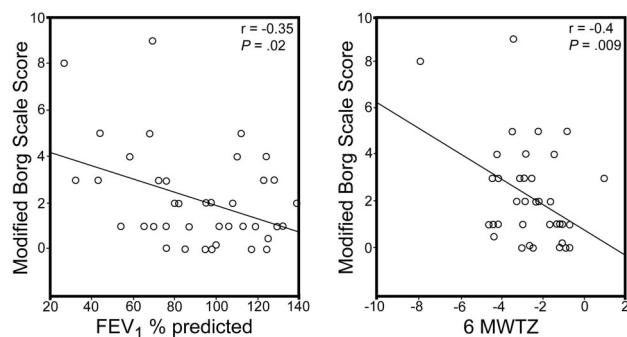


Fig. 2. Correlations between the modified Borg scale and (left) the percent-of-predicted FEV<sub>1</sub>, and (right) the Z score of the 6-min walk test (6MWTZ) in children and adolescents with cystic fibrosis.

curve (0.75) to predict an FEV<sub>1</sub>% lower than 80% was obtained from the cut-off point of 2.5 of the Borg scale. In this age group there was significant correlation of the modified Borg scale with FEV<sub>1</sub>% ( $r = -0.41$ ,  $P = .02$ ) and 6MWTZ ( $r = -0.4$ ,  $P = .03$ ).

In another analysis, the performance of the test was even better in patients older than 9 years of age, by the receiver operating characteristic curve. The area obtained from the cut-off point of the modified Borg scale of 2.5 was 0.80, providing a sensitivity of 80% and a specificity of 77% to predict an FEV<sub>1</sub>% lower than 80%. In this age group the accuracy of the modified Borg scale was 0.78. There were significant negative correlations of the modified Borg scale with the FEV<sub>1</sub>% ( $r = -0.59$ ,  $P = .003$ ) and with the 6MWTZ ( $r = -0.46$ ,  $P = .03$ ) in this analysis (Fig. 3). For the other variables, the degree of significance established was not reached.

When the patients were stratified with different degrees of compromise, according to the FEV<sub>1</sub>, no better performance of the modified Borg scale after the 6MWT was achieved.

## Discussion

In the present study, a population of young patients with CF, assisted in 2 reference centers for the treatment of the disease, was evaluated. The FEV<sub>1</sub>, which represents an important marker of the progression of the disease, was used as an outcome to evaluate the accuracy of the modified Borg scale. There was an inverse correlation of the scale with the FEV<sub>1</sub>% and with the 6MWTZ, and it was observed that 61% of the patients presented 6MWTZ lower than the inferior normality limit, although 68% presented FEV<sub>1</sub> higher than 80%. This may be attributed to the fact that the FEV<sub>1</sub> and the 6MWT evaluated distinct components, which justifies the fact that patients with normal pulmonary function walked distances less than -2 SD of the mean in the 6MWT. An explanation is that perhaps

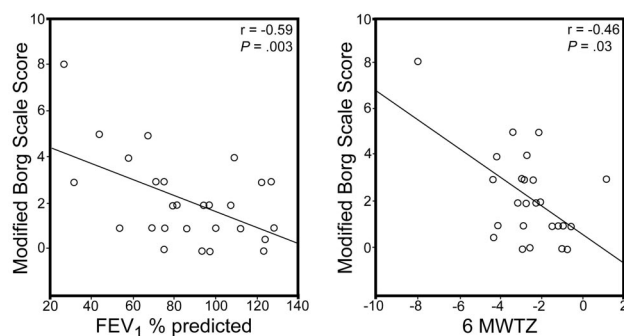


Fig. 3. Correlations between the modified Borg scale and (left) the percent-of-predicted FEV<sub>1</sub>, and (right) the Z score of the 6-min walk test (6MWTZ) in children older than 9 years and adolescents with cystic fibrosis.

functional capacity declines before pulmonary function, or the FEV<sub>1</sub> is not the most sensitive variable to evaluate pulmonary compromise. Judge and his collaborators<sup>22</sup> demonstrated that structural lung lesions appeared before any alteration in spirometric variables.

Exercise capacity can be influenced by factors such as pulmonary function and nutritional status. In this study there was no correlation between 6MWTZ and BMI or FEV<sub>1</sub>. An alternative explanation for such findings concerning a low 6MWTZ could be the unfamiliarity of the patients with the test, since they were doing it for the first time. Published data show that after a second testing, most patients walk greater distances.<sup>10,19</sup> Another possible explanation is that Austrian children, from whom reference data were used, have different levels of physical conditioning than Brazilian children, from whom reference figures are still missing. Genetic and nutritional factors could also play a role in such differences.

Regarding the perception of effort, measured via the modified Borg scale, it must be perceived and interpreted by the individual.<sup>18</sup> Different ages could be an important factor in causing variations in the response to the scale. The receiver operating characteristic curve presented a variable performance of the scale in predicting the FEV<sub>1</sub>%, according to age, suggesting that the scale was more adequate for children older than 9 years of age.

In a study, Cunha et al<sup>23</sup> found a moderate positive correlation of the distance walked in the 6MWT and the perception of dyspnea ( $r = 0.55$ ,  $P < .03$ ) in children and adolescents with CF (mean  $\pm$  SD age  $11.0 \pm 1.9$  y and FEV<sub>1</sub>%  $63 \pm 21$ ). In contrast, our results presented an inverse correlation of the modified Borg scale with 6MWTZ ( $r = -0.46$ ,  $P = .05$ ) and the FEV<sub>1</sub>% ( $r = -0.58$ ,  $P = .01$ ). Our findings suggest that children with more functional compromise have more dyspnea. In the first study, the distance traveled in the 6MWT in relation to predicted values was not normalized, as reference values for the distance walked in children younger than 12 years that

take into consideration height and sex had not yet been published. It is possible that older individuals, who usually walk longer distances, but who could have a lower 6MWTZ if the distance walked were normalized, might have been those who perceived their dyspnea as more intense.

Many factors might interfere with the subjective response to the scale, such as the general instructions given, understanding of the method and its purpose, and this is why the one in charge of the application must supply all the information that might be relevant and necessary to the individual.<sup>18</sup> It is probable that the cognitive capacity for the subjective perception of dyspnea in these children older than 9 years of age is adequate, when compared to younger children, who presented difficulty in the interpretation of the scale. In our findings, including children and adolescents with a mean age of  $11.1 \pm 4.1$  years, the mean of the distance traveled was similar to other studies.<sup>23,24</sup>

### Conclusions

In short, the modified Borg scale was shown to be a useful and adequate instrument to measure the subjective sensation of dyspnea after physical activity, and good accuracy of the scale in children older than 9 years of age and adolescents with CF was observed. As it is a simple, low-cost instrument that can be applied easily, it can benefit centers with few resources. We suggest that the scale be used regularly in the assessment of these individuals, both for a follow-up and for treatment as to the intensity of the training proposed.

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