Relationship between exercise capacity and quality of life in adolescents with asthma*

Relação da capacidade de exercício com a qualidade de vida de adolescentes asmáticos

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Abstract

Objective: To determine whether the quality of life of adolescents with asthma correlates with parameters obtained prior to and after the six-minute step test (6MST); spirometric results after the 6MST; and level of physical activity. **Methods:** Nineteen adolescents with asthma, ranging from 11-15 years of age, were assessed with spirometry, 6MST, the International Physical Activity Questionnaire (IPAQ), the Pediatric Asthma Quality of Life Questionnaire (PAQLQ), and the 10-point Borg category-ratio scale. **Results:** Sensation of dyspnea correlated negatively with the total PAQLQ score (r = −0.54) and with the scores of its activity limitation (AL) and symptoms domains (r = −0.64 and r = −0.63, respectively), leg fatigue also correlating negatively with those same domains (r = −0.49 and r = −0.56, respectively). The total IPAQ score correlated with the total PAQLQ score (r = 0.47) and with the PAQLQ AL domain (r = 0.51); IPAQ time spent walking correlated with the PAQLQ symptoms domain (r = 0.45); and IPAQ time spent in vigorous activity correlated with the AL domain (r = 0.50). In the regression analysis, only sensation of dyspnea remained significantly correlated with the total PAQLQ score and the PAQLQ AL domain; leg fatigue remained significantly correlated with the symptoms domain. **Conclusions:** Higher levels of physical activity indicate better quality of life, as do lower perception of dyspnea and less leg fatigue. The 6MST proved to be a viable option for evaluating exercise capacity in adolescents with asthma, because it reflects the discomfort that asthma causes during activities of daily living.

Keywords: Asthma; Quality of life; Dyspnea.

Resumo

Objetivo: Determinar se parâmetros obtidos antes e após a realização do teste do degrau de seis minutos (TD6), respostas espirométricas após o TD6 e o nível de atividade física se correlacionam com a qualidade de vida de adolescentes asmáticos. **Métodos:** Foram avaliados 19 adolescentes asmáticos, com idades variando de 11-15 anos, por meio de espirometria, TD6, *International Physical Activity Questionnaire* (IPAQ, Questionário Internacional de Atividade Física), Questionário sobre a Qualidade de Vida na Asma Pediátrica (QQVAP) e escala CR10 de Borg. **Resultados:** Houve correlações negativas entre sensação de dispneia e pontuação total do QQVAP (r = −0,54) e de seus domínios limitação nas atividades (LA) e sintomas (r = −0,64 e r = −0,63, respectivamente), assim como entre fadiga nos membros inferiores (MMII) e os mesmos domínios (r = −0,49 e r = −0,56, respectivamente). O escore total do IPAQ correlacionou-se com a pontuação total do QQVAP (r = 0,47) e o domínio LA (r = 0,51), enquanto o tempo de caminhada correlacionou-se com o domínio sintomas (r = 0,45), e o tempo de atividade intensa correlacionou-se com o domínio LA (r = 0,50). Na análise de regressão, somente a sensação de dispneia associou-se significativamente ao escore total e o domínio limitação nas atividades do QQVAP, e o mesmo ocorreu entre a fadiga dos MMII e o domínio sintomas. **Conclusões:** Quanto maior for o nível de atividade física e menor for a dispneia e a fadiga nos MMII, melhor é a qualidade de vida. O TD6 mostrou-se uma opção na avaliação da capacidade ao exercício desses indivíduos por refletir o incômodo que a asma provoca na prática das atividades da vida diária.

Descritores: Asma; Qualidade de vida; Dispneia.

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Introduction

Asthma is a chronic inflammatory disease that can have a considerable impact on the daily lives of adolescents.[1] Asthma is characterized by recurrent episodes of wheezing, chest tightness, breathlessness, and cough due to a variety of stimuli, the most common of which is physical exercise.[2,3] Exercise-induced bronchospasm (EIB) occurs in 40-90% of all individuals with asthma[3] and can reduce exercise tolerance, leading individuals with asthma to adopt a more sedentary lifestyle than that adopted by those without.[4]

Asthma severity and reduced exercise capacity can affect the social, educational, and emotional lives of children and adolescents with asthma, the quality of life of such individuals being significantly worse than that of those without asthma.[5,6] Therefore, it is important to identify and address the factors affecting the quality of life of children and adolescents with asthma in order to provide comprehensive asthma treatment.[7] Clinical parameters such as symptoms, frequency of medication use, and airflow measurements are not strongly related to quality of life and therefore fail to provide a complete picture of how children and adolescents with asthma perceive the disease and of how asthma limits their activities of daily living.[7,8] Therefore, it important to determine whether objective measurements of exercise capacity reflect the impact of asthma on quality of life in order to evaluate such individuals more comprehensively and prescribe a rehabilitation program suited to their limitations and disease severity.

Various tests have been used in order to assess functional capacity in patients with lung disease.[9-12] However, because submaximal exercise tests are safe, easy to apply, and readily available for routine clinical assessment and because they can predict the ability to perform activities of daily living,[13] submaximal exercise testing has been suggested as an option to evaluate asthma patients, given that it can detect EIB and aid in the early diagnosis of physical activity limitation.[9,10] However, we found no studies evaluating whether submaximal exercise responses as elicited by a submaximal test such as the six-minute step test (6MST) reflect the impact of asthma on quality of life.

Therefore, the primary objective of the present study was to determine whether the quality of life of adolescents with asthma correlated with parameters obtained prior to and after the 6MST (i.e., physical performance, cardiorespiratory responses, sensation of dyspnea, and leg fatigue) and with spirometric results after the 6MST. A secondary objective was to determine whether the quality of life of those adolescents correlated with their level of physical activity.

Methods

The present study was conducted between March and October of 2010 at the Federal University of São Carlos Respiratory Therapy Unit, located in the city of São Carlos, Brazil. We evaluated 19 adolescents with asthma who were recruited through active community surveillance and who were in the 11-15 year age bracket. The parents or legal guardians of the adolescents who participated in the present study gave written informed consent, and the study was approved by the local research ethics committee (Ruling no. 119/2008).

We included adolescents with a diagnosis of asthma (a clinical diagnosis, a spirometric diagnosis, or both), the diagnosis having been confirmed by pre- and post-bronchodilator spirometry performed under the supervision of a pulmonologist.[14] The participants were clinically stable, having had no respiratory infections or asthma attacks for at least three weeks. We excluded patients who were clinically unstable because of acute respiratory infections or asthma attacks in the three weeks preceding the evaluation, as well as those with other respiratory diseases, heart disease, rheumatic disease, musculoskeletal disease, orthopedic disease, or neurological sequelae that prevented them from performing the proposed tests.

Initially, the adolescents were interviewed. During the interview, an anamnesis form and the short version of the International Physical Activity Questionnaire (IPAQ)[15] were completed in order to characterize the level of physical activity, the Pediatric Asthma Quality of Life Questionnaire (PAQLQ)[16] being also completed. Subsequently, the participants underwent general physical examination and respiratory system examination, as well as receiving instructions regarding the proposed protocol.

On the same day, the participants underwent spirometry with a portable spirometer (EasyOne™; ndd Medizintechnik AG, Zurich, Switzerland). All technical procedures, acceptability criteria,

and reproducibility criteria were in accordance with the American Thoracic Society/European Respiratory Society guidelines.[17] We obtained three technically acceptable curves for slow vital capacity, FVC, and maximal voluntary ventilation. The values obtained were compared with those proposed by Polgar & Promadhat.[18]

For functional capacity evaluation, the 6MST was performed on a different day.

The 6MST was performed in accordance with methods described elsewhere.[19] At the end of every minute, standard phrases of encouragement were provided. At the end of every two minutes, SpO_2 was measured with a pulse oximeter (Model 2500; Nonin Medical Inc., Minneapolis, MN, USA), HR was measured with an HR monitor (Model Vantage NV™ 1901001; Polar, Kempele, Finland), and sensation of dyspnea and leg fatigue were measured by the 10-point Borg category-ratio scale. Those measurements, together with measurements of systolic blood pressure, diastolic blood pressure, and RR, were performed at rest and immediately after the test, as well as at recovery minutes 1, 3, and 6.

In addition to the abovementioned measurements, FVC maneuvers were performed at various time points: before the test; immediately after the test; and within 5, 10, 15, and 30 minutes after the test, the better of two maneuvers being selected. The participants performed FVC maneuvers at post-test minutes 15 and 30 only if the FEV_1 at post-test minute 10 decreased by ≥ 15% in comparison with the pre-test FEV_1 value.[9,20] Performance on the 6MST was determined by the total number of times that the individual being tested went up and down the step, and maximal HR (HRmax) was calculated by the following formula: HRmax = 210 – (0.65 × age in years).[21]

For the present study, we chose to use the short version of the IPAQ, previously translated to Portuguese and validated for use in Brazil.[15] The questionnaire consists of 7 open questions, the answers to which provide information that allows us to estimate the weekly time spent in different activities. The questions address the duration and frequency of moderate to vigorous activities and the time spent walking in the previous week. On the basis of the information obtained, the IPAQ allows us to classify individuals as sedentary, insufficiently active, active, or very active.[15]

We also used the Brazilian Portuguese-language version of the PAQLQ, previously adapted and validated for use in Brazil.[16] The PAQLQ was developed for children and adolescents in the 7-17 year age bracket and consists of 23 questions distributed into three domains: symptoms, comprising 10 questions; activity limitation, comprising 5 questions; and emotional function, comprising 8 questions. Children are asked to report how they felt in the previous week and to answer each of the 23 questions on a 7-point scale (7 = not bothered at all and 1 = extremely bothered). The score for each of the PAQLQ domains is calculated by summing the scores for each question and dividing the sum by the total number of questions, the total PAQLQ score being calculated by summing the individual domain scores.

In the statistical analysis, we used the Shapiro-Wilk test in order to evaluate the normality of the data. In addition, we used descriptive statistics for variables with parametric distribution, the data being expressed as mean ± standard deviation, and for those with nonparametric distribution, the data being expressed as median (interquartile range). Subsequently, we used Pearson's correlation coefficient (for variables with parametric distribution) or Spearman's correlation coefficient (for variables with nonparametric distribution) and performed backward multiple linear regression analysis of correlated variables in order to find the independent variable determining quality of life, the PAQLQ scores being therefore considered dependent variables.

We used the Statistical Package for the Social Sciences, version 13.0 (SPSS Inc., Chicago, IL, USA). The power of the study was calculated using the GraphPad StatMate software, version 2.0 for Windows (GraphPad Software Inc., San Diego, CA, USA), and the sample corresponded to a power of 80% for the study variables, in accordance with a pilot study involving healthy adolescents. The level of significance was set at 5%.

Results

We evaluated 19 asthma patients (15 boys and 4 girls), who were classified as having mild intermittent asthma or mild persistent asthma in accordance with the Global Initiative for Asthma criteria.[14] All of the patients were clinically stable. Of the 19 patients with asthma, 5 were using

inhaled corticosteroids regularly (mean dose, 200 µg) and 14 used a β_2 agonist for symptom relief.

Table 1 shows the following: demographic, anthropometric, and spirometric data at baseline; the level of physical activity, as determined by the time (in min) spent walking, the time (in min) spent in moderate activity, the time (in min) spent in vigorous activity, and the total time spent in physical activity in the previous week; the scores for each PAQLQ domain; and the total PAQLQ scores. The level of physical activity in the study sample was determined on the basis of the answers to the IPAQ.[15] Of the 19 participants, 7 were classified as insufficiently active, 7 were classified as active, and 5 were classified as very active.

There were no significant differences between pre-test FEV_1 and post-test FEV_1 (as measured immediately after the test and at post-test minutes 5, 10, and 15), and post-test FEV_1 did not decrease by ≥ 15% in comparison with pre-test FEV_1, which would have characterized EIB.[20] Of the 19 participants, 3 had to stop the 6MST for approximately 20 s, on average, because of leg fatigue, resuming the test.

Neither the total PAQLQ score nor the PAQLQ domain scores correlated with the total number of times that the individual being tested went up and down the step during the 6MST or with pre- or post-test RR, HR, systolic blood pressure, diastolic blood pressure, and FEV_1. The values obtained at the end of the 6MST are shown in Table 2. Sensation of dyspnea correlated negatively with the total PAQLQ score and with the scores of the PAQLQ activity limitation and symptoms domains, leg fatigue also correlating negatively with those same domains (Table 3).

Regarding the impact of the level of physical activity on quality of life, we found that the time spent in physical activity correlated positively with the total PAQLQ score and the PAQLQ activity limitation domain. Likewise, the time spent walking correlated with the PAQLQ symptoms domain, and the time spent in vigorous activity correlated with the PAQLQ activity limitation domain (Table 3).

In the multiple regression analysis, only sensation of dyspnea remained significantly correlated with the total PAQLQ score ($\beta = -0.27$; $p = 0.003$) and the PAQLQ activity limitation domain ($\beta = -0.33$; $p \leq 0.001$), sensation of dyspnea having explained 42% of the variation in the total PAQLQ score and 63% of the variation in the activity limitation domain score; leg fatigue remained significantly correlated with the PAQLQ symptoms domain ($\beta = -0.22$; $p = 0.003$), having

Table 1 - Demographic variables, anthropometric variables, spirometric variables, level of physical activity, and quality of life questionnaire scores for 19 adolescents with mild intermittent asthma or mild persistent asthma.[a]

Variable	Result
Gender, M/F	15/4[b]
Age, years	12.4 ± 1.4
Weight, kg	51.7 ± 14.1
Height, m	1.6 ± 0.1
FEV_1, L	2.5 ± 0.6
FEV_1, % of predicted	87.5 ± 8.1
FVC, L	2.9 ± 0.6
FVC, % of predicted	93.2 ± 6.5
FEV_1/FVC, %	92.8 ± 7.5
MVV, L/min	77.9 ± 20.6
MVV, % of predicted	80.1 ± 13.9
Weekly time spent walking, min	40 (0-100)[c]
Weekly time spent in moderate activity, min	30 (0-120)[c]
Weekly time spent in vigorous activity, min	60 (0-180)[c]
Total weekly time spent in physical activity, min	225 (90-420)[c]
Total PAQLQ score	5.9 ± 1.0
Symptoms domain	5.8 ± 1.1
Activity limitation domain	5.8 ± 1.0
Emotional function domain	6.0 ± 1.0

MVV: maximal voluntary ventilation; and PAQLQ: Pediatric Asthma Quality of Life Questionnaire. [a]Data expressed as mean ± SD, except where otherwise indicated. [b]Data expressed as n/n. [c]Data expressed as median (interquartile range).

Table 2 - Physical performance, sensation of dyspnea, leg fatigue, respiratory variables, and cardiovascular variables at the end of the six-minute step test.[a]

Variable	Value
T-6MST	146.6 ± 30.4
SpO_2, %	97 (96-97)
RR, breaths/min	21.0 ± 2.7
HR, bpm	148.5 ± 21.6
HRmax, %	73.0 ± 10.0
SBP, mmHg	120 (110-130)
DBP, mmHg	70 (60-80)
Borg scale (dyspnea)	2.0 (0.8-4.3)
Borg scale (leg fatigue)	3.0 (1.0-4.3)

T-6MST: total number of times that the individual being tested went up and down the step during the six-minute step test; HRmax: maximal HR; SBP: systolic blood pressure; and DBP: diastolic blood pressure. [a]Data expressed as mean ± SD or median (interquartile range).

Table 3 - Correlations of the quality of life questionnaire with the six-minute step test variables and with the level of physical activity.

Variable	PAQLQ			
	Total	Symptoms	AL	EF
Borg scale (dyspnea)	−0.54*	−0.63*	−0.64*	−0.39
Borg scale (leg fatigue)	−0.41	−0.56*	−0.49*	−0.21
Weekly time spent walking, min	0.44	0.45*	0.37	0.34
Weekly time spent in moderate activity, min	0.22	0.08	0.22	0.17
Weekly time spent in vigorous activity, min	0.30	0.31	0.50*	0.05
Total weekly time spent in physical activity, min	0.47*	0.33	0.51*	0.38

PAQLQ: Pediatric Asthma Quality of Life Questionnaire; AL: activity limitation domain; and EF: emotional function domain. *$p \leq 0.05$.

explained 37% of the variation in the symptoms domain score.

Discussion

The objective of the present study was to determine whether the quality of life of adolescents with asthma correlated with physical performance, cardiorespiratory responses, sensation of dyspnea, leg fatigue, and spirometric results after the 6MST, as well as with the level of physical activity.

The 6MST has been used and recommended as a method for evaluating patients with lung disease.[12] Because it is a submaximal exercise test, the 6MST assesses functional capacity in terms of the ability to perform activities of daily living.[12,13] The 6MST was found to be a test of moderate intensity for the asthma patients in the present study, having allowed the participants to achieve 73% of their HRmax (Table 2) and having caused, on average, mild dyspnea and moderate leg fatigue or pain, although some of the participants experienced severe dyspnea and leg fatigue or pain.

In the present study, the 6MST was self-paced, meaning that the stepping rate did not remain constant throughout the test. Therefore, a high (> 80%) HR was not achieved or maintained throughout the test. This prevented the occurrence of EIB despite mouth breathing having contributed to turning the inhaled air drier and colder, which can cause EIB.[11,20]

In one study,[9] a step test performed at an intensity that was sufficient to maintain an HR > 150 bpm for 5 min caused EIB. In the present study, however, the 6MST was self-paced in order to be as functional as possible and reflect possible limitations in the ability to perform activities of daily living.

In the present study, we found no correlation between quality of life and cardiorespiratory responses to the 6MST or between quality of life and spirometric results after the 6MST. This finding is consistent with those of studies showing a weak correlation between clinical variables and quality of life in asthma patients.[7,8] Such a weak correlation is due to the multifaceted nature of quality of life, which has physical, emotional, and social aspects and is therefore difficult to assess by means of objective parameters. However, sensation of dyspnea and leg fatigue during the 6MST, which are subjective sensations, correlated with the symptoms domain score and the activity limitation domain score, dyspnea having also correlated with the total PAQLQ score. A more intense perception of dyspnea and a greater degree of leg fatigue during the 6MST translated to worse quality of life in our sample of adolescents with asthma.

It is of note that the questions on the quality of life questionnaire used in the present study refer to the previous week, and, because the study participants were clinically stable, the score was high for all domains, especially the emotional function domain. This result is consistent with those of a study showing that patients with controlled asthma have a better quality of life than do those with uncontrolled asthma.[22] However, although the mean score for the activity limitation domain and that for the symptoms domain were equal, the activity limitation domain showed the lowest scores; this constitutes evidence that the asthma patients had lower exercise tolerance, which affected their quality of life.[4-6]

Studies have shown that physical activity improves the quality of life of asthma patients.[23-25] Therefore, we quantified the level of physical activity and classified the adolescents under study in accordance with their level of physical activity, having subsequently determined whether the level of physical activity correlated with quality of life.

None of the adolescents under study were classified as sedentary, most having been classified as active or insufficiently active.[15] This, together with the fact that the adolescents were clinically stable, might have contributed to the high scores obtained on the quality of life questionnaire. In addition, we found positive correlations between the time spent in physical activity and the score on the questionnaire, a finding that is consistent with those of studies[23-25] showing that physical activity is beneficial to the quality of life of asthma patients. However, our regression analysis showed that the weekly time spent in physical activity was not an independent predictor of quality of life, although sensation of dyspnea and leg fatigue were, underscoring the importance of functional assessment of asthma patients in order to evaluate their symptoms and limitations.

The correlations of sensation of dyspnea and leg fatigue with the PAQLQ variables, together with our regression analysis, showed that the sensation of dyspnea and leg fatigue reported at the end of the 6MST reflected the extent to which patients are bothered (term used in the PAQLQ) by asthma and its symptoms, such as cough, fatigue, breathlessness, and chest tightness, and the extent to which the disease limits their ability to perform activities of daily living. Our findings are also consistent with those of studies showing that sensation of dyspnea is one of the major factors limiting the ability of asthma patients to perform physical activity.[4,26]

One limitation of the present study is the fact that the study sample consisted exclusively of adolescents with mild intermittent asthma or mild persistent asthma. Had we evaluated a more diverse sample of asthma patients, the results of the present study might be generalizable. However, our results are important because those are the most prevalent types in the spectrum of asthma severity.

The quality of life of adolescents with mild intermittent asthma or mild persistent asthma correlates with the level of physical activity, as well as with sensation of dyspnea and leg fatigue during the 6MST. These subjective sensations reflect the extent to which asthma symptoms limit the ability of patients to perform moderate to vigorous activities of daily living, therefore reflecting the impact of asthma on the quality of life of adolescents. In addition, given the relationship between exercise capacity and quality of life and the importance of the latter for comprehensive asthma treatment, the 6MST is a viable option for evaluating exercise capacity in asthma patients in clinical practice.

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