J Rehabil Med 2006; 38: 130–135

EFFECTS OF PHYSICAL EXERCISE ON QUALITY OF LIFE, EXERCISE CAPACITY AND PULMONARY FUNCTION IN CHILDREN WITH ASTHMA

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Objective: **To investigate the effects of regular submaximal exercise on quality of life, exercise capacity and pulmonary function in asthmatic children.**

Patients and methods: **Sixty-two children with mild–moderate asthma (mean age 10.4 (SD 2.1) years) were randomly allocated into exercise and control groups. The exercise group underwent a moderately intensive basketball training program for 8 weeks. A home respiratory exercise program was advised to both groups. Pediatric Asthma Quality of Life Questionnaire (PAQLQ) was used for the evaluation of activity limitation, symptoms and emotional functions. Exercise capacity was evaluated through the physical work capacity (PWC 170 test) on a cycle ergometer and 6-minute walk test. Spirometric tests were also performed and medication and symptom scores were recorded.**

Results: **Although PAQLQ scores improved in both groups, the improvement in the exercise group was significantly higher. The exercise group performed better in the PWC 170 and 6-minute walk tests, whereas no improvement was detected in the control group at the end of the trial. Medication scores improved in both groups, but symptom scores improved only in the exercise group. No significant changes were detected in pulmonary function in either group, except for peak expiratory flow values in the exercise group.**

Conclusion: **Eight weeks of regular submaximal exercise has beneficial effects on quality of life and exercise capacity in children with asthma. Submaximal basketball training is an effective alternative exercise program for asthmatic children.**

Key words: asthma, children, quality of life, exercise, physical capacity, pulmonary rehabilitation.

J Rehabil Med 2006; 38: 130–135

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Submitted July 14, 2005; accepted November 7, 2005

INTRODUCTION

Asthma, a leading cause of chronic illness in childhood, can have a considerable impact on the daily life of children (1, 2). Asthmatic children tend to have a sedentary lifestyle compared with their peers. They show less tolerance to exercise because of shortness of breath, so-called exercise-induced bronchoconstruction, and restriction of activities secondary to medical advice or family influence (3). Apart from the lower exercise capacity and symptoms such as shortness of breath, cough and wheeze, these children are also affected by physical, social, educational and emotional impairments (4). It has been reported that asthmatic children have significantly poorer health-related quality of life (QoL) than other children (5).

Published reports recommend regular physical activity and participating in sports to be considered in the management of asthma (6). Evidence-based analysis identifies exercise training as the most effective part of pulmonary rehabilitation (PR) programs, which comprise multidisciplinary therapy with essential components such as assesment, patient education, exercise training, psychosocial intervention and follow-up (7–9). PR programs have been increasingly prescribed for adult patients with chronic pulmonary diseases including bronchial asthma. These programs have been proven to increase functional capacity, decrease symptoms, especially dyspnoea, reduce utilization of healthcare resources and, finally, improve QoL (7, 9, 10). On the other hand, published reports on the rehabilitation of children with chronic pulmonary diseases are sparse. Positive effects of physical training on cardiopulmonary fitness and pulmonary function have been reported in these studies, but published data lacks evidence of the effects of exercise on QoL in asthmatic children (6).

The American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) recommends exercise training in PR to contain both lower and upper extremity endurance training, strength training and respiratory muscle training. Home exercise prescription should also be provided for patients participating in rehabilitation programs (7). The British Thorax Society (BTS) also reports that physical aerobic training, particularly of the lower extremities (brisk walking or cycling) is mandatory and upper limb and strength-building exercises can also be included (10). Since swimming is considered to be a safer form of exercise, which precipitates asthma less than land-based exercise, it is well accepted and frequently prescribed for asthmatic children (11). A few randomized controlled trials have searched the effects of other physical training methods in children with asthma, but none of these concentrated on QoL (6). In this trial we decided to perform a land-based team sport for exercise training, expecting that it would increase compliance to the training sessions. Basketball training enables

DOI: 10.1080/16501970500476142

children to be socially active during exercise and can be more enjoyable.

The primary end-point of this study is investigating the effects of a regular submaximal basketball training program on QoL in mild–moderate asthmatic children. The secondary end-points are the changes in exercise capacity as well as pulmonary function of the study group after exercise training.

PATIENTS AND METHODS

The study was conducted at the outpatient clinic of the Department of Physical Medicine and Rehabilitation in Cukurova University Medical Faculty, Adana, Turkey. The local ethics committee approved the study and written informed consent was obtained from all of the patients and their parents.

Patients

Seventy-seven mild–moderate asthmatic patients admitted to the Pediatric Allergy-Immunology Department for their follow-up visits were evaluated. Patients were classified as having mild or moderate asthma according to their symptom severity, night-time symptoms and lung function (1). Of the 77 patients, 15 were excluded (11 declined to participate because of transport problems, 3 declined because of the fear of bronchoconstruction and 1 patient was withdrawn because of his additional restrictive component resulting from chest deformity).

The study population comprised 62 mild–moderate asthmatic children (40 boys, 22 girls) with a mean age of 10.4 (SD 2.1) years (range 7–15 years). The patients were randomly assigned to either exercise (group E, $n = 31$, 20 boys and 11 girls) or control (group C, $n = 31$, 20 boys and 11 girls). The 2 groups did not differ with respect to age, sex, height, body mass index (BMI), Tanner stage, duration of disease (Table I) or pulmonary function.

Baseline assessment

A clinical and medicational history was obtained from all subjects, followed by physical examination, spirometric tests and determination of Tanner stage, medication and symptom scores. The hallway 6-minute walk test (6MWT), physical work capacity at a heart rate of 170 beats per minute (PWC 170 test) and Pediatric Asthma Quality of Life Questionnaire (PAQLQ) were performed on both groups.

Lung function was measured using a spirometer and the variables were expressed as percentage of predicted value. Medication scores were recorded according to the Modified Asthma Medication Score as follows: 0 = no medication; 1 = inhaled salbutamol 200 µg; 2 = inhaled salbutamol 600 µg; 3 = inhaled cromolyn or nedocromil or oral ketotifen; 4 = inhaled steroid; 5 = inhaled steroid plus oral aminophylline; 6 = oral steroid <20 mg; 7 = oral steroid >20 mg (12). Symptom scores were determined on a scale of 0 to 3 (0 = no symptoms, 1 = mild, symptoms present but not troublesome, 2 = moderate, symptoms sufficient to interfere with daily activities, 3 = severe symptoms, incapacitating) (13).

The hallway 6MWT was performed on a 30-metre long enclosed quiet corridor after patients were instructed to walk from end to end, covering as much ground as possible in the allocated time period (14). The 6MWT was performed on all of the patients and the distance walked in 6 minutes was recorded in both groups.

The PWC 170 test was assessed by a continuous graded test on a bicycle ergometer by the same exercise physiologist. Each subject was required to pedal continuously for a total of 9 minutes after a 2-minute warm-up, during which time the workload was increased twice. The baseline load (load 1) was obtained from a normative data according to age, gender and activity level. According to the heart rates at 3 and 6 minutes, the workload was increased twice (load 2 and 3) making 3 loads in all. Heart rate was measured during the last 15 seconds of each load, and the workload increases were regulated so that the heart rate achieved at the end of the test approached 170 beats per minute (bpm). The load that could be achieved at a heart rate of 170 bpm was calculated through a formula using loads 2 and 3, and the heart rates in loads 2 and 3. The PWC 170 test results are expressed as the load achieved at a heart rate of 170 bpm per kg body weight (W/kg) (15). The PWC 170 test could not be performed on 8 children in group E and 9 children in group C as the children's height had to be more than 1.35 metres in order to use the bicycle ergometer.

PAQLQP is a disease-specific questionnaire administered to evaluate health-related QoL of the asthmatic children. The interviewer-administered form of the questionnaire was used. The instrument includes 23 items in 3 domains; activity limitation ($n = 5$), symptoms ($n = 10$) and emotional function ($n = 8$). In the activity limitation domain, 3 of the items are individualized according to the activities that affected the patients most because of their asthma. Both the scores of 3 domains and the overall score range from 1 to 7 (1 indicates maximum impairment and 7 indicates no impairment). For PAQLQ, an average change in score of 0.5 per domain and for overall QoL has been shown to be the minimal clinically important difference (4, 5, 16).

Table I. *Baseline characteristics of the patients in exercise or control groups*

	Exercise ($n = 31$) Mean (SD)	Control ($n = 31$) Mean (SD)
Age (years)	10.35 (2.2)	10.45 (2.1)
Male/female (n)	20/11	20/11
Height (cm)	140.84 (13.7)	142.77 (13.4)
BMI (kg/m^2)	19.0 (3.8)	17.7 (3.2)
Duration of disease (years)	5.42 (3.3)	4.80 (2.7)

BMI = body mass index.

Training program

Group E underwent a submaximal aerobic training designed as a moderately intensive basketball training program including both lower and upper extremity activities. During the 8-week training program the sessions were performed 3 times a week (Monday, Wednesday and Friday) for one hour in each session. A typical session in the gymnasium started with warm-up and callisthenics (15 min) followed by submaximal basketball training (30–35 min), cool-down and flexibility exercises (10 min). Except daily routines, specific exercise training was not encouraged in group C. A regular home respiratory exercise program consisting of relaxation and breathing exercises was advised to both groups.

Final evaluation

After the 8-week period, spirometric tests, medication and symptom scores, 6MWT, PWC 170 test and PAQLQ were reassessed in both groups.

Statistical analysis

Statistical analyses were performed using the statistical package SPSS v 12.0. Normality was checked for each continuous variable. Appropriate parametric tests were chosen for the data distributed normally. Student's t-test was used for comparing differences between groups E and C. Changes of total activity, symptom and emotional scores of PAQLQ were calculated from the difference between final and baseline values (delta PAQLQ scores) and also Student's t-test was used for comparing these values between the 2 groups. Paired t-test was used to evaluate the differences within dependent groups. The ratio of gender and Tanner stages between groups was analysed through the χ^2 test. Results were presented as mean (SD) and n (%). The level of statistical significance was set at $p < 0.05$.

RESULTS

In the baseline evaluation, no significant differences were found between group E and group C except for a difference on symptom score ($p < 0.01$) and 6MWT distance ($p < 0.01$) (Table II). The baseline symptom score and the distance covered in the 6MWT in group E were significantly higher before the training.

The training program was well tolerated and completed by most of the children in group E. Only one patient discontinued the intervention, due to receiving a traumatic tibia-fibula fracture in a traffic accident during the third weekend of the trial. In group C, 2 patients (siblings) were lost to follow-up because of moving to another city. Another patient was withdrawn from the final evaluation as they did not perform the home exercise program. Therefore, 30 patients in group E and 28 patients in group C underwent final analysis at the end of the 8-week period.

According to the individualized 3 items in activity limitation domain in PAQLQ, the most commonly restricted activities during the week preceeding the baseline assessment were running (86%), climbing (52%) and playing football (38%). The overall PAQLQ score and scores of the 3 domains (activity limitation, symptom, emotional function) improved significantly in group E and group C at the final evaluation (Table II). Although significant effects of the interventions were found on the overall PAQLQ scores and on each domain scores within each group, the degree of improvement (delta PAQLQ scores) in group E was significantly higher than in group C ($p < 0.001$) (Fig. 1). When we compared the PAQLQ scores between groups after training, statistically significant differences were detected in all subscores, but the most prominent difference was seen in the activity limitation domain ($p < 0.01$) (Table II).

No significant correlations were found between QoL and the other variables, such as exercise capacity, pulmonary functions, duration of disease, socioeconomic variables and medication and symptom scores. Only the change in symptom scores correlated significantly with the change in total QoL scores.

The distance in 6MWT and the PWC 170 test results increased significantly in group E ($p < 0.05$), whereas no statistically significant improvement was detected in group C (Table II).

Medication scores improved in both group E ($p < 0.001$) and group C ($p < 0.01$). Despite higher baseline mean symptom score in group E, significant improvement in symptom scores was observed at the final evaluation indicating a better health status ($p < 0.01$). No significant improvement of symptom scores was detected in group C (Table II).

As expected, the intervention had no significant effect on pulmonary functions except a significant improvement in peak expiratory flow (PEF) values in group E ($p < 0.05$). However, the comparison of PEF values between groups revealed no significant difference at the final evaluation. No exercise-induced bronchospasm was observed throughout the training sessions.

Table II. *Comparison of outcome measures between and within exercise and control groups*

	Exercise ($n = 30$) Mean (SD)	Control ($n = 28$) Mean (SD)	$p^{\#}$
PAQLQ Total (pre-training)	5.03 (0.7)	5.31 (0.8)	0.13
(post-training)	6.23 (0.4)***	5.73 (0.8)***	0.01
PAQLQ Activity (pre-training)	4.65 (0.6)	4.65 (0.7)	0.78
(post-training)	5.93 (0.6)***	5.28 (0.8)***	0.00
PAQLQ Symptom (pre-training)	4.91 (0.8)	5.34 (0.8)	0.07
(post-training)	6.23 (0.5)***	5.73 (0.9)**	0.02
PAQLQ Emotion (pre-training)	5.27 (0.9)	5.58 (1.0)	0.22
(post-training)	6.43 (0.5)***	6.02 (0.9)**	0.04
PWC 170 (W/kg) (pre-training)	1.82 (0.4)	1.87 (0.5)	0.59
(post-training)	2.01 (0.4)*	1.84 (0.5)	0.27
6MWT (metres) (pre-training)	662.1 (47.1)	620.4 (59.5)	0.01
(post-training)	688.3 (69.8)*	640.4 (58.7)	0.01
Symptom score (pre-training)	0.74 (0.5)	0.32 (0.7)	0.02
(post-training)	0.20 (0.8)**	0.39 (0.7)	0.35
Medication score (pre-training)	4,93 (2.5)	3.93 (2.3)	0.12
(post-training)	3,53 (2.1)***	3.04 (2.4)**	0.41
FEV_V (%) (pre-training)	91.3 (12.4)	88.2 (12.9)	0.34
(post-training)	90.2 (12.1)	91.4 (12.2)	0.71
FVC % (pre-training)	83.0 (10.3)	83.0 (12.5)	0.99
(post-training)	82.6 (10.1)	82.5 (12.3)	0.99
FEV1/FVC (pre-training)	92.8 (8.6)	90.4 (7.9)	0.26
(post-training)	92.1 (8.8)	92.9 (7.1)	0.72
MEF % (pre-training)	97.3 (28.5)	89.0 (25.5)	0.22
(post-training)	93.4 (25.1)	95.8 (19.9)	0.72
PEF % (pre-training)	82.9 (17.1)	81.9 (13.7)	0.80
(post-training)	87 (14.4)*	86.1 (17.1)	0.77

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$ within group between pre- and post-training (paired t-test); $^{\#}p$ value between exercise and control groups (Student's t-test).

PAQLQ = Pediatric Asthma Quality of Life Questionnaire; PWC 170 = physical work capacity at a heart rate of 170 beats per minute; 6MWT = 6-minute walk test; FEV_1 = 1-second forced expiratory volume; FVC = forced vital capacity; MEF = maximum expiratory flow; PEF = peak expiratory flow.

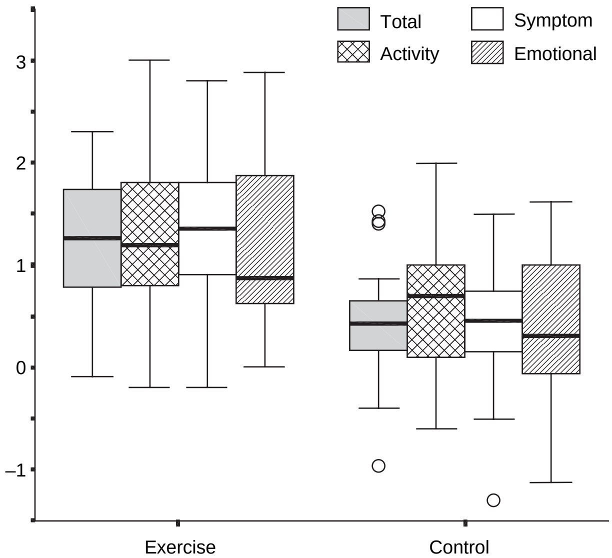

Fig. 1. Differences for total, activity, symptom and emotional scores of Pediatric Asthma Quality of Life Questionnaire of exercise ($n = 30$) and control ($n = 28$) groups. The differences are significant ($p < 0.001$) for all scores in the exercise vs control groups. Whiskers = interquartile ranges 25–75%; line in box = median; circles = outliers.

DISCUSSION

Health-related QoL has become an essential part of the health outcome measures in chronic disorders (17). Children with asthma have been shown to have significantly poorer health-related QoL, which is related to both disease and non-disease factors (18). PR programs in adult patients improve QoL as well as exercise capacity and decrease symptoms and health costs (10). However, despite many articles, reviews and meta-analyses concerning these beneficial effects in adult COPD and asthmatic patients (10, 19–24), few studies have concentrated on QoL in asthmatic children (25–30). Most of these articles discuss the effects of education and asthma self-management programs on QoL. To the best of our knowledge, the effect of outpatient exercise training on QoL has not yet been studied in asthmatic children.

Swimming is well accepted and investigated in asthmatic children. Only a few randomized controlled trials have questioned the effects of other physical training methods (6, 11). In the current study, we evaluated the effects of basketball training on QoL along with exercise capacity and pulmonary functions of children with mild–moderate asthma. The results revealed that children in the exercise group improved their QoL as well as their exercise capacity. The QoL also improved in the control group in which the children performed a home exercise program. This is consistent with the study by Bingol et al. (26) in which a daily home exercise program resulted in improvements in QoL in asthmatic children. These beneficial effects on QoL might be explained by the positive effects of regular home respiratory exercise. As expected, the QoL improvement in the exercise group was more than the control group in our trial. The psychosocial benefits of participating in an exercise program of team sport and sharing with other asthmatic children could have an additional effect on QoL besides the training program itself.

No significant correlations were observed between QoL and other variables such as exercise capacity, pulmonary functions, duration of disease, socioeconomic variables and symptom scores in our study group. Change in symptom scores was the only parameter to correlate significantly with the change in total QoL scores. Improvement in QoL seems to be independent of the physiological parameters such as Fuchs-Climent et al. (31) have also found in their study of a short and intensive inpatient rehabilitation program. They, too, have found improvements in QoL and exercise endurance, yet no significant correlations between QoL and physiological parameters throughout their rehabilitation program. The impact of an asthma program on QoL which consisted of agressive medical management and education have also been investigated by Munzenberger & Vinuya (25) and significant improvements have been seen in overall QoL scores as well as in each domain. However, no relationship has been detected between exercise tolerance, symptoms and changes in QoL total score.

The literature presents several studies concerning the effects of different asthma management programs on QoL of asthmatic children. It is quite challenging to compare these results as the contents of these rehabilitation programs, the duration and follow-up periods show a wide range of variability. Marabini et al. (32) investigated the short-term effects of an asthma education program and significant improvements were found in overall QoL and in symptom domain. The long-term effect of indoor rehabilitation was investigated in 8–16-year-old asthmatic children by Bauer et al. (28). Significant improvements in asthma management, days absent from school, MEF 50 and QoL were observed after 12 months. In another study, the impact of a population-based asthma management program on paediatric asthma patients and their caregivers was investigated (27). Statistically significant outcomes were observed in various domains, such as symptomatology, restricted activity days for children and workdays lost for adult carers after a period of 12 months.

Our secondary end-points were investigating the effects of the intervention on exercise capacity and pulmonary functions. The functional exercise capacity determined by 6MWT and PWC 170 test improved in group E whereas no significant improvements were seen in group C. There are some limitations of the 6MWT and the PWC 170 test in interpreting the results of children for a precise determination of exercise capacity. The 6MWT distance normally ranges from 400 to 700 metres in healthy adults (33), but there is, to-date, no data for healthy children. The minimal clinically significant change in 6MWT distance was found to be 54 metres for adult patients with chronic obstructive pulmonary disease (COPD) (34). There is also no defined data regarding the minimal clinically significant change in 6MWT distance when performed on children. Therefore, the clinical importance of the significant change of 26 metres in the 6MWT results of group E in our study remains unclear.

The PWC 170 test, on the other hand, has been shown to have good correlation with maximal oxygen uptake (VO_2max) and provides crude estimate of VO_2max, but should not be used to predict individual maximal aerobic power (35). In clinical practice, it is easy to perform the PWC 170 test compared with the other direct measurement techniques of VO_2max, especially in children. However, it is technically not possible to perform on children less than 1.35 metres tall.

Our findings are consistent with the current literature concerning aerobic improvement as well as symptomatic improvement and medication reduction with physical training in asthma. Neder et al. (3) investigated the short-term effects of aerobic training in moderate-to-severe asthma and detected aerobic improvement with a significant reduction in the medication score. Effects of an exercise program consisting of regular group exercises and home exercises for a period of 3 months on aerobic capacity, endurance and coping with asthma was evaluated by van Veldhoven et al. (2). They also found significant improvements in exercise parameters and coping with asthma. However, neither of these studies has evaluated the effects of the interventions on QoL.

In their review, Ram et al. (6) evaluated the effects of physical training on resting pulmonary functions, aerobic fitness, clinical status and QoL in asthmatic children who were $\geq$ 8 years. The clearest finding of this meta-analysis was that aerobic power increased with physical training. No improvement in resting lung function was shown and any benefits of regular exercise were reported to be unrelated to effects on lung function. In the review mentioned above, no data were available on a number of outcome measures, such as exercise endurance, symptoms, bronchodilator use and measures of QoL.

To the best of our knowledge, this is the first article evaluating the effects of a supervised indoor physical training program in the form of a team sport (basketball training) on QoL in mild–moderate asthmatic children. Our results support the positive effects of submaximal aerobic exercise on QoL and exercise capacity in children with asthma. Eight weeks of regular submaximal basketball training is an effective alternative program for asthmatic children. Children with asthma should be encouraged to engage in sports and lifetime exercise. However, further randomized controlled trials using larger samples are needed to confirm these findings and to assess the long-term effects of physical training on QoL in asthmatic children as well as to determine which form of exercise training is most beneficial.

REFERENCES

1. Sly RM. Allergic disorders. In: Behrman RE, Kliegman RM, Jenson HB, eds. Nelson textbook of pediatrics, 16th edn. Philadelphia: WB Saunders Co.; 2000, pp. 664–680.
2. van Veldhoven NH, Vermeer A, Bogaard JM, Hessels MG, Wijnroks L, et al. Children with asthma and physical exrcise: effects of an exercise programme. Clin Rehabil 2001; 15: 360–370.
3. Neder JA, Nery LE, Silva AC, Cabral ALB, Fernandes ALG. Short-term effects of aerobic training in the clinical management of moderate to severe asthma in children. Thorax 1999; 54: 202–206.
4. Juniper EF, Guyatt GH, Feeny DH, Ferrie PJ, Griffith LE, Townsend M. Measuring quality of life in children with asthma. Qual Life Res 1996; 5: 35–46.
5. Juniper EF. How important is quality of life in pediatric asthma? Pediatr Pulmonol 1997; (suppl 15): 17–21.
6. Ram FS, Robinson RM, Black PN. Effects of physical training in asthma: a systematic review. Br J Sports Med 2000; 34: 162–167.
7. American Association of Cardiovascular & Pulmonary Rehabilitation. Guidelines of pulmonary rehabilitation programmes, 2nd edn. Champaign, IL, USA: Human Kinetics; 1998, ISBN: 0-88011-863-6.
8. Cochrane LM, Clark CJ. Benefits and problems of a physical training programme for asthmatic patients. Thorax 1990; 45: 345–351.
9. Cooper CB. Exercise in chronic pulmoner disease: limitations and rehabilitation. Med Sci Sports Exerc 2001; 33: S643–S646.
10. BTS Statement. Pulmonary rehabilitation. Thorax 2001; 56: 827–834.
11. Matsumoto I, Araki H, Tsuda K, Odajima H, Nishima S, Higaki Y, et al. Effects of swimming training on aerobic capacity and exercise induced bronchoconstriction in children with bronchial asthma. Thorax 1999; 54: 196–201.
12. Akmanlar N, Altintas D, Guneser-Kendirli S, Yilmaz M, Bingol G. Comparison of conventional and rush immunotherapy with Der PI in childhood respiratory allergy. Allergol Immunopathol 2000; 28: 213–218.
13. Crompton GK, Ayres JG, Basran G, Schiraldi G, Brusasco V, Eivindson A, et al. Comparison of oral bambuterol and inhaled salmeterol in patients with symptomatic asthma and using inhaled corticosteroids. Am J Respir Crit Care Med 1999; 159: 824–828.
14. Solway S, Brooks D, Lacasse Y, Thomas S. A qualitative systematic overview of the measurement properties of functional walk tests used in the cardiorespiratory domain. Chest 2001; 119: 256–270.
15. Astrand P, Rodahl K. Textbook of work physiology. Physiological bases of exercise, 2nd edn. New York: McGraw Hill Company; 1977, pp. 331–361.
16. Juniper EF, Guyatt GH, Willan A, Griffith LE. Determining a minimal important change in a disease-speCific quality of life instrument. J Clin Epidemiol 1994; 47: 81–87.
17. Rutishauser C, Sawyer SM, Bowes G. Quality of life assessment in children and adolescents with asthma. Eur Respir J 1998; 12: 486–494.
18. Sawyer MG, Spurrier N, Whaites L, Kennedy D, Martin AJ, Baghurst P. The relationship between asthma severity, family functioning and the health-related quality of life of children with asthma. Qual Life Res 2000; 9: 1105–1115.
19. Wijkstra PJ, Ten Vergert EM, van der Mark Th W, Postma DS, van altera R, Kraan J, et al. Relation of lung function, maximal inspiratory pressure, dyspnoea and quality of life with exercise capacity in patients with chronic obstructive pulmonary disease. Thorax 1994; 49: 468–472.
20. Griffiths TL, Burr ML, Campbell IA, Lewis-Jenkins V, Mullins J, Shiels K, et al. Results at 1 year of outpatient multidisciplinary pulmonary rehabilitation: a randomised controlled trial. Lancet 2000; 355: 362–368.
21. Cambach W, Wagenaar RC, Koelman TW, van Keimpema AR, Kemper HC. The long-term effects of pulmonary rehabilitation in patients with asthma and chronic obstructive pulmonary disease: a research synthesis. Arch Phys Med Rehabil 1999; 80: 103–111.
22. Gallefos F, Bakke FS, Kjaersgaard P. Quality of life assessment after patient education in a randomized controlled study on asthma and chronic obstructive pulmonary disease. Am J Respir Crit Care Med 1999; 159: 812–817.
23. Lacasse Y, Wong E, Guyatt G, King D, Cook DJ, Goldstein RS. Meta-analysis of respiratory rehabilitation in chronic obstructive pulmonary disease. Lancet 1996; 348: 1115–1119.
24. Lacasse Y, Brosseau L, Milne S, Martin S, Wong E, Guyatt GH, et al. Pulmonary rehabilitation for chronic obstructive pulmonary disease. Cochrane Database Syst Rev 2002; (3): CD 003793.

25. Munzenberger PJ, Vinuya RZ. Impact of an asthma program on the quality of life of children in an urban setting. Pharmacotherapy 2002; 22: 1055–1062.
26. Bingol-Karakoc G, Yilmaz M, Sur S, Altintas D, Sarpel T, Guneser-Kendirli S. The effects of daily pulmonary rehabilitation program at home on childhood asthma. Allergol Immunopathol 2000; 28: 12–14.
27. Georgiou A, Buchner DA, Ershoff DH, Blasko KM, Goodman LV, Feigin J. The impact of a large-scale population-based asthma management program on pediatric asthma patients and their caregivers. Ann Allergy Asthma Immunol 2003; 90: 308–315.
28. Bauer CP, Petermann F, Kiosz D, Stachow R. Long-term effect of indoor rehabilitation on children and young people with moderate and severe asthma. Pneumologie 2002; 56: 478–485.
29. Bratton DL, Price M, Gavin L, Glenn K, Brenner M, Gelfand EW, et al. Impact of a multidisciplinary day program on disease and healthcare costs in children and adolescents with severe asthma: a two-year follow-up study. Pediatr Pulmonol 2001; 31: 177–189.
30. Yilmaz A, Akkaya E. Evaluation of long-term efficacy of an asthma education programme in an out-patient clinic. Respir Med 2002; 96: 519–524.
31. Fuchs-Climent D, Le Gallais D, Varray A, Desplan J, Cadopi M, Prefaut C. Quality of life and exercise tolerance in chronic obstructive pulmonary disease: effects of a short and intensive inpatient rehabilitation program. Am J Phys Med Rehabil 1999; 78: 330–335.
32. Marabini A, Brugnami G, Curradi F, Casciola G, Stopponi R, et al. Short-term effectiveness of an asthma educational program: results of a randomized controlled trial. Respir Med 2002; 96: 993–998.
33. Enright PL. The six-minute walk test. Respir Care 2003; 48: 783–785.
34. Redelmeier DA, Bayoumi AM, Goldstein RS, Guyatt GH. Interpreting small differences in functional status: the six minute walk test in chronic lung disease patients. Am J Respir Crit Care Med 1997; 155: 1278–1282.
35. Petzl DH, Haber P, Schuster E, Popow C, Haschke F. Reliability of estimation of maximum performance capacity on the basis of submaximum ergometric stress tests in children 10–14 years old. Eur J Pediatr 1988; 147: 174–178.