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Effects of an aerobic physical training program on psychosocial characteristics, quality-of-life, symptoms and exhaled nitric oxide in individuals with moderate or severe persistent asthma

Efeito de um programa de condicionamento físico aeróbio nos aspectos psicossociais, na qualidade de vida, nos sintomas e no óxido nítrico exalado de portadores de asma persistente moderada ou grave

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Abstract

Objective: To evaluate the role of an aerobic physical training program on psychosocial characteristics, quality of life, symptoms and exhaled nitric oxide of adults with moderate or severe persistent asthma. **Methods:** Twenty patients were randomly assigned to a Control Group (CG, n= 10, education program and respiratory exercises) and a Trained Group (TG, n= 10, education program and respiratory exercises plus aerobic training at 70% of the maximum power obtained). The intervention took place twice a week for three months. Maximum aerobic capacity, pulmonary function, effort dyspnea, anxiety levels, depression levels and quality of life were assessed before and after the treatment. Exhaled nitric oxide at rest and the number of days without asthma symptoms were evaluated every month. **Results:** The TG presented increased numbers of symptom-free days (TG 24.8 days [95%CI= 23-27] *versus* CG 15.7 days [95%CI= 9-21]; p< 0.05), decreased exhaled nitric oxide levels (TG 25.8 ppb [95%CI= 15.3-44.0] *versus* CG 44.3 ppb [95%CI= 24-60]; p< 0.05), decreased anxiety scores (TG 39.3 [95%CI= 37-50] *versus* CG 40.9 [95%CI= 37-50]; p< 0.001), decreased depression scores (TG 6.6 [95%CI= 1-21] *versus* CG 9 [95%CI= 1-20]; p< 0.001), improved quality of life (TG 42.8% [95%CI= 34.3-71.7] *versus* CG 69.6% [95%CI= 45.1-87.9]; p< 0.001) and improved aerobic aptitude (TG 25.7 mL/kg/min [95%CI= 6.2-31.3] *versus* CG 20.5 mL/kg/min [95%CI= 17.3-24.1]; p< 0.001). **Conclusions:** Our results suggest that physical training reduces exhaled nitric oxide and symptoms and improves the quality of life and psychosocial characteristics of adults with moderate or severe persistent asthma.

Key words: asthma; psychosocial characteristics; exhaled nitric oxide; quality of life; asthma symptoms; physical training.

Resumo

Objetivo: Avaliar o papel de um programa de condicionamento físico aeróbio nos aspectos psicossociais, qualidade de vida, sintomas e óxido nítrico exalado (NOe) de adultos com asma persistente moderada ou grave. **Materiais e métodos:** Vinte pacientes foram divididos aleatoriamente em Grupo Controle (GC, n= 10; programa de educação e exercícios respiratórios) e Grupo Treinado (GT, n= 10; programa de educação e exercícios respiratórios mais condicionamento aeróbio, 70% potência máxima obtida). A intervenção aconteceu duas vezes por semana durante três meses. Antes e após, foram avaliados a capacidade aeróbia máxima, a função pulmonar, a dispnéia ao esforço, os níveis de ansiedade e depressão e a qualidade de vida. Mensalmente, eram avaliados o NOe em repouso e o número de dias livres de sintomas. **Resultados:** Apenas o GT apresentou redução dos sintomas (GT 24,8 [IC95%= 23-27] *versus* GC 15,7 [IC95%= 9-21] dias livres de sintomas, p< 0,05), dos níveis de NOe (GT 25,8 [IC95%= 15,3-44] *versus* GC 44,3 [IC95%= 24-60] ppb, p< 0,05), da ansiedade (GT 39,3 [IC95%= 37-50] *versus* GC 40,9 [IC95%= 37-50] escore, p< 0,001) e da depressão (GT 6,6 [IC95%= 1-21] *versus* GC 9 [IC95%= 1-20] escore, p< 0,001), melhora da qualidade de vida (GT 42,8 [IC95%= 34,3-71,7] *versus* GC 69,7 [IC95%= 45,1-87,9] %, p< 0,001), e incremento da aptidão aeróbia (GT 25,7 [IC95%= 16,2-31,3] *versus* GC 20,5 [IC95%= 17,3-24,1] mL/kg/min, p< 0,001). **Conclusões:** Os resultados sugerem que o treinamento físico reduz o NOe, os sintomas e melhora a qualidade de vida e os aspectos psicossociais de adultos com asma persistente moderada ou grave.

Palavras-chave: asma; aspectos psicossociais; óxido nítrico exalado; qualidade de vida; sintomas de asma; treinamento físico.

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Introduction

Although there are a great number of stimuli which cause acute asthma attack, physical activity is one of the most common precipitating factors[1]. The dyspnea experienced by the asthmatic patients during exercise, or the fear of experiencing it, is responsible for distancing them from sports practice and group physical activities[2]. Therefore, asthmatic subjects tend to be less active and in poorer physical condition than healthy subjects[3,4] and, hence, they remain physically inactive[5,6]. Physical, emotional and social restrictions imposed by asthma are capable of profoundly modifying patients' lives, leading to depression, social isolation, low self-esteem, and loss of motivation[7].

Physical conditioning has been considered an important part of rehabilitation programs for asthma patients[8], however, a recent systematic review of the literature showed that the only proven effects are improvement of cardiovascular capacity, resistance to exercise, reduction of dyspnea related to exercise[9], exercise-induced bronchospasm incidence and corticoid administration[10]. On the other hand, physical conditioning effects on factors related to quality of life, symptoms and psychosocial morbidity of asthma patients are still not well understood.

The fact that physical training reduces corticoid administration necessity and asthma symptoms, suggests a modulator role in pulmonary inflammation. However, the role of physical training on clinical management and pulmonary inflammation of asthmatic patients has never been analyzed. Reduction of the number of days free of symptoms, level of exhaled nitric oxide (NOe) and number of eosinophils in the induced sputum have been the main targets of inflammation management in asthmatic patients[11,12].

Acute and unexpected shortness of breath episodes are constant threats to asthmatic patients and are associated with anxiety[13]. The benefits of physical conditioning for reduction of anxiety and depression levels in healthy adults and the elderly are widely recognized[14] and, thus, it is possible that the regular practice of physical exercise can benefit asthmatic patients[15]. However, there are three studies which evaluated the effects of physical conditioning on quality of life of asthmatic subjects. The first one investigated adults with asthma and COPD[16] and the other two evaluated the effects on children[10,17].

The objective of the present study was to assess the effectiveness of an aerobic conditioning program on psychosocial aspects, quality of life and symptoms of adult patients with moderate or severe persistent asthma.

Methods

Subjects

Twenty adults were studied (14F), men and women, with moderate or severe persistent asthma, aged between 20 and 50 years and with a body mass index (BMI) ranging between 20 and 30 Kg/m^2. They had a score of 50% or inferior in the domain of physical limitation of the quality of life questionnaire - Escola Paulista de Medicina (EPM)[18]. The patients had to be under outpatient medical treatment for at least six months and demonstrate clinical stability (without hospitalization episodes or need for emergency care for, at least, 30 days). The diagnosis and treatments were conducted according to the Global Initiative for Asthma (GINA)[19]. The exclusion criteria included presence of another pulmonary associated disease, clinical diagnosis of cardiopathy and/or pulmonary hypertension, and osteomuscular diseases which could interfere in the evaluations. The patients were selected after a medical consultation and there were no medication changes during the whole program. Subjects with other diseases were excluded. The study was approved by the Ethics in Research Committee of Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP) with protocol number 0297/07 and the patients signed an informed consent form. Costs of transport and medication were paid by the researchers.

Experimental design

The subjects were randomly assigned to two groups: a control group (CG) and a training group (TG). The patients in the CG were submitted to an educational program and to a respiratory exercise program. Patients of the TG were submitted to all procedures of CG and to an additional program of physical aerobic conditioning. The training intensity was 70% of the maximal power obtained in the cardiopulmonary effort test carried out before the beginning of training. In the initiation and end of treatment period, all patients performed the pulmonary function test, cardiopulmonary effort test and answered questionnaires which assessed factors related to quality of life and levels of anxiety and depression. NOe and days free of symptoms were recorded and registered monthly, by means of a symptoms diary.

- *Education program:* The program had a duration of four hours and was comprised of two interactive classes which aimed at explaining disease physiopathology, correct use of medications, and an action plan in case of worsening of symptoms[19].
- *Respiratory exercise program:* The program started the week after the education program. Patients of both

groups were submitted to the respiratory exercise program which was carried out for 30 minutes, twice a week, over three months. The respiratory exercise program was conducted as previously described[20].

- *Aerobic Conditioning Program:* The program started the week after the education program and each session had a duration of 30 minutes and was carried out after the CG performed the respiratory exercises. Patients were submitted to aerobic training on a treadmill (Imbramed Export Plus, RS, Brazil). The heart rate (HR) and level of respiratory discomfort of the subjects were monitored. The training intensity was 70% of maximum power obtained in the cardiopulmonary effort test, which was carried out before the beginning of the training and monitored by patients' HR. During the first two weeks, the patients adapted to a program intensity level of 60% of the maximum power obtained[10]. There were no modifications in training intensity during the 12 weeks of treatment.

Analyzed variables

- *Pulmonary function:* Spirometric evaluations were conducted before and after the administration of 200ug of inhaled salbutamol (Kokko spirometer, Pulmonary Data System, USA). Technical procedures and criteria of acceptability and reproducibility were the ones recommended by ATS[21] and previewed normality curves were the ones proposed by Knudson[22]. Increases of 12% or 200ml in the forced expiratory volume (FEV_1) were defined as a positive response to bronchodilator[21].
- *Cardiopulmonary test:* The test was performed on a treadmill linked to a digital computer which included a system of exercise evaluation (Sensormedics, Vmax 229, CA, USA). This system carried out analyses of metabolic, ventilatory and cardiovascular parameters of breathing patterns. The modified protocol of Balke-Ware[23] was used and according to this protocol, the subject walked at the speed of 1.5 km/h on a non-inclined treadmill during a warm-up period and, after three minutes, an increase of 2.5 degrees occurred every two minutes. Values of VO_2 peak were determined according to Cooper et al.[24] and the lack of aerobic physical conditioning was classified as mild (over 70% of previewed), moderate (70-50% of previewed), or severe (lower than 50% of previewed)[24]. The values of VO_2 at the anaerobic threshold (VO_2AT) were determined by the gas exchange method through visualization of the point of inflexion of VCO_2 versus VO_2 (modified V slope)[25]. The values of VO_2 at the point of respiratory compensation (VO_2PCR) were detected through the exponential increases in CO_2.
- *Quality of life:* This was evaluated through the EPM questionnaire of quality of life for asthmatic subjects. This questionnaire was translated and validated into the Portuguese language and consists of four domains[18]: i) patients' physical limitations due to asthma symptoms; ii) symptom frequency; iii) socioeconomic limitations; and iv) psychosocial limitations. Questionnaire scores were expressed in percentages, with a maximum value of 100%. Low scores indicated better quality of life whereas high scores indicate poorer quality of life.
- *Evaluation of the levels of anxiety and depression:* The validated[28,29] questionnaire of depression[26] and State-trait Anxiety Inventory (IDATE)[27] were used. IDATE is a questionnaire which examines the levels of state-anxiety and trait-anxiety symptoms.
- *Asthma symptoms:* These symptoms were analyzed through a previously described diary[30]. The diaries were filled out daily by patients and included questions about episodes of crises and symptoms (coughing, wheezing, shortness of breath, "waking up at night", and the use of inhalers. The days which were free of any of symptoms were summed and considered monthly. The 20 days before the beginning of treatment of both groups were considered for the first evaluation.
- *Evaluation of exhaled nitric oxide levels:* The fraction of NOe was measured over four occasions: before treatment and 30, 60 and 90 days after the termination of treatment. Patients were oriented to blow into a Mylar bag maintaining an expiratory pressure of 10 cmH_2O, in order to avoid contamination of nasal cavity air. All collected samples were examined up to 24 hours after collection and analyzed by chemoluminescence (Sievers 280)[31,32].

Statistical analyses

Sample size was calculated for an analysis of variance (ANOVA) with four groups (control and training, before and after training), and improvements of 40% for the domains related to quality of life (main variable), an expected within-group standard deviation of 30% and a statistical power of 80%. Normality of data was assessed through the Kolmogorov-Smirnov test. The variables obtained before training were compared with the Student t-test. Comparisons of the initial and final data on quality of life, anxiety, depression and aerobic capacity were analyzed using ANOVA. NOe and symptoms data were compared using repeated measures ANOVA. The level of significance was set at 5% ($p< 0.05$).

Results

Three patients (2CG/1TG) dropped out of the study during the first month of treatment (two patients due to work schedule changes and one due to moving to another city). Twenty

patients completed the study; 10 in the control group (6F) and 10 in the training group (7F). Before the beginning of the study, patients from the CG and TG were similar in relation to gender, age, body mass index, pulmonary functions and corticosteroid dose (Table 1). There were no differences related to aerobic capacity, factors related to quality of life and levels of anxiety and depression, number of days free of symptoms, and levels of NOe between subjects of CG and TG, before training.

After three months of treatment, individuals in the TG showed increases in the physiological effort parameters in comparison to theCG (Table 2). Trained adults reported increases in VO_2peak, predicted VO_2 and oxygen pulse at exercise peak ($p< 0.05$). Patients in the TG also showed increases in VO2peak, and in submaximal parameters, such as anaerobic threshold and point of respiratory compensation ($p< 0.05$). Trained subjects (TG) showed a reduction of effort perception at exercise peak in comparison to the values obtained before the physical training period ($p< 0.05$); however, effort perceptions of TG and CG were not different at the end of treatment ($p> 0.05$). None of the training programs resulted in pulmonary function improvement (data not presented).

The physical conditioning program improved the following domains: physical limitations, frequency of symptoms, psychosocial limitation, and the total score of quality of life questionnaire ($p< 0.001$) and there were no alterations in the socioeconomic domain (Table 3). Subjects who were not submitted to physical training showed equal or worse values in the domains of the reported quality of life questionnaire.

At the beginning of the study, patients of both groups (10/10; 100%) showed moderate trait-anxiety scores (Table 3). Physical conditioning reduced trait-anxiety levels of the TG in comparison to the initial levels ($p< 0.05$), although there were

Table 1. Anthropometrical characterizistics, pulmonary function and corticoid doses of asthmatic adult patients before the training program.

	Control Group (n= 10)	Training Group (n= 10)	p-value
Anthropometrical Data			
Gender (W/M)	6/4	7/3	
Age (yrs)	34.6 (21.0-47.0)	34.6 (21.0-47.0)	0.57
BMI (Kg/m2)	23.2 (18.0-29.0)	25.8 (24.0-27.0)	0.16
Pulmonary Function			
FEV1 (L)	2.0 (1.4-2.7)	2.1 (1.2-3.4)	0.72
(% of predicted value)	71.8 (55.0-85.0)	76.7 (48.0-114.0)	0.44
FEVC (L)	3.2 (2.3-4.0)	3.0 (2.3-4.0)	0.48
(% of predicted value)	85.0 (71.0-107.0)	90.3 (76.0-117.0)	0.31
FEV1/FEVC	65.5 (52.0-83.0)	70.9 (52.0-85.0)	0.25
PEFR (L/s)	4.3 (3.6-5.0)	4.1 (1.0-6.6)	1.00
(% of predicted value)	60.6 (45.0-82.0)	64.8 (25.0-101.0)	0.60
Budesonide (mcg/day)	680 (400.0-800.0)	720 (400.0-800.0)	0.73

Data are expressed as median and 95%CI; BMI= body mass index, W= women; M= men. FEV1= forced expiratory volume in the first second; PEFR= Peak Expiratory Flow Rate; FEVC= forced expiratory vital capacity; Statistical analysis ($p< 0.05$).

Table 2. Cardiopulmonary exercise testing and dyspnea of asthmatic adult patients before and after the training program.

Peak	Control Group (n=10)		Training Group (n=10)		p-value
	Pre	Post	Pre	Post	
VO_2 (mL/kg/min)	22.2 (17.7-26.0)	20.5 (17.3-24.1)	20.6 (16.3-24.5)	25.78†* (16.20-31.30)	< 0.001
VO_2 (% pred)	56.9 (66.0-100.0)	52.9 (39.7-63.5)	57.7 (49.7-74.6)	71.84†* (52.94-95.42)	< 0.001
VO_2/CF (mL/min/beat)	10.3 (6.6-13.9)	8.6 (6.5-10.8)	8.4 (5.4-12.7)	10.20†* (7.10-12.80)	0.004
RCP					
VO_2 (mL/kg/min)	20.37 (17.2-25.60)	19.4 (17.0-21.4)	18.8 (15.5-25.6)	23.3†* (16.0-27.4)	< 0.001
VO_2/CF (mL/min/beat)	9.7 (5.8-12.5)	8.3 (6.6-13.3)	7.80 (5.2-12.5)	9.3 (5.8-12.5)	0.071
AT					
VO_2 (mL/kg/min)	16.2 (13.2-21.0)	15.4 (12.5-19.9)	15.0 (11.9-19.7)	17.41†* (10.09-23.30)	0.041
VO_2/CF (mL/min/beat)	8.6 (6.0-12.3)	7.2 (5.0-10.5)	6.8 (5.1-8.3)	8.14 (5.60-11.20)	0.055
Borg	3.9 (3.0-5.0)	3.1 (2.0-4.0)	3.9 (2.0-5.0)	2.50* (1.00-5.00)	0.003

Data are expressed median and 95%CI; VO_2= maximum consumption of O_2; RCP= respiratory compensation point; AT= anaerobic threshold; CF= cardiac frequency. Borg= evaluation of stress perception by the modified Borg scale. Pre= before the start of training; Post= after the training period; *$p< 0.05$ when compared to the intra-group value obtained before (pre); †$p< 0.05$ when compared to the Control group.

Table 3. Anxiety and depression levels and health related quality of life of asthmatic adult patients before and after the training program.

	Control Group (n=10)		Training Group (n=10)		p-value
	Pre	Post	Pre	Post	
EPM HRQoL domains					
Physical limitation	64.1 (51.5-90.9)	74.0 (57.5-90.9)	68.8 (50.0-93.9)	35.71*† (12.12-81.81)	< 0.001
Symptom frequency	72.4 (50.0-83.3)	79.1 (25.0-100.0)	66.6 (41.6-83.3)	39.93*† (16.66-83.33)	0.002
Socioeconomic	66.2 (27.2-90.9)	69.9 (27.2-90.9)	69.9 (45.4-90.9)	67.23 (27.27-90.90)	0.455
Psychosocial	55.3 (42.8-85.7)	67.0 (28.5-100.0)	56.8 (28.5-100.0)	34.28*† (28.57-71.42)	0.003
Total score	63.7 (48.5-79.8)	69.6 (45.1-87.9)	63.8 (54.3-78.2)	42.86*† (34.30-71.72)	< 0.001
Anxiety					
Trace	44.30 (35.00-55.00)	40.90 (37.00-50.00)	43.8 (39.0-48.5)	39.3 (37.0-50.0)	< 0.001
State	44.10 (36.00-57.00)	41.00 (34.00-55.00)	44.1 (35.0-57.0)	41.0 (33.0-49.0)	0.489
Depression	12.45 (5.00-24.00)	9.05 (1.00-20.00)	11.0 (2.0-22.0)	6.6 (1.0-21.0)	< 0.001

Data are expressed as median and 95% confidence interval; HRQoL= health related quality of life; Pre= before the training program; Post= after the training program; *p< 0.05 when compared to the intra-group value obtained before the study (pre); †p< 0.05 when compared with Control Group.

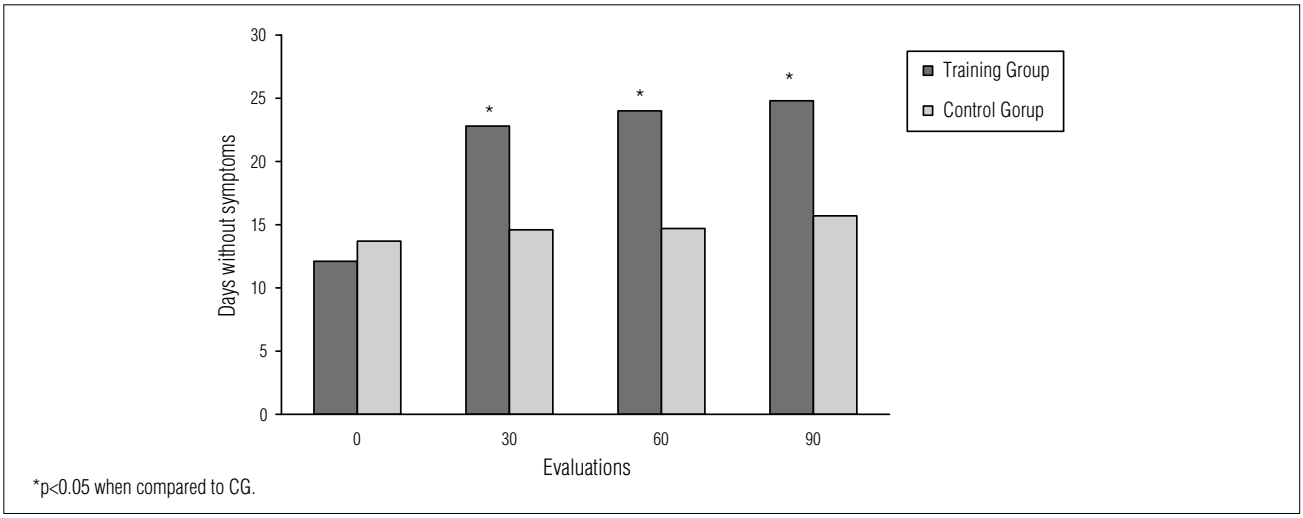

Figure 1. Asthma symptoms during the training period and expressed as number of symptom-free days per month. First evaluation was performed comprised of information obtained before the study (20 days), second evaluation was performed after 30 days, third evaluation was performed after 60 days and fourth evaluation at the end of the treatment period (90 days).

no differences in comparisons to the CG. On the other hand, there was no difference between initial and final levels of state-anxiety of the CG and TG.

It was observed that 50% of the patients in the CG (5/10) and in TG (5/10) had low scores of depression before the beginning of the study (Table 3). At the end of the study, the trained subjects demonstrated a reduction in their depression levels when compared to non-trained subjects (p<0.05). There was a significant reduction in the number of individuals with low levels of depression only in the TG (1/10).

The frequency of symptoms of patients was assessed by means of the monthly sum of days free of symptoms, reported and registered in their diary. Subjects in the CG and TG showed a mean of 12.9 days free of symptoms during the month before training (respectively, 12.10 [95%CI 8.0-18.0] and 13.7 [95%CI 10.0-18.0] days free of symptoms) (Figure 1). There was an increase in the number of days free of symptoms of TG, 30 days after the beginning of physical training (22.8 [95%CI 20.0-25.0]) which remained after 60 (24.0 [95%CI 22.0-26.0]) and 90 (24.8 [95%CI 23.0-27.0]) days of training (p<0.05) (Figure 2). In contrast, there was no alteration in the number of days free of symptoms of CG after 30, 60 and 90 days of training (respectively, 14.6 [95%CI 10 to 18], 14.7 [95%CI 10-18] and 15.7 [95%CI 9-21]) (p<0.05).

NOe measurements were conducted before the beginning of treatment and repeated every 30 days. There were no differences in NOe levels of TG and CG before the beginning of treatment (respectively, 35.03 [95%CI 22.4-59.2] vs 44.62 [95%CI 24.0-67.1] ppb). In contrast, NOe levels of CG patients were lower than the levels of TG patients at the evaluation carried out after 30 days (respectively, 31.5 [95%CI 14.0-62.0] vs 47.3 [95%CI 29.0-75.2] ppb) (p<0.05),

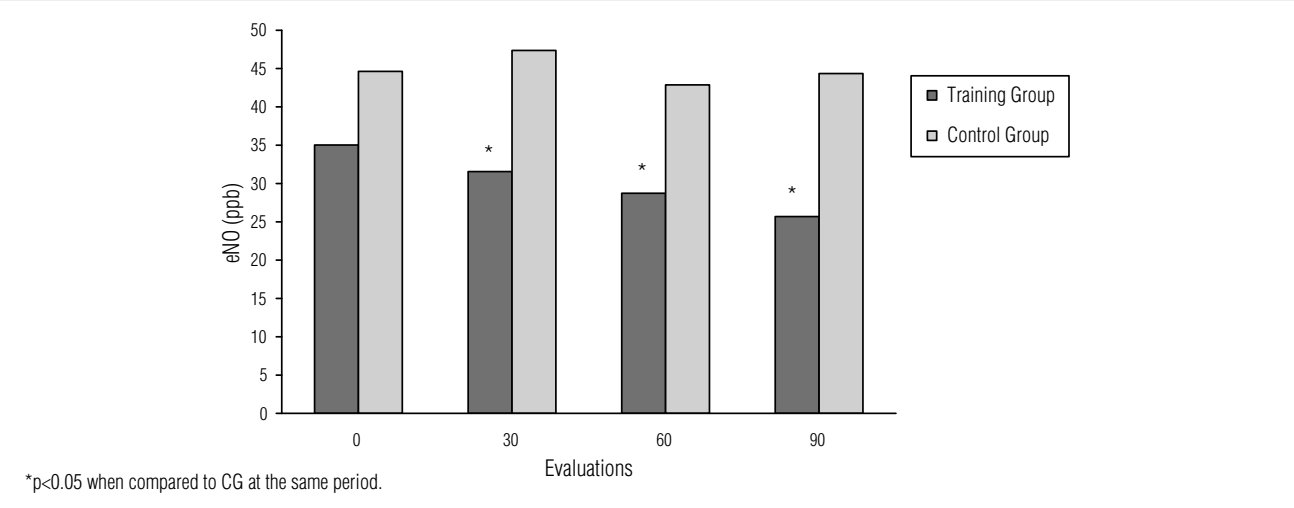

Figure 2. NOe levels were quantified monthly during the training period in parts per billion (ppb). The first evaluation was performed in the first day of training program. Second, third and fourth evaluation was performed, respectively after 30, 60 and 90 days.

60 days (respectively, 28.7 [95%CI 18.0-50.0] vs 42.8 [95%CI 22.5-57.7] ppb) ($p<0.05$), and 90 days (respectively, 25.6 [95%CI 15.3-44.0] vs 44.35 [95%CI 24.0-60.0] ppb) ($p<0.05$) after the beginning of training (Figure 2).

Discussion

The results of the present study showed that patients with moderate or severe persistent asthma demonstrated improvements of aerobic capacity and quality of life and reduction of symptoms, anxiety and depression and in levels of exhaled NOe after 12 weeks of moderate physical conditioning. Consequently, these data suggested that a physical conditioning program may have played a key role as an adjunct intervention in the treatment of asthmatic patients who were clinically stable and under appropriate drug therapy.

It has been demonstrated that the prescription of physical exercises for asthmatic patients produces an increase in aerobic capacity, leading these patients to achieve levels of physical activity which are within the normal range[8]. Generally, most patients (15/20, 75%) in the present study showed a maximal aerobic capacity (VO_2peak) <70% of the predicted and, thus, a moderate physical limitation[24]. This decreased physical conditioning was related to an enhancement of the maximal and sub-maximal cardiovascular conditioning parameters (Table 2). Trained asthmatic patients showed an enhancement of VO_2peak, anaerobic threshold and point of respiratory compensation. In fact, after training, all patients of TG, except one, showed an increase greater than 10% of their aerobic capacity. In contrast, all patients in the CG had an unaltered or reduced VO_2peak at the second evaluation. There are only five randomized controlled studies which investigated the effects of physical training on VO_2max. The improvements found were 5.5mLO_2/kg/min (from 3.9 to 7.1 mLO_2/kg/min)[9]. The results obtained in the present study are in accordance with those previously described, since our patients demonstrated a mean VO_2peak increase of 5.1 mLO_2/kg/min (from 0.1 to 10.7 mLO_2/kg/min) (Table 2).

Quality of life is an individual perception which is inserted in the cultural context and value systems in which the subjects live. The context and values are related to the objectives, expectations, criteria and interests of these subjects[33]. Asthma causes negative effects on the quality of life to the extent that it causes anxiety related to the expectation of experiencing new crises. It also impairs sleep and makes participation in group and daily-living activities impossible[34-36]. The reduction in physical activity of asthmatic patients also contributes to obesity and low self-steam[37]. Studies which investigated the role of physical conditioning in the quality of life of adult asthmatic patients are still scarce. Cambach[16] demonstrated that physical exercise, practiced regularly, is responsible for improving the quality of life of patients with respiratory diseases, including asthma and COPD patients. The results of the present study showed that physical conditioning lead to improvements of quality of life of asthmatic patients. Trained subjects showed reductions in their physical limitation scores, frequency of symptoms and psychosocial limitations, whereas none of these changes were observed in the untrained group.

Asthma can decrease quality of life and is consequently associated with psychosocial complications, such as high levels of depression and anxiety[38]. With asthmatic patients,

psychosocial morbidity is associated with low adherence to drug treatment and to the worsening of the clinical disease picture[39]. Physical conditioning programs improve humor and reduce levels of anxiety and depression in healthy adults and the elderly[11]. However, the effects of regular physical activity practice on the psychosocial aspects of asthmatic patients are unknown. The present results demonstrated that 50% of the subjects (10/20) showed low levels of depression before the beginning of treatment in comparison to Brazilian data for a healthy population measured with the Beck inventory[26]. It is noteworthy that, after the physical conditioning period, patients in the TG showed improvements of the depression levels, suggesting that aerobic training programs can reduce depression in asthmatic subjects.

Anxiety levels were assessed using the Spielberger inventory which classifies anxiety as: trait-anxiety and state-anxiety[27]. State-anxiety refers to the fear of a subject facing a situation or a specific stimulus, such as an acute asthma crisis. Trait-anxiety refers to subject's perception of a situation in its totality, that is, asthma as a chronic disease. Before the beginning of the study, our patients showed anxiety levels greater than those described for healthy Brazilian individuals[38]. The reduction of trait-anxiety without modification in state-anxiety, observed in trained subjects, suggests that physical conditioning enhancement improved the perception of asthma as a chronic disease; however, it did not modify the fears of the patient facing acute asthma attacks (bronchoconstriction).

The role of physical training in reducing asthma symptoms is controversial[9]. Non-controlled and non-randomized studies suggest that, after a patient has submitted to an aerobic physical training program, there is a reduction in the number of hospitalizations and in the demand for medical emergency services[2,8]. In addition, the effects of physical exercise practice on exercise-induced bronchospasm, the necessity of control medication and symptoms of asthmatic patients remain controversial[9]. The present study demonstrated that the subjects who were submitted to a physical conditioning program demonstrated a reduction of asthma symptoms (coughing, wheezing, dyspnea, night awakening and need for relief medication).

Measurement of the levels of NOe is a simple and non-invasive means of evaluating pulmonary inflammation and this measure is used to assess patients' improvements in response to treatment with inhaled corticosteroids[40]. The results presented in this study suggest that moderate aerobic physical training for asthmatic patients lead to a reduction in the values of NOe, as well as in the presence of disease symptoms, suggesting an adjunctive role of exercise in the reduction of chronic allergic pulmonary inflammation (Figure 2). It is important to stress that the decreases in NOe levels cannot be attributed to changes in medication, since the study was carried out during the period between two medical consultations, the two groups (control and training) received the same drug therapy, with inhaled corticosteroids, and the medication doses remained unaltered during the study.

Research involving asthmatic subjects and physical training relate cardiovascular capacity increases, quality of life improvement and symptom reduction in these patients, and hypothesize that their results are due to the reduction in pulmonary inflammation[5]. Recent studies show that ovalbumin-sensitive mice (experimental model of chronic allergic pulmonary inflammation) which were submitted to physical conditioning, demonstrated reductions in mucus production and pulmonary inflammations[41] suggesting that aerobic training may cause pulmonary inflammation reductions.

NOe has been suggested as an inflammatory marker in asthma, which responds to treatment with corticoid[40]; however, this is still controversial[42]. In the present study, quantification of NOe levels had the objective of verifying if there would be any variations in this parameter over the physical training period. However, the fact that NOe levels were reduced in conjunction with reduced reported symptoms in the trained group suggest to us that it could be a marker of patients' clinical improvements due to physical training. These data were even more relevant when it is verified that there were no alterations in NOe levels for the CG and that both groups maintained corticoid doses over the study.

Limitations of the study

A possible criticism to our study is the evaluation of pulmonary inflammation using NOe levels. Although these techniques are widely used in clinical practice to monitor pulmonary inflammation, some authors suggest that they have limitations and, thus, do not appropriately express pulmonary inflammatory processes[42]. However, NOe levels and asthma symptoms are used to measure the treatment effectiveness of corticoids in patients with moderate persistent asthma[43]. One possible interference in the evaluation of the behavior of NOe values of the subjects in this study could be modifications, made by the physician in charge of the patients, in corticoid doses. This limitation, however, was bypassed by conducting treatment during the period between two medical consultations, which made it impossible to change medication doses.

The reduced number of patients evaluated is a relevant limitation of our study. The authors, are aware of the importance of this issue and of the necessity of increasing the studied sample size, and are currently conducting a new study.

Conclusions

The results of the present study suggest that physical training reduced the values of exhaled NOe, the number of days with asthmatic symptoms and psychosocial morbidity in patients with moderate or severe persistent asthma. These results reinforce the importance of improving physical conditioning during clinical management of asthmatic patients.

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