Neumol Pediatr 2019; 14 (4): 210 - 215

EFFECTS OF EXERCISE TRAINING IN CHILDREN WITH ASTHMA

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ABSTRACT

Asthma is a chronic obstructive respiratory disease with high prevalence in children. Several factors may trigger asthma symptoms, including exercise, which can lead to exercise-induced bronchoconstriction (EIB). Although physical exercise may represent a risk factor for triggering bronchial obstruction in asthmatics, studies have also indicated several positive effects. Thus, this article aimed to summarize current evidence on the effects of exercise training in children with asthma. There is substantial available evidence on the topic. Most of the findings show that exercise induce positive effects, including the increase of aerobic fitness, decrease of EIB levels, as well as an increase in both disease control and quality of life levels in asthmatic children. As for possible influencing factors in order to obtain exercise-induced positive effects, an adequate prescription of exercise intensity highlights and should be personalized, as well as established close to the anaerobic threshold. Thus, considering the evidence showing beneficial effects and the fact that the practice of physical exercise consists of a low cost and safe non-pharmacological therapy, supervised, personalized and individual recommendation of exercise training by health professionals are indicated to asthmatic children.

Key words: asthma; exercise training; exercise-induced bronchoconstriction; quality of life; pediatrics.

INTRODUCTION

Asthma is a chronic respiratory disease characterized by partial and/or fully reversible airway obstruction, with high prevalence (11.6%) in the pediatric population. Clinically, the signs and symptoms of the disease are wheezing, dyspnea, chest tightness and dry cough. According to the World Health Organization (WHO), 300 million people worldwide are asthmatics, with a mortality rate of 250.000 people per year (1, 2).

Several factors may trigger asthma symptoms, including exercise, which can lead to exercise-induced bronchoconstriction (EIB) (3). EIB is defined as a transient airway obstruction during or after exercise and may be objectively evidenced by a fall in the forced expiratory volume in one second (FEV1), associated with the presence of signs or symptoms of the disease (3). Normally, the lower exercise tolerance reported by asthmatics are associated to the degree of airway obstruction at rest, decreased ventilatory capacity, greater sensation of dyspnea and EIB. Such factors determine early discontinuation of exercise and contribute to a more sedentary lifestyle (4). In addition, several other aspects may affect the participation of asthmatic children in exercising, including the patient's belief that the disease limits their level of physical activity, as well as frequent misinterpretation by family members and teachers on the relationship between asthma and exercise. There is increasing evidence that low physical fitness may play a role in increasing asthma severity, while high physical fitness has been linked to a lower occurrence of symptoms (4). A study in Greece (5) demonstrated that decreased physical activity levels in children aged 10 to 12 years old were associated with the presence of EIB. In contrast, other studies (6, 7) found no difference in physical activity levels and general physical condition between children with and without asthma.

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Although physical exercise may represent a risk factor for triggering bronchial obstruction in asthmatics, studies indicate that exercise generates positive effects on cardiovascular and musculoskeletal health, impacting the quality of life of these patients (8, 9). The Global Initiative for Asthma (GINA) (1) recommends regular exercise prescription as part of non-pharmacological treatment for asthma based on the general health benefits, including management and treatment of EIB when associated with the appropriate pharmacological treatment. Thus, even though physical exercise may represent a risk factor for triggering asthma symptoms, studies have shown that exercise training may induce several benefits, including reduced EIB and bronchial hyperresponsiveness, as well as an improvement in quality of life, exercise capacity and clinical disease control (8).

Thus, this article presents a narrative review on the effects of exercise training in children with asthma, aiming to summarize current evidence and discuss the main clinically relevant outcomes for an adequate monitoring and treatment of the disease. Therefore, the main effects of exercise training in children with asthma: exercise capacity, exercise-induced bronchoconstriction, lung function, airway inflammation, disease control and quality of life are described below and summarized in table 1.

EXERCISE CAPACITY

Physical fitness is considered an important aspect for asthmatic patients, as it is associated with better quality of life levels, aerobic performance, reduced number of symptoms and use of relief medications. Studies have shown that poor physical condition in asthmatic children is associated with a clinical worsening of the disease (4, 10). Thus, the assessment of exercise capacity is an important tool to objectively measure exercise intolerance, allowing an individualized and safe prescription for physical training.

Exercise training induces positive effects on cardiorespiratory fitness parameters in children with asthma (4, 10-13). Studies evaluating the effects of physical training on exercise capacity in asthmatic children have found significant improvement in several aerobic fitness parameters after an exercise program, including maximal oxygen uptake (VO2peak) (11), minute ventilation (VE) (12), pulse of oxygen (11) and maximum heart rate (HRmax) (4). However, it is noteworthy that these studies have used a personalized training intensity established at values close to the anaerobic threshold. Among the main factors that seem to contribute to a greater effectiveness of physical training protocols in asthmatic patients are the adequate intensity prescription (established at the anaerobic threshold), as well as frequency and duration, which is to exercise for at least 120 minutes a week, divided into two or three sessions, for at least 3 months. Although there is no single ideal standardization regarding the type of exercise, frequency and duration, an individualized prescription of the training intensity is a key factor for each patient. Moreover, intensity rather than the type of training, seems to be one of the most important factors in determining the success of an exercise intervention.

On the other hand, there are some studies in the literature that do not show significant improvement on exercise capacity (14, 15) in response to a training program. However, when an individual analysis of each study is performed, it is worth noting that the physical training protocols used present intensities considered either as low, at the anaerobic threshold but for a reduced duration, or with very poor methodological description (14, 15).

Thus, considering the evidence available in the literature, it is possible to state that the practice of physical exercise produces beneficial effects on the aerobic conditioning of asthmatic children. However, it is important to highlight that the physical training program should follow the main recommendations regarding the prescription of intensity, frequency and duration of the activity.

Table 1. Principales efectos del entrenamiento físico en niños con asma.

Main outcome	Effects	References
Exercise capacity	↑ VO_2peak, ↑ V_E, ↑ Pulse of oxygen, ↑ HRmax	4, 10, 11, 12, 13
Exercise-induced bronchoconstriction	↑ FEV_1, ↓ EIB	9, 16, 17
Lung function	No changes in FEV_1, FVC and PEF	4, 9, 16, 21
Airway inflammation	↓ or no change in airway inflammation	23, 24, 27, 28, 29
Disease control	↓ Symptoms, ↓ Hospitalizations, ↓ School absenteeism	23, 25, 30, 31
Quality of life	↑ Group activities, ↑ Physical exercise, ↑ Symptoms	9, 21, 33, 34

↑: increase; ↓: decrease; VO2: maximal oxygen uptake; VE: minute ventilation; EIB: exercise-induced bronchoconstriction; FEV1: forced expiratory volume in one second; FVC: forced vital capacity; PEF: peak expiratory flow; HRmax: maximum heart rate.

EXERCISE-INDUCED BRONCHOCONSTRICTION

EIB is an important clinical characteristic of bronchial hyperresponsiveness in asthma. It is defined as a transient airway obstruction during or after exercise and can be objectively evidenced by a fall in the FEV1 associated with classic signs and/or symptoms of the disease (3). The practice of physical exercise may represent a risk factor for the trigger of bronchial obstruction in asthmatics. Usually, clinical symptoms start two to four minutes after exercise begins, with a peak from five to ten minutes, and commonly disappears around 20 to 40 minutes. Regarding prevalence, there is great variability in the literature, as data indicate that 40 to 90% of children with asthma may develop EIB (3). The obstructive mechanism is not yet fully understood, although it appears to be associated to a rapid increase in minute ventilation, requiring a higher rate of heat and water vapor transfer from the airway walls (3).

There is evidence that exercise training may prevent or decrease the severity of EIB (9). Studies have evaluated the effects of physical training on EIB in asthmatic children and have shown improvements in the FEV1 fall after physical training. The precise mechanism by which this effect occurs is not yet clear, but it is speculated that exercise intensity is an important factor, as better results are seen with intensity training near the anaerobic threshold (9, 16, 17). On the other hand, an adequate clinical management of EIB is essential in these cases, and guidelines recommend inhaled use of short acting ß2 agonists (SABA) 15 minutes before exercising (1). However, one of the main limiting factors in these cases is the patient's understanding on the management of EIB, which is often characterized as inadequate, considering that only 22.2% of individuals with exercise-related symptoms report using rapid relief medications before exercising (3).

Thus, considering the studies available to date, it is possible to state that physical exercise, when adjusted to an intensity close to the anaerobic threshold, may contribute to the reduction of the severity of EIB in asthmatic children. In addition, the adequate use of medication before exercising is an additional factor of great clinical impact.

LUNG FUNCTION

Lung function measurements provide an assessment of the severity of airflow limitation, its reversibility and variability, as well as contribute to confirm the diagnosis of asthma. The use of spirometry allows the documentation of the severity of airflow obstruction and the monitoring of disease progression. According to international guidelines, FEV1 is one of the most commonly clinical parameter used for the diagnosis and follow-up of the disease (1). Data on the literature (18) indicate that lower FEV1 values are associated with clinical worsening, disease exacerbation and presence of EIB. On the other hand, there is evidence that lung function values in asthmatic children are within or near normal ranges (19). In addition, peak expiratory flow (PEF) measurement is a simple, but less accurate, way to diagnose airflow limitation and is often used in asthmatic patients. A previous study on the topic (20) has demonstrated a positive correlation between FEV1 and PEF, indicating that the measurement of PEF may also be important in the follow-up of these patients.

As for the effects of exercise, most available studies have shown that physical training has no relevant impact on lung function in asthmatic children (4, 9, 16, 21). These findings are also in agreement with a study in adults, suggesting that lung volumes and lung function do not appear to be improved with the practice of regular exercise (22). However, there is evidence that exercise may improve several other aspects, including disease control (23), quality of life (21), exercise capacity (4) and EIB (9), demonstrating that, although there are no significant changes in lung function, physical exercise is still recommended as an adjuvant therapy in the treatment of asthmatic patients. This recommendation is also reinforced by a study (24) demonstrating that pharmacological treatment associated with a physical training program significantly improved lung function in asthmatic children.

Considering the studies evaluating the effects of physical training on lung function of asthmatic children only a few showed improvement in FEV1 and PEF (24, 25). The available data shows that only PEF seem to slightly improve after physical training, probably due to an increase in the respiratory muscle strength (8). This is also reinforced by the findings that changes in PEF after physical training are not accompanied by changes in FEV1.

Thus, current available data seems to indicate that physical training has little influence on lung function in asthmatic children. Considering that many patients in the pediatric age group present with normal pulmonary function and that physical exercise has beneficial effects on several other parameters, the recommendation of physical training as a complementary therapy for asthmatic patients remain, regardless of the absence of significant changes on lung function.

AIRWAY INFLAMMATION

Asthma is a disease characterized by chronic airway inflammation. The chronic inflammatory state is associated with airway hyperresponsiveness that leads to recurrent episodes of wheezing, shortness of breath, chest tightness and cough. The inflammation may be triggered by allergens (atopic asthma) or non-allergic irritants (non-atopic asthma), even though in most patients a combination of allergic and non-allergic factors contribute to the clinical presentation of the disease. In addition to inflammation, oxidative stress is also an important component of the pathophysiology of asthma (24). Oxidative stress is associated with chronic inflammation through the activation of inflammatory cells, including neutrophils and eosinophils, which generate reactive oxygen species (ROS). Elevated levels of ROS under inflammatory conditions have been reported in several inflammatory diseases, in addition to exerting several toxic effects. It is likely that ROS play a vital

role in the pathogenesis of asthma, as they have been shown to be associated with many pathophysiological changes, such as increased lipid peroxidation, increased reactivity and airway secretion, increased chemoattractant production, and increased vascular permeability (24).

Regular physical exercise is already known to have an anti-inflammatory effect in individuals with chronic diseases and seems to reduce the susceptibility to infections. On the other hand, single exercise sessions may induce immune cell activation (26). Studies have shown that exercise training decreases lung inflammation in asthmatic children (23, 24, 27). However, there are also evidences indicating that inflammatory markers do not respond significantly after physical training programs in asthmatic patients (28, 29). Thus, considering the present evidence, the effects of exercise programs on airway inflammation levels in asthma seems to remain inconclusive.

DISEASE CONTROL

Considering that asthma is a chronic disease, its treatment aims to achieve the maximal symptom control as possible. By definition, according to GINA, disease control is defined by an effective management of the clinical characteristics and symptoms of asthma. In this case, effective means the lowest possible dose of medication to achieve disease control, reducing or avoiding possible adverse effects to the patient. Lack of disease control, in addition to affecting patients' quality of life, increases disease costs due to increased demand for emergency visits and hospitalizations, as well as indirect costs due to absenteeism at school and at work (1).

There is evidence that exercise may be an important non-pharmacological component of clinical asthma control in children (23, 30). Studies assessing the effects of exercise on clinical asthma control have shown significant improvements after a physical training program (23, 25, 30, 31). Exercise reduces asthma symptoms (number of asthma attacks and days of wheezing) (25) and the number of exacerbations (number of hospitalizations) (30). One study showed that two months of swimming physical training significantly improved clinical variables, including symptoms, hospitalizations, emergency room visits, and school absenteeism, when compared to previous medical history. In addition, the health benefits obtained seems to be continuously observed even 12 months after the program conclusion, demonstrating that the beneficial effects of the physical training may last longer than expected (30).

QUALITY OF LIFE

Asthma is one of the main chronic diseases of childhood and its repercussions affect not only the patient, but the whole family, inducing long-term problems that will result in impaired quality of life. Asthmatic children are reported to have significantly worse health-related quality of life than other children (32). This negative effect on quality of life seems to be related to an anxiousness profile normally present in asthma patients, considering the expectation of experiencing symptoms and the impossibility of participating in certain group activities. In addition, the reduction of physical activity levels contribute to the increase of obesity and the appearance of low self-esteem, further worsening the quality of life levels in these patients.

Most studies aiming to investigate exercise-induced effects on quality of life of asthmatic children have shown that physical training generally improves quality of life, evidenced by both overall Pediatric Asthma Quality of Life Questionnaire (PAQLQ) scores, as well as specific scores of the domains activity limitation, symptoms and emotional function (9, 21, 33, 34). The study of Cambach et al. (35) demonstrated that regular exercise is responsible for improving the quality of life of patients with respiratory diseases. Better physical fitness is associated with improved quality of life, as trained subjects have decreased frequency of symptoms and psychosocial limitations. Taken together, current literature suggests that physical exercise induces positive impacts on the quality of life of asthmatic children, contributing to the appropriate clinical management of the disease.

CONCLUSION

Asthma is a disease of great individual and social impact, not only for adults, but also for children, adolescents and their families. Thus, therapeutic actions that contribute to an adequate clinical management and to increase treatment adherence are of great relevance in order to increase symptom control and quality of life levels. To date, there is substantial evidence on the impact of exercise training on different clinical aspects of asthma in children. In general, physical exercise may have positive effects on exercise capacity, EIB levels, disease control and quality of life of asthmatic children. However, several factors may interfere in obtaining these effects, including an adequate prescription of exercise intensity, which should be personalized and established close to the anaerobic threshold. It is noteworthy that for an adequate intensity prescription it is essential to carefully evaluate the exercise capacity before the start of a physical training program. If the gold standard for this assessment, cardiopulmonary exercise test (CPET), is not available, field tests such as the modified shuttle test (MST) and the six-minute walk test (6MWT) have already been tested and may be used as an alternative. Therefore, considering the several benefits already demonstrated for exercising and the fact that the practice of physical exercise consists of a low cost and safe non-pharmacological therapy, it is important to highlight the significance of improving patient and family awareness on benefits and recommendations for exercise in asthma, as well as the need for an adequate exercise training prescription by health professionals.

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