REVISTA CIÊNCIAS EM SAÚDE
HEALTH SCIENCES JOURNAL e-ISSN 2236-3785
HOSPITAL DE CLÍNICAS ITAJUBÁ - MG

ORIGINAL ARTICLE

Impacts of aerobic exercise on children with asthma diagnosis: an integrative review

Impactos do exercício aeróbico em crianças com diagnóstico de asma: revisão integrativa

Bianca Espinosa dos Santos[1,*], Lohanna Chrystina dos Santos Antunes de Macedo[1], Ana Paula Guimarães Adomaitis[1], Ane Milena Macêdo de Castro[1], Juliana Teixeira De Almeida[1], Mara Lisiane de Moraes dos Santos[1], Leila Simone Foerster Merey[1]

[1]*Integrated Health Institute, Federal University of Mato Grosso do Sul. Campo Grande, Mato Grosso do Sul, Brazil*

Submitted on Jun 27, 2021, accepted on Nov 30, 2021, published on Mar 27, 2022

KEYWORDS
Adolescent
Asthma
Child
Exercise
Quality of life

ABSTRACT

Objective: To identify the impacts of aerobic exercise on the health of children with asthma, seeking to know protocols of rehabilitation programs and their impacts.
Methods: Clinical trials published from 2010 to 2020 were selected, filtered by the descriptors: 'asthma', 'exercise' or 'physical training', 'children' or 'adolescents' and 'quality of life'.
Results: Nineteen articles were included; the duration of the programs ranged from 4 to 24 weeks, 2 to 6 times/week, with the sessions varying from 30 min to 1h10min and intensity from 40% to 100% of the Maximum Heart Rate. The studies evaluated strength, lung capacity and function, inflammatory mediators, quality of life, and asthma control. Aerobic interventions made it possible to improve cardiorespiratory capacity, intracellular action of antioxidants, quality of life, and disease control. Significant results were found in protocols with playful exercises performed for 60 min, three times a week, and for at least 12 weeks.
Conclusion: The ease of reproducing the protocols can provide greater coverage of care and rehabilitation, which in the long term can help to reduce the hospitalization rate, cost, and hospital demand for severe exacerbations.

*Corresponding author:
Integrated Health Institute, Federal University of Mato Grosso do Sul.
Addr.: Av. Costa e Silva, s/n - Bairro: Pioneiros. Campo Grande, MS, Brasil | CEP: 79.070-900
Phone: +55 67 99101-5675
E-mail: biianca.esp@gmail.com (Espinosa dos Santos B)

This study was conducted at the Federal University of Mato Grosso do Sul

https://doi.org/10.21876/rcshci.v12i1.1174

How to cite this article: Espinosa dos Santos B, Macedo LCSA, Adomaitis APG, Castro AMM, Teixeira de Almeida J, Moraes dos Santos, ML, et al. Impacts of aerobic exercise on children with asthma diagnosis: integrative review. Rev Cienc Saude. 2022;12(1):14-23. https://doi.org/10.21876/rcshci.v12i1.1174

PALAVRAS-CHAVE
Adolescente
Asma
Criança
Exercício
Qualidade de vida

RESUMO

Objetivo: Identificar quais os impactos do exercício aeróbico na saúde da criança com asma, buscando conhecer protocolos de programas de reabilitação e seus impactos.
Métodos: Foram selecionados ensaios clínicos publicados de 2010 a 2020, filtrado pelos descritores: *'asthma'*, *'exercise'* ou *'physical training'*, *'children'* ou *'adolescents'* e *'quality of life'*.
Resultados: Foram incluídos 19 artigos; a duração dos programas variou de 4 a 24 semanas, sendo de 2 a 6 vezes por semana, com as sessões variando de 30 min a 1h10min e intensidade de 40% a 100% da Frequência Cardíaca Máxima. Os estudos avaliaram força, capacidade e função pulmonar, mediadores inflamatórios, qualidade de vida e controle da asma. As intervenções aeróbicas possibilitaram a melhora da capacidade cardiorrespiratória, da ação intracelular de antioxidantes, da qualidade de vida e controle da doença. Resultados significativos foram encontrados em protocolos com exercícios lúdicos realizados por 60 min, três vezes por semana e por pelo menos 12 semanas.
Conclusão: A facilidade na reprodução dos protocolos pode proporcionar maior cobertura de atendimento e reabilitação, que a longo prazo podem auxiliar na redução do índice de internação, custo e demanda hospitalar por agudizações graves.

INTRODUCTION

Asthma is a chronic inflammatory disease common in the pediatric population, characterized by airway hyperresponsiveness. Reactive bronchoconstriction leads to recurrent wheezing, dyspnea, and cough, predominant at night or early in the morning. The inflammatory process is characterized by intermittent and reversible bronchial narrowing due to bronchial smooth muscle contraction, edema, and hypersecretion of the mucous glands[1].

An estimated 334 million people worldwide have asthma. It is the most common chronic disease of childhood, affecting 14% of children worldwide. There are approximately 20 million people with asthma in Brazil, and it is the fourth leading cause of hospitalizations[1,2].

A Brazilian multicenter study found a mean prevalence of asthma in schoolchildren of 24.3% and 19.0% in adolescents[3]. Because it is a complex disease, several factors such as atopy, prematurity, sex, tobacco smoke, respiratory infections, and breastfeeding itself can be risk factors for its appearance.

The lack of adequate physical training in this population leads to a reduced quality of life compared to healthy children. Physical therapy treatment objectives for asthma include maintenance of lung function; maintenance of daily activities, including exercise; control of symptoms and exacerbations; prevention of the development of irreversible airway obstruction; elimination of the side effects of drugs; and prevention of asthma mortality[4,5].

Therefore, it is essential to conduct an integrative review study on this topic, with the following guiding question: 'What are the impacts of aerobic exercise on the health of children with asthma?', seeking to know the protocols used in rehabilitation programs and their impacts on the daily life and quality of life of children with asthma, given the scarcity of updated review articles that address the topic.

METHODS

Randomized clinical trials and trials published from 2010 to 2020 in MEDLINE, PubMed Central (PMC), Web of Science, and Latin American and Caribbean Literature on Health Sciences (LILACS) were selected. The searches were conducted in pairs, from April to September 2020, using the following descriptors: 'asthma', 'exercise' or 'physical training', 'children' or 'adolescents' and 'quality of life', grouped by the logical operators 'AND' and 'OR'. The development of this review followed the PRISMA-ScR recommendations.

The selected articles were in Turkish, English, and Portuguese and had a title, abstract, and full-text article. We included randomized or non-randomized clinical trials that evaluated children and/or adolescents with asthma who participated in a rehabilitation program that included aerobic training as an intervention, regardless of the modality adopted. Abstracts, studies with non-detailed population and intervention, literature reviews, systematic reviews and meta-analyses, book chapters, conference and congress papers, commentaries, and case studies were not included because of the need for a complete description of the rehabilitation protocol.

After obtaining the articles in the databases, two researchers selected pairs so that each researcher analyzed independently to map out the articles from the titles and then by the abstracts. After the previous selection, a new evaluation was made to list the studies included in the review consensually. In case of conflict in the selection, a third researcher was consulted. The data collected from the articles were attached to an electronic spreadsheet.

This integrative review was registered on the Open Science Framework platform and can be accessed via https://osf.io/5fvs2.

For this review, information was gathered from the articles regarding the population investigated (sample size, age, and disease severity), the intervention performed (type of activity, frequency, and duration of the rehabilitation program), and the results obtained in functional capacity, muscle strength, flexibility, balance, lung function, inflammatory mediators, asthma control, and quality of life. The results were described using tables and text.

RESULTS

Nineteen studies were included in the review, as described in Figure 1. After the complete reading of the 24 articles selected by title and abstract, five were excluded due to the methodology not fitting the inclusion criteria. The characteristics of the studies regarding assessment, intervention, and sample size are summarized in Table 1. Clinical trials and randomized trials were included, as described in Table 2.

Muscle strength evaluation employing handgrip dynamometry and the Sit and Reach test[10] showed significant improvement in their values in the post-intervention of the exercise group, which may be related to the increased level of physical activity and improvement of motor skills of the children included in the study. In the countermovement jump test, when comparing the pre- and post-intervention, it was evident that, after the application of the protocol, there was an increase in the height of the jump and the number of repetitions, but without any significant difference. There were also no significant differences in the test of 5 maximum repetitions, used by Sanz-Santiago et al.[23].

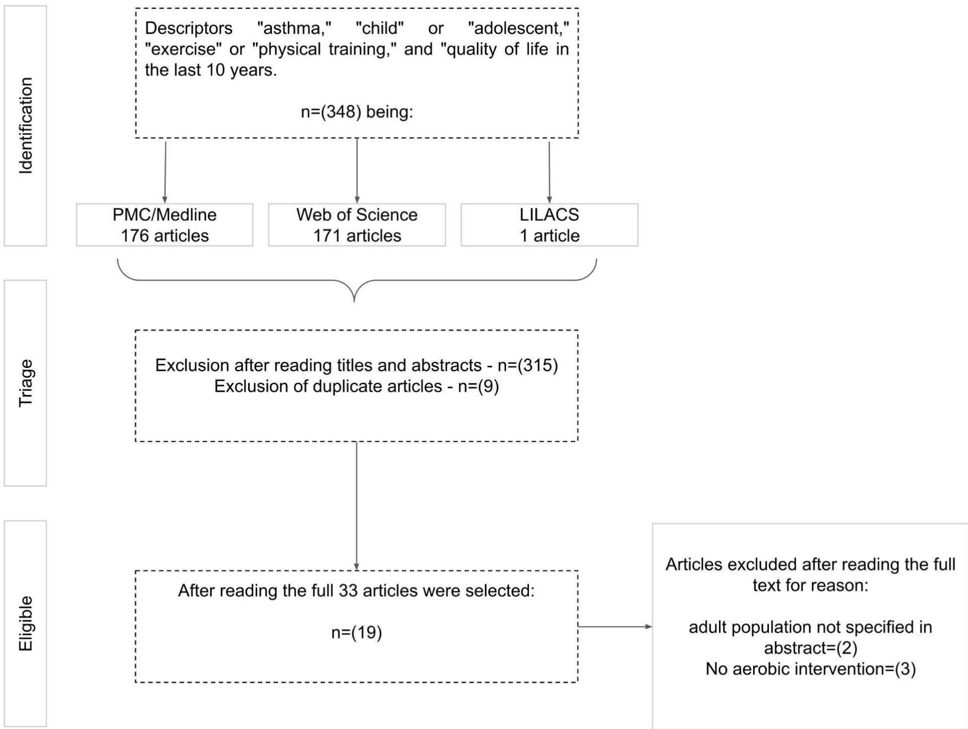

Figure 1 — Flowchart of the literature base search with a summary of evidence selection.

The Ozeretski test used by Khodashenas et al.[19] assessed gross and fine motor activity. In the patients in the exercise group, statistical differences were found in gross motor skills, the final sum of the test, and its relationship with quality of life at the end of the intervention. The balance evaluation by Kovacikova et al.[16] verified a reduction in speed and the mediolateral and anteroposterior body sway at the end of the intervention.

The intensity of the exercise was adopted based on the maximum-exhaled oxygen volume (VO_2max) and maximum heart rate (HRmax), and/or target heart rate (target HR) associated with dyspnea scales such as the adapted Borg Scale. Generally, intensities ranged from 40% to 100% of HRMax.

The FVC and FEV1 values, FEV1/FVC ratio, FEV 25-75%, PEF, and minute ventilation (MV) were collected during the lung capacity and function measurements by spirometry. Cardiopulmonary capacity and exercise tolerance were assessed by the Timed Up and Go test and the 6-min walk test (6MWT).

Gomes et al.[11] analyzed the VO_2 by the exercise program; both groups showed improvement after a training program using the treadmill and a video game with jumping, squatting, and lateral and upper limb movements. Sanz-Santiago et al.[23] only used the Timed Up and Go Test to check physical fitness in their study population and showed improvements after the treatment program. Westergren et al.[13] used the measurement of VO_2, and only three of the six children

Table 1 — Assessment and intervention methods of the included studies.

Authors	Year	Sample	Evaluation	Intervention	Frequency
Wicher et al.[6]	2010	61 children aged 6-18 years EG: 30 CG: 31	FM, Lung Function, and IgE	Swimming	60 min, 2x/week for three months.
Onur et al.[7]	2011	30 children aged 8 to 13 years divided into: CG: drug EG: drug and physical therapy.	CVF e VEF1; MDA, GSH-Px, SOD, NO.	Cyclo-ergometer	60 min, 2x/week for 8 weeks
Gunay et al.[8]	2012	43 children from 8 to 13 years old EG: 30 CG: 13	LTE4, creatinine, MMP9, endothelin, MDA, specific IgE, and IgE.	Cyclo-ergometer	60 min, 2x/week for 8 weeks.
Andrade et al.[9]	2014	33 children from 6 to 17 years old EG: 14 CG: 19	Cytokines; Physical Activity Score; 6MWT; FM; Lung Function; PAQLQ.	Treadmill	70 min, 3x/week for 6 weeks.
Latorre-Román et al.[10]	2014	105 children from 10 to 13 years old EG: 58 CG: 47	Height, weight, BMI, abdomen/hip ratio, skinfold measurement, fat mass, body density, palmar grip; countermovement jumping; 6MWT; Borg; Sit and Reach test; Lung function; PAQLQ.	Aerobic and anaerobic exercises	60 min, 3x/week, for 12 weeks
Gomes et al.[11]	2015	36 children from 5 to 10 years old Video game: 20 Treadmill: 16	Bruce protocol; Borg scale; VO2; FeNO; lung function; ACQ; height, weight, and abdominal circumference; Energy expenditure.	Reflex Ridge Game	40 min, 2x/week for 8 weeks
Latorre-Román et al.[12]	2015	118 children aged 10-14 years EG: 59 CG: 49	Height (m), body mass (kg), BMI; TC6; Borg; PACES; PAQ-C; PAQLQ; Physical self-concept questionnaire.	Walking, running, dancing, flexibility, and relaxation.	60 min, 3x/week for 12 weeks
Westergren et al.[13]	2015	6 children from 10 to 12 years old; GE only.	Pulmonary function; VO2max; PAQLQ; ACQ; Habitual physical activity.	Active play and games.	60 min, 2x/week, for 6 weeks
Lin et al.[14]	2016	61 children aged 9 to 11 years EG: 20 asthmatics and 18 healthy. CG: 9 asthmatics and 14 healthy.	Lung function, FeNO, and PAQLQ.	Tai Chi Chuan	60 min, 1x/week for 12 weeks
Willeboordse et al.[15]	2016	86 children aged 6 and 16 years CG: 44 children; EG: 42 children.	Dietary intake, FVC%, FEV1%, BMI, ACQ, PAQLQ, BIE, aerobic capacity (%VO2 peak predicted), leptin, and serum adiponectin.	Usual care, 18 lifestyle sessions, 10 sessions with parents, 8 sports sessions.	18 months; 60 min per session, 2x/week, evolving to 3x/week.

Authors	Year	Sample	Evaluation	Intervention	Frequency
Kovacikova et al.[16]	2017	19 children from 9 to 13 years old EG: 9. CG: 10.	Static standing balance with eyes open and closed; FM and lung function.	Proprioceptive exercise, strength, coordination, endurance, and re-expansive breathing training.	45 min, 6x/week for 4 weeks
Doğruel et al.[17]	2018	255 children from 7 to 16 years old	PAQLQ; AQLQ; Lung function; MEF.	Swimming, street basketball, athletics, and badminton	60 min/day for 2x/week for 12 weeks
Lu et al.[18]	2018	19 children from 6 to 13 years old.	Anthropometric data; lung function; CHSA; PAQLQ; habitual activity level and sedentary time; cardiopulmonary stress test; complete blood count; metabolic panel, lipid panel, and IgE.	Warm-up, a combination of aerobic and resistance exercises.	45-minute sessions, 3x/week for 16 weeks.
Abdelbasset et al.[4]	2019	38 children aged 8 and 12. EG: 19 CG: 19	Bodyweight, height, and BMI; VO2max; Spirometry; PAQLQ; 6MWT and fatigue index.	Treadmill and breathing exercise	40 min, 3x/week for 10 weeks
Khodashenas et al. [19]	2019	15 children aged 6 and 18 years. EG: 9 and CG: 6.	Spirometry; Ozeretski test; BMI; St. George respiratory questionnaire;	Warm-up, aerobic and strength exercises, relaxation.	45 min, 3x/week for 8 weeks
Liao et al.[20]	2019	57 children from 6 to 12 years old. EG: 29 children; CG: 28 children.	Allergy history and body weight, lung function tests, FeNO, blood cell counts, IgE levels, medication and exacerbation data, PAQLQ and C-ACT;	Tai Chi Chuan	1x/week for 1 hour for 12 weeks
McNarry et al.[21]	2019	64 children from 9 to 14 years old. EG: 31 adolescents CG: 33 adolescents	Anthropometry; Lower limb length; FEV1; Physical activity; Incremental ramp test; Square wave exercise tests; Pulmonary ventilation (LV) and gas exchange (VO2 and VCO2).	HIIT	30 min, 3x/week for 6 months.
Zhang et al.[22]	2019	72 children aged 4 to 12 years. EG: 36: FE and montelukast CG: 36: montelukast.	Clinical symptoms; Spirometry; PADQLQ.	Aerobic circuit.	40 min, 3x/week for 6 weeks
Sanz-Santiago et al.[23]	2020	70 children from 7 to 17 years old. EG: 35; CG: 35.	ACQ; PAQLQ; Lung function; 5RM test; Exercise-induced bronchoconstriction; Timed Up and Go test.	Cyclo-ergometer	1 h of combined training, 3x/week for 12 weeks.

EG: exercise group; CG: control group; VO2: exhaled oxygen volume; PAQLQ: Pediatric Asthma Quality of Life Questionnaire; GSH-Px: glutathione peroxidase enzyme; SOD: superoxide dismutase; MDA: malonic dialdehyde; MMP-9: matrix metallopeptidase; LTE4: Leukotriene E4; NO: Nitric oxide; 6MWT: 6 min walk test; BMI: Body mass index; FeNO: Exhaled fraction of nitric oxide; ACQ: Asthma control questionnaire; VO2max: Maximal exhaled volume of oxygen; HIIT: High-Intensity Interval Training. C-ACT: Childhood Asthma Control Test; CHSA: Children's Health Survey for Asthma.

in their study showed an increase in VO_2 max after six weeks of active play protocol.

Inflammatory mediators were analyzed by blood collection of complete blood count with the description of serum IgE and specific IgE dosage, measurement of malondialdehyde (MDA), glutathione peroxidase enzyme (GSH-Px), superoxide dismutase (SOD), total nitric oxide (NO), exalted nitric oxide fraction (FeNO), matrix metallopeptidase (MMP-9) levels, leukotriene E4 (LTE4), endothelin, cytokine and tumor necrosis factor-alpha (TNFα) dosage. Creatinine levels were measured through urine collection.

Table 2 *— Description of the types of studies included.*

Authors	Type of study
Wicher *et al.*[6] Andrade et al.[9] Latorre-Román et al.[10-12] Gomes *et al.*[11] Abdelbasset et al.[4] Willeboordse et al.[15] Kovacikova et al.[16] Khodashenas et al. [19] Sanz-Santiago *et al.*[23]	Randomized clinical trial with exercise and control groups
Onur *et al.*[7] Zhang *et al.*[22]	Randomized clinical trial with exercise + pharmaceutical group and control group (only pharmaceutical)
Gunay *et al.*[8] Lin et al.[14] Liao et al.[20] McNarry *et al.*[21]	Clinical trial with exercise group and control group
Westergren *et al.*[13] Doğruel et al.[17] Lu et al.[18]	Clinical trial with exercise group

The studies by Wicher et al.[6], Lu et al.[18], and Liao et al.[20] analyzed the change in IgE values after exercise. The researchers found increased baseline values compared to the control groups and no significant reductions after the intervention. Liao et al.[20]observed a significant reduction in eosinophil values, indicators of asthma exacerbation.

The studies by Onur et al.[7] and Gunay et al.[8] analyzed the variation of MDA values after the intervention with children with asthma.Both observed that exercise could reduce MDA indices at the end of the intervention, making them similar to the baseline values of healthy children. Onur et al.[7] also observed a reduction in baseline GSH-Px values in children with asthma at the end of the intervention.

Onur et al.[7], Gomes et al.[11], Lin et al.[14], and Liao et al.[20] investigated the variation of NO and FeNO, comparing the baseline evaluation and after the physical intervention. They found a reduction in the values expressed in the groups submitted to the intervention at the end of the protocol.

The Physical Activity Questionnaire for Children (PAQ-C) and the Children's Health Survey for Asthma (CHSA) were also administered.Asthma control was monitored by the Children's Asthma Control Questionnaire (C-ACT). Quality of life was assessed by the Pediatric Asthma Quality of Life Questionnaire (PAQLQ), the Asthma Quality of Life Questionnaire (AQLQ), and the Pediatric Allergic Disease Quality of Life Questionnaire (PADQLQ).

Twelve articles analyzed the quality of life in children with asthma, 11 through the PAQLQ and one through the PADQLQ. Only the study by Sanz-Santiago et al.[23] Observed improvement in QL values in the intervention group, but without significant changes after applying for a rehabilitation program in their participants.

DISCUSSION

Peripheral muscle strength, flexibility, and balance

The variability of the results found regarding muscle strength in children with asthma may be related to the heterogeneity of the age range that the groups cover, ranging from 6 to 18 years. It is possible to identify morphological alterations in bone and muscle mass in school-aged children. In this type, I fibers predominate since in adolescence there is a transition to type II fibers[24,25].

Janssen and Leblanc[26] suggested that school children benefit more from aerobic exercises that stimulate muscular endurance (jumping and peak running). Significant results are evidenced when workouts are performed moderately to intensely, ranging from three to seven hours per week. The lack of significance in the studies included in this review may be related to the reduced frequency and intensity.

The use of corticosteroids and their dosage also influences muscular endurance. Villa et al.[27] showed that using high pharmacological dosages or prolonged time resulted in lower muscular endurance of the quadriceps femora, with preserved muscular strength.

Thus, implementing balance, resistance, and motor skills training in physical therapy rehabilitation may benefit the participants, promoting self-confidence for daily activities and improved quality of life.

Respiratory muscle strength and lung function

The protocols that correlated pharmacological treatment with aerobic training achieved significant improvement in pulmonary function in the participants, demonstrating that aerobic training can be used as a potentiator of drugs and an influencer of vital capacities, as can be observed when analyzing the data from the articles selected in this review. The randomized study by França-Pinto et al.[28] corroborates these findings, showing that after 12 weeks of intervention in moderate to severe patients who have asthma, aerobic training associated with medication could improve the symptoms of the disease in its participants, such as bronchial hyperresponsiveness

(BHR), inflammation, and quality of life, and to decrease asthma exacerbations.

However, the benefits of aerobic training on lung capacity, especially on FEV1 and PEF values, are still controversial, but significant improvements in FVC values have been shown.

Kovacikova et al.[16] correlated the improvement in respiratory mechanics and respiratory muscle strength, and lung function with improved postural stability in the experimental group after the intervention. This can be justified by the non-respiratory action that the muscles of the scapular and thoracic waists exert in maintaining the stability of the trunk and upper limbs; thus, the re-education of this muscle group and postural adequacy potentiate the respiratory mechanics.

Adequate aerobic training can reduce lung elastic recoil, represented by FVC. In contrast, FEV1 and PEF values were consistent with inflammation and bronchial hyperresponsiveness. The decrease in these is not yet evident; thus, no effects of these parameters were found[29].

Cardiorespiratory capacity

Patients who have asthma submitted to adequate rehabilitation programs for their clinical condition obtained an improvement in the distance walked in the six-minute walk test, after an intervention period in groups that performed exercises in the ergometric treadmill, treadmill with inclination progression, and aerobic and anaerobic exercises at different speeds of walking, running and dancing[4,10,12].

Children with asthma have a significant reduction in exercise capacity that corresponds to the severity of the disease. Children with moderate to severe asthma have a higher level of deconditioning and lower levels of VO_2max[27]. A possible explanation for this hypothesis would be the pathophysiological consequences characteristic of asthma, such as increased airway resistance (VVAA) and lung elastic recoil, lung hyperinflation, hypoxemia, which causes a greater demand for ventilation and consequently the sensation of dyspnea when performing exercises[5,30].

Moraes et al.[31] showed that patients in the inter-crisis period of asthma do not present significant differences between their severity and deconditioning. This is due to the stable clinical status making the VO_2max similar between individuals with mild intermittent and persistent asthma, which could demonstrate a compensation of the carrier's body.

Children with asthma have reduced physical performance and sedentary behavior due to the limitations of the disease[5]. The sedentary lifestyle correlates to weight gain in this population and consequently to a low level of cardiorespiratory fitness, besides favoring the onset of other chronic diseases such as hypertension and diabetes mellitus.

Obesity can also worsen asthma symptoms and decrease exercise tolerance. Weight reduction can improve symptoms and cardiopulmonary function[10]. Willeboordse et al.[15] and Lu et al.[18] corroborate these findings, correlating the decrease in weight or BMI with improved aerobic fitness in their participants.

Inflammatory mediators

Malondialdehyde (MDA) is a reactive oxygen species considered a biomarker for measuring cellular oxidative stress. Due to the inflammatory cascade, the production of oxygen free radicals during seizures can cause structural changes in the lung parenchyma and the activity of the superoxide dismutase enzyme[32].

GSH-Px is an antioxidant that is present in large quantities in the lung epithelium. Its manifestation in healthy children is essential to promote homeostasis between antioxidant action and reactive species[33].

The reduction in GSH-Px and MDA can be related to increased metabolic demand and improved cardiovascular and muscle function.The modulation of their values suggests the importance of exercise in reducing asthma exacerbations since the increased activity of reactive species favors the occurrence and severity of crises.

The reduction in GSH-Px may be related to the cycle of enzyme activity, antioxidants, and reactive species so that its activity is directly proportional; if there is a reduction in reactive species (such as MDA), there will also be a reduction in GSH-Px. The proximity of the MDA and GSH-Px values after the intervention to the values expressed in healthy children suggests the potential of exercise to modulate the inflammatory mediators related to asthma exacerbations[7,8].

The reduction in NO, FeNO, and eosinophil values found in the groups submitted to the intervention[7,11,14,20] may be related to the modulation of inflammation and asthma control, the decrease in the amount and severity of exacerbations, since these mediators indicate increased enzyme activity and a decrease in the degree of inflammation.

Matrix metallopeptidase (MMP-9) is a zinc-dependent endopeptidase expressed by mast cells. In a joint action with Th2 cytokines, interleukins 5 and 13, and endothelin, it acts about three to 10 hours after the onset of exacerbation, manifesting high values. They act responsibly for fibrosis and lung tissue remodeling[34,35]. The cellular expression of MMP-9 was evaluated by Gunay et al.[8]. In the exercise group, the expression of higher values of MMP-9 was observed at the beginning of the intervention, which was reduced with the physical intervention, remaining similar to the baseline levels of healthy children. This demonstrates and reinforces the importance of exercise as a modulator of inflammation and metabolic action in the body.

The variation of leukotriene E4 (LTE4) was studied by Gunay et al.[8] and Liao et al.[20]. These studies found a reduction in the values after the intervention, evidencing the relationship between reducing its expression in the circulation and the modulation of exacerbations since the LTE4 affects the contraction of peribronchial and vascular smooth muscle, favoring the release of prostaglandins, mucus secretion, and edema formation.

Lu et al.[18] and Liao et al.[20] also analyzed the triglyceride and LDL cholesterol levels in children with asthma since this public tends to be sedentary for fear of triggering crises when performing physical exercises. The reduction in circulating LDL and triglyceride values found by the authors are relevant to highlight the importance of physical activity in preventing cardiovascular diseases such as atherosclerosis, heart attacks, and strokes.

Asthma Control and Quality of Life

Quality of life (QoL) is determined by self-knowledge related to life, culture, values and, in this population, especially the concerns of the disease[36]. The application of the questionnaires can be used as a guide as to how the child or the family members feel about the appropriate treatment and help measure the effectiveness or adherence of the children to the rehabilitation program.[37,38].

A possible explanation for the absence of significance in the quality-of-life evaluation may be related to the high score presented at the beginning of the research and, thus, less possibility of improvement after intervention.

Zhang et al.[22] used the PADQLQ before and after six weeks of drug treatment associated with aerobic circuits, the observed improvement in symptom relief and quality of life in their patients.

Matsunaga et al.[39] showed that children and adolescents who had greater control of disease symptoms had better scores on the questionnaires of perceived quality of life and disease control since children with control of exacerbations can participate effectively in their daily activities, which corroborates the findings of Gomes et al.[11], Westergren et al.[13] and Willeboordse et al.[15].

Applicability in the community

Asthma can be considered a condition sensitive to Primary Health Care (PHC) since, although there is assistance and dissemination of treatment guidelines in public health, it still does not occur satisfactorily with commitment and knowledge about the concepts of the disease and the proposal of the Ministry of Health for primary care[40].

All the studies included in this review present low-cost exercises that can be adapted and reproduced in Basic Health Units. Free-active exercises and obstacle circuits can be adapted with homemade resistances, such as pet bottles and rubber bands. Their effective implementation in Primary Care and the training of professional educators allow the reduction of exacerbation and facilitate disease control, minimizing spending on hospital and outpatient demand.

The costs of treatment and psychosocial and economic alterations in the patient significantly impact the population with asthma and encourage scientific entities to plan control and care actions. Therefore, the implementation of a protocol and group of physical activity for the pediatric population, based on the benefits of exercise as a modulator of inflammatory mediators and lung function and strength, can improve the quality of life of children, reduce the burden on parents and the costs on both the family income and the Health System.

Limitations

Limitations to our study were the non-use of a quality analysis instrument of the articles included the non-inclusion of articles present in the existing gray literature and review articles. The scarcity of articles on the subject and the wide variety of intervention and population age range also interfered with the analysis and correlation of the data.

CONCLUSION

Interventions that use aerobic exercise as a training tool in children diagnosed with asthma present as main benefits of improving cardiorespiratory capacity, peripheral and respiratory muscle strength, and tolerance to physical activity. It can be used as a strategy to reduce exercise-induced bronchospasm, reduce oxidative stress, and reduce the inflammatory response due to its intracellular action in the medium term, which consequently results in improved quality of life and disease control.

The ease of adaptation and reproduction of the studies included in this review can also provide greater coverage of care and rehabilitation of the population with asthma, which in the long term can reduce the rate of hospitalization and hospital demand for severe acute illnesses. Thus, more studies with methodological rigor are needed to show which assessment and care tools have greater effectiveness in this target audience.

REFERENCES

1. Sociedade Brasileira de Pneumologia e Tisiologia. Diretrizes da Sociedade Brasileira de Pneumologia e Tisiologia para o manejo da asma. J Bras Pneumol, 2012;38(supl. 1): s1-46.
2. Forum of International Respiratory Societies. The Global Impact of Respiratory Disease – Second Edition. Sheffield, European Respiratory Society, 2017 [cited 2022 Feb 24]. Available from: https://www.who.int/gard/publications/The_Global_Impact_of_Respiratory_Disease_ES.pdf
3. Solé D, Camelo-Nunes IC, Wandalsen GF, Mallozi MC. A asma na criança e no adolescente brasileiro: contribuição do International Study of Asthma and Allergies in Childhood (ISAAC). Rev Paul Pediatr. 2014;32(1):114-25. https://doi.org/10.1590/S0103-05822014000100018
4. Abdelbasset WK, Alsubaie SF, Tantawy SA, Abo Elyazed TI, Kamel DM. Evaluating pulmonary function, aerobic capacity, and pediatric quality of life following a 10-week aerobic exercise training in school-aged asthmatics: a randomized controlled trial. Patient Prefer Adherence. 2018;12:1015-23. https://doi.org/10.2147/PPA.S159622
5. Reimberg MM, Castro RAS, Selman JPR, Meneses AS, Politti F, Mallozi MC, et al. Patients with asthma have reduced functional capacity and sedentary behavior. J Pediatr (Rio J). 2020;96(1):53-9. https://doi.org/10.1016/j.jpedp.2018.11.004
6. Wicher IB, Ribeiro MAGO, Marmo DB, Santos CIS, Toro AADC, Mendes RT, et al. Effects of swimming on spirometric parameters and bronchial hyperresponsiveness in children and

adolescents with moderate persistent atopic asthma. J Pediatr (Rio J). 2010;86(5):384-90. https://doi.org/10.2223/JPED.2022
7. Onur E, Kabaroğlu C, Günay Ö, Var A, Yilmaz Ö, Dündar P, et al. The beneficial effects of physical exercise on antioxidant status in asthmatic children. Allergol Immunopathol (Madr), 2011;39(2):90-5. https://doi.org/10.1016/j.aller.2010.04.006
8. Gunay O, Onur E, Yilmaz O, Dundar PE, Tikiz C, Var A, at al. Effects of physical exercise on lung injury and oxidant stress in children with asthma. Allergol Immunopathol (Madr), 2012;40(1):20-4. https://doi.org/10.1016/j.aller.2010.10.006
9. Andrade LB, Britto MCA, Lucena-Silva N, Gomes RG, Figueroa JN. The efficacy of aerobic training in improving the inflammatory component of asthmatic children. Randomized trial. Respir Med. 2014;108(10):1438-45. https://doi.org/10.1016/j.rmed.2014.07.009
10. Latorre-Román PA, Navarro-Martínez AV, García-Pinillos F. The effectiveness of an indoor intermittent training program for improving lung function, physical capacity, body composition and quality of life in children with asthma. J Asthma. 2014;51(5):544-51. https://doi.org/10.3109/02770903.2014.888573
11. Gomes ELFD, Carvalho CRF, Peixoto-Souza FS, Teixeira-Carvalho EF, Mendonça JFB, Stirbulov R, et al. Active video game exercise training improves the clinical control of asthma in children: randomized controlled trial. Plos One. 2015;10(8):0135433. https://doi.org/10.1371/journal.pone.0135433
12. Latorre-Román PA, Martínez AVN, García-Pinillos F. Efeito de um programa de atividade física no gozo do esporte, participação na atividade física, autoconceito físico e qualidade de vida em crianças asmáticas. Motriz. 2015;21(4):386-92. https://doi.org/10.1590/S1980-65742015000400007
13. Westergren T, Fegran L, Nilsen T, Haraldstad K, Kittang OB, Berntsen S. Active play exercise intervention in children with asthma: a pilot study. BMJ Open. 2016;6(1):e009721. https://doi.org/10.1136/bmjopen-2015-009721
14. Lin H, Lin H, Yu H, Wang L, Lee J, Lin Y, et al. Tai-Chi-Chuan exercise improves pulmonary function and decreases exhaled nitric oxide level in both asthmatic and nonasthmatic children and improves quality of life in children with asthma. Evid Based Complement Alternat Med. 2017;2017:6287642. https://doi.org/10.1155/2017/6287642
15. Willeboordse M, Kant KDG, Tan FES, Mulkens S, Schellings J, Crijns Y, et al. A multifactorial weight reduction programme for children with overweight and asthma: a randomized controlled trial. Plos One, 2016;11(6):e0157158. https://doi.org/10.1371/journal.pone.0157158
16. Kováčiková Z, Neumannova K, Rydlova J, Bizovská L, Janura M. The effect of balance training intervention on postural stability in children with asthma. J Asthma, 2017;55(5):502-10. https://doi.org/10.1080/02770903.2017.1342257
17. Doğruel D, Altintaş DU, Yilmaz M. Astımlı çocuklarda fiziksel egzersizin klinik ve fonksiyonel parametrelere etkisi [Turkish]. Cukurova Med J. 2018;43(2):457-62. https://doi.org/10.17826/cumj.366166
18. Lu KD, Cooper DM, Haddad F, Radam-Aizik S. Four months of a school-based exercise program improved aerobic fitness and clinical outcomes in a low-ses population of normal weight and overweight/obese children with asthma. Front Pediatr. 2018;6:380. https://doi.org/10.3389/fped.2018.00380
19. Khodashenas E, Bakhtiari E, Sohrabi M, Mozayani A, Arabi M, Haghighi VV, et al. The effect of a selective exercise program on motor competence and pulmonary function of asthmatic children: a randomized clinical trial. International Int J Pediatr. 2019;7(7):9711-17. https://doi.org/10.22038/ijp.2019.37253.3243
20. Liao P, Lin H, Chiang B, Lee J, Yu H, Lin Y, et al. Tai Chi Chuan Exercise improves lung function and asthma control through immune regulation in childhood asthma. Evid Based Complement Alternat Med. 2019;2019:9146827. https://doi.org/10.1155/2019/9146827
21. Mcnarry MA, Lewis MJ, Wade N, Davies GA, Winn C, Eddolls WTB, et al. Effect of asthma and six-months high-intensity interval training on heart rate variability during exercise in adolescents. Med Sci Sports Exerc. 2019;37(19):2228-35. https://doi.org/10.1080/02640414.2019.1626115
22. Zhang Y, Yang L. Exercise training as an adjunctive therapy to montelukast in children with mild asthma. Medicine. 2019;98(2):e14046. https://doi.org/10.1097/MD.0000000000014046
23. Sanz-Santiago V, Diez-Vega I, Santana-Sosa E, Nuevo CL, Ramirez TI, Vendrusculo FM, et al. Effect of a combined exercise program on physical fitness, lung function, and quality of life in patients with controlled asthma and exercise symptoms: A randomized controlled trial. Pediatr Pulmonol. 2020;55(7):1608-16. https://doi.org/10.1002/ppul.24798
24. Muehlbauer T, Gollhofer A, Granacher U. Associations between measures of balance and lower-extremity muscle strength/power in healthy individuals across the lifespan: a systematic review and meta-analysis. Sports Med. 2015;45(12):1671-92. https://doi.org/10.1007/s40279-015-0390-z
25. Locquet M, Beaudart C, Durieux N, Reginster JY, Bruyère O. Relationship between the changes over time of bone mass and muscle health in children and adults: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2019;20:429. https://doi.org/10.1186/s12891-019-2752-4
26. Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act. 2010;7:40. https://doi.org/10.1186/1479-5868-7-40
27. Villa F, Castro APBM, Pastorino AC, Santarém JM, Martins MA, Jacob CMA, at el. Aerobic capacity and skeletal muscle function in children with asthma. Arch Dis Child. 2011;96(6):554-9. https://doi.org/10.1136/adc.2011.212431
28. França-Pinto A, Mendes FAR, Carvalho-Pinto RM, Agondi RC, Cukier A, Stelmach R, et al. Aerobic training decreases bronchial hyperresponsiveness and systemic inflammation in patients with moderate or severe asthma: a randomized controlled trial. Thorax. 2015;70:732-9. https://doi.org/10.1136/thoraxjnl-2014-206070
29. Zhang W, Wang Q, Liu L, Yang W, Liu H. Effects of physical therapy on lung function in children with asthma: a systematic review and meta-analysis. Pediatr Res. 2021;89:1343-51. https://doi.org/10.1038/s41390-020-0874-x
30. Vogiatzis I, Zakynthinos G, Andrianopoulos V. Mechanisms of physical activity limitation in chronic lung diseases. Pulm Med. 2012;2012:634761. https://doi.org/10.1155/2012/634761
31. Moraes EZC, Trevisan ME, Baldisserotto SV, Portela LOC. Capacidade aeróbica em crianças e adolescentes com asma intermitente e persistente leve no período intercrises. J Bras Pneumol. 2012;38(4):438-44. https://doi.org/10.1590/S1806-37132012000400005
32. Júnior DRSA, Souza RB, Santos SA, Andrade DR. Os radicais livres de oxigênio e as doenças pulmonares. J Bras Pneumol. 2005;31(1):60-8. https://doi.org/10.1590/S1806-37132005000100011
33. Sahiner UM, Birben E, Erzurum S, Sackesen C, Kalayci O. Oxidative stress in asthma. World Allergy Organ J. 2011;4(10):151-8. https://doi.org/10.1097/WOX.0b013e318232389e
34. Constantino GTL, Mello Jr JF. Remodelamento das vias aéreas inferiores e superiores. Rev Bras Otorrinolaringol. 2009;75(1):151-6. https://doi.org/10.1590/S0034-72992009000100024
35. Pawankar R. Perspectivas atuais sobre inflamação e remodelamento das vias aéreas na asma e na rinite alérgica. Braz J Allergy Immunol. 2013 [cited 2022 Feb24];1(5):243-252. Avaiable from: https://bit.ly/36Ew7Br
36. La Scala CS, Naspitz CK, Solé D. Adaptation and validation of the Pediatric Asthma Quality of Life Questionnaire (PAQLQ) in Brazilian asthmatic children and adolescents. J Pediatr (Rio J), 2005;81:54-60. https://doi.org/10.2223/1283
37. Annett RD. Assessment of health status and quality of life outcomes for children with asthma. J Allergy Clin Immunol. 2001;107(5):S473-81. https://doi.org/10.1067/mai.2001.114949
38. Everhart RS, Fiese BH. Asthma severity and child quality of life in pediatric asthma: A systematic review. Patient Educ Couns. 2009;75(2):162-8. https://doi.org/10.1016/j.pec.2008.10.001

39. Matsunaga NY, Ribeiro MAGO, Saad IAB, Morcillo AM, Ribeiro JD, Toro AADC. Evaluation of quality of life according to asthma control and asthma severity in children and adolescents. J Bras Pneumol. 2015;41(6):502-8. https://doi.org/10.1590/s1806-37562015000000186

40. Leal RCAC, Braile DM, Souza DRS, Batigália F. Modelo assistencial para pacientes com asma na atenção primária. Rev Assoc Med Bras. 2011;57(6):697-701. https://doi.org/10.1590/S0104-42302011000600019

Conflicts of interest: No conflicts of interest declared concerning the publication of this article.

Indications about the contributions of each author:
Conception and design: BES, LCSAM, LSFM, MLMS, AMMC
Analysis and interpretation of data: BES, LCSAM, APGA
Data collection: BES, LCSAM, APGA
Writing of the manuscript: BES, LCSAM, APGA, AMMC
Critical revision of the text: JLSFM, JTA, MLMS
Final approval of the manuscript*: BES, LCSAM, LSFM, JTA, MLMS, AMMC
Statistical analysis: Not applicable
Overall responsibility: BES, LCSAM
*All authors have read and approved of the final version of the article submitted to Rev Cienc Saude.

Funding information: not applicable.