

Effect of exercise-induced bronchospasm and parental beliefs on physical activity of asthmatic adolescents from a tropical region

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ABSTRACT

Background: Physical activity (PA) is an essential health promotion factor. In asthmatic children and adolescents, exercise-induced bronchospasm (EIB) and parental beliefs and attitudes toward PA may be limiting issues.

Objective: To compare PA levels in asthmatic adolescents with and without EIB and the influence of mothers' beliefs of asthma worsening due to PA and attitudes in restraining their children's PA, asthma severity, severe EIB, or bronchospasm perception.

Methods: We performed a cross-sectional, hypothesis-testing study from December 1, 2008, through August 31, 2009, using the International Physical Activity Questionnaire to assesses PA levels in 134 asthmatic adolescents (10–19 years of age, 60% male) from an underprivileged community. EIB was defined as a decrease in forced expiratory volume in 1 second greater than 10% from basal 5, 15, or 30 minutes after treadmill running for 8 minutes. Subjective factors were evaluated through specific questionnaires.

Results: EIB was diagnosed in 46% of patients and was not associated with lower PA levels (odds ratio, 1.62; 95% confidence interval, 0.75–3.52). The other factors evaluated were also not associated with lower PA levels, although 78% of the mothers said they believe asthmatic children cannot participate in PA as much as nonasthmatic children, 44% that exercise can be harmful, and 52% that they restrained their children's PA.

Conclusion: We found no association between EIB and low PA levels, although EIB was a frequent event that should be addressed by health care professionals, along with mother's beliefs and attitudes toward PA.

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Introduction

Physical activity (PA) must be encouraged as a health-promoting factor and should be stimulated by the family and health care and educational professionals for children and adolescents because it improves body development, motor coordination, socialization, physical conditioning, and self-esteem. It is specially recommended for asthmatic children¹ because it improves cardiovascular performance and physical fitness, contributes to symptoms control,² and has been found to reduce airway inflammation² and remodeling.³

The literature shows conflicting results about asthmatic children's and teenagers' PA levels and fitness when compared with their nonasthmatic peers.^{4–7} Some factors have been pointed to as

possible causes for low PA levels, such as poor disease knowledge by patients, parents, schoolteachers, or coaches, fear that vigorous PA could worsen asthma,⁶ low self-esteem and self-perception,⁸ and poor asthma control.⁶

Exercise-induced bronchospasm (EIB) occurs in 50% to 90% of asthmatic children and adolescents,^{9–12} and its association with lower PA or fitness in these individuals has been suggested.^{8,13} Fear that vigorous physical activities may aggravate asthma, along with the dyspnea sensation due to poor physical fitness and not EIB itself, can make some parents and asthmatic children unnecessarily impose avoidance or lower limits of PA.^{6,14}

The objectives of this study were to compare the PA levels of asthmatic adolescents with and without EIB and to examine the influence of possible confounding factors, such as mothers' beliefs of worsening asthma due to PA and attitudes toward restraining their children's PA, asthma severity, EIB with a decrease in forced expiratory volume in 1 second (FEV₁) greater than 20%, or bronchospasm perception by patients. Our opera-

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tional hypothesis was that asthmatic children with EIB are less active than their peers without EIB.

Methods

Settings and sample

This is a cross-sectional, hypothesis-testing study performed at the Respiratory and Allergy Department of the Hospital das Clínicas, Federal University of Pernambuco, Recife, Brazil, a public university medical center that attends to an economically underprivileged population, from December 1, 2008, through August 31, 2009. This project was approved by the institutional ethics committee, and all the parents and adolescents signed an informed consent form. The adolescents were referred from the allergy clinic of the same hospital where they had their asthma diagnosis and disease severity classified by the assistant specialist (allergist or pulmonologist) according to the Global Initiative for Asthma.¹

Exclusion criteria

Individuals with an FEV₁ lower than 60% of predicted (for safety reasons), who had asthma exacerbation or respiratory infection within 2 months, who were unable to perform adequate forced expiratory maneuvers who had constraints for treadmill running, who could not stop taking their medications, or who were using systemic steroids or xanthines were excluded from the study.¹⁵

Data collection

PA level was evaluated with the short version of the International Physical Activity Questionnaire (IPAQ), which was validated and translated to Brazilian Portuguese.¹⁶ This questionnaire takes into consideration PA performed for at least 10 continuous minutes at any day on the previous week and its intensity. PA levels were obtained by the summed daily and weekly vigorous and moderate (including walking) activity times, and participants were classified as active if they had PA of more than 150 min/wk and 30 min/d or more on 5 days per week or inactive' for those with less weekly or daily PA times.

EIB evaluation was performed according to a standardized protocol.¹⁵ After basal FEV₁ measurement (Cosmed Kit Micro spirometer; Cosmed, Rome, Italy), patients were instructed to walk on the treadmill (EG700X; Ecafex, São Paulo, Brazil) for 30 seconds, and the speed was increased during 1 to 2 minutes to reach 80% to 90% of the maximum heart rate for 6 more minutes. The examination room was air conditioned and the temperature kept at approximately 25°C with 70% relative air humidity. FEV₁ evaluation was repeated 5, 15, and 30 minutes after running. Short-acting β -adrenergic bronchodilators were interrupted for 8 hours and the long-acting ones for 48 hours. Patients were asked to refrain from caffeine drinks for 12 hours. Patients taking inhaled steroids were not asked to stop. No patient was taking chromone agents or leukotriene-blocking drugs. Adequacy of forced expiratory maneuvers was evaluated by the same physician (J.A.R.) according to the standardization criteria.¹⁵

EIB was diagnosed as a decrease of 10% or more in FEV₁ compared with basal at any time after the treadmill running.¹⁵ For EIB, a decrease of 10% or greater but less than 20% in FEV₁ was considered mild, 20% or greater to 30% or less was considered moderate, and greater than 30% was considered severe.¹⁷ If an FEV₁ decrease was maintained at 30 minutes or was severe at any time, 4 puffs of albuterol were given and the patient reevaluated before discharging. Predicted FEV₁ values were calculated according to the National Health and Nutrition Examination Survey III.¹⁸

Questionnaires were applied to check for some factors identified in the literature that could interfere with asthmatic adolescents' PA practice.^{6,14} The athletic competence and self-worth domains of the Self-Perception Profile for Children¹⁹ validated

Table 1

General characteristics of the 134 study patients

Activity level	Active	Inactive	P value
Total included, No. (%)	85 (63)	49 (37)	
M/F, No. (%)	50/35 (59/41)	30/19 (61/39)	.93
Age, mean (SD), y	13.1 (2.1)	13.3 (2.2)	.60
Height, mean (SD), cm	155.6 (8.8)	158.4 (10.8)	.11
Weight, mean (SD), kg	47.3 (11.0)	50.8 (14.0)	.11
BMI, mean (SD)	19.4 (3.6)	20.0 (3.8)	.70
Asthma, mean (range), y ^a	7.8 (0.5–15)	7.8 (0.5–17)	.99
FEV ₁ , mean (SD), % predicted	81.9 (13.7)	82.5 (12.6)	.79

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); FEV₁, forced expiratory volume in 1 second.

^aYears since asthma symptoms began.

and translated to Portuguese were also investigated. Mothers' anxiety levels were evaluated through the Hospital Anxiety and Depression Scale validated and translated to Portuguese.²⁰ Questions about mothers' beliefs and attitudes toward PA in asthmatic kids were adapted from the study by Lang et al,⁶ and their face validity held by 5 pediatric allergists. Mothers were also directly asked if they could identify asthma or wheezing during or after their children's PA and if they imposed restrictions to such activities. Questionnaires were completed in less than 30 minutes. In addition, we examined possible associations between PA levels and age, sex, asthma, and EIB severities.

Sample size and statistical analysis

A sample size of 126 asthmatic adolescents was calculated to detect a 0.25 difference in the proportion of inactive children with and without EIB, taking into account a 0.21 proportion of inactivity found in asthmatic children by Lang et al⁶ and α and β errors of .05 and .20, respectively.

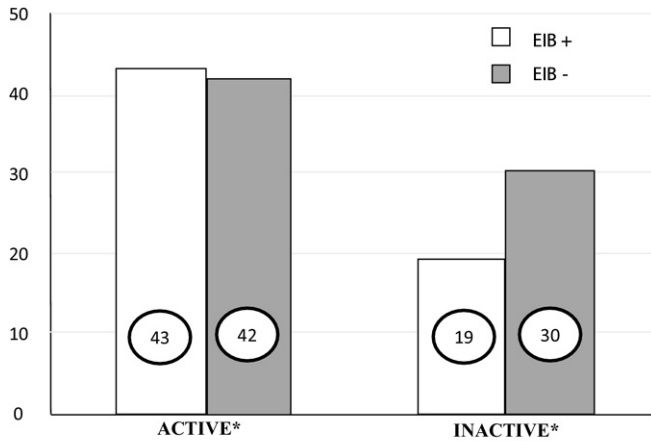
The χ^2 test was used to check for an association between PA level and EIB. All other predictive variables were checked individually by comparing proportions using the χ^2 test and odds ratios (ORs) with 95% confidence intervals (CIs) in univariate analysis to identify which of them individually presented an association with PA level for construction of a multivariate regression model. For continuous variables, such as scores on the Self-Perception Profile for Children, the *t* test for independent samples was used. Data were analyzed using SPSS for Windows, version 12.0 (SPSS Inc, Cary, North Carolina).

Results

One hundred thirty-five asthmatic adolescents were recruited, and 134 of them completed the evaluation. They were classified according to PA level into active and inactive as stated, and the general characteristics of both groups are described and compared in Table 1. One mother withdrew her permission during the questionnaire phase. Only 23% of patients reported regular inhaled steroid use, and none reported use of other controller medications. Twelve patients initially recruited did not fulfill the inclusion and exclusion criteria and were excluded (all due to FEV₁ values below 60% of predicted).

Exercise-induced asthma and PA

Sixty-two of the 134 patients (46.3%) showed a decrease in FEV₁ of 10% or more after exercise, and 49 (36.6%) of them were classified as inactive. Although the proportion of active patients was higher in asthmatic adolescents with EIB (52% vs 39%), this difference was not statistically significant and no association between PA levels and EIB was found (Fig 1). These findings were maintained even when stratified and compared by the 4 IPAQ original levels of activity: sedentary (*n* = 9), less than 150 min/wk of activity (*n* = 40), 150 min/wk or more to less than 300 min/wk (*n* = 62), or 300



* IPAQ defined – see text. Circles= absolute numbers.
 EIB + : exercise-induced bronchospasm: FEV₁ fall $\geq$ 10%
 EIB - : no exercise-induced bronchospasm
 Odds Ratio 1.62; 95%CI : 0.75-3.52
 Chi-square test, $p=0.187$

Fig. 1. Physical activity level and exercise-induced bronchospasm (EIB).

min/wk or more ($n = 23$) ($P = .58$). In a comparison of PA that took into account age (patients younger or older than 14 years of age) and sex, no differences were found between the proportion of active and inactive individuals with and without EIB (OR, 1.11; 95% CI, 0.51–2.42; and OR, 1.34; 95% CI, 0.55–3.29, respectively).

Basal FEV₁, EIB intensity, asthma severity, and adolescents' perceptions

No difference was found between the active and inactive groups regarding mean (SD) FEV₁ basal levels (81.9% [13.7%] vs 82.5% [12.7%]; $P = .79$). In addition, no association was found between PA levels and EIB severity classified by the decrease in FEV₁ after the treadmill running (Table 2). Irrespective of activity levels, EIB was more frequent among the adolescents with more severe asthma (OR, 3.64; 95% CI, 1.65–8.11; $P < .001$). Asthma severity was not associated with lower PA levels (Table 2; $P > .58$).

A total of 88 of the 134 adolescents (65.7%) in the studied population stated that they had wheeze or asthma symptoms while they were playing sports and games (not associated with lower PA levels; Table 2), but among these 88 adolescents, only 49 (55.7%) showed a greater than 10% decrease in FEV₁ after running. It was the adolescents' perception that 46 of the 134 mothers (34.4%) actively advised against PA, and 86 (64.2%) stated that they avoided or played less actively due asthma when not in an exacerbation, but, again, this was not associated with lower PA levels (Table 2).

There was a stronger sense of self-competence in the athletic domain of the Self-Perception Profile for Children in inactive compared with active adolescents (mean score, 15.5 vs 14.0 points; $P = .03$) but not the self-worth domain (16.1 vs 16.2; $P = .90$).

Mothers' beliefs and attitudes

Mothers' PA levels and their beliefs about exercise for children with and without asthma had no association with the asthmatic adolescents' PA levels (Table 3). It is worth noting that almost all mothers believed that exercise is important for adolescents (97%), but 78% believe that asthmatic adolescents cannot participate in PA as much as nonasthmatic adolescents and 44% that exercise can be harmful to adolescents with asthma.

Mothers' perception of children's wheezing or asthma after playing games or sports also was not associated with lower PA levels. This perception was not associated with FEV₁ decrease after exercise, even in those adolescents who had a greater than 20% reduction. Fifty-two percent of the mothers stated that they restrained their children's PA, but this had no influence on their children's PA levels and was poorly concordant with the adolescents' opinion about the mothers' restriction ($\kappa=.32$).

Anxiety levels of mothers did not show a difference between the 2 groups either, with mean (SD) scores of 9.7 (3.9) and 8.6 (3.5) for mothers of active and inactive asthmatic adolescents, respectively ($P = .12$).

Discussion

Some authors suggest that low PA levels in asthmatic patients could be related to the EIB, but we were not able to find any published investigation that formally evaluated this association.^{8,13} The aim of the study was to address this question; however, our findings did not corroborate this hypothesis because no association

Table 2
Factors that could interfere with adolescents' physical activity levels

Factor	Active, No. (%)	Inactive, No. (%)	OR (95% CI)	P value ^a
EIB severity ($n = 62$)			0.63 (0.18–2.14)	.58
>20% decrease in FEV ₁	23 (74)	8 (26)		
=10% to <20% decrease in FEV ₁	20 (64)	11 (36)		
Asthma severity			0.76 (0.34–1.67)	.58
Intermittent/mild	50 (61)	32 (39)		
Moderate/severe	35 (67)	17 (33)		
Questionnaire				
1. Is there space for playing at school or next to home?			3.1 (0.61–17.36)	.14
Yes	82 (65)	44 (35)		
No	3 (37)	5 (63)		
2. Do you wheeze or have asthma when playing sports or games?			1.18 (0.53–2.63)	.79
Yes	57 (65)	31 (35)		
No	28 (61)	18 (39)		
3. Do you avoid playing or play less actively sports or games because of asthma when you don't have asthma symptoms?			0.80 (0.36–1.79)	.69
Yes	53 (60)	33 (40)		
No	32 (67)	16 (33)		
4. Does your mother advise you against playing sports or games when you don't have asthma symptoms?			1.13 (0.50–2.53)	.90
Yes	30 (65)	16 (35)		
No	55 (62)	33 (38)		

Abbreviations: CI, confidence interval; EIB, exercise-induced bronchospasm; FEV₁, forced expiratory volume in 1 second; OR, odds ratio.

^a χ^2 test.

Table 3
Mothers' related factors that may interfere with the physical activity of the asthmatic patients^a

Factor	Active, No. (%)	Inactive, No. (%)	OR (95% CI)	P value ^b
Mother's physical activity level			1.90 (0.63–5.75)	.31
Inactive	9 (50)	9 (50)		
Active	76 (65)	40 (35)		
Questionnaire				
1. Is exercising important to adolescents?			3.43 (0.23–98.57)	.55
Yes	79 (63)	46 (37)		
No	1 (33)	2 (67)		
2. Can adolescents with asthma participate in physical activities as much as those without asthma?			1.68 (0.59–4.94)	.40
Yes	19 (73)	7 (27)		
No	58 (62)	36 (38)		
3. Is exercising harmful or dangerous to adolescents with asthma?			0.68 (0.29–1.59)	.43
Yes	28 (57)	21 (43)		
No	41 (66)	21 (34)		
4. Does your son/daughter wheeze or has asthma when playing games or sports?			0.79 (0.34–1.81)	.67
Yes	55 (61)	35 (39)		
No	28 (67)	14 (33)		
5. Do you restrain your son/daughter from participating in games or sports because of the asthma when he/she is not in crisis?			0.89 (0.41–1.95)	.90
Yes	32 (61)	20 (39)		
No	52 (64)	29 (36)		

Abbreviations: CI, confidence interval; OR, odds ratio.

^aDenominator varies as some questions had the answer "I don't know."

^b χ^2 test.

between EIB and reduced PA levels was found in this group of asthmatic adolescents. In this tropical, underprivileged community, adolescents' PA was mostly due to utilitarian activities, such as walking or biking for transport purposes, or nonorganized PA, such as informal soccer playing or other leisure activities. Only 14% were engaged formally in some sort of sports.

Although taking into account the differences in evaluation instruments, there are still controversies about the association between asthma and PA level in asthmatic children and teenagers. Although some authors report asthma itself as an associated factor with children's and adolescents' lower PA levels,^{5,6,14} Jones et al²¹ and Welsh²² did not find such association, even when asthma severity was taken into account. Our results are in agreement with these authors. Comparing our asthmatic sample with that from a large, epidemiologic, Brazilian study that adopted a similar questionnaire to evaluate PA in students from the general population with the same age span,²³ no differences were found in PA levels because 33.8% (866/2561) of adolescents from the city of Recife, Brazil, and 36.6% of the asthmatic adolescents in this study were considered active at less than 150 min/wk ($P > .05$).

Both asthma and EIB can induce symptom perceptions that could negatively influence PA practice.^{6,10} For our sample there was no influence of asthma severity, magnitude of FEV₁ decrease after the treadmill run, or asthma symptoms or wheezing perception after or during exercise on PA levels (Table 2). In accordance to our results, Pianosi and Davis⁸ did not find an association between the severity of disease and physical conditioning in 64 asthmatic children. No association was found between dyspnea or wheeze perception during or after PA by the patients themselves or by their mothers and EIB (defined as a greater than 10% reduction in FEV₁) after treadmill running; therefore, for exercise-induced asthma diagnosis, it is not enough to ask about exercise-associated or exercise-induced symptoms. An exercise bronchial provocation test is advisable, especially in asthmatic children and adolescents who experience respiratory symptoms during or after exercise and in those engaged in competitive sports, as shown by others.^{10–12}

The fear that exercise may aggravate asthma, not EIB itself, could induce some parents and asthmatic adolescents to impose limits to their physical activities.^{6,14} We were not able to find an association between PA levels and exercise avoidance among asthmatic adolescents, but the proportion of patients who answered

that they avoided playing or played games or sports more carefully due to asthma (Table 2) was impressive in both groups (45% and 46%, respectively). These findings are in agreement with those of Williams et al,¹⁴ who found a large number of children with asthma who believed that limitation to their activities was an inevitable part of the disease. It is a worrying issue that should have the attention of health care and educational professionals because, once properly treated, there is no reason for these patients to refrain from or be afraid of PA and sports.

The lack of facilities or spaces for playing or engaging in sports may be a barrier to the practice of PA. A study that evaluated a population living in *favelas* (slums) in a Brazilian capital pointed out that the narrow streets in these urban agglomerates is a major cause for low recreational PA levels.²⁴ Almost the entire population in this study, even if coming from low socioeconomic communities, stated that space was available for PA practice at school or near home.

The concept that children may become sick or have their asthma worsened by exercise has been associated with low PA levels in both American and Chinese families.^{6,25} In this research, almost all of the mothers of active and inactive adolescents said to believe that exercise is important to children, asthmatic or not, but 44% of them answered that physical exercise may be harmful or dangerous to children with asthma, and more than one-third stated that they imposed restrictions to their activities in games or sports (Table 3). The last issue is an interesting one because there was a weak agreement between what was said by the mothers and what was perceived by their children ($\kappa=0.32$), but an association was found between what was perceived by the sons as their mothers' recommendation about PA and their attitudes (Table 2, questions 4 and 3, respectively). In other words, 45% of the adolescents who answered that their mothers imposed some restriction to their PA said they avoided playing or played less actively in sports or games compared with 25% of those who said that their mothers imposed no restriction ($P = .02$). This finding reflects the importance of the family stimulus in promoting the children's PA practice.²⁶

Of the 133 mothers evaluated, 87% were considered active, with no difference between their activity levels and their children's. Housework, job activities, and transport to work, very frequently by walking, may be the PA-determining factors in this economically underprivileged Brazilian sample. According to

Gray et al,²⁷ low family income and lifestyle could be related to the individuals' inactivity in a US population, but this was not the case in our sample.

Because mothers' anxiety and children's perceived athletic competence or self-worth could influence PA levels,^{8,28,29} these factors were evaluated to control for possible interferences. No differences in mothers' anxiety levels and in adolescents' self-worth were found, but less active adolescents had a slightly higher but significant ($P = .02$) score in the athletic competence domain than those considered active. This seemingly paradoxical finding could be due to methodologic flaws of the evaluation instrument, or it could be that some of these adolescents were engaging less in PA activities because they considered themselves physically fit.

Although more precise methods of PA measurements are available (ie, doubly labeled water and accelerometry), self-report PA questionnaires are easy and low-cost instruments adopted by many researchers, even if it is recognized that they have some drawbacks, such as interpretation of the questions, recall, and misclassification bias. Another problem in comparing results is the lack of adoption of standardized questionnaires. We used the IPAQ (short version), a validated questionnaire that was formally translated to Brazilian Portuguese and was developed to assess PA levels in populations across countries, with acceptable measurement properties and a test-retest correlation coefficient of 0.8 on data obtained on participants from 12 countries, including Brazil.¹⁶ Adolescents answered the questionnaire without help or interpretation of questions.

It was not our aim to evaluate the influence of asthma control on EIB, but it was shown by others that improvement in children's asthma control significantly improves activity levels.³⁰ The fact that only 23% of our patients were regularly taking control medication, despite 61% having persistent asthma, reflects the underuse of adequate treatment strategies in our population in a similar way it also happens with patients from wealthier economies.

In conclusion, the results of our study show that EIB is not a limiting factor for PA in this asthmatic adolescent population. The fact that most of the PA practice in this community that mirrors many others around the world is performed for utilitarian purposes or as nonorganized sports activities could be one explanation for these findings. EIB, however, must be adequately identified and treated in the context of disease control, and a series of concepts, perceptions, and attitudes about asthma and its relationship to PA by asthmatic adolescents and their mothers must be considered by health care professionals as possible determinants of low PA levels in many patients.

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