

PAEDIATRICS

Daily physical activity in asthmatic children with distinct severitiesAndrey Wirgues Sousa, MS¹, Anna Lúcia Barros Cabral, PhD², Milton Arruda Martins, PhD³, and Celso R. F. Carvalho, PhD¹¹Department of Physical Therapy, School of Medicine, University of São Paulo, São Paulo, Brazil, ²Department of Pulmonology, Darcy Vargas Children's Hospital, São Paulo, Brazil, and ³Department of Clinical Medicine, School of Medicine, University of São Paulo, São Paulo, Brazil**Abstract**

Objective: The objective of this study was to evaluate daily physical activity (DPA) in asthmatic children with different levels of disease severity, but with good asthma control, relative to a control group. **Methods:** This was a cross-sectional study in which a total of 121 children between the ages of 7 and 12 years old were evaluated; 72 were asthmatic children (32 mild, 24 moderate and 23 severe), and 42 children were not asthmatics. The asthmatic children studied had been in medical treatment for at least 6 months and experienced no change in symptoms during the 4 weeks prior to the study. The DPA was monitored over 6 days (4 weekdays and 2 weekend days). Motor activity was recorded with an accelerometer that measured the total number of steps (TNS), the number of steps in moderate physical activity (NS-MPA) and the duration, in minutes, of physical activity performed at moderate intensity. **Results:** There were no differences among the TNS performed by children with mild, moderate or severe persistent asthma and the control group ($14\,410 \pm 4379$, $14\,710 \pm 4892$, $13\,838 \pm 3341$ and $12\,968 \pm 3682$ steps, respectively). The NS-MPA was also similar among all of the groups (6589 ± 2065 , 6605 ± 2324 , 6223 ± 1689 and 5990 ± 1840 steps, respectively). Sedentary asthmatic children were overweight more often than asthmatic children who were physically active, although lung function was not different between these groups. **Conclusion:** Children with good asthma control, independent of disease severity, had DPA levels similar to children without asthma. However, more asthmatic children were overweight if sedentary as compared to physically active asthmatic children.

Keywords

Accelerometer, children, motor activity, sedentary, step

History

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Introduction

Asthma is a chronic inflammatory disease of the airways that is more common in children [1]. This condition is characterized by episodes of wheezing, breathlessness, chest tightness and coughing, particularly at night [1]. Exercise-induced bronchospasm is common in asthmatic patients, and there is evidence that this occurrence prevents the practice of regular physical activity, especially in patients with more severe disease [2]. The restriction of physical activity caused by asthma symptoms leads to a loss of fitness as well as other health factors related to quality of life [3,4]. In contrast, regular physical activity enhances the health-related quality of life of asthmatics by improving aerobic capacity, and by reducing dyspnea, dose of inhaled corticosteroids, intensity of exercise-induced bronchoconstriction, and disease exacerbation [5–8]. Thus, it is important to

encourage the asthmatic patient to practice regular physical activity [9].

Several studies have evaluated daily physical activity (DPA) in asthmatic children, with quite controversial results [2,8,10–18]. Some studies have shown that asthmatic children perform less DPA than children without asthma [2,10–13], whereas other studies suggest that the DPA performed by both is similar [8,14–18]. However, none of these studies evaluated DPA among asthmatic patients as a function of their disease severity.

Accelerometer measurements are currently thought to provide more reliable assessment of DPA than questionnaires [19,20] as this instrument quantifies physical activity in real life. These measurements must be performed for at least 4 days to obtain confidence coefficients >80% [21,22]. Despite the consensus that accelerometry is the optimal tool for assessing motor activity [19], to the best of our knowledge, there are few studies that have used this method to evaluate DPA in physician-diagnosed asthmatic children with good asthma control. Furthermore, these studies included only children with mild persistent asthma [8,14,16].

Thus, the objective of this study was to evaluate the daily physical activity of asthmatic children with different levels of disease severity, but with good asthma control, as compared to the DPA of healthy children.

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Methods

Subjects

This cross-sectional study was performed between March 2010 and June 2011 during regular school sessions (the study was suspended during school vacations and holidays). The 121 children enrolled in the study included 79 asthmatic children and 42 children without asthma, from both genders, between 7 and 12 years of age, prepubescent or pubescent up to Tanner stage G2 [23]. Among the asthmatic children, 32 had mild, 24 had moderate and 23 had severe persistent asthma. The diagnosis of the disease, assessment of the intensity of treatment, and good asthma control were made by a physician, in accordance with the Global Initiative for Asthma (GINA) [1]. Asthma severity was classified according to the intensity of the treatment, type and dose of medications (inhaled corticosteroid) required to achieve good asthma control. Mild, moderate and severe persistent asthma require low, medium and high daily doses of inhaled corticosteroid, respectively [1]. All of the asthmatic children had been medically treated for at least 6 months, and experienced no change in symptoms during the 4 weeks prior to the study, thus presenting good asthma control. Asthmatic children were recruited in the pediatric outpatient clinic of a public health hospital in São Paulo. Children without asthma (the control group) were recruited at the same hospital among the children of employees who agreed to participate in the study. The control group of children presented normal spirometry and no symptoms of asthma or rhinitis as evaluated by the ISAAC questionnaire [24]. All of the children had the same socio-economic status and attended public schools. Control children were matched with asthmatic children for age, weight, height and pubertal stage. None of the children were involved in any regular exercise program other than their school physical education program. The study was approved by the Hospital's Ethics Committee, and patients were enrolled after their parents or guardians signed a written informed consent.

Experimental design

The asthmatic children were invited to participate in the study following a routine medical examination. Upon enrollment, their anthropometric parameters were measured, stride length was evaluated for accelerometer calibration, and spirometry was performed. Each child then received an accelerometer and was instructed to keep it in a pocket for six consecutive days (4 days during the week and 2 days on the weekend) and to return to the hospital with the device at the end of this period.

Evaluations

Daily physical activity was quantified using an accelerometer (Power Walker-610, Yamax, Japan). This instrument measures the total number of steps (TNS), the number of steps in moderate physical activity (NS-MPA) and the duration, in minutes, of physical activity performed at moderate intensity. Physical activity of moderate intensity is defined as the period during which a child takes at least 110 steps per minute [25]. The accelerometer captures data from this type of movement. All of the children enrolled in the study, and their caregivers,

were instructed to place their accelerometer in a pocket each morning and keep it there throughout the day, removing it only to shower and sleep. The children were directed to collect the moderate intensity physical activity data from the accelerometer at the end of each day. In addition, the children were instructed not to change their DPA while using the device. DPA was classified based on the total number of daily steps taken by each child. To be considered physically active, a child's accelerometer had to register 15 000 and 12 000 steps per day for the boys and girls, respectively [26]. Children whose DPA did not obtain these values were classified as sedentary.

Spirometry was performed before and after the inhalation of 400 µg of salbutamol. The technical procedure, eligibility criteria and reproducibility were established as recommended by the American Thoracic Society [27]. The spirometer (Koko, DigiDoser, Louisville, Kentucky) was coupled to a microcomputer, and the following parameters were evaluated: forced expiratory volume in 1 s (FEV₁), forced vital capacity (FVC) and FEV₁/FVC. A fixed obstruction was considered present when FEV₁/FVC measured during the previous 12 months was <0.8 following the use of a bronchodilator (BD). Variability in FEV₁ was considered to be present when the pre-BD FEV₁ value varied by >20% in any of the spirometric examinations performed during the previous 12 months. A response to the BD was considered to be present when FEV₁ increased >12% or there was a change in FVC >200 ml after using the BD [1]. Overweight was defined as a body mass index (BMI) exceeding the age-adjusted cut point, while the normal weight was defined as BMI below the age-adjusted cut point as defined by Cole et al. [28] (≥85th percentile and <85th percentile, respectively). The BMI value was expressed as kg/m² and is presented as the median BMI percentile.

Statistical analysis

The sample size was calculated to detect a variation of 2000 steps with a SD of 3000 steps, which would require 23 patients per group. The normality of the data was assessed using the Kolmogorov–Smirnov test. Comparisons of the TNS and NS-MPA among children with differing asthma severities and non-asthmatic children were evaluated using an analysis of variance (ANOVA). The chi-squared test was used for the variables of fixed obstruction, variability of lung function, response to bronchodilator and overweight. The significance level was set at 5% ($p < 0.05$), and the statistical program SPSS (version 15.0) was used for the analysis.

Results

Of the 134 children screened, 13 were excluded (1 had musculoskeletal disease; 3 had other respiratory diseases; 5 participated regularly in aquatic physical activities; and 4 whose caregivers refused to participate). There were no differences in the anthropometric characteristics between the asthmatic and non-asthmatic children (Table 1). The TNS and NS-MPA of the children with mild, moderate and severe persistent asthma were similar to those of the children in the control group ($p > 0.05$, Figure 1). Similarly, the time spent engaged in moderate physical activity was not significantly different among the children with mild, moderate and severe

Table 1. Anthropometric and spirometric data from asthmatic and non-asthmatic children.

	Asthma	Control	<i>p</i>
Anthropometric data			
Number of children/boys	79/54	42/24	–
Age, years	9.8 (1.5)	9.7 (1.7)	0.63
Height, m	1.40 (0.1)	1.40 (0.1)	0.87
Weight, kg	37.5 (9.1)	36.9 (11.2)	0.74
BMI percentile	65.4 (29.5)	63.7 (27.2)	0.85
Spirometry			
FVC (%)	99.1 (11.0)	101.3 (11.9)	0.49
FEV ₁ (%)	91.4 (11.9)	95.6 (11.3)	0.13
FEV ₁ /FVC ratio	0.82 (0.06)	0.84 (0.04)	0.07
Presence of fixed obstruction (%)	23.9	–	–
Response to BD (%)	85.1	–	–
Variability present (%)	28.4	–	–

Anthropometric data are shown as the mean and SD, except for gender, which is presented in number of patients and BMI percentile presented as the median. Spirometric data are shown as percentages, except for FEV₁/FVC shown as an absolute value. Student's *t*-test student was used to compare the mean data; *p* > 0.05.

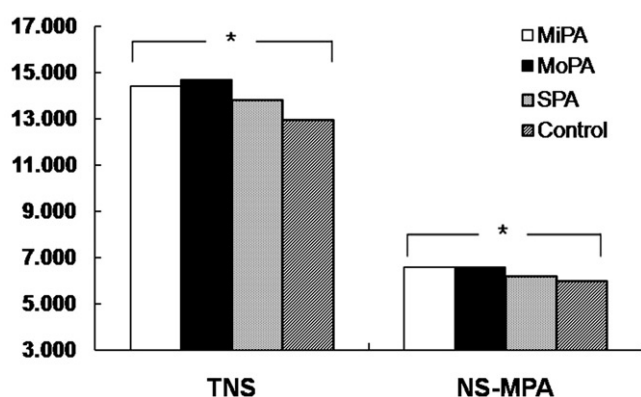


Figure 1. Comparison of DPA measured as TNS and NS-MPA among all asthma severities and the control group. ANOVA was used to evaluate the statistical significance; **p* > 0.05: no statistical significance. MiPA, mild persistent asthma; MoPA, moderate persistent asthma; SPA, severe persistent asthma.

Table 2. Percentage of children classified as physically active.

	Asthma	Control
Weekdays	54.4%	50.0%*
Weekend	36.7%†	35.7%*,†

Children classified as physically active during weekdays and weekend. The chi-squared statistical test was used; **p* > 0.05 when compared asthma versus control; †*p* < 0.05 when compared weekdays versus weekend in both groups. To be considered physically active the children were required to achieve 15 000 and 12 000 steps per day for the boys and girls, respectively

persistent asthma and the children in the control group (respectively, 50.6, 52.5, 49.2 and 49 min per day, *p* > 0.05). Based on the TNS taken during the week, 54.4% of asthmatic children were considered to be physically active, a percentage similar to the 50% observed in non-asthmatic children (*p* > 0.05, Table 2). In addition, both groups performed more DPA on week days than on weekend days (*p* < 0.05,

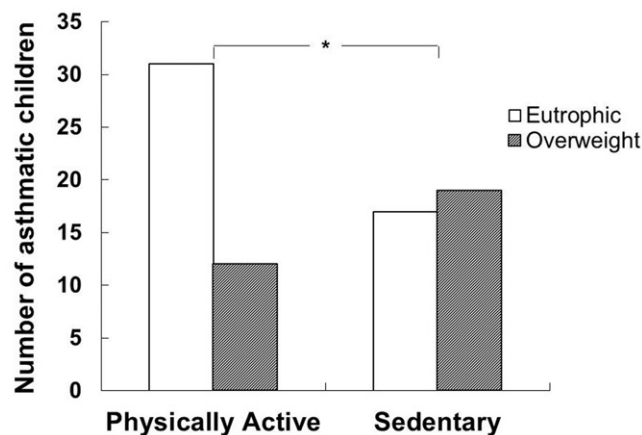


Figure 2. Relationship between physical activity and weight. In asthmatic group, more physically active children were of normal weight, while more sedentary children were overweight. Chi-squared test statistical was used; **p* < 0.05: statistical significance.

Table 2). Interestingly, sedentary asthmatic children were proportionately more overweight than asthmatic children who were more physically active. (*p* < 0.05, Figure 2). Among the asthmatic children, there were also no differences in the pulmonary function variables (fixed obstruction, variability and response to bronchodilator) or in the TNS and time of moderate physical activity (*p* > 0.05, Table 3).

Discussion

Our results demonstrate that independent of their disease severity, children with good asthma control had levels of daily physical activity (DPA) similar to those of children without asthma. The levels of physical activity were greater during weekdays than on weekend days for all children. Our results also show that sedentary asthmatic children were more overweight than physically active asthmatic children, but this did not correlate with changes in pulmonary function.

Our results show that children with mild, moderate and severe persistent asthma, as well as children without asthma, have similar DPA levels. While it is widely accepted among health professionals that asthmatic children are more sedentary than children without asthma [2,10–13], other studies suggest that both groups have similar DPA [8,14–18]. The discrepancies between these studies may be due to factors such as the instruments used to assess DPA, the criteria for diagnosis of the disease, and categorization with respect to good asthma control, disease severity and the children's ages. In our study, DPA was evaluated using accelerometers and all asthmatic children were diagnosed by a pediatrician, had good asthma control and were stratified into three levels of disease severity using the GINA criteria [1]. Previous studies showed that asthmatic patients who achieve good asthma control demonstrate improved physical fitness; however, most of these studies have evaluated children with mild persistent asthma [8]. To the best of our knowledge, our study is the first to evaluate daily physical activity in asthmatic children with distinct levels of disease severity and under good asthma control. Taken together, these results suggest that asthmatic children can perform normal DPA independent of the severity of their disease.

Table 3. Daily physical activity performed per week by asthmatic children with respect to pulmonary function.

	Number of children	Total numbers of steps	<i>p</i>	Minutes in moderate physical activity	<i>p</i>
Fixed obstruction	Present (20)	14 763 ± 3853	0.63	50.5 ± 13.2	0.49
	Absent (59)	15 629 ± 4214		55.4 ± 15.4	
Response to BD	Present (65)	15 401 ± 4204	0.82	53.9 ± 14.6	0.60
	Absent (14)	15 378 ± 3646		57.3 ± 17.5	
Variability	Present (23)	14 983 ± 3862	0.75	52.5 ± 15.9	0.76
	Absent (56)	15 493 ± 4301		54.7 ± 14.9	

The numbers of children for whom the pulmonary function variable was present or absent are shown. The total numbers of steps and the time in moderate physical activity are shown as the means and SDs.

Currently, there are four methods for evaluating the level of physical activity: questionnaires and motion sensors (used to assess DPA), and maximal and sub-maximal tests to evaluate physical fitness [29,30]. Currently, we are aware of six studies that have evaluated DPA in asthmatic children using accelerometers to compare physical activity between asthmatic and non-asthmatic children [8,10,14–16,18]. Five studies showed no difference in DPA between asthmatic and non-asthmatic children [8,14–16,18], and one study showed that asthmatic children performed less physical activity than the non-asthmatic children [10]. All of the studies in which DPA was shown to be similar between asthmatic and non-asthmatic children included solely asthmatic children with mild persistent asthma [8,14–16,18], that is, children with fewer asthma symptoms [1]. Only the Firrincieli [10] study evaluated the physical fitness of the children with moderate and severe persistent asthma. The study showed that those children are less fit than non-asthmatic children [13]. Unfortunately, the Firrincieli study included only children from 3 to 5 years of age, precluding direct comparison with the results presented here. Thus, our study contributes the important information that good asthma control is more important than disease severity in maintaining DPA in asthmatic children.

The children in all groups (asthmatics and controls) performed more physical activities during the week than on weekend days. Most studies have shown that children are more active during the weekdays in various populations [31,32].

There are discrepancies [33], however, possibly related to economic, environmental, political, cultural and geographic dimensions [34]. We believe that daily routines such as going to school and physical education classes contributed to greater DPA during weekdays. In addition, it is possible that parents living in larger cities tend to keep their children at home during weekends in order to minimize exposure to unsafe situations [35]. This is compatible with the situation in São Paulo, the third most populated city in the world with over 12 million habitants and located in a developing country.

The current study demonstrated that asthmatic children with lower DPA were more prone to be overweight, regardless of disease severity. These data suggest that despite the fact that, in general, asthmatic children have similar DPA to non-asthmatics, special attention should be paid in clinical practice to those children who are less physically active because they are likely to become overweight or obese and might have poor asthma control.

Our study has some limitations. First of all, this is a cross-sectional study and it is not possible to demonstrate a cause-and-effect relationship between good asthma control and DPA; however, we believe that this investigation represents the first step towards a comprehensive understanding of how disease control can improve maintenance of DPA in asthmatic children. Secondly, the motion sensor equipment used to evaluate physical activity in our study did not quantify intense physical activity, precluding comparisons of higher levels of DPA; however, it is known that high intensity physical activities in children are generally infrequent and are performed only for brief periods [36,37].

Conclusion

Our results show that asthmatic children with good asthma control performed similar daily physical activity to their non-asthmatic peers independent of disease severity, lung function and day of the week. However, sedentary asthmatic children were more likely to be overweight. Despite physical activity being multifactorial, achieving good asthma control may provide asthmatic children the ability to perform regular physical activities similar to those of non-asthmatic children.

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Declaration of interest

The protocol was submitted and approved by the Ethic's Committee of our University and all family members gave written signed consent. All authors wish to state that no company has provided grants, gifts, equipments and or any drugs to this study or any participant. Also, any tobacco company has not funded any part of this manuscript. Any unexpected adverse effects or changes in protocols have been disclosed. The main author had access to the entire manuscript and by that means he takes the responsibility for the integrity and accuracy of the data.

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