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Objectively measured daily-life physical activity of moderate-to-severe Brazilian asthmatic women in comparison to healthy controls: A cross-sectional study

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ABSTRACT

Considering the complex relationship between asthma symptoms and exercise, asthmatics are usually believed to be less active in daily life than healthy subjects. However, few studies have objectively assessed daily-life physical activity (DLPA) of asthmatic adults. *Objective:* To objectively assess DLPA of a sample of Brazilian asthmatic women in comparison to healthy controls, and to investigate the associations between DLPA and asthma control, health-related quality of life, anxiety and depression levels, and the Six-minute walk test (6MWT) in this population. *Methods:* Sixty-six women were included, 36 in the asthma group (AG) and 30 in the control group (CG). The AG was composed by clinically stable moderate-to-severe asthmatics. The CG was composed by apparently healthy volunteers. All subjects underwent DLPA assessment (considered as the average of steps taken during six consecutive days measured by a pedometer) and performed the 6MWT. Additionally, participants in the AG were assessed using the Asthma Control Questionnaire, the Asthma Quality of Life Questionnaire (AQLQ), and the Hospital Anxiety and Depression Scale. *Results:* There was no difference between the AG and the CG regarding DLPA (7490.3 ± 3330.2 vs 6876.4 ± 3242.1 steps respectively, $p = 0.45$), even after adjustment for covariates. DLPA was significantly correlated to the activity limitation domain of the AQLQ among asthmatics ($r = 0.43$, $p < 0.01$). *Conclusion:* Despite the association between self-perceived activity limitation and DLPA among asthmatics, there were no differences regarding DLPA between a sample of moderate-to-severe Brazilian asthmatic women and apparently healthy controls.

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Introduction

Asthma is a chronic disease characterized by variable expiratory airflow limitation and respiratory symptoms usually triggered by external factors, including allergen or irritant exposure, weather changes, and viral respiratory infections [1]. Exercise might also elicit asthma symptoms, a phenomenon known as exercise-induced bronchoconstriction (EIB) [2, 3].

The fear of having asthma symptoms triggered by exercise can hinder physical activity (PA) practice [4] and can result in a detrimental cycle of inactivity, deconditioning, and dyspnea. In fact, a comprehensive population-based study on the impacts of EIB in asthmatic adults revealed that almost one-half of the patients reported PA avoidance because of respiratory symptoms [5]. However, simple attitudes, such as pretreatment with short-acting bronchodilator medication, might prevent EIB [6] and allow exercise practice. Moreover, it has been demonstrated by systematic reviews that physical training improves

aerobic fitness and is well tolerated by asthmatics [7, 8]. Additionally, benefits in quality of life [9–11] and disease control [9], as well as reductions in anxiety and depression levels [10], have been attributed to exercise in asthma literature.

It is usually believed that asthmatic patients present lower levels of PA compared to the general population. However, studies investigating the PA levels of asthmatic adults have provided conflicting results [12–15], and whether physical inactivity prevalence among asthmatics differs from general population remains unclear. Moreover, the available data on the subject derive mostly from questionnaires and self-reports, and few studies have objectively assessed daily-life physical activity (DLPA) of asthmatic adults. Considering the higher prevalence of asthma among women [16] and the differences between genders regarding PA levels [17], the aim of the present study was to objectively assess DLPA of a sample of Brazilian asthmatic women in comparison to

sex-matched healthy controls. We hypothesized that the asthmatic group would present a lower DLPA level in comparison to controls. Additionally, we aimed to investigate the associations between DLPA and asthma control, health-related quality of life, submaximal exercise capacity, and anxiety and depression levels in this population.

Methods

Study design and subjects

This is a cross-sectional study performed at a Brazilian Teaching Hospital (Hospital Universitário da Universidade Federal de Juiz de Fora, Minas Gerais, Brazil). Volunteers were recruited from the patients seen at the Asthma Outpatients Clinic (asthma group—AG) and at the Gynecology Outpatients Clinic (control group—CG) of the hospital. In both cases, consecutive patients from the public health system who presented at the clinics for scheduled medical appointments were assessed regarding study eligibility, and were invited to participate. The Ethics Review Board of the institution approved the study, and all participants provided written informed consent prior to study inclusion.

Participants were included if they were 18–65 years old and, in the AG, if they presented asthma diagnosis for at least 6 months (according to the Global Initiative for Asthma [18] criteria), were under regular drug therapy with at least moderate doses of inhaled corticosteroids or with inhaled corticosteroids plus long-acting beta2-agonists and were clinically stable in the previous 30 days. For both groups, exclusion criteria were: male sex, PA practice over once a week, lung diseases (besides asthma for AG), musculoskeletal or neurological conditions that, according to clinical judgment, could impair daily physical activities, more than 10 pack-years of smoking, illiteracy, pregnancy, and refusal to participate.

Assessments

After obtaining the written informed consent from the volunteers, their anthropometric, medical, and sociodemographic data were collected. Submaximal exercise capacity was assessed through the Six-minute walk test (6MWT) [19].

DLPA was assessed using a pedometer (SW-200, YAMAX, Tokyo, Japan). Patients were instructed to place the device at the waistline and to wear it during the awake periods of six consecutive days, except during showers and water activities. They were asked to maintain their regular routine and to record the number of steps taken

each day on a diary. The DLPA measurement was considered for analysis if the patient wore the device for at least five days, including one day of the weekend. DLPA was considered as the average of steps/day taken during the assessment period.

Additionally, participants from AG underwent forced spirometry with bronchodilator test [20] (Koko PFT spirometer, PDS Instrumentation, Louisville, CO, EUA) and were assessed regarding disease control, health-related quality of life, and anxiety and depression scores. Asthma control was assessed through the Asthma Control Questionnaire [21] (ACQ), in which patients are asked to answer 6 questions on important aspects of asthma control (night-time waking, symptoms on waking, activity limitation, shortness of breath, wheeze, and rescue short-acting b2-agonist use) on a 7-point scale, based on their experiences during the previous week. A similar scale is used to score the pre-bronchodilator forced expiratory volume in the first second (%FEV₁). The final score is the average of the 7 items, ranging from 0 (totally controlled) to 6 (severely uncontrolled). A score of 0.75 indicates well-controlled asthma, whereas a score of 1.50 indicates inadequate control [22].

Health-related quality of life was assessed using the standardized version of the Asthma Quality of Life Questionnaire [23] (AQLQ). It is a 32-item disease-specific questionnaire designed to measure the functional impairments of asthmatic adults during the previous 2 weeks [24]. The items may be grouped into four domains: activity limitations (11 items), symptoms (12 items), emotional function (5 items), and exposure to environmental stimuli (4 items) [25]. Each item is scored on a 7-point scale, ranging from 1 (totally impaired) to 7 (no impairment). The score of each domain is calculated as the average of the respective items, whereas the total score is the average of all 32 questions.

Anxiety and depression levels were assessed using the Hospital Anxiety and Depression Scale [26] (HADS). Its purpose is to screen for clinically significant anxiety and depressive symptoms in medically ill patients [27]. The HADS is composed by 14 items, equally divided into anxiety- and depression-related questions. Each item is rated on a 4-point scale, ranging from 0 (no impairment) to 3 (highest impairment). Anxiety and depression scores are considered as the sum of the respective items, ranging from 0 to 21.

Statistical analysis

Data were summarized as means and standard deviations, medians, and interquartile ranges or percentages, as appropriate (Kolmogorov–Smirnov test). Differences between groups were assessed by the independent *t* test,

Mann–Whitney *U* test, or chi-square test, according to data normality and characteristics. Univariate regression analysis was used to assess the effects of group allocation on DLPA. Multivariate analysis was used in order to account for the effects of covariates, with DLPA as the dependent variable and group allocation and variables significantly different between groups as independent variables. The associations between DLPA and the ACQ score, the total score, and the different domains of the AQLQ, the depression and anxiety scores of the HADS and the 6MWT were assessed using Pearson or Spearman correlation, as appropriate. The level of significance was set at 5% for all cases. All tests were performed using SPSS version 13.

Results

Sixty-six participants were included, 36 in AG and 30 in CG. Table 1 presents the anthropometric and sociodemographic data of volunteers, as well as the variables assessed in each group.

As presented in Table 1, the groups differed significantly in education level ($p = 0.02$) and family income ($p < 0.01$). There was no difference between groups regarding DLPA (7490.3 ± 3330.2 vs 6876.4 ± 3242.1 , $p = 0.45$). In univariate analysis, considering DLPA as the dependent variable and group allocation as the independent variable, the regression model was not statistically significant ($R^2 = 0.01$, $p = 0.45$). The multiple regression model, considering DLPA as the dependent variable and group allocation, educational level, and family income as independent variables, also failed to reach statistical significance ($R^2 = 0.01$, $p = 0.89$).

Table 2 presents the post-bronchodilator pulmonary function and ACQ, AQLQ, and HADS scores of AG patients. Regarding the correlations performed between DLPA and the ACQ score, the total score and the different domains of the AQLQ, the depression and anxiety

Table 2. Post-bronchodilator pulmonary function and ACQ, AQLQ, and HADS scores of AG patients.

Asthma group ($n = 36$)	
FEV ₁ (%)	78.8 ± 21.8
FVC (%)	$97.0 [29.2]$
FEV ₁ /FVC	0.7 ± 0.1
ACQ	1.9 ± 1.1
AQLQ-T	4.1 ± 1.2
AQLQ-S	4.3 ± 1.3
AQLQ-AL	4.2 ± 1.1
AQLQ-EF	$3.7 [3.6]$
AQLQ-ES	3.7 ± 1.7
HADS-A	11.1 ± 4.5
HADS-D	8.5 ± 4.1

FEV₁ (%): post-bronchodilator forced expiratory volume in one second (percentage of predicted); FVC (%): post-bronchodilator forced vital capacity (percentage of predicted); ACQ: Asthma control questionnaire score; AQLQ-T: Asthma quality of life questionnaire-total score; AQLQ-S: Asthma quality of life questionnaire-symptom domain score; AQLQ-AL: Asthma quality of life questionnaire-activity limitation domain score; AQLQ-EF: Asthma quality of life questionnaire-emotional function domain score; AQLQ-ES: Asthma quality of life questionnaire-exposure to environmental stimuli domain score; HADS-A: Hospital Anxiety and Depression Scale-anxiety score; HADS-D: Hospital Anxiety and Depression Scale-depression score. Data expressed as means $\pm$ standard deviations or medians [interquartile ranges].

scores of the HADS and the 6MWT, statistical significance was found only between DLPA and the activity limitation domain of the AQLQ ($r = 0.43$, $p < 0.01$).

Discussion

The results of the present study show that, in a sample of Brazilian women, there were no differences regarding DLPA between moderate-to-severe asthmatics and apparently healthy controls, even after adjustment for covariates. Moreover, among asthmatics, DLPA was significantly correlated to the activity limitation domain of the AQLQ. To the best of the authors' knowledge, this is the first published study to objectively assess DLPA of Brazilian asthmatic adults and to correlate it with disease control, health-related quality of life, 6MWT, and anxiety and depression levels.

Considering the complex relationship between asthma and exercise, it would be expected to observe a lower DLPA level among asthmatics in comparison to healthy controls. However, in the present study, the average difference between groups (613.9 steps) failed to reach statistical significance. The authors are not aware of studies examining the minimal important difference (MID) for steps/day or other measurements of DLPA in asthmatic adults. Recently, Demeyer et al. [28] provided the first report on the MID for PA in patients with chronic obstructive pulmonary disease (COPD). According to the authors, the MID after pulmonary rehabilitation lies between 600 and 1100 steps/day in this population. Interestingly, the average difference between groups observed in the present study is very close to the lower range of the aforementioned interval. Moreover, considering

Table 1. Data of volunteers according to group allocation.

	Asthma group ($n = 36$)	Control group ($n = 30$)	<i>p</i> value
Age (years)	45.8 ± 12.3	44.3 ± 11.6	0.62
BMI (kg/m^2)	$28.9 [7.2]$	$26.9 [7.4]$	0.45
Education (≥ 8 years)	14 (38.9%)	20 (66.7%)	0.02
Family income (MW)			<0.01
≤ 2	22 (61.1%)	7 (23.3%)	
Between 2 and 5	13 (36.1%)	19 (63.3%)	
>5	1 (2.8%)	4 (13.3%)	
6MWT (m)	525.1 ± 56.9	529.8 ± 68.1	0.76
DLPA (steps/day)	7490.3 ± 3330.2	6876.4 ± 3242.1	0.45

BMI: body mass index; MW: Minimum wage; 6MWT: Six-minute walk test; DLPA: daily-life physical activity. Data expressed as means $\pm$ standard deviations, medians [interquartile ranges], or absolute values (percentages).

the known impacts of COPD on PA [29], it is possible to infer that the MID for DLPA in asthmatic adults would be higher than the one reported by Demeyer et al. [28]. Taken together, these facts reinforce the absence of clinically significant differences regarding DLPA between asthmatics and controls found in the present study.

Previous studies on asthma and PA have provided conflicting results: while some have reported lower PA levels among asthmatics [13, 14], others have found similar [15] or even higher [12] PA levels in this group in comparison to healthy subjects. It is noteworthy that the available evidence derives mostly from questionnaires and self-reports. This fact may account for the discrepancies observed in the literature, considering that these methods, although convenient for large population-based studies, present low-to-moderate correlation with objective measurement instruments, such as pedometers and accelerometers [30].

The use of objective assessment methods could better clarify the relationship between asthma and DLPA. The first objective data on DLPA of asthmatic adults were recently provided by van't Hul et al. [31]. In this study, asthmatics walked, on average, 1200 steps less than healthy subjects, as well as spent less time on vigorous PA. Some reasons might justify the differences between these and our results. The first one is the studies' sample sizes. Even though there was no prior sample size calculation in both studies, the van't Hul et al. work [31] comprised 422 subjects (221 asthmatics), which enables more statistical power to detect differences between groups. The second one is the use of different criteria for CG selection. In the present study, the CG was selected among patients seen at the same hospital, whereas in the aforementioned study [31], the CG was recruited among relatives and employees of the hospital where the study was performed. This might have influenced the composition of the CGs in both studies. In fact, while the average number of steps taken in the AG was quite similar between studies (7490 *vs* 7593 steps, for the present study and van't Hul et al. [31], respectively), in the CGs, the difference was more pronounced (6876 *vs* 8795 steps, respectively). Moreover, in our study, we only included subjects not engaged in regular exercise practice. This criterion was chosen based on the limitation of pedometers to detect non-ambulatory activities, such as swimming or cycling, thus reflecting the true PA pattern of the included volunteers. However, this might have led to the inclusion of less active subjects in comparison to the van't Hul et al. work [31]. Finally, in order to avoid the known influence of gender on PA profile [17], our sample was composed solely by women, while the van't Hul et al. study [31] included subjects from both genders. Considering that women are less active than men [17], this fact might also have influenced our results.

Previous reports on the association between PA and asthma-related outcomes have shown better results among more active patients, such as lower risks of exacerbation [32, 33] and health care use [32], as well as better disease control [34]. However, as these results were based on PA self-reports, it limits a direct comparison with our results. The first association between asthma control and objectively assessed PA in asthmatic adults was also provided by van't Hul et al [31]. The authors reported a significant (albeit weak) correlation between average steps/day and ACQ score. In our sample, composed by moderate-to-severe sedentary asthmatic women, this association was not found. This might be due to, on one hand, our small sample size, and on the other hand, to the differences among samples' characteristics. Considering that we only included sedentary women, it is possible that DLPA has no association with asthma control in this population. Future studies are needed, with larger samples and patients with different PA profiles, in order to better understand the association between DLPA and asthma in adults.

In a previous work [35] investigating the relationship between maximal aerobic capacity and psychosocial factors in adults with moderate-to-severe asthma, an association between reduced exercise capacity, low health-related quality of life, and increases in depressive symptoms was reported. To the best of our knowledge, no previous study has investigated the associations between objectively measured DLPA and health-related quality of life, 6MWT, and anxiety and depression levels in this population. In our sample, less active subjects perceived themselves as more limited by asthma symptoms in their daily activities, as shown by the moderate correlation between DLPA and the activity limitation domain of the AQLQ. This is in line with previous studies showing that many asthmatics report to perceive daily activity limitations as a consequence of the disease [4, 5]. Interestingly, in our sample, DLPA was not related to physical capacity (measured by the 6MWT) or to the disease control. So, one could argue that even in the absence of an actual exercise limitation or despite good disease control, some asthmatic patients could restrict DLPA as a consequence of his/her self-perception of limitation. Considering our study design, no causal relationship could be established here, and whether the activity limitation perception influences (or is influenced by) DLPA remains unclear. More studies are needed in order to better understand the factors associated to DLPA in asthmatic adults.

Our study presents some limitations. First, we included only women, what precludes the generalization of our results to asthmatic men. Secondly, as our DLPA data are based on pedometers' outputs, we could not assess PA

intensity or duration. Finally, we report data of a relatively small sample. In fact, our power to detect a difference between groups regarding DLPA was low, approximately 11.4% ($\alpha = 0.05$, two-tailed test). However, considering the scarcity of data on objectively assessed DLPA of asthmatic adults, we consider that our results provide useful information for future research on this field.

In conclusion, we found no differences regarding DLPA between a sample of moderate-to-severe Brazilian asthmatic women and apparently healthy controls. Moreover, DLPA was significantly correlated to the activity limitation domain of the AQLQ among asthmatics. Future studies, with larger samples, are needed in order to better clarify the impacts of asthma on DLPA of asthmatic adults.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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