

Balance Deficits are Correlated with Bronchial Obstruction Markers in Subjects with Asthma

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Abstract. [Purpose] Balance deficits are increasingly recognized in chronic obstructive pulmonary disease, but little is known regarding this issue in asthma. Our primary aim was to assess the correlation between postural balance and pulmonary function in adults with asthma. Secondly, we aimed to correlate balance with functional capacity and body mass index in these subjects. [Methods] A cross-sectional study of 26 adults with asthma was performed in which they were subjected to stabilometry, pulmonary function testing, a 6-minute walking test, and nutritional assessment. [Results] We found significant correlations of forced expiratory volume at one second ($\rho=-0.49$) and total lung capacity ($\rho=0.39$) with mediolateral displacement with feet apart/eyes open. Significant correlations were observed between peak expiratory flow and a number of stabilometric parameters. There were several significant correlations between airway-specific conductance and the tasks performed on the force platform, especially one with the feet apart/eyes open. The Berg Balance Scale revealed significant correlations with mediolateral displacement, mediolateral range, and anteroposterior range for feet together/eyes closed ($\rho=-0.49$). There were no significant correlations between stabilometry, body mass index, and six-minute walking distance. [Conclusion] In adults with asthma, there is an association between balance and the bronchial obstruction markers. This finding may contribute to improvement of rehabilitation programs for these subjects.

Key words: Asthma, Respiratory function tests, Postural balance

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INTRODUCTION

Asthma is a chronic inflammatory disease that is characterized by bronchial hyperresponsiveness and variable airflow limitation. Inflammation, which constitutes the main pathophysiological etiology of the disease, presents with eosinophilic infiltration, mast cell degranulation, damage to the walls of the respiratory tract, and activation of T helper 2 (Th2) lymphocytes¹⁾. The World Health Organization estimates that 255,000 people died of asthma in 2005 and that 300 million people worldwide suffer from the disease²⁾. In asthma, airflow obstruction results in excessive recruitment of the expiratory and accessory inspiratory muscles, which contributes to adaptive hypertrophy. Under high tension, these muscles shorten and lose flexibility, decreasing muscle length and strength. However, the biomechanics of the rib cage influences overall body mechanics. Thus, a respiratory imbalance could potentially result in altered total

body balance^{3, 4)}.

However, body balance is a complex functional process that involves not only the somatosensory system but also the vestibular system and visual receptors, with participation of both afferent and efferent structures. Balance can be affected by changes in the sequence of muscle activation, delayed recruitment of synergistic muscles, activation of antagonist muscles, delayed activation of postural responses, and even by changes in the amplitude of muscle response. These changes lead to a decrease in a person's ability to detect and control mediolateral and anteroposterior body oscillations both statically and during movement^{4, 5)}.

The current evidence suggests that there is a significant deficit in postural balance in different pulmonary diseases and that the pathophysiological basis for these changes is multifactorial³⁾. The risk factors for falls in subjects with respiratory disease include lower limb weakness, balance disorders, nutritional depletion, malnutrition, affective states, cognitive impairment, and the use of medications. Many of these risk factors are observed in patients with chronic obstructive pulmonary disease (COPD)⁶⁾. Several studies suggest that the control of anteroposterior balance is impaired in individuals with severe COPD who require supplemental oxygen^{6, 7)}. Whether the increase in the amplitude of the mediolateral center of pressure is closely related to falls in subjects with chronic obstructive respiratory disease has

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been questioned^{7, 8}.

Although asthma has been well studied in terms of pathophysiology and pharmacokinetics, little is known about changes in postural balance resulting from this condition. Asthma might cause systemic repercussions due to its severity and the effects of treatment, including myopathy caused by chronic use of oral corticosteroids and steroid-caused macular degeneration^{9, 10}. We hypothesized that subjects with more severe disease according to pulmonary function assessment have major changes in balance control. We also hypothesized that lower functional capacity and poor nutritional status are associated with major changes in balance in adults with asthma. In these subjects, a possible relationship between postural imbalance and lung disease may provide important information for planning rehabilitation programs. Therefore, our primary aim was to assess the correlation between postural balance and pulmonary function. Secondly, we aimed to correlate balance with functional capacity and body mass index (BMI) in this group of subjects.

SUBJECTS AND METHODS

Subjects

We conducted a cross-sectional study of subjects recruited from a medical center in the city of Rio de Janeiro, Brazil. Individuals with asthma, aged >18 years, were included in the study. The diagnosis and classification of asthma were performed according to the Global Initiative for Asthma criteria¹¹. The classification of asthma according to the value of forced expiratory volume at one second (FEV₁) was established as follows: intermittent or mild persistent – FEV₁>80% predicted; moderate persistent – FEV₁ between 60–80% predicted; and severe persistent – FEV₁<60% predicted¹¹. Individuals who were taking psychotropic medications, who were unable to perform the Berg Balance Scale (BBS) tasks, and who had a diagnosis or history of cardiovascular disease, vestibular comorbidity, tobacco use or respiratory infection within the previous three months, or some physical disability that impaired locomotion were excluded from the study. Subjects over 50 years of age were also excluded from the study due to increased risk of falls in this population^{6, 12, 13}. All subjects continued their regular asthma treatment for the duration of the study according to the recommendations of the Global Initiative for Asthma¹¹.

This study was approved by the Institutional Research Ethics Committee under number 012/2011. All subjects signed an informed consent form, and the research was in compliance with the Helsinki Declaration ethical standards.

Methods

The subjects underwent stabilometry on a force platform (AccuSway Plus, AMTI, Watertown, MA, USA), and the data collected (sampling frequency of 100 Hz) were analyzed using the Suite EBG software, version 1.0, at the Laboratory of Human Movement of Augusto Motta University, Rio de Janeiro, Brazil. All participants were tested during four postural tasks: feet apart/eyes open (FAEO), feet together/eyes open (FTEO), feet apart/eyes closed (FAEC),

and feet together/eyes closed (FTEC). The subjects were asked to maintain a static position with their eyes focused on a target on the wall for 30 seconds. Then, the following stabilometric variables were calculated: mediolateral standard deviation (X SD), anteroposterior standard deviation (Y SD), mediolateral range (X range), anteroposterior range (Y range), effective area, average velocity, mediolateral maximum velocity (X max velocity), and anteroposterior maximum velocity (Y max velocity)^{14–16}. Additionally, on the day of recruitment, we used the BBS also to assess the postural balance. This scale consists of 14 tasks with scores ranging from 0 to 4. The cutoff point that suggests a risk of falling is 47 points¹⁷.

Spirometry and whole-body plethysmography were performed using the Collins Plus Pulmonary Function Testing System (Warren E. Collins, Inc., Braintree, MA, USA) at the Laboratory of Pulmonary Function of the State University of Rio de Janeiro. All tests followed the standards of the American Thoracic Society (ATS)¹⁸. The equations described by Pereira (spirometry) and Neder (static pulmonary volumes and maximal respiratory pressures) were adopted for the interpretation of functional parameters^{19–21}. The 6-minute walking test (6MWT) was also performed at this location in a 30-meter-long corridor according to the ATS's recommendations²². The predictions for each subject were calculated using the equations described by Gibbons et al²³.

The sample size was calculated using MedCalc version 8.2 (Medcalc Software, Mariakerke, Belgium). A minimum of 23 cases were required to test for the alternative hypothesis that the correlation coefficient is higher than 0.50 with $\alpha=5\%$ (significance level) and $\beta=80\%$ (power of test).

The data were described using medians and interquartile ranges (25–75% percentiles) or frequencies (percentages). Because the variables did not fit a normal distribution by the Shapiro-Wilk test, nonparametric tests were used. The Mann-Whitney test was used for the respiratory muscle strength comparisons. Friedman's test was used in order to compare the four postural tasks tested by stabilometry, and the Wilcoxon signed-rank test was used to determine where the differences were. The correlations were evaluated using the Spearman's correlation test. Once asthma severity was assessed through pulmonary function testing, we evaluated the correlations between measures of pulmonary function and parameters recorded on the force platform. In order to evaluate if other study variables were correlated with balance, we also studied the associations between stabilometry, BBS, six-minute walking distance (6MWD), and BMI. Correlation coefficients <0.25 (or –0.25) represent weak correlation; those between 0.25 and 0.50 (or –0.25 and –0.50) represent reasonable correlation; those between 0.50 and 0.75 (or –0.50 and –0.75) represent moderate to good correlation; and those >0.75 (or –0.75) represent good to excellent correlation²⁴. The analyses were performed using the statistical package SigmaStat for Windows, Version 3.5 (Systat Software, Inc., Chicago, IL, USA). Statistical significance was defined as $p<0.05$.

RESULTS

Thirty-six adults with asthma were assessed between September 2011 and April 2012, and twenty-six completed the study. Of the ten excluded subjects, three were excluded for only completing part of the tests, one was excluded for not being able to perform pulmonary function testing, two were excluded for having the sequelae of tuberculosis, and four were excluded because they withdrew from the study. According to the value of FEV₁, the subjects were classified as follows: mild persistent asthma = 4, moderate persistent asthma = 15, and severe persistent asthma = 7.

The majority of adults with asthma were female (73%) with a median age of 25.4 (22.5–31.2) years. The median 6MWD was 591.5 m (526–663 m). The percentage of the predicted value (median) for this distance was 80.6 (74.7–92.2) (Table 1). Four subjects had a BMI <25 kg/m²; 15 had a BMI between 25 and 30 kg/m²; and seven had a BMI ≥30 kg/m². Of the 26 adults with asthma, the maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) were 50.5% (31–68.5%) predicted and 54.5% (44–75.7%) predicted, respectively. Regarding the classification of the disease, subjects with severe asthma showed a lower MIP [29 (26.5–51.5) vs. 54 (36–70); *p*<0.001] and lower MEP [38 (36–54) vs. 58 (51–81.5); *p*<0.001] than those with non-severe asthma.

In the sample, nine had a score of 56 points on the BBS, 12 had a score of 55 points, and five had a score of 54 points. Regarding the force platform assessment, we observed significant differences in all stabilometric variables when the task was modified (Table 2).

The correlation coefficients between pulmonary function parameters, BMI, and stabilometric variables are shown in Tables 3 and 4. FEV₁ and FEV₁/FVC were significantly correlated with X SD under the FAEO conditions. PEF was significantly correlated with X SD and X range under both the FAEO and FAEC conditions. TLC was significantly correlated with X SD under the FAEO conditions; and with X range under the FAEC conditions. RV/TLC was significantly correlated with X SD under the FAEO conditions. Raw was significantly correlated with Y range under the

FTEO conditions. SGaw was significantly correlated with X SD, Y SD, X range, Y range, effective area, and velocity average under the FAEO conditions; X SD, X range, effective area, and average velocity under the FAEC conditions; and effective area under the FTEO conditions. There were no significant correlations between pulmonary function parameters, X max velocity, and Y max velocity.

Regarding the BBS, it was significantly correlated with Y SD under the FAEC conditions and with X SD, Y SD, X range, and Y range under the FTEC conditions (*ρ*=–0.49 and *p*<0.01 for all). There were no significant correlations between 6MWD and stabilometric variables.

Table 1. Median and interquartile range for the anthropometry, Berg Balance Scale, functional capacity, and pulmonary function in adults with asthma

Variables	Median (interquartile range)
Sex (female/male)	19/7
Age (years)	25.4 (22.5–31.2)
BMI (kg/m ²)	25.6 (22.3–33.6)
FVC (% predicted)	93.5 (79–104)
FEV ₁ (% predicted)	73.5 (52–84)
FEV ₁ /FVC (%)	80.5 (65–87)
PEF (% predicted)	61.5 (42–77)
TLC (% predicted)	119 (103–126)
RV (% predicted)	138 (105–216)
RV/TLC (%)	39 (34–47)
Raw (cm H ₂ O·L ⁻¹ ·s ⁻¹)	1.44 (0.97–2.48)
SGaw (s·L ⁻¹ ·cm H ₂ O ⁻¹)	0.14 (0.10–0.20)
Berg scores	55.5 (54–56)
6MWD (% predicted)	80.6 (74.7–92.2)

Results expressed as medians (interquartile range) or numbers (%). Abbreviations: BMI, body mass index; FVC, forced vital capacity; FEV₁, forced expiratory volume at one second; PEF, peak expiratory flow; TLC, total lung capacity; RV, residual volume; Raw, airway resistance; SGaw, airway-specific conductance; 6MWD, distance in the six-minute walking distance test.

Table 2. Median and interquartile range for the measurements on the force platform in adults with asthma

Variables	FAEO (task 1)	FAEC (task 2)	FTEO (task 3)	FTEC (task 4)	Friedman's test / Wilcoxon signed-rank test
X SD (cm)	0.18 (0.13–0.32)	0.21 (0.16–0.36)	0.43 (0.31–0.54)	0.41 (0.36–0.66)	<i>p</i> <0.001 / 1-3, 1-4, 2-3, 2-4
Y SD (cm)	0.36 (0.22–0.53)	0.33 (0.22–0.56)	0.42 (0.22–0.51)	0.50 (0.36–0.63)	<i>p</i> <0.001 / 1-4, 2-4
X range (cm)	0.97 (0.70–1.37)	0.93 (0.75–1.57)	1.90 (1.65–2.75)	2.23 (1.67–3.11)	<i>p</i> <0.001 / 1-3, 1-4, 2-3, 2-4, 3-4
Y range (cm)	1.79 (1.07–2.46)	1.52 (1.03–2.51)	1.90 (1.06–2.64)	2.43 (1.67–3.11)	<i>p</i> <0.001 / 1-4, 2-4, 3-4
Effective area (cm ²)	0.47 (0.21–1.27)	0.55 (0.30–1.73)	1.26 (0.45–2.63)	1.41 (0.76–2.82)	<i>p</i> <0.001 / 1-3, 1-4, 2-3, 2-4, 3-4
Average velocity (cm/s)	0.50 (0.36–0.56)	0.62 (0.50–0.82)	0.72 (0.57–0.87)	1.07 (0.76–1.48)	<i>p</i> <0.001 / 1-3, 1-4, 2-3, 2-4, 3-4
X max velocity (cm/s)	1.99 (1.08–3.09)	1.77 (1.21–2.47)	2.76 (2.08–4.57)	3.72 (2.66–5.23)	<i>p</i> <0.001 / 1-3, 1-4, 2-3, 2-4, 3-4
Y max velocity (cm/s)	2.41 (1.96–5.40)	2.72 (1.98–3.59)	2.23 (1.77–4.02)	3.46 (2.62–5.49)	<i>p</i> <0.001 / 1-4, 3-4

Results expressed as medians (interquartile range) or numbers (%). Friedman's test (comparisons of the four postural tasks) / Wilcoxon signed-rank test (comparisons between postural tasks): dashes are used to indicate significant differences between tasks. Abbreviations: X SD, mediolateral standard derivation; Y SD, anteroposterior standard derivation; X range, mediolateral range; Y range, anteroposterior range; X max velocity, mediolateral maximum velocity; Y max velocity, anteroposterior maximum velocity; FAEO, feet apart, eyes open; FTEO, feet together, eyes open; FAEC, feet apart, eyes closed; FTEC, feet together, eyes closed.

Table 3. Spearman's correlation coefficients for the measurements on the force platform that resulted in correlation with body composition and spirometry

Variables	Postural tasks	BMI	FVC	FEV ₁	FEV ₁ /FVC	PEF
X SD (cm)	FAEO	-0.10	-0.35	-0.50**	-0.49*	-0.46*
	FTEO	-0.16	0.20	0.04	-0.07	0.02
	FAEC	-0.82	-0.08	-0.21	-0.18	-0.38*
	FTEC	-0.01	-0.16	-0.18	-0.15	-0.19
Y SD (cm)	FAEO	-0.22	-0.10	-0.31	-0.35	-0.29
	FTEO	-0.21	0.28	0.14	0.03	0.11
	FAEC	-0.33	-0.01	-0.11	-0.13	-0.10
	FTEC	-0.16	-0.04	-0.05	-0.29	-0.01
X range (cm)	FAEO	-0.07	-0.23	-0.36	-0.35	-0.39*
	FTEO	-0.08	0.27	0.15	0.05	-0.05
	FAEC	-0.19	-0.09	-0.23	-0.23	-0.43*
	FTEC	-0.02	-0.27	-0.26	-0.20	-0.26
Y range (cm)	FAEO	-0.17	-0.07	0.26	-0.31	-0.29
	FTEO	-0.17	0.23	0.08	-0.01	0.03
	FAEC	-0.34	-0.02	-0.02	-0.12	-0.10
	FTEC	-0.17	-0.08	-0.08	-0.10	-0.10
Effective area (cm ²)	FAEO	-0.19	0.23	-0.27	-0.33	-0.24
	FTEO	-0.21	0.10	0.01	-0.11	-0.03
	FAEC	-0.34	-0.09	-0.23	-0.23	-0.26
	FTEC	-0.10	-0.09	-0.10	-0.08	-0.17
Average velocity (cm/s)	FAEO	-0.34	-0.13	-0.28	-0.29	-0.23
	FTEO	-0.15	0.01	-0.08	-0.12	-0.14
	FAEC	-0.27	-0.02	-0.19	-0.21	-0.19
	FTEC	-0.24	-0.16	-0.13	-0.08	-0.09

X SD, mediolateral standard deviation; Y SD, anteroposterior standard deviation; X range, mediolateral range; Y range, anteroposterior range; FAEO, feet apart/eyes open; FTEO, feet together/eyes open; FAEC, feet apart/eyes closed; FTEC, feet together/eyes closed; BMI, body mass index; FVC, forced vital capacity; FEV₁, forced expiratory volume at one second; PEF, peak expiratory flow. *p<0.05. **p<0.01.

DISCUSSION

The main findings of the present investigation were that, in adults with asthma, there are significant correlations between the stabilometric variables, pulmonary function (indicators of bronchial obstruction), and the BBS and that the alterations in static balance are mainly due to mediolateral displacement of the center of pressure. To the best of our knowledge, this study is the first to assess the correlations between measurements obtained on a force platform and pulmonary function parameters in this group of individuals.

In our study, the oscillations of the center of pressure were different when comparing tests with the eyes open with those with the eyes closed, showing that visual input interferes with the balance of adults with asthma. Similarly, by narrowing the base of support (feet together), our patients showed worse imbalance with statistical significance in all stabilometric parameters measured. Changing from standing with the feet apart to standing with the feet together or from standing with the eyes open to standing with the eyes closed increases whole-body movement patterns to control

standing stability^{15, 25, 26}). Despite these findings being well known in healthy adults^{25, 26}), the numerous mechanisms involved in both systemic repercussions arising from the severity of the disease and the effects of their treatment make us suppose that postural balance is quite impaired in subjects with asthma. Obviously, a control group could help to clarify this speculation.

The small variation in the BBS scores (54–56) demonstrates the homogeneity of our sample in terms of risk of fall in this parameter. Using the BBS, Beauchamp et al.²⁷) evaluated the static balance of 39 elderly subjects with COPD who were divided into two groups according to the number of falls experienced. These subjects, even those who had not fallen, had worse pulmonary function, BBS scores, and 6MWDs than the individuals assessed in our study. We observed a larger variation in stabilometric variables than in BBS scores, probably because use of a force platform is a more sensitive method of detecting balance abnormalities.

Era et al.¹⁴) evaluated 7,979 normal individuals older than 30 years of age with stabilometry using the FAEO task, FAEC task, average velocity, X max velocity, and Y max velocity. Consistent with the present study, a higher X

Table 4. Spearman's correlation coefficients for the measurements on the force platform that resulted in correlation with whole body plethysmography

Variables	Postural tasks	TLC	RV	RV/TLC	Raw	SGaw
X SD (cm)	FAEO	0.39*	0.23	0.38*	0.33	-0.51**
	FTEO	0.01	-0.20	0.18	-0.33	-0.21
	FAEC	0.36	0.06	0.25	0.10	-0.42*
	FTEC	0.01	-0.09	0.12	0.14	-0.11
Y SD (cm)	FAEO	0.21	0.01	0.17	0.30	-0.52**
	FTEO	-0.09	-0.26	0.19	-0.37	-0.44
	FAEC	0.14	-0.07	0.04	-0.04	-0.30
	FTEC	-0.14	-0.23	-0.04	0.18	-0.23
X range (cm)	FAEO	0.28	0.11	0.25	0.29	-0.45*
	FTEO	0.03	-0.19	0.22	-0.32	-0.23
	FAEC	0.42*	0.14	0.29	0.12	-0.46*
	FTEC	0.01	-0.02	0.21	0.12	-0.07
Y range (cm)	FAEO	0.32	-0.06	0.14	0.33	-0.54**
	FTEO	-0.19	-0.22	0.26	0.45*	0.24
	FAEC	0.11	-0.13	0.06	-0.01	-0.30
	FTEC	-0.21	-0.28	-0.09	0.25	-0.22
Effective area (cm ²)	FAEO	0.29	-0.01	0.13	-0.26	-0.48*
	FTEO	0.09	-0.10	-0.11	0.23	-0.44*
	FAEC	0.28	0.03	0.18	0.05	-0.42*
	FTEC	-0.07	-0.20	0.04	0.16	-0.18
Average velocity (cm/s)	FAEO	0.05	-0.04	0.26	0.33	-0.45*
	FTEO	0.08	-0.10	0.01	0.33	-0.37
	FAEC	0.31	0.06	0.13	0.23	-0.43*
	FTEC	0.23	-0.25	-0.06	0.16	-0.04

X SD, mediolateral standard deviation; Y SD, anteroposterior standard deviation; X range, mediolateral range; Y range, anteroposterior range; FAEO, feet apart/eyes open; FTEO, feet together/eyes open; FAEC, feet apart/eyes closed; FTEC, feet together/eyes closed; TLC, total lung capacity; RV, residual volume; Raw, airway resistance; SGaw, airway-specific conductance. * $p < 0.05$. ** $p < 0.01$.

max velocity was observed because spreading the feet apart provides greater mediolateral stability. However, in contrast to our study, the Y max velocity values were larger than those of normal individuals in the youngest age range (30–39 years) when performing the FAEO and FAEC postural tasks. Moreover, women had lower values than men. The X max velocity with the open eyes in adults with asthma was equivalent to that of normal controls in the same age group. On the contrary, in the eyes-closed position, the values were lower than those obtained from normal individuals within the same age range.

Interestingly, Kayacan et al.²⁸⁾ concluded that airflow obstruction and disease duration could reduce the conduction velocity of peripheral nerves and cause neurophysiological changes, such as balance deficits in subjects with obstructive lung disease. These data corroborate our results, although the pulmonary function of adults with asthma was better than the pulmonary function of patients with COPD in the study conducted by Rocco et al.²⁹⁾ In our research, the indicators of bronchial obstruction showed significant correlations with the abnormalities observed on a force platform.

Some hypotheses may explain the results found in our

study. Smith et al.³⁾ showed that balance is impaired in individuals with COPD and that the balance deficit involves mediolateral oscillation instead of anteroposterior control. In our study, we observed several significant correlations between X SD and pulmonary function parameters: forced expiratory volume at one second (FEV_1) under the FAEO conditions, FEV_1 /forced vital capacity (FVC) under the FAEO conditions, peak expiratory flow (PEF) under the FAEO and FAEC conditions, total lung capacity (TLC) under the FAEO conditions, residual volume (RV)/TLC under the FAEO conditions, and airway-specific conductance (SGaw) under the FAEO and FAEC conditions. To some extent, these findings are expected, given that mediolateral control is more dependent on trunk movement, due to the poor efficiency of the ankle muscles for controlling balance in this direction^{30, 31)}. Increased tonic activity of the internal and external abdominal oblique muscles has been observed in healthy individuals during periods of increased respiratory demand³²⁾. Similarly, there is an increase in the neural activity of the diaphragm, erector spinae, latissimus dorsi, and trapezius muscles with increased respiratory demand¹⁵⁾. The increased activity of the superficial trunk muscles and the diaphragm increases trunk stiffness and

probably results in the reduction in trunk movement and balance control. Modified control of trunk muscles and reduction in trunk movement have been associated with increased center of pressure displacement, particularly in the mediolateral direction³³. Therefore, the influence of the trunk muscles on balance and respiration was probably responsible for the association between pulmonary function and X SD³⁴. It is noteworthy that balance impairment is also associated with other consequences of asthma, especially when it is a difficult-to-control disease. In these patients, the use of oral steroids can cause respiratory and peripheral muscle weakness, which, in turn, can contribute to imbalance³⁵. Interestingly, a recent study also showed anxiety as a contributor to the imbalance in subjects with asthma; in fact, anxiety may act as a trigger for imbalance by vestibular malfunctioning when there is no visual or kinesthetic information for proper balance³⁶.

PEF measurements are particularly useful for monitoring subjects with asthma, and collection of them with a peak flow meter may be done at the bedside, in the emergency department, or at home. In our study, we observed several negative correlations between PEF and measurements obtained on a force platform. PEF is determined by the size of the lungs, lung elasticity, and the strength and speed of contraction of the expiratory muscles³⁷. Since muscle strength is one of the determinants of PEF, we think the respiratory muscles also influence the balance control in adults with asthma.

In our study, SGaw demonstrated negative correlations with a large number of stabilometric variables. SGaw shows the conductance per liter of lung volume and is a more sensitive indicator of bronchial obstruction as compared with spirometry³². Since caliber of the airways is under the control of the autonomic nervous system³⁸, we hypothesized that this might be the link between SGaw and standing stability.

Our study did not include a healthy control group and was conducted on a relatively small number of individuals, which prevented multivariate analysis. Despite these limitations, this is the first investigation to evaluate the correlation between postural balance and pulmonary function in adults with asthma. These preliminary results point to the need for future investigations to determine if adults with asthma can benefit from rehabilitative strategies directed to improve body balance.

In conclusion, the present study shows that, in adults with asthma, there is an association between postural balance and bronchial obstruction severity. This finding may have clinical relevance and contribute to improvement of rehabilitation programs for these subjects, since professionals have not previously been concerned with the rehabilitation of postural imbalance in lung disease.

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