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Dynamic lung volumes responses to a single bout graded cycling exercise in obese men with asthma

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Abstract

Asthma is a major public health concern affecting a large percentage of people worldwide. The purpose of this study was to investigate the effects of an acute exercise on spirometry parameters as pulmonary function in a group of asthma patients. Seventeen asthma patients (35 ± 5 yr, 175 ± 7 cm, 95 ± 12 kg) underwent a spirometry test before and after an acute (single bout of exercise) cycling exercise in order to FEV1, FEVI/FVC and MVV as respiratory functional in response to mentioned exercise. Pre- and post exercise independent variables were compared using a paired-samples t-test. Significance was accepted at $P < 0.05$. FEV1 levels were significantly increased in response to acute exercise when compared with baseline levels ($P < .05$). Moreover the other spirometry parameters such as FVC, FEVI/FVC and MVV showed a significant improvement by cycling exercise in studied patients ($P < .05$). Our findings indicate that exercise intervention even for a session can be improving respiratory function in asthma patients. These data provide a clear explanation for exercise-rehabilitation role in Improvement or reducing the severity of asthma.

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Introduction

What is clear is that Asthma is chronic inflammatory disorders of the airways in which mast cells, eosinophils and T-lymphocytes play a major role (Sahoo *et al*., 2009), although the exact mechanisms leading to this disease are not fully understood. The majority of patients with reduced FEV1 have asthma, and it has been established that asthma patients have a higher forced expiratory volume in 1 s (FEV1) and forced vital capacity (FVC) than normal subjects (Mannino *et al.,* 2003). Impaired cardiovascular and respiratory functions are associated with increased mortality and morbidity (Blair *et al.,* 1996; Schunemann *et al.,* 2000). On the other hand, according to the population studies, it has been indicated that impaired lung function as measured by FVC or FEV1, in addition to respiratory diseases, is a powerful predictor of some chronic diseases such as ischemic heart disease and of mortality due to cardiovascular disease (Sin *et al.,* 2005; Schroeder *et al.,* 2003). In this area, the relationship between reduced FEV1 and cardiovascular mortality also exists in those with none-asthma or none-smokers, and even a modest decline in FEV1 is associated with a substantial increase in death from coronary artery disease (Sin *et al.,* 2005).

From the present findings it be concluded that the increased severity of asthma or respiratory impairment characterized by measuring certain spirometric indicators such as FEV1, FVC or forced expiratory volume in 1 s / forced vital capacity (FEV1/FVC) are somehow associated with the prevalence or escalation of some other chronic diseases that are affected one way or another by cardio-respiratory fitness. These findings support the relationship between asthma and cardiovascular diseases. Hence, reducing the severity of asthma or improving respiratory function in these patients and other diseases are the main goals of the health sciences experts. Although today some bronchodilator medications are commonly prescribed in patients with asthma or other lung disease, some scientific sources argue that taking these medications, especially inhaled corticosteroids is associated with some irreparable side effects, such as osteoporosis (Kearney *et al.,* 2009; Bruun *et al.,* 2003). Hence, identification of other non-pharmacological approaches such as exercise to improve or reduce the severity of this disease is particularly important. Hence, the present study aims to determine the effect of acute exercise on some indices of respiratory function in a group of middle-aged asthmatic patients.

Material and methods

This study's purpose was 1) to compare pulmonary functional between obese men with and without mild to moderate asthma, 2) to determine effect a single bout graded cycling exercise on pulmonary function in asthma patients. For this purpose, we compared some markers indicative of pulmonary function as FEV1, FVC, Maximum voluntary ventilation (MVV) and FEV1/FVC between adults obese men (36 ± 6) with asthma (n = 16) and without asthma (n = 14) by resting spirometry test. Asthma diagnosis and its severity were determined by FEV1/FVC. Informed consent was obtained from all the patients prior to enrolment.

Inclusion criteria to study for asthma group were as existing mild to moderate asthma for at least 3 years. Participants were non-athletes, non-smokers and non-alcoholics. Neither the asthma or none-asthma subjects had participated in regular exercise/diet for the preceding 6 months, nor did all subjects have stable body weight. Participants had no evidence of coronary artery disease; tobacco use; participation in exercise/diet programs; or use of systemic steroids, diabetes treatments, ß-blockers, or thiazides. Subjects with a history or clinical evidence of recent myocardial infarction, congestive heart failure, active liver or kidney disease, growth hormone deficiency or excess, neuroendocrine tumor, anemia were excluded.

Table 1. Baseline anthropometrical characteristics of asthma and none-asthma subjects.

Variables	Asthma group	Healthy group
Age (year)	42 ± 6	43 ± 5
Weight (kg)	95 ± 12	96 ± 8
Height (cm)	175 ± 7	176 ± 7
Body Fat (%)	31± 2.23	30.99 ± 3.12
Body mass index (kg/m²)	31.02 ± 3.08	23.18 ± 2.44
Abdominal circumference (cm)	105 ± 11	103 ± 8

Table 2. Mean and standard deviation of Dynamic lung volumes in two groups.

Variables	Healthy group	Asthma patients	
		Pre-exercise	**Post-exercise**
FVC %	96 ± 8	88 ± 7	95 ± 12
FEV1 %	93 ± 9	75 ± 8	85 ± 11
FEV1/FVC %	84 ± 7	68 ± 6	75 ± 7
PEF %	98 ± 11	80 ± 8	90 ± 10
FEF %25 / %75	94 ± 9	59 ± 9	66 ± 7
EVC %	102 ± 13	92 ± 11	98 ± 12
MVV	131 - 12	122 - 12	128 ± 11

FEV1: forced expiratory volume in 1 s, **FVC**: forced vital capacity, **MVV:** Maximum voluntary ventilation
FEV1/FVC: forced expiratory volume in 1 s / forced vital capacity
PEF: Peak expiratory flow, **EVC**: Expiratory vital capacity,

Anthropometric measurements (body height and weight, waist and hip circumference) were performed with the subjects wearing light underwear and without shoes. Height and body mass were measured using a wall- mounted stadiometer and a digital scale, respectively. Body mass index was calculated as body mass (in kilograms) divided by height squared (in square meters). Waist circumference was measured at the level of the umbilicus using a nonelastic tape to the nearest 0.1 cm.

Spirometry was performed before and after (half hours = 30 min of recovery) a single bout graded cycling exercise for measuring Respiratory symptoms. Cycling exercise test was a YMCA standard test on leg ergometery cycle (Tunturi, made in Finland). This protocol was performed in 5 continues stage without rest between stages. Each stage lasted 3 minute (Mullis *et al.,* 1999). Subjects were asked to refrain from tea, coffee, chocolates and caffeinated soft-drinks on 3 hours before Spirometry. The subjects were advised to avoid any physical activity or exercise 48 hours before the exercise test. Subjects were instructed to take maximum inspiration and blow into the pre-vent pneumotach as rapidly, forcefully and completely as possible for a minimum of 6 seconds, followed by full and rapid inspiration to complete the flow volume loop. The best of the three trials was considered for data analysis. Calibration of spirometer and all testing protocols were performed as outlined in the instruction manual of the spirometer.

Statistical analyses

Statistic analysis was done with SPSS 15.0 for Windows. Normal distribution of data was analyzed by the Kolmogorov-Smirnov normality test. An Independent sample T-test was used to compare all variables between asthma and none-asthma subjects. Student's t-tests for paired samples were performed to determine significance of changes in variables by exercise test in asthma subjects. Significance was accepted at $P < 0.05$.

Results

In this study, at first, we compared some spirometry parameters as dynamic lung volumes between adult obese men with and without asthma. The data of independent showed that at baseline there were no differences in the age, body weight, BMI, waist circumference and Body fat percentage (see Table 1).

But, we observed lower levels of all spirometry parameters in asthma patients when compared to none-asthma subject ($P < 0.05$) (Table 2). These data demonstrated the respiratory functional in obese people with asthma (mild to moderate of severity) is significantly lower than those without asthma symptoms. The statistical analysis have also showed that FEV1 were significantly increased in response to acute cycling exercise (30 min of recovery) when compared with before exercise in asthma patients ($p = 0.034$). In addition, cycling test increases FVC, and FEV1/FVC compared to baseline levels in these patients ($P < 0.05$). Also, Maximum voluntary ventilation as respiratory muscle strength have significantly increased in response to acute cycling ($p = 0.026$).

Discussion

The initial findings of our study showed that Dynamic lung volumes and capacity such as FVC, FEV1, FEV1/FVC, and MVV in asthma patients are lower than none-asthma subjects. There is considerable evidence that many cells and cellular elements such as mast cells, eosinophils, T lymphocytes, macrophages, neutrophils, and epithelial cells play an important role in chronic inflammatory disorder of the airways. Is well known that asthma is a condition characterized by airway hyperresponsiveness, which results in reversible increases in bronchial smooth muscle tone, and variable amounts of inflammation of the bronchial mucosa.

On the other hand, a number of studies have demonstrated that obesity has a direct effect on the function of respiratory system by altering lung volume, airway caliber and respiratory muscle strength (Inselma *et al.,* 1993). FVC is the volume of air that can forcibly be blown out after full inspiration, measured in liters. FVC is the most basic maneuver in spirometry tests. It is well known that The most common index of airway resistance, FEV1, correlates with the clinical condition, with the arterial oxygen tension (Pao) (McFadden *et al.,* 1968), and with the alveolar-arterial oxygen tension gradient (AaPo2) (Wilson *et al.,* 1970), all of which are reflections of uneven ventilation with respect to blood flow.

FVC and FEV1 are strong indicators of lung function, which decline due to obesity and sedentary life style (Chanavirut *et al.,* 2006; Inselma *et al.,* 1993). It has been demonstrated that obesity to be related to allergy symptoms or to higher serum IgE levels (a marker for atopy) (Schachter *et al.,* 2003; Schroeder *et al.,* 2003; Xu *et al.,* 2000) whereas others have not (Tantisira *et al.,* 2003; Chen *et al.,* 2006). Several studies have shown an association between obesity and asthma (Chinn, 2003; Huovinen *et al.,* 2003; Stanley *et al.,* 2005).Although the physiopathological mechanisms underlying these associations are largely unknown. One possibility is that obesity and allergy share common risk factors such as sedentary lifestyle and dietary factors. On the other hand some research stated a gradual age related decline in the pulmonary function beginning at about age forty (Shehab *et al.,* 2003). It is probably reduced FVC and FEV1 in obese subjects are results of respiratory muscle weakness due to sedentary lifestyle and increased BMI. It is important to make a note here that Obesity affects respiratory function, because it alters the relationship between the lungs, chest wall, and diaphragm, decreases lung volumes and increases airway resistance (Rochester *et al.,* 1974; Lazarus *et al.,* 1977). Some authors noted that obese children have altered pulmonary function, which is characterized by reductions in lung diffusion capacity, ventilatory muscle endurance and airway narrowing (Inselma *et al.,* 1993).

The major finding of this investigation was that a single bout cycling exercise led to improvement in all respiratory functional in asthma patients. This study showed an increase in FEVI/FVC in these patients. FEVI/FVC is the percentage of the vital capacity which is expired in the first second of maximal expiration. In healthy patients the FEV1/FVC is usually around 70%. In respiratory diseases (asthma, COPD, chronic bronchitis, emphysema) FEV_1 is diminished because of increased airway resistance to expiratory flow.The data showed that the baseline of this respiratory index in asthma studied patients is significantly lower than 70%. To support these findings, some studies have reported a positive association between physical activity, physical fitness and lung capacity (Courteix *et al.,* 1997). It was found that respiratory muscle strength is significantly low in individuals with sedentary lifestyle (Simões *et al.,* 2010). MVV is the measure of respiratory muscle performance (Farrell, 1981). Maximum voluntary ventilation (MVV) is a measure of the maximum amount of air that can be inhaled and exhaled within one minute. Average values for males and females are 140–180 and 80–120 liters per minute respectively. Our study showed a lower MVV in asthma patients when compared with none-asthma subjects. Therefore, we can conclude low MVV in asthma patients compared to health people is partly due to decreased respiratory strength or performance. Although the mechanisms by which physical inactivity might influence FVC and FEV1 are unclear. It is most likely that reduced FVC and FEV1 in the asthma patients are results of respiratory muscle weakness due to sedentary lifestyle and increased BMI in our subjects. Our study also showed that a single bout cycling exercise increases MVV in asthma patients. Of course, it is likely MVV response to a session exercise to be an acute response. What is clear is that exercise may result in respiratory muscle hypertrophy, and it is obvious that respiratory indices are related partly to respiratory muscles power (Farrell, 1981).

The present study showed that asthmatic patients possess lower levels of respiratory function indices compared with healthy subjects of the same weight. In this context, the findings of this study and other previous studies have shown that reduced respiratory function in asthmatic patients in our study is in addition to being due to airway resistance in these individuals, as well as respiratory muscle weakness in the patients compared with healthy subjects and is also due to the obesity and sedentary lifestyle in these patients than in active individuals. Also according to these findings it is concluded that exercise even for a single session leads to improvement in respiratory function in patients with asthma, of course it must be noted that the response of respiratory function indices to a single exercise session is only temporary and does not represent an enduring compatibility. Hence, similar studies, but with long-term exercise enable better understanding of mechanisms associated with the effect of exercise on respiratory function in patients with asthma or other respiratory diseases.

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