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Aerobic exercise training resulted in improvements in respiratory function in diabetic patients

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Abstract

Accumulating evidence indicates that an inactive and sedentary lifestyle can be affects respiratory function not only in respiratory diseases but also in the other obesity related chronic diseases. In this study we investigated the respiratory function markers in response to three months aerobic exercise program. For this purpose, anthropometrical and some spirometry markers (forced vital capacity: FVC, forced expiratory volume in 1 second: FEV1, FEV1/FVC) and forced expiratory volume in 1 second (FEV1)) were measured in thirty two non-trained diabetic patients (aged 40 ± 5.3 years and BMI of 30.40 ± 2.3 kg/m^2) that divided into exercise (exercise program, 3 months/3 time weekly) and control groups by accidentally. All measurements were repeated after aerobic exercise program in two groups. Aerobic exercise program resulted in significant improvements in FEV1, FVC and FEV1/FVC as respiratory function markers in studied patients. Anthropometrical indexes were also decreased in response to exercise program. All variables remained unchanged in the control group. Our findings indicate that a prolonged aerobic training results in improvement in respiratory function in diabetic patients.

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Introduction

Diabetes Mellitus (DM) describes a metabolic disorder of multiple aetiology, characterized by chronic hyperglycemia with disturbances of carbohydrate, protein and fat metabolism, resulting from inadequate secretion of insulin or peripheral insulin resistance (Ali *et al.,* 2009).

A large body of evidence suggests low lung function in obese people or those with respiratory disorders (Eizadi[a] *et al.,* 2011).Recent epidemiologic studies have demonstrated that impaired cardiovascular and respiratory functions play important role in mortality and morbidity in worldwide (Blair *et al.,* 1996; Schunemann *et al.,* 2000; Cheng *et al.,* 2003). Furthermore, there is also evidence that obesity has been established that to be associated with impaired respiratory functional in healthy or unhealthy populations (Inselma *et al.,* 1993). But limited information is available about lung function in diabetic. Although, it has been demonstrated that the improvements in lung function following intensive insulin therapy support the concept that the lung may be a target organ for damage in diabetes (Niranjan *et al.,* 1997). In addition, Some Previous investigations have described a positive association between reduced lung function and diabetes (Goldman, 2003). Also, in a recent study, a close association was reported between glycemic markers and forced vital capacity (FVC) as an important marker of respiratory functional in diabetic patients (McKeever *et al.,* 2005). Data from a recent observational study indicate that both type 1 and type 2 diabetes mellitus adversely affect the various pulmonary function tests (Dhaher *et al.,* 2012).

It seems that, The presence of obesity in patients with type II diabetic is one of the main reasons for the decline in respiratory function in these patients, because most recent studies suggests low lung function in obese subjects when compared with normal weight peoples (Inselma *et al.,* 1993). However, apart from obesity, a sedentary lifestyle and low cardiorespiratory fitness are another factors contributing to low respiratory function in these patients.

On the other hand, some recent studies have reported that exercise program for short or long time can be improvements in spirometry markers such as FVC, forced expiratory volume in 1 second (FEV1) and forced expiratory volume in 1 second/ forced vital capacity (FEV1/FVC) as lung function markers in obese (Eizadi[a] *et al.,* 2011) or respiratory diseases (Eizadi[b] *et al.,* 2011). But, fewer studies was reported about the respiratory functional in response to aerobic exercise training in type 2 diabetic patients. Hence, in this study, we aimed to follow the role of aerobic exercise program on respiratory functional markers in these patients.

Subjects and methods

Subjects were thirty four sedentary untrained adult men with type 2 diabetic aged 40 ± 5.3 years and BMI of 30.40 ± 2.3 kg/m^2. The objective of this study was to determine the effect of three months aerobic exercise on respiratory functional markers in above mentioned patients. All participants were recruited by accessible sampling and were divided to exercise (aerobic exercise program) and control group matched with respect to age and physical fitness. Informed consent was obtained from each subject after full explanation of the purpose, nature and risk of all procedures used.

Neither the control nor exercise subjects had participated in regular exercise for the preceding 6 months, nor did all subjects have stable body weight. All subjects were non-smokers. Inclusion criteria for study group were determined as existing type 2 diabetic for at least three years. 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.

Spirometry markers and anthropometrical indexes were measured before and after aerobic exercise program in exercise and control groups.

Anthropometric measurements of participants were performed while they stood in light clothing without shoes. The weight and height of the participants were measured by the same person when the participant had thin clothes on and was wearing no shoes by using the standard hospital scales. Body Mass index (BMI) was calculated using the formula body weight/height2 in terms of kg/m². Body fat percentage was determined using body composition monitor (OMRON, Finland). Spirometry test was performed in order to measuring FVC, FEV1 and FEV1/EVC as respiratory functional markers. 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. Subjects were asked to refrain from tea, coffee, chocolates and caffeinated soft-drinks on the day of recording Spirometry. The subjects were advised to avoid any physical activity or exercise 48 hours before the exercise test.

Table 1. Mean and standard deviation of anthropometrical and spirometric markers before and after intervention in studied groups.

Variables	Exercise diabetic		Control diabetic	
	Pretest	post-test	Pretest	post-test
Age (year)	40 ± 5.3	40 ± 5.3	41.2 ± 4.6	41.2 ± 4.6
Height (cm)	173.3 ± 6.8	173.3 ± 6.8	174.1 ± 7.4	174.1 ± 7.4
Weight (kg)	91.3 ± 7.8	87.2 ± 9.2	92.5 ± 10.1	92.8 ± 9.2
BMI (kg/m2)	30.40 ± 2.3	29.03±3.1	30.52 ± 2.6	30.62 ± 2.12
Body fat (%)	31.2 ± 3.3	27.3 ± 4.8	31.9 ± 3.2	31.88 ± 3.5
FVC (%)	94.7 ± 6.8	105.8 ± 8.5	95.6 ± 7.6	94.3 ± 6.9
FEV1 (%)	94.3 ± 7.3	102.6 ± 9.5	95.6 ± 8.2	94.2 ± 8.4
FEV1/FVC (%)	80.1 ± 5.2	95.2 ± 9.4	81.2 ± 4.9	80.3 ± 7.3

Subjects in exercise group trained under supervision for three months, three sessions per week at intensity of 60-80% of HRmax. Each session lasted 60 – 90 min. Adherence to the exercise prescription was documented through the use of Polar heart rate monitors, and subjects received feedback if training intensities were either too high or low in comparison with desirable intensities. After a warm-up, subjects trained for approximately 30 - 45 min and 5–10 min of cool down activity. Aerobic exercises in each session included walking on a treadmill and stationary cycling. Initially, subjects exercised at low intensity and the intensity of exercise was gradually increased to 80% of peak heart rate in next sessions. Attendance was taken at each exercise session to monitor compliance with the program. Subjects were contacted if an exercise session was missed. In this three months period, participants in the control group were barred from participating in any exercise training.

Statistical analysis

Experimental data are presented as means ± SD and were analyzed with the SPSS software version 15.0. Normal distribution of data was analyzed by the Kolmogorov-Smirnov normality test. Independent student t test was used for between groups comparison at baseline. Student's paired 't' test was applied to compare the pre and post training values. An alpha-error below 5% was considered as statistically significant.

Results

Baseline and post training spirometry markers and anthropometrical indexes of two groups are shown in Table 1. All values are given as mean and standard deviation. At baseline there were no differences in the age, spirometry markers (FEV1, FVC and FEV1/FVC), body weight and other anthropometrical indexes between the two groups (see Table 1).

Anthropometrics and lung function variables improved significantly after the therapy in exercise groups. Compared to pre-training, FEV1 increased significantly ($p = 0.023$) after exercise program but not in control group (Fig 1). FVC levels were significantly increased in response to aerobic exercise when compared with baseline levels ($p = 0.022$). Additionally, after exercise intervention, FEV1/FVC increased in exercise group ($p = 0.019$, Fig 2) but remained unchanged in control group. With aerobic exercise training, subjects in exercise group lost body fat percentage ($p = 0.014$), BMI ($p = 0.021$) and body weight ($p = 0.031$), but these variables remained unchanged in control group.

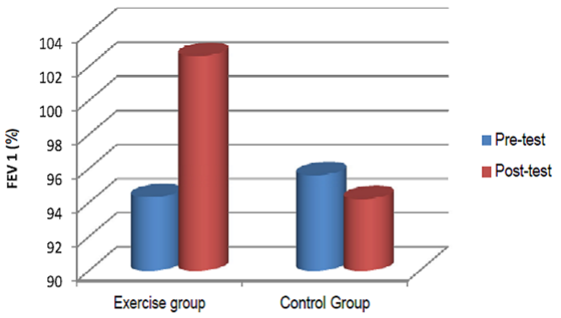

Fig. 1. The changes pattern of FEV1 in baseline and by interventions in two groups. The results showed that FEV1 in response to aeropic training significantly increased compared to baseline levels.

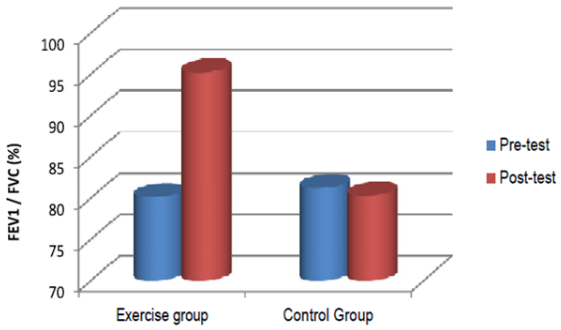

Fig. 2. The changes pattern of FEV1/FVC in baseline and by interventions in two groups. The results showed that FEV1 in response to aeropic training significantly increased compared to baseline levels.

Discussion

In present study, we observed significant improvement in some spirometry markers such as FEV1, FVC and FEV1/FVC as respiratory function in response to three months aerobic exercise in adult men with type II diabetes.

A large body of evidence suggests that diabetes mellitus and insulin resistance have been independently associated with impaired lung function (Lawlor *et al.,* 2004; Cazzato *et al.,* 2004). There is evidence that persons with previously diagnosed diabetes had an FEV1 lower than persons without diabetes (McKeever *et al.,* 2005). These authors pointed out a positive correlation between glycemic markers and FVC in these patients (McKeever *et al.,* 2005). Also, the data by a study demonstrated a reduction in FEV1 of 239 ml among diabetics who required insulin and a reduction of 117 ml among diabetics treated with oral hypoglycemic agents in comparison with non-diabetics (Lange *et al.,* 1989).

Clear evidence has established that appropriate interventions, such as prescribed physical activity programs, may prevent lung function deterioration in these young subjects (Ahmad *et al.,* 2011). In present study, in addition to improving respiratory function, aerobic exercise program results in decrease in body weight, body mass index and body fat percentage in studied patients. Accumulating evidence indicates that obesity and overweight are associated with low respiratory function, because it alters the relationship between the lungs, chest wall, and diaphragm, decreases lung volumes and increases airway resistance (Belousova *et al.,* 1997). Nevertheless, Patients in this study were classified as obese. Simultaneous improvement in anthropometrical indexes and lung function after long term exercise program were also observed in another studies on obese or the others obesity related diseases (Eizadi[a] *et al.,* 2011; Eizadi[b] *et al.,* 2011). Therefore, it seems that Weight loss following exercise program is one of the main reasons for the improvement in lung function in these patients. To support our data, in another study on obese subjects, a reduction in fat mass has been found to be associated with an increased lung volume (Mehrotra *et al.,* 1998). Although, some previous study showed that short-time exercise (acute) increases all respiratory markers in another population (Eizadi[a] *et al.,* 2011).

Sedentary lifestyle particularly in chronic diseases is known to be associated with low cardiorespiratory fitness. On the role of physical activity on respiratory function, two recent studies have established that supervised physical activity like yoga and Tai Chi Chuan exercise can improve lung function in men and asthmatic children (Tager *et al.,* 1998). Increased FVC and FEV1 were also reported in another original study after programmed physical activity in preadolescents (Balke *et al.,* 2003).
According to previous study, this is likely the aerobic capacity or cardiovascular fitness was improved by aerobic exercise in diabetic patients in this study. To support our hypothesis, previous studies have reported that exercise training improves physical fitness and work capacity and to decreases dyspnea, exercise-induced bronchospasm, peak expiratory flowvariability, and daily use of inhaled steroids (Ram *et al.,* 2005; Fanelli et al., 2007). In addition, some previous studies have reported a positive association between physical activity, physical fitness and lung capacity (Ehteshami et al., 2002; Klijn *et al.,* 2003). However, lack measuring of cardiorespiratory fitness after exercise program is a main limitation og this study, but according the finding of previous studies, it is likely increased physical fitness or cardiorespiratory function in response to exercise program to be a main reason of improvements lung function in these studied patients.

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