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Maximal oxygen consumption in asthma patients before and after aerobic training program

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ABSTRACT: The objective of present study was to assess whether cardiovascular fitness was affect with aerobic exercise program in asthma patients. Twenty two inactive males with asthma were randomly assigned into exercise and control groups. Subjects of exercise group were participated in aerobic training for 3 times per weeks at 60-80% of maximal heart rate. Control subjects were instructed to maintain their habitual activities. Pre and post training values of cardiorespiratory fitness (VO_2max) was calculated by a stationary cycle ergometer. Student's paired't' test was applied to compare the pre and post training outcome. A p-value of less than 0.05 was considered to be statistically significant. There were no statistically significant differences between the exercise and control subjects with regard to the anthropometrical markers or VO_2max (P>0.05). Compared to pre-training, VO_2max increased significantly (p = 0.001) after exercise program in exercise group but was not changed in control subjects. All anthropometrical markers decreased significantly by exercise program (p < 0.05). A long-term aerobic exercise intervention can induce favorable changes in cardiorespiratory fitness in adult males with mild to moderate asthma.

Keywords: cardiovascular fitness, aerobic training, Respiratory

INTRODUCTION

Lifestyle change, lack of exercise, and exposure to allergens might lead to the development of some respiratory diseases such as asthma [1]. Asthma is an airway disease with allergic origin. Physiologically, it appears with narrowing of the respiratory tract; while, from the clinical perspective, it starts with sudden attacks of shortness of breath, coughing, and wheezing [2]. The outbreak of asthma has been increased significantly from the 1970s onwards, particularly in developed countries, such that between 5 and 7% has been added to the outbreak of asthma annually [3]. Outbreak of asthma in Iran is at an intermediate level, swinging between 5 and 15%. That is, about 6.5 million people suffer from this disease [4].

According to the literature, the increase in resistance of respiratory tract in patient with asthma is associated with reduced pulmonary function [3]. In addition, narrowing of the respiratory tract leads to the reduced amount of oxygen into the blood stream, which in turn, causes decreased cardiorespiratory fitness in these patients as well as other patients with respiratory disease [5]; such that, most studies pointed out lower levels of VO_2max as a key index of cardiorespiratory fitness in patients with asthma or chronic obstructive pulmonary disease (COPD) than in healthy people [6]. However, there exist rare studies which have reported no differences in cardiorespiratory fitness, heart rate, and Minute ventilation in patients with asthma and healthy subjects [7, 8].

Reduced cardiorespiratory fitness in patients with asthma is not only resulted from the resistance of the airway, but also inactive life style to avoid asthma attacks in patients, in addition to other restrictions, are among the main reasons for the decline in the patient's cardiorespiratory fitness [9]. Hence, it appears that physical activity and regular exercise programs, particularly aerobic exercise, tends to increase cardiorespiratory fitness in these patients. Increase in indicators such as maximum vital capacity, maximum voluntary ventilation in response to exercise training in patients with asthma have been reported [10]. However, findings on the impact of physical activity on cardiorespiratory fitness in these patients are often contradictory. As some studies reported the improvement of this physiological parameters [11, 12, 13], while other studies reported no change [14] in response to training programs. This research also intends to, once again, evaluate the effect of three-month aerobic training on VO2max as an indicator of cardiorespiratory fitness in asthmatic patients.

METHODS

A. Subjects

Twenty four adult men (39.9 ± 7.6 years, mean ± standard deviation) with asthma participated in the study by accessible sampling and assigned into exercise and control group by randomly. The study was conducted with the approval of the Ethics Committee of Islamic Azad University, Iran. After the nature of the study was explained in detail, informed consent was obtained from all participants.

B. Inclusion and exclusion criteria

All subjects of two groups were inactive, non-smoker and non-alcoholics. Main inclusion criteria for study group were determined as existing chronic asthma for at least three years. Subjects with other respiratory, cardiac, rheumatic, musculoskeletal and orthopedic diseases and with associated neurological sequelae which could interfere in the performance of the proposed assessment were excluded from both groups.

C. Anthropometric measures

Each subject's body weight and height were measured. Each of these measurements was conducted two times and the average was reported. Height was measured without shoes on standing while the shoulders were tangent with the wall. Body weight was measured in duplicate in the morning following a 12-h fast. All of these measurements were conducted by the same researcher. Body mass index (BMI) was calculated by dividing body mass (kg) by height in meters squared (m^2).

D. Exercise program

Cardiorespiratory fitness (measured as oxygen consumption per unit of time (VO_2max)) was determined using results of a graded cycle ergometer exercise (15). This measurement was preformed in 2 occasions before exercise program and one week after lasted exercise session. Aerobic program lasted 12 weeks for 3 times per week.

Each exercise session started by 5-10 warm up and finished by 5-10 cool up. The main part of each exercise sessions was performed in a treadmill at moderate intensity (60-80% HRmax; increasing 5% each 3 weeks) for 25-40 minutes (increasing 5 minutes each 3 weeks).

E. Data Analysis

All values are reported as mean and standard deviation. Data were analyzed by computer using the Statistical Package for Social Sciences (SPSS) for Windows, version 11.5. All data were tested for normal distribution by the Kolmogorov-Smirnov test. At baseline**;** comparisons of parameters between the two groups were made by independent Student t test. Student's paired 't' test was applied to compare the pre and post training values. A p-value of less than 0.05 was considered to be statistically significant.

RESULTS

In this investigation, the effect of aerobic training program on aerobic capacity or cardiorespiratory fitness was measured in males with chronic asthma.

Table 1shows descriptive characteristics of spirometry in studied patients. All data represent by mean and standard deviation. Data showed no significant difference in all anthropometrical and physiological markers between two groups at baseline ($p \geq 0.05$).

Compared to pre-training, except AHO (abdominal to hip circumference ratio) ($p = 1.000$) all anthropometrical markers as body weight ($p = 0.000$), BMI ($p = 0.000$), abdominal circumference ($p = 0.000$), hip circumference ($p = 0.000$) and body fat percentage ($p = 0.014$) decreased significantly after exercise program but this clinical variables was not changed in control subjects (Table 2 and 3). Aerobic program resulted a significant increase in VO_2max when compared with pretest ($p = 0.001$) but this variable did not change in control group (Table 2 and 3). We also showed a significant decrease in resting heart rate after exercise program in exercise subjects ($p = 0.000$) (Table 2 and 3).

Table 1: Mean and standard deviation of spirometric markers in studied subjects.

Variables	Mean ± Standard deviation
Forced vital capacity (%)	90 ± 9.4
Forced expiratory volume in 1 s (%)	78 ± 8.5
FEV1/FVC (%)	69 ± 3
Peak expiratory flow (%)	80 ± 15
Forced expiratory flow (25%-75%)	60 ± 15
Forced expiratory flow (75%)	54 ± 16

Table 2: Mean and standard deviation of anthropometrical and physiological markers in studied groups.

Variables	Control		Exercise	
	Pretest	**post-test**	**Pretest**	**post-test**
Age (year)	40 ± 7.6	-----	41 ± 6.4	-----
Height (cm)	173 ± 2.3	-----	174 ± 3.3	-----
Weight (kg)	94.3 ± 12.1	90.1 ± 11.4	95.1 ± 9.3	95.6 ± 7.9
Waist circumference (cm)	106 ± 11.5	101 ± 10	107 ± 9.6	106 ± 12
Hip circumference (cm)	107 ± 8.9	102 ± 8	108 ± 9.6	107 ± 6.9
Abdominal to hip ratio	0.99 ± 0.046	0.99 ± 0.045	0.99 ± 0.05	0.99 ± 0.06
BMI (kg/m2)	31.5 ± 3.9	30.1 ± 4.5	31.41 ± 3.2	31.58 ± 2.1
Body fat (%)	30 ± 4.5	27.8 ± 3.7	31.1 ± 2.3	29.6 ± 3.4
Resting heart rate (bpm)	82 ± 7.2	72 ± 6.1	81 ± 6.7	79 ± 7.5
VO_2max (ml.kg.min)	36.6 ± 8.99	45.8 ± 11.32	37.1 ± 5.64	36.6 ± 6.11

Table 3: Data of paired samples test about anthropometrical and VO_2max between pre and post training in exercise groups.

		Paired Differences				t	Sig. (2-tailed)
		Mean	Std. Deviation	95% Confidence Interval of the Difference Lower	Upper		
Pair 1	Weight (pre) - Weight (post)	4.250	1.422	3.346	5.154	10.352	.000
Pair 2	Abdominal (pre) - Abdominal (post)	4.583	2.275	3.138	6.029	6.980	.000
Pair 3	Hip (pre) - Hip (post)	4.583	1.443	3.666	5.500	11.000	.000
Pair 4	WHO (pre) - WHO (post)	.00000	.02296	-.01459	.01459	.000	1.000
Pair 5	BMI (pre) - BMI (post)	1.425	.496	1.110	1.740	9.959	.000
Pair 6	Body fat (pre) - Body fat (post)	2.267	2.705	.548	3.985	2.903	.014
Pair 7	Heart Rate (pre) - Heart Rate (post	10.500	4.700	7.514	13.486	7.739	.000
Pair 8	VO2max (pre) - Vo2max (post)	-9.167	6.534	-13.318	-5.015	-4.860	.001

DISCUSSION

Today, physicians frequently encourage asthmatic children to attend regular training programs because improving physical fitness and mental changes can lead to increased quality of life in these patients [16]. Physical training is a well established method in the rehabilitation of patients with chronic obstructive pulmonary disease [17]. In the present study, the effect of three months of aerobic exercise on some cardiorespiratory fitness indicators such as resting heart rate and maximum oxygen consumption were measured. The obtained results of the study showed that three months of aerobic exercise resulted in significant increase in aerobic capacity and significant reduction in resting heart rate in adult patients with asthma, who had previously an inactive life style. Several studies show that regular exercise in order to decrease asthma symptoms and to reduce dyspnea by mechanisms such as enhancing respiratory muscles and improving spirometric indices will result in improvement of lung function in patients with asthma, which ultimately may increase VO_2max as an indicator of cardiorespiratory fitness [15, 19]. VO_2max attained during a graded maximal exercise to voluntary exhaustion has long been considered by WHO as the single best indicator of cardiorespiratory fitness [20]. In this field, the findings of a recent study showed that 8 weeks of aerobic exercise, 3 times a week, will significantly improve respiratory volume in men with asthma [21]. In line with the findings of the present study, in another study, three-month exercise led to VO2max increase, and significant reduction in submaximal heart rate, as well as running time increase in children with asthma [22]. Breathing exercise is considered as the most important rehabilitation feature for asthmatic patients. It leads to improvement of exercise capacity and reduced respiratory muscle fatigue [23]. Sport activities, especially aerobic exercises, for 30 minutes per session with a lower exercise intensities of 40 (%) VO_2max at the initial sessions and then gradually increasing the intensity of subsequent sessions have been suggested for improvement of cardiorespiratory fitness in these patients [23].

Some literature has also noted that aerobic exercise performance, compared to high intensity exercise (anaerobic), in patients has better effects on cardiovascular exercises. And, anaerobic training has long-term adverse effects such as hyperventilation [24]. Recommendations for rehabilitation of asthmatic patients would include individualized exercise prescription and advice based on objective criteria of exercise capability, with flexibility in the programs offered, in order to cater to the broadest spectrum of patient disability [25]. Although the increase in VO_2max, in response to aerobic exercise program, may primarily be attributed to the improvement of respiratory volume, it is also possible that this physiological index improvements roots from improvement of other confounding factors in asthma such as inflammatory or anti-inflammatory cytokine. This is because some previous studies indicated the relationship between VO_2max and cytokines such as IL-6, TNF-α, and IL-1ß [26]. In addition, a significant reduction of these mediators of the inflammatory cytokine peptide is reported in literature as a response to short- and long-term training programs [27, 28].

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