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Bronchospasm Analysis Following the Implementation of a Program of Maximum Aerobic Exercise in Active Men

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Abstract**—**Exercise-induced bronchospasm (EIB) is a transitory condition of airflow obstruction that is associated with physical activities. It is noted that high ventilation can lead to an increase in the heat and reduce in the moisture in airways resistance of trachea. Also causes of pathophysiological mechanism are EIB. Accordingly, studying some parameters of pulmonary function (FVC, FEV1) among active people seems quintessential. The aim of this study was to analyze bronchospasm following the implementation of a program of maximum aerobic exercise in active men at Chamran University of Ahwaz. Method: In this quasi-experimental study, the population consisted of all students at Chamran University. Among from 55 participants, of which, 15 were randomly selected as the experimental group. In this study, the size of the maximum oxygen consumption was initially measured, and then, based on the maximum oxygen consumed, the active individuals were identified. After five minutes' warm-up, Strand treadmill exercise test was taken (one session) and pulmonary parameters were measured at both pre- and post-tests (spirometer). After data normalization using KS and non-normality of the data, the Wilcoxon test was used to analyze the data. The significance level for all statistical surveys was considered $p \leq 0/05$. Results: The results showed that the ventilation factors and bronchospasm (FVC, FEV1) in the pre-test and post-test resulted in no significant difference among the active people ($p \geq 0/05$). Discussion and conclusion: Based on the results observed in this study, it appears that pulmonary indices in active individuals increased after aerobic test. The increase in this indicator in active people is due to increased volume and elasticity of the lungs as well. In other words, pulmonary index is affected by rib muscles. It is considered that progress over respiratory muscle strength and endurance has raised FEV1 in the active cases.

Keyword**—**Bronchospasm, aerobic active maximum, pulmonary function, spirometer.

I. Introduction

THE respiratory system consists of a series of branches of airways that lead to alveolar gas exchange units, i.e. alveolus surrounded by capillaries, so as to increase the exchange of gas from lungs to blood and vice versa [1]. Any disruption in airway and endotracheal tubes impairs the entry and exit of air into the lungs and it is likely that it jeopardizes oxygen consumption at rest and at maximum exercise modes [2]. Resistance to air flow is the most common and most severe cause of respiratory failure. Sever obstruction of breathing is a big threat and may develop in any part of the respiratory tract, including the smallest airways, in the tractor-bronchial tree, larynx and trachea [3]. Asthma is one of the most common chronic diseases in the world and its prevalence has experienced a certain increase among people. Although the prevalence and incidence of asthma has risen among people in developed countries over the past few decades, the causes of this epidemic are still unknown. However, variation in the diet and severity of infection and exposure to allergens early in life indoor and outdoor air pollutants are associated with asthma [4]. EIB is a transitory effect on airflow obstruction that is associated with physical activities.

A high ventilation result in an increase in heat and reduction of moisture in airway and that one of the main factors of patho-physiological mechanism is EIB. Its clinical symptoms are cough, wheezing, dyspnea and excessive mucus [5]. Exercise-induced asthma is one of the frequent aspects of a common disease that requires proper diagnosis and treatment. Along with the proper treatment of exercise-induced asthma, people should be able to participate in sports and everyday activities. They have to compete with peers or with a number of athletes who do not have exercise-induced asthma in a series of field games [6].

The diagnosis of exercise-induced asthma is based only on clinical symptoms and is challenging. This important condition is known among people who do exercise. Asthma may limit physical activities and reduce lung function [7]. In one of the latest researches in the field of pulmonary functions in girls and boys, the effect of an aerobic training remained unchanged [8]. In the study, respiratory muscle training (limiting the chest) was performed during exercise and VO2max and only a few cases of lung volumes (FEV1, FVC, etc.) were measured. In another study, aerobic activities were conducted in the laboratory and on the bicycle ergometer that had little resemblance with aerobic exercises used in most sports [9]. Aerobic physical exercise in polluted air decreased lung function tests including FEV1 and FVC25 to 75% in the first and second post-tests; however, it seems that anaerobic exercises in polluted air decreased FEV1 indicators less in the first and second post-tests [10]. In their study, Nadershavandi et al. studied the effect of eight weeks of aerobic training on lung FEV1 and FVC and its relationship with BMI in obese subjects and came to the conclusion that after eight weeks of

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selective exercise, no significant differences were observed between FVC and FEV1 in both groups, whereas they observed a significant relationship between BMI and FVC and lung FEV1 indices in the two groups [11]. A significant percentage of athletes with no history of asthma or bronchospasm develop these complications during or after exercise. This mode happens after the onset of physical activity up to 30 minutes after stopping exercise and it is even observed in many professional athletes as well [12]. The prevalence of exercise-induced asthma (as an isolated factor of asthma) has been 6% to 19% among people in recent reports; however, it has been estimated that 70% to 90% of patients with asthma have already been diagnosed that suffer from exercise-induced asthma [13]. Within 1966 and 1986, deaths from lung obstruction had a growth rate of 71%; in the meantime, active people were no exception. Dynamic lung volumes depend on various factors such as pulmonary ventilation, diffusion of oxygen and carbon dioxide in the blood to the cells and vice versa, as well as on the regulation of breathing [14]. Therefore, any disorder in each of these factors can endanger and interfere with the volume capacity and damage athletic performance. Given the bulk of studies in the field of EIB, maximum activity can cause problems and limitations for respiratory system. However, there is a dearth of research on bronchospasm following the implementation of a program of maximum aerobic exercise in active men. Accordingly, in this study, the researcher sought to answer the question whether or not the value of FVC and FEV1 following the implementation of a program of aerobic maximal exercise is different in the pre-test and post-test in the active group?

II. Methodology

The current study was a quasi-experimental and applied study performed with an active group using pre- and post-tests. The condition for being active was to have a range of maximum oxygen consumption between 40 ml to 55 ml per kg per minute.

The study population consisted of all students in Chamran University, Ahvaz. The sample was selected in a way that 15 students were selected after *Bruce* Test among from students in Chamran University, Ahvaz as the active experimental group. The initial selected samples were 55 cases who had voluntary participated in the study and then, were selected according to the level of obtained maximum oxygen consumption. The samples 1- had an average age of 18 years to 25 years; 2- had no history of asthma, allergies and other respiratory diseases; 3- were not smoking; 4- had no skeletal deformities such as chest deformity; 5- had no history of cardiovascular surgery, and 6- had no work experience in the occupational, educational etc., pollutant areas such as hospital, laboratory and oil industry. To obtain the pulmonary parameters (FVC, FEV1), in order to diagnose bronchospasm, a spirometer device, model GANSHORN (IF8) equipped with a screen and printer made in Germany was used. After the consent form was filled in by the subjects, their health indicators were taken in terms of breathing, as well as their age, height, weight and body fat percentage. Then, after examining physical and respiratory conditions of the participants, those who met inclusion criteria were invited to participate in the study and then, to determine the level of VO2max, all the individuals qualified in the study were taken Bruce Test and among them, 15 patients eligible for this study were selected. One day before maximum aerobic tests, spirometry test was taken to obtain the scores on the pre-test. Spirometry test was performed in a way that all the subjects sat on a chair and leaned on it. It was tried to have suitable condition for testing because body condition has an important effect on pulmonary volumes and capacities at the time of the implementation. That is why all the subjects were tested in the same way. Before undertaking the test, the health of all subjects participating was ensured through a spirometry test run to identify any respiratory diseases including infections or colds, etc. of recorded information had been refused. Also, before running the tests, the implementation method and the subjects' performances were fully explained. Then, maximum aerobic test (treadmill Strand) was performed in a way that the subjects were activate on a treadmill at a constant rate of 8.05km per hour for three minutes and then, 2.5% was added to the tilt device every two minutes to the extent that the subjects were no longer able to be active. The test was taken from 8 a.m. to 11 a.m. from the subjects. Before running these tests, subjects were five minute warm-up. After the aerobic test, participants had three-minute break and then, the pulmonary parameters were again measured by spirometer in the same way as previously described. The obtained data were recorded by the computer connected to the device. The test accuracy was confirmed according to the diagrams recorded by the device and by the researcher with regard to the existing resources. The results of the prediction percentage were recorded for each sample. In this study, descriptive statistics were used to calculate the mean and standard deviation of descriptive data such as age, height, weight, body fat percentage, and maximum oxygen consumption. Inferential statistics were used to analyze the changes in the parameters of lung function index and Wilcoxon test was used to diagnose bronchospasm in both pre-test and post-test after high-intensive aerobic exercise. It should be noted that SPSS software version 16 was run to analyze the data.

III. Results

In this study, the mean and standard deviation of age, height, weight, body fat percentage and maximum oxygen consumption were 21.0±1.5, 1.7±0.056, 63.6±8.0, 0.7±6.0 and 48.1±4.16, respectively. In this study, the training protocol was a strand aerobic test (treadmill) and conducted as a single meeting. In Table II, the descriptive indices of active individuals have been shown for each of the study variables before the implementation of the exercise period. In Table III, the descriptive indices of active individuals have been shown for each of the study variables after the implementation of exercise period. According to the results of Table IV, the level of significance of Wilcoxon test is greater than 0.05 ($P>0.05$); accordingly, the null hypothesis is not rejected, i.e. it can be said that the rate of FVC has no significant change from pre-test to post-test stages in the active group following the implementation of the maximum aerobic test. In other words, it can be said that maximum aerobic exercise has no significant effect on the rate of FVC in active individuals. According to the results in Table V, the level of significance of Wilcoxon test is greater than 0.05 (P>0.05), so, the null hypothesis is not rejected, i.e. it can be said that the rate of FEV1 has no significant change in the active group following the implementation of the maximum aerobic test. In other words, it can be said that maximum aerobic exercise did not make a significant change in the rate of FEV1 in active people.

TABLE I
THE MEAN ± SD OF AGE, HEIGHT, WEIGHT, BODY FAT PERCENTAGE AND MAXIMUM OXYGEN UPTAKE

Variables	Active individuals
Weight	68.63
Height	71.1
Age	21
body fat percentage	73.16
VO_2max	16.48

TABLE II
MEAN ± SD BEFORE THE IMPLEMENTATION OF EXERCISES

Before the implementation of exercises	Mean	SD	SEM	Minimal	Maximal
Active					
FVC	86.93	15.98	4.13	37.00	107.00
FVC1	81.93	16.18	4.18	36.00	105.00

TABLE III
MEAN ± SD FOR BOTH GROUPS AFTER THE IMPLEMENTATION OF EXERCISES

After implementation of exercises	Mean	SD	SEM	Minimal	Maximal
FVC	89.53	9.44	2.44	76.00	109.00
FVC1	84.33	13.13	3.39	66.00	108.00

TABLE IV
THE RATE OF FVC FOLLOWING THE IMPLEMENTATION OF MAXIMAL AEROBIC EXERCISE FROM PRE-TEST TO POST-TEST

Mean ± SD before exercise	Mean ± SD after exercise	Level of significance
86.933±15.979	89.533±9.440	0.699

TABLE V
THE RATE OF FVC1 FOLLOWING THE IMPLEMENTATION OF MAXIMUM AEROBIC EXERCISE FROM PRE-TEST TO POST-TEST

Mean ± SD before exercise	Mean ± SD after exercise	Level of significance
81.933±16.175	84.333±13.129	0.977

IV. DISCUSSION AND CONCLUSION

The present study sought to analyze bronchospasm following the implementation of a maximum aerobic exercise program in active men. FEV1 is the maximum volume of air that exit within one second after a full breath out of lungs [15], [16] and could be measured on FVC curve [15]-[19] and is usually expressed as a percentage of Forced Vital Capacity (FVC). The results showed that the rate of FEV1 following maximum aerobic exercise from the pre-test to post-test in active people showed no significant difference. Despite the fact that FEV1 has increased in post-test during maximal aerobic test, it has not shown a significant difference. In other words, FEV1 has been influenced by rib muscles. So, the improvement of respiratory muscle strength and endurance likely causes an increase in FEV1 in active people. It also appears that excessive fatigue, especially the early fatigue of respiratory muscles causes changes in some of the indices. Previous research has indicated that by implementing exercises, FEV1 increases and its amount is more in athletes than non-athletes. This is consistent with the results obtained in this study [15], [16], [19]. The studies conducted on wrestlers reveal an increase in FEV1 under the impact of participating in these training programs [17]. In his study, the author concluded that aerobic exercise in children leads to improved lung function parameters including FEV1 [20]. The study results are also in line with the results obtained in this study [21]. John examined the effect of BMI on lung volume and airway resistance index and concluded that aerobic exercise can reduce FEV1 which shows respiratory function caused by asthma or respiratory diseases will considerably be reduced. FEV1 is related to respiratory muscles and when these muscles are weak, the ability for fast exhalation reduces and indicators of FVC, FEV1 decline. The results obtained in this study are inconsistent with those of the present study. It seems that a possible reason for this could be due to respiratory function response to this training session in active people. In this regard, observed the decline in FEV1 in 10% or more after exercise in 22 patients (9.6%) in children [22]. This is not in line with the results of this study the possible differences may pertain to the research population, ambient temperature, and the mean age of participants as well as the exercise protocol of the subjects and methods of training devices used by this research.

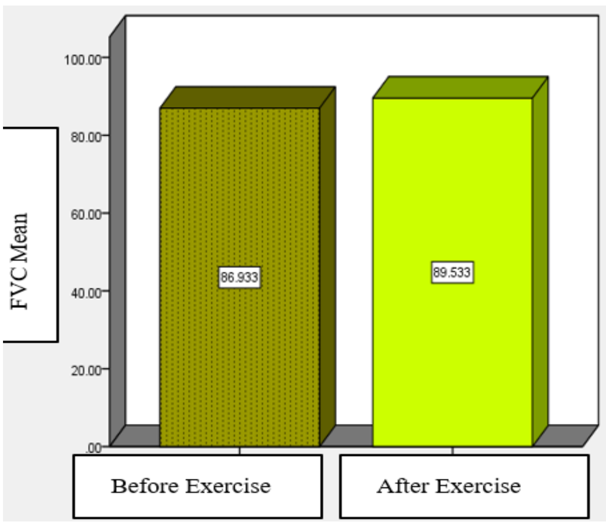

Fig. 1 Comparing the rate of FVC before and after the implementation of maximum aerobic exercise in active individuals

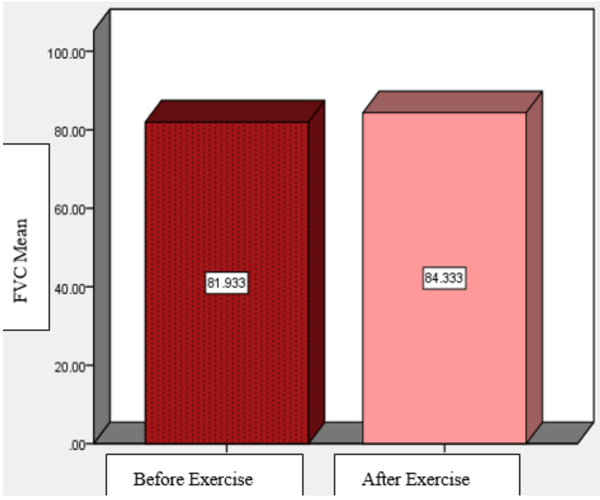

Fig. 2 Comparing the rate of FVC1 before and after the implementation of maximum aerobic exercise in the active group

FVC is the changes in lung volume between a full and deep inhalation (up to the total lung capacity) and a full and maximal exhalation (to achieve the remained volume). FVC index is one of the ways that shows the breathing resistance and the airway and lung capacity which depends on the track and elastic resistance of the lungs [14]. Moreover, the results of this study indicated no significant difference in FVC following maximum aerobic exercise from the pre-test to post-test in active individuals. Also, FVC following maximum aerobic exercise increased in physically active people. It seems that the increase in FVC following one session of aerobic exercise in active people was due to the increased volume as well as the elasticity of the lungs. In other words, FVC is affected by rib muscle. Therefore, the improvement in respiratory muscle strength and resistance increase FVC. The effects of physical activity is also important in increasing the permeability of blood gas carriers, the transfer of red blood cells and plasma proteins into the alveolar space, setting pulmonary hemodynamics through vascular expanders and surfactant production. Increased production of surfactant by increasing the diameter of airways and reducing air resistance leads to an increase in FVC. In his research, Khalili [20] concluded that aerobic exercise training in children results in improved lung function parameters including FVC. Johnson [21] investigated the effect of BMI on lung volume and airway resistance and concluded that aerobic exercise can lead to an increase in the FVC index. The results of FVC in the study in terms of the increase rate in active men are consistent with the results of this study [23]. In another study, Ziaee et al. examined lung function before and after basketball in professional basketball and semi-professional basketball players. In total, the rate of FVC decreased in all groups after the exercise [24]. In another study, the effects of high intensity exercise in hot and cold temperatures on EIB in adolescent boy athletes were investigated. The results showed that on average there was a 50% significant increase in FVC compared to pre-exercise in cold weather that are incompatible with the results obtained in this study. As it was seen, several studies have so far been conducted with respect to the effects of exercise and physical activity on EIB. In general, the results showed that there was no significant difference in the FEV1 and FVC indices after test implementation in active individuals. Therefore, based on the findings obtained in this research, it seems that pulmonary indices in active individuals increased after aerobic tests. This shows that an increase in these indices among active people is due to the increased volume and elasticity of the lungs. In other words, pulmonary indices are affected by rib muscles. So it is likely that improvement in respiratory muscle strength and endurance increased FEV1 in the active group.

V. Limitations of the Study

1. The influence of hereditary factors.
2. The rate of the subjects' learning and performance in ventilation and respiratory gases tests in spirometry in the time allotted to do them.
3. The accuracy of the responses in the questions related to personal data.
4. The existence of the pollutants in the environment and sports activities
5. Although the subjects were advised not to take part in any physical activity during the test periods, the subjects were not at hand, with the exception of the study period.
6. Predicted pulmonary index values were estimated by the device.

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