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EFFECT OF AEROBIC EXERCISE TRAINING ON PULMONARY FUNCTION TESTS: A PRAGMATIC RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

The aim of the study was to evaluate the effect of aerobic exercise training on pulmonary function tests in young healthy volunteers. We recruited eighty, apparently healthy medical students of either sex, aged 17-20 years. Randomization into experimental and control groups (40 each), was carried out with a table of random numbers. Experimental group participated in a 16 weeks aerobic exercise plan, while control group had no plan of exercise during that period of time. Pulmonary Function Test was recorded before the commencement of training and at the end of 16 weeks in both the groups. The data were analyzed by paired' test. $P < 0.05$ was considered significant. After 16 weeks of aerobic training there was significant improvement in pulmonary functions in the experimental group ($P < 0.05$). In conclusion, the current study has shown that, there is significant positive relationship between aerobic training and pulmonary function tests.

KEY WORDS

Aerobics, Exercise, Pulmonary Function Tests, Healthy adults

INTRODUCTION

Aerobic exercise is an important component of pulmonary rehabilitation for patients with chronic obstructive pulmonary disease (COPD). The American College of Sports Medicine (ACSM) defines aerobic exercise as "any activity that uses large muscle groups, can be maintained continuously, and is rhythmic in nature." It is a type of exercise that overloads the heart and lungs and causes them to work harder than at rest[1]. Examples: walking, jogging, running, skipping, dancing, swimming, bicycling, etc.

Forced vital capacity (FVC) is the volume of the air that can be expired rapidly with a maximum force following a maximum inspiration. Forced Expiratory Volume in One Second (FEV1) is the volume expired in the first second of maximal expiration after a maximal inspiration and is a useful measure of how quickly full lungs can be emptied. It represents the volume of air expired in the first second of a FVC. Estimation of FEV_1 is the most commonly used screening test for airway diseases. Normally FEV_1 is about 80% of the FVC. It is useful in distinguishing between restrictive and obstructive diseases. Peak Expiratory Flow Rate (PEFR) is the highest flow value measured during forced expiration. It is an effort-dependent value. PEFR measures how fast a person can exhale air. It is one of many tests that measure how well our airways work. It is a simple method of measuring airway obstruction and it will detect moderate or severe disease[2]. Factors which determine PEFR are airway obstruction, closure and compression of small airways, strength of expiratory muscles and the lung and chest mechanics.

Impaired pulmonary functions are associated with increased mortality and morbidity[3-5]. Physical activity is known to improve physical fitness and to reduce morbidity and mortality from numerous chronic ailments[6]. There are very few studies on aerobic exercise and pulmonary function in general population[7]. Most studies on the effects of physical activity are cross sectional ones, on special populations such as athletes or patients with COPD [8-11]. Physical activity rehabilitation is widely used in patients with pulmonary diseases. Exploration of the relation between aerobic exercise and respiratory functions, will aid in understanding the mechanisms of how aerobics improve patient's quality of life and in finding a better way to evaluate the effects of rehabilitation. The present study was carried out to investigate the relationship between aerobic exercise and pulmonary function in young, healthy volunteers in an Indian setting.

MATERIALS AND METHODS

This study was approved by ethics committee of the institute. We recruited eighty, apparently healthy medical students of either sex, aged 17-20 years. Informed consent was obtained. Participants were non-athletes, non-smokers, non-obese and non-alcoholics. Randomization into experimental and control groups (40 each), was carried out with a table of random numbers. Subjects' height and weight were measured; BMI was calculated. Subjects in the two groups were comparable as regards their age, educational status, socioeconomic status and anthropometric parameters (See Table 1).

Table 1

Mean height and weight of the experimental and control groups at the beginning of the study

Group	No. of Subjects	Age (years)	Height (cms)	Weight (Kgs)
Experimental	40 (20F, 20M)	17-20	165.5 ± 13.5	58.9 ± 10.2
Control	40 (20F, 20M)	17-20	167.5 ± 12	57.3 ± 9.6

F- females, M- males

Subjects were asked to refrain from tea, coffee, chocolates and caffeinated soft-drinks on the day of recording Spirometry. The forced expiratory maneuver was demonstrated to all the subjects. The test was recorded by a computerized spirometer (CPFS/D^{USB}, Medgraphics Company) in standing position. Before beginning the test, it was ensured that, there was no flow through the pneumotach. It was also ensured that, opening at the end of pneumotach was not obstructed and subject's finger did not obstruct the pneumotach opening during the procedure. 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. They were asked not to lean forward during the procedure. It was ensured that a tight seal was maintained between the lips and the pneumotach of the spirometer. Nose clip was applied during the procedure. Three technically acceptable maneuvers were recorded for each subject. 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.

Experimental group participated in 16 weeks aerobic exercise plan (five 20 minute sessions of jogging in a week with 5 minutes of warm-up and 5 minutes of cool-down exercises), while control group had no plan of exercise during that period of time. The distance covered was 2.5 Km (5 laps of college ground) and exercise heart rate was 116 ± 8 beats/min. This was a moderate intensity exercise according to WHO classification. Spirometry was performed at the end of 16 weeks in both the groups.

The data were analyzed using Microsoft Excel software. Student's paired't' test was applied to compare the pre and post training values of both the groups. Statistics were tested at the $P < 0.05$ level of significance and data were reported as mean ± standard deviation.

RESULTS

The two groups were comparable for all parameters at baseline. After 16 weeks of aerobic training there was significant ($P < 0.05$) improvement in pulmonary functions in the experimental group (See Table 2). There was no significant change in the control group. There were no serious adverse events during the study and the subjects were comfortable.

Table 2
Mean values (pre test and post test) in experimental and control groups

Statistical Indexes Variable (Unit)	Study Groups	Pre Test x ± S.D.	Post Test x ± S.D.	P Value
FVC (L)	Experimental	3.16 ± 0.38	4.02 ± 0.46	< 0.001*
	Control	3.23 ± 0.23	3.29 ± 0.32	0.134
FEV_1 (L)	Experimental	2.71 ± 0.38	3.54 ± 0.46	< 0.001*
	Control	2.67 ± 0.23	2.73 ± 0.32	0.161
FEV_1/FVC %	Experimental	88.25 ± 6.55	88.34 ±7.32	0.338
	Control	87.52 ± 7.16	87.72 ±7.48	0.158
PEFR (L/min)	Experimental	437.8 ± 64	512.9 ± 62	< 0.001*
	Control	429.7 ± 53	431.5 ± 59	0.491

**** Significant, x ± S.D. Mean ± Standard Deviation***

DISCUSSION

Physical inactivity and low cardio-respiratory fitness are recognized as important causes of morbidity and mortality[6,7]. It is generally accepted that people with higher levels of physical activity tend to have higher levels of fitness and that physical activity can improve cardio-respiratory fitness[8].

In the present study, Pulmonary Function Tests improved significantly in the experimental group after 16 weeks of aerobic exercise training. It can be explained that as both groups had similar conditions at the beginning of the study, aerobic exercise caused an increase in FVC, FEV1 and PEFR values among the experimental group. Thus an association between aerobic exercise training and improvement of lung function was supported by our data. There was no significant change in FEV1/ FVC ratio in both the groups.

Other studies comparing respiratory function among men and women engaged in various sports found that sports persons have higher level of function than sedentary people[12]. Our result is supported by Y.J. Cheng et al. study in which the physical activity improved pulmonary function in healthy sedentary people[13]. Reza Farid et al. showed an improvement in pulmonary function with aerobic exercise training in asthma patients[14]. Cedric Nourrey et al. showed in a prospective study that aerobic exercise improves pulmonary function and alters exercise breathing pattern in children[15]. K.D. Fitch et al. studied the effect of 5 month swimming training on school children with asthma and found improved lung function, and improved posture and fitness[16]. Bruce G Nickerson et al. have shown in their study that distance running program improved fitness in asthmatic children without pulmonary complications or changes in exercise induced bronchospasm[17]. C.J Clark in his study found that cardio-respiratory fitness significantly improved and breathlessness decreased over a wide range of work corresponding to activities of daily living[18]. Christopher Kaufman et al. studied the effect of aerobic training on ventilatory efficiency in overweight children, and found that the training helped to reverse the decrements in cardiopulmonary function observed overtime in overweight children[19].

Our study also showed that the experimental group was able to have more powerful and more effective inspiration and expiration as opposed to what they have been able to before participating in such aerobic exercise. One limitation of our study is that most of our healthy subjects were from middle to upper socioeconomic strata. So the results may not be generalized for all the sections of society.

CONCLUSION

In conclusion, the current study has shown that, there is significant positive relationship between Aerobic Exercise Training and Pulmonary Function Tests. The health care community should recognize aerobics as a complement to conventional medical care. This will lead to better and improved treatment of COPD.

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