Ventilatory Response to Aerobic Exercises in Smoking Adolescents

Amany Raafat, PH.D
Physiotherapy Department, Cairo University Hospitals.

ABSTRACT

Background: *Cigarette smoking affects pulmonary functions by causing obstructive type respiratory problems and by worsening existing restrictive type respiratory problems. The aim of this study was to determine the effect of aerobic exercise on the ventilatory functions in smoking male adolescents. Aerobic training stimulate adaptation in pulmonary ventilation during sub-maximal and maximal exercises. Such adaptations generally reflect a breathing strategy that minimizes respiratory work at a given exercises intensity. There is positive training adaptation in pulmonary ventilation during submaximal exercise.* ***Methods:*** *Sixty smoking male adolescents participated in the study, their ages ranged from 14 to 19 years. They were divided into two equal groups. The exercise group subjects performed aerobic exercise, while the control group subjects did not take part in the exercise intervention program and were instructed to maintain their usual activities during the experimental period. The program continued for 10 weeks (three sessions per week), ventilatory functions were measured at the beginning and after the exercise program for both groups.* ***Results:*** *No statistically significant changes were found in ventilatory functions. The investigation concluded that 10 weeks of aerobic exercise were insufficient to result in significantly positive changes in almost all ventilatory functions, except for the maximum voluntary ventilation.* ***Conclusion:*** *It is recommended to use aerobic exercise in order to improve the maximum voluntary ventilation in smoking male adolescents.*

INTRODUCTION

It is estimated that over 4,000 adolescents try their first cigarette each day, and one third of those adolescents will die prematurely due to a smoking-related disease. Despite small declines in cigarette smoking among adolescents, almost one third of adolescents currently smoke cigarettes[6].

One of the most useful tests to assess the overall ability to move air in and out of the lungs (ventilation) is called forced vital capacity (FVC). This is the maximum amount of air that can be forcefully and rapidly exhaled after a deep breath (maximal inspiration) and measures approximately 5 liters for an adult male[14].

The relationship between The volume of air expired in the first second of a forced expiratory maneuver (FEV_1) and FVC is expressed as FEV_1/FVC ratio or FEV_1 % which is simple screening test that will assist in the diagnosis of any respiratory impairment[20].

Maximum voluntary ventilation (mvv) is the maximum air, which can be expired in a minute by deepest and fastest breathing. Normally equals 60:120 L/min for females and 80:160 L/min for males. It can never be normal in presence of lung disease. It requires the subject to breathe as maximally and rapidly as possible for 15 seconds[11].

Regular smoking increased risk for asthma among adolescents, especially for non-allergic adolescents and those exposed to maternal smoking during the in utero period. Regular smoking, defined as smoking at least 7 cigarettes per day on average during the week before and 300 cigarettes in the year before each annual interview[9].

Aerobic exercise such as walking increases the body's capacity to take up and use oxygen through the sustained rhythmic contraction of large muscle groups[8].

Maximal pulmonary ventilation in untrained subjects, typically increases from a beginning rate of about 100 to 120 L/min, to about 130 to 150 L/min or more following training. Pulmonary ventilation rates typically increase to about 180 L/min in highly trained athletes and can exceed 200L/min in very large highly trained endurance athletes. Two factors account for the increase in maximal pulmonary ventilation following training, increased tidal volume and increased respiratory rate[12].

Also it was found that, Eight weeks of high-intensity intermittent running training enhanced resting pulmonary function and led to deeper exercise ventilation reflecting a better effectiveness in prepubescent children[16].

Men and women who were physically active in 1985 and 1995 had the highest lung function in both sexes and in all age groups. The reduction in FEV_1 ranged from 20 ml to 170 ml, similar to 1-7% of predicted values dependent on physical activity level. The findings show that a high level of physical activity corresponds to about 3-5 years of normal decline in FEV_1 (30 ml/year), and may therefore overcome the disadvantages of a decline in FEV_1 from increasing age[17].

Physical activity was significantly associated with respiratory function, thus indicating that the pulmonary function of individuals who exercise regularly is better than those who do not. These results support the clinical use of physical training to counteract the harmful effects of smoking on respiratory function[2].

Small but significant increases in FEV_1, FVC, and decrease in airway resistance were seen after training. Total lung capacity did not change as a result of training. It was a surprise to find a small, but significant increase in FEV_1 after training[18].

Exercise combined with NRT (nicotine replacement therapy) facilitates smoking cessation, improves functional exercise capacity, and delays weight gain in women smokers. It is recommend that physicians and health care professionals recommend exercise and NRT together for highly motivated women interested in quitting smoking[19].

METHODOLOGY AND PROCEDURES

The present investigation made use of a quantitative experimental research design, using pre- and post-tests to determine the effects of an intervention. The groups consisted of an exercising study group and a non-exercising control group. The study group received the treatment, which was a ten-week aerobic exercise program. Both the exercise and control groups included 30 subjects and underwent similar tests both pre- and post the study period.

Subjects

We studied 60 sedentary male, smoking adolescents. Subjects were randomly selected from students in the faculty of Physical therapy, The students' ages ranged from 14 to 19 years. All subjects were mild smokers (less than 20 cigarettes/day), they were required not to have participated in any regular exercise for six months prior to the study.

Evaluation Equipments

- Cardiopulmonary exercise test . It was used for measuring ventilatory function with disposable mouth piece and nasal clips. It is a computerized apparatus with an electronic memory allowing on a single forced exhalation, the forced vital capacity, the maximum voluntary ventilation.
- Body weight and height scale. It was used to measure the subject's weight and height to calculate the body mass index (BMI) according to the formula:BMI = body weight in kilograms/ height in meter squared.
- Mercury sphygmomanometer and Stethoscope were used to measure blood pressure before and after each session.

Training Equipment

Electronic Treadmill: its speed, inclination, and timer are adjustable.

Procedures

A) Assessment Procedures:

The exercise and control group subjects took part in identical pre-and post- test protocols. All tests took place in the post-absorptive state (after four hours) and at least 48 hours after the last training session. The evaluation steps included:

a- Resting Blood Pressure (RBP) and Resting Heart Rate (RHR).
b- Smoking Analysis.
c- Calculation of BMI: BMI= weight (kg) / height (m^2).
d- Ventilatory Function Test: Spirometry testing is performed with the intention of detecting and quantifying pulmonary diseases these tests can be utilized as objective measurements in determining the effectiveness of therapeutic interventions.

The spirometry of all subjects was evaluated before and after the ten-week experimental period and was performed after a four-hour cessation period of smoking. The following ventilatory parameters were assessed:

- forced vital capacity (FVC),
- forced expiratory volume in the 1st second (FEV_1),
- forced expiratory volume in the 1st second/forced vital capacity (FEV_1/FVC),
- maximum voluntary ventilation (MVV)

B) Training Procedures:

In the present investigation, only the exercise group subjects were allowed to participate in the structured exercise program. The present study utilized a ten weeks training period. The exercising subjects train three sessions per week (non-consecutively) over the ten-weeks period. Each training session included:

* Warming up: Include walking on the treadmill for 5 minutes at speed 1.5 km/h with zero inclination.
* Active phase:

- Duration: 20 minutes.
- Mode: walk/run on electronic treadmill with zero inclination.
- Intensity: moderate intensity i.e. quite an effort; you feel tired but can continue.

* Cooling down:

Each study group subject had to conclude every exercise session with walking on the treadmill for 5 minutes at speed 1 km/h with zero inclination and gradually decreasing speed until reach zero.

The control group subjects did not take part in the exercise intervention program and were instructed to maintain their usual activities and not to participate in any form of exercise during the ten-weeks experimental period.

Statistical analysis

The dependent paired t-test and independent paired t-test were utilized in the present investigation. The dependent paired t-test was utilized to determine the within group changes from pre- to post-test. The findings were reduced to a single set of measurements by finding the difference between the pre- and post values. The samples were used to determine if a significant difference (significance level P = 0.05) existed between the different populations from the pre- to post-test t-tests.

RESULTS

This study is comprised of sixty smoking male adolescents selected from Faculty of Physical Therapy. The data were collected from subjects and classified into pre and post test values.

The subjects were divided into 2 groups:

a- Exercise group included thirty male subjects receiving aerobic exercise.

b- Control group included thirty male subjects who received no program.

Table (1): Shows FVC mean values of exercise and control group before and after the exercise program.

Group / Parameter	Exercise Group	Control Group	t-value	P-value
Before exercise	4.001± 0.54	3.99 ± 0.54	0.026	P>0.05**
After exercise	4.027±0. 52	4.001±0.54	0.18	P>0.05**
t-value	1.33	1.8		
% change	0.64 increase	0.27 increase		
P-value	P>0.05**	P>0.05**		

Level of significance at P<0.05 * = significant ** = non significant.

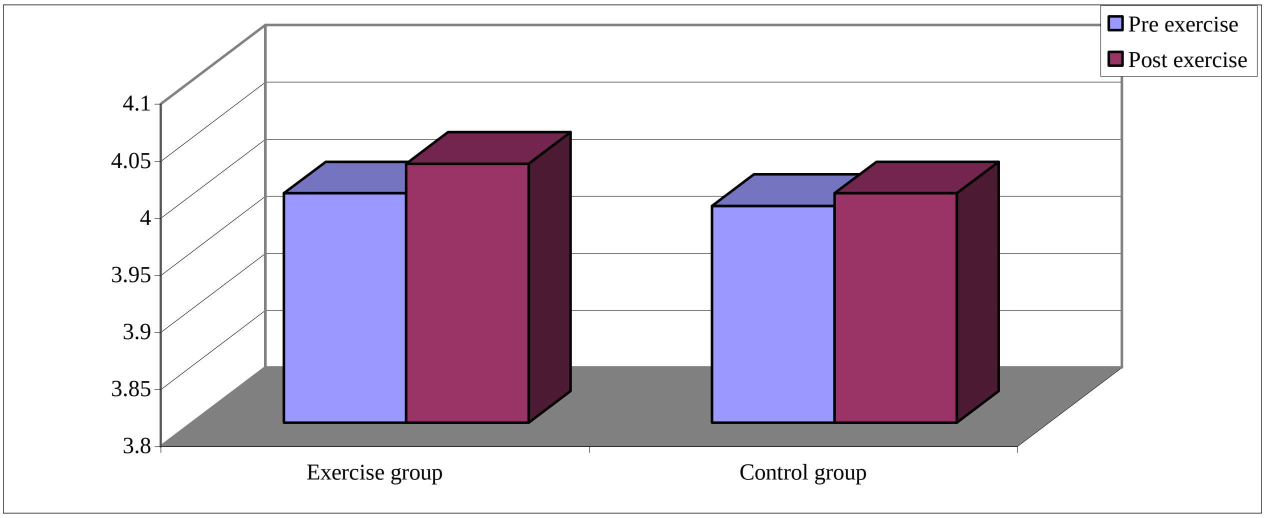

Fig. (1): Shows FVC mean values of exercise and control group.

Table (1) and Fig. (1) showed that there was a statistically non significant difference between pre and post study mean value of FVC in study and control group as (4.001±0.54 vs 4.027±0.52) and (3.99±0.54 vs 4.001±0.54) respectively.

Table (2): Shows FEV_1 mean values of exercise and control groups before and after the exercise program.

Group / Parameter	Exercise Group	Control Group	t-value	P-value
Pre exercise program	3.48± 0.46	3.49± 0.47	0.066	P>0.05**
Post exercise program	3.52±0. 47	3.52±0.46	0.025	P>0.05**
t-value	3.2	1.24		
% change	1.03 increase	0.85 increase		
P-value	P>0.05**	P>0.05**		

Level of significance at P<0.05 * = significant ** = non significant.

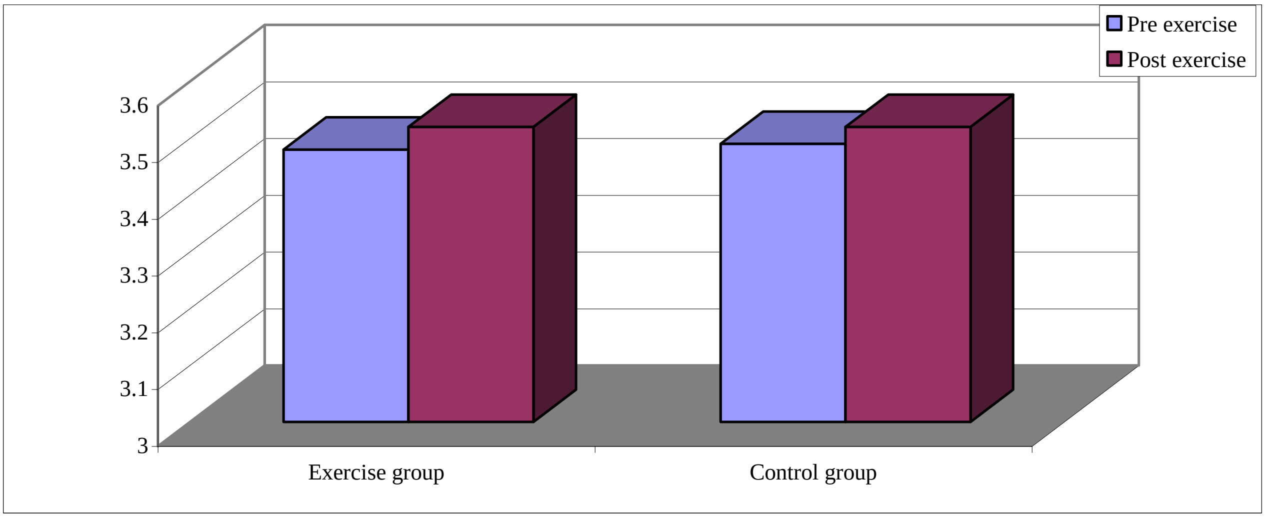

Fig. (2): Shows FEV_1 mean values of exercise and control groups before and after the exercise program.

Table (2), Fig. (2) revealed that, there was a statistically non significant increase in FEV_1 mean value of both study and control group post study in comparison to its pre study mean value as (3.52±0.47 vs 3.48±0.46) and (3.52±0.46 vs 3.49±0.47), P> 0.05.

Table (3): Shows FEV_1/FVC mean values of exercise and control groups before and after the exercise program.

Group / Parameter	Exercise Group	Control Group	t-value	P-value
Pre exercise program	87.1±4.05	87.4±3.57	0.304	P>0.05**
Post exercise program	87.4±4.1	87.6±3.89	0.233	P>0.05**
t-value	0.7	2.5		
% change	0.34 increase	0.22 increase		
P-value	P>0.05**	P>0.05**		

Level of significance at P<0.05 * = significant ** = non significant.

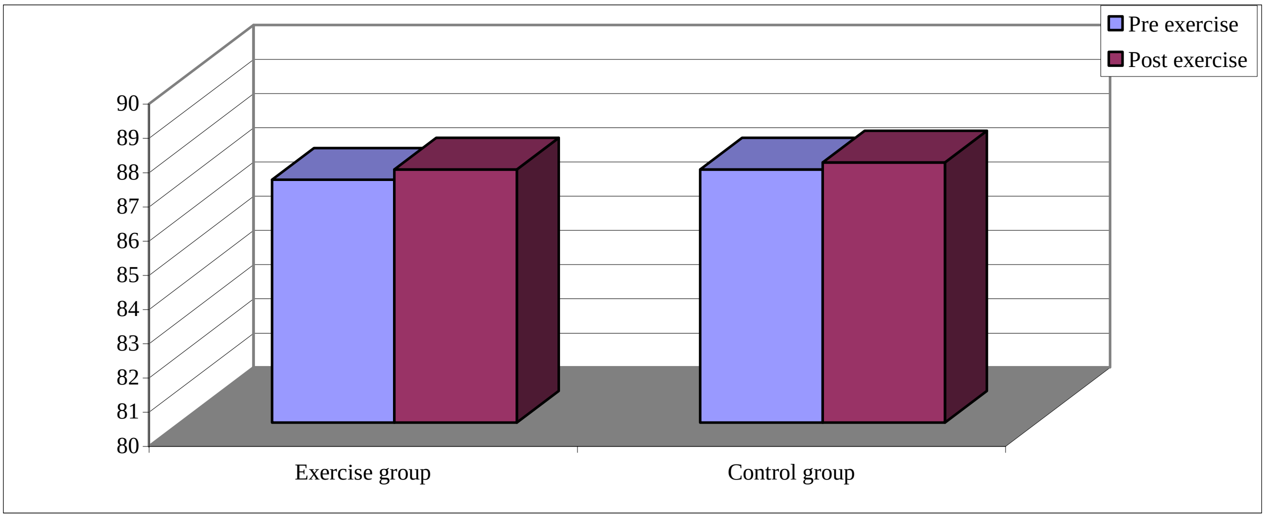

Fig. (3): Shows FEV$_1$/FVC mean values of exercise and control groups before and after the exercise program.

Table (3), Fig. (3) showed that, there was a statistically non significant difference between pre and post study mean value of FEV$_1$/FVC in study and control group as (87.4±4.1 vs 87.1±4.05) and (87.6±3.89 vs 87.4±3.57) respectively.

Table (4): shows MVV mean values of exercise and control groups before and after the exercise program.

Group / Parameter	Exercise Group	Control Group	t-value	P-value
Before exercise	122±14.3	123.5±16	0.36	P>0.05**
After exercise	128.1±14.1	124.3±16.1	0.98	P<0.05*
t-value	9.07	3.4		
% change	5 increase	0.64 increase		
P-value	P<0.05*	P>0.05**		

Level of significance at P<0.05 * = significant ** = non significant.

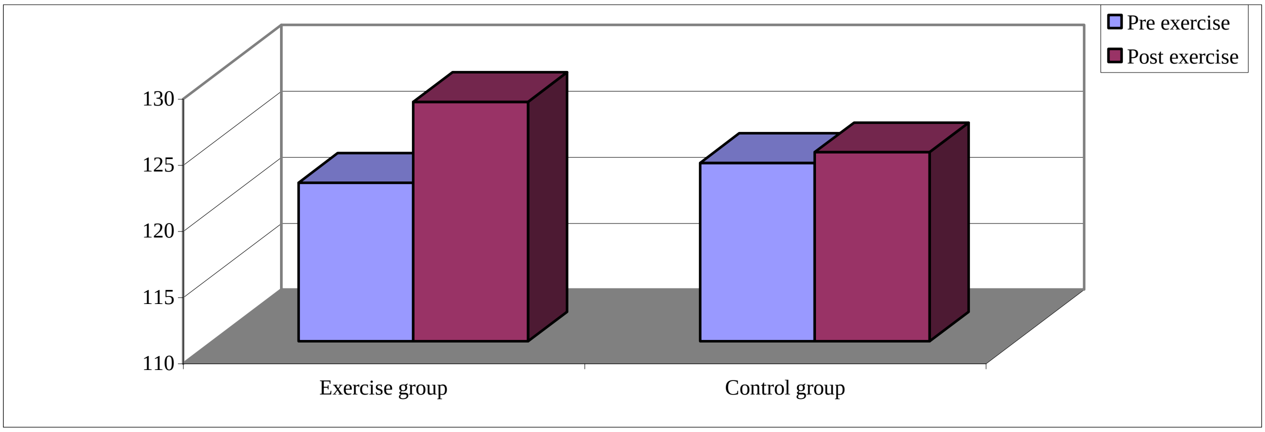

Fig. (4): Shows MVV mean values of exercise and control groups before and after the exercise program.

Table (4) and Fig. (4) showed that, there was a statistically significant increase in MVV post study in comparison to pre study value as (128.1±14.1 vs 122±14.3). However, there was non significant difference between pre and post study mean value of MVV of the control group as (124.3±16.1 vs 123.5±16).

DISCUSSION

At present, it appears that the use of aerobic training is novel in its use of improving pulmonary function and more specifically spirometry parameters, though numerous researchers suggest the importance of it[5,10]. In the literature the relationship between habitual physical activity and lung function in younger age groups is not well documented[13].

Therefore, the aim of this study was to investigate the effect of aerobic exercise program on the ventilatory functions in smoking adolescents.

Our results in this study showed that a program of moderate aerobic exercise, three days per week, for 10 weeks led to a non-significant improvement in the ventilatory functions except for maximum voluntary ventilation (MVV) which showed a significant improvement by 5%.

Previous research that has focused on the effect of aerobic exercise on forced vital capacity (FVC) as it was demonstrated that, FVC in healthy prepubescent children significantly increased (7±4%) after eight weeks of high-intensity intermittent running training. Also, it was established that 10 weeks aerobic training of moderate and high intensity showed a significant mean increase in FVC in elderly individuals[10,16].

In contrast to the abovementioned positive findings, an investigation established that their subjects' FVC did not change significantly following the completion of a four week intensive aerobic exercise program[3,21].

In agreement with the above mentioned studies, the present investigation found that FVC showed a non-significant increase by 0.64% from the pre- to post-test in the experimental group.

These findings by the above researchers support the findings of the present investigation, since the current study also found a non-significant improvement in FEV_1. In this regard, in the present investigation, the FEV_1 increased (non-significantly) by1.03% in the exercise group.

It was established that, chronic exercise may cause an increase in FVC which could be due to increased strength of respiratory musculature[1].

Concerning changes in MVV improvement our study results showed that the exercise group's maximal voluntary ventilation significantly increased by (5%) and non-significantly increased by (0.64%) in the control group.

In agreement with this significant MVV improvement in 18 subjects following a 3-week cycle ergometer exercise training program was reported[15]. Also, MVV was improved significantly in smoker subjects after a 36-session aerobic exercise program[22].

However, the findings of the MVV in the present study contrasts with studies in which exercise caused non-significant or even no effect on MVV. One of these Studies was that found no change in MVV after 6 weeks of aerobic and anaerobic training in children[7].

On the other hand, non-significance in the study group's values of FVC, FEV_1, and FEV_1/FVC shown in the present study could be due to the moderate intensity of the training procedure.

There is an important factor should be taken into consideration that may account for the non-significance in the study group's values of FVC, FEV_1, and FEV_1/FVC is smoking which might have limited improvement in these parameters more than in the MVV as these variables are known to be affected by smoking more than MVV[4].

Conclusion

Aerobic exercise produced a significant increase in the maximal voluntary ventilation in smoking adolescents with normal lung function indicating improvement in the ventilatory muscles strength and endurance. The aerobic exercise program was insufficient to result in significantly positive changes in the majority of the ventilatory functions (FVC, FEV_1 and, FEV_1/ FVC)and these changes might have been more statistically significant if the population studied had lower spirometry values or had pulmonary diseases (i.e. chronic bronchitis).

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الملخص العربي

مدى استجابة وظائف التهوية الرئوية للتدريبات الهوائية لدى المراهقين المدخنين

هدف هذا البحث هو دراسة مدى استجابة وظائف الرئة لدى المراهقين المدخنين لبعض التدريبات الهوائية أجريت هذه الدراسة على 60 شخص من المراهقين المدخنين تتراوح أعمارهم بين 14 و19 عام . تم تقسيم الأشخاص إلى مجموعتين متساويتين : مجموعة الدراسة والمجموعة الضابطة واشتملت كل مجموعة على 30 شخص . مارس أفراد مجموعة الدراسة برنامج من التمرينات الهوائية بينما أفراد المجموعة الضابطة لم يمارسوا أ ي تمرينات . تم قياس وظائف التهوية الرئوية قبل بداية البرنامج العلاج ي وبعد انتهائه لجميع أفراد المجموعتين حيث كانت مدة البرنامج 10 أسابيع اشتملت 30 جلسة بمعدل 3 جلسات أسبوعياً . أظهرت نتائج البحث أنه لا توجد فروق ذات دلالة إحصائية تفيد وجود تحسن ملحوظ في وظائف الرئة لدى مجموعة . الدراسة بالمقارنة بقياسات نفس الوظائف قبل البرنامج العلاج ي فيما عدا وجود فروق ذات دلالة إحصائية في وظيفة التهوية اللاإرادية القصوى بين أفراد مجموعة الدراسة تشير إلى تحسن في هذه الوظيفة بعد البرنامج العلاجي .