The Effect Of Interval Aerobic Exercise On Forced Vital Capacity In Non-Active Female Students

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ABSTRACT

The purpose of the present study was to examine the effect of interval aerobic exercise on forced vital capacity in non-active female students. Forty healthy non-active female students with no cardiovascular and pulmonary disease and skeletal deformity or smoking experience were randomly selected and divided into two groups; experimental group (N=20) and control group (N=20). The experimental group performed 36 sessions of 45-minute interval aerobic running with 65-80% of heart rate reserve while control group had no training program. Before beginning exercise plan and after 18th, 24th and 36th session of training program, forced vital capacity (FVC) was evaluated by Lung Test1000 Spirometer. The results were analyzed by General Linear Model- Repeated Measures and the mean differences were tested. P>0.05 was considered as non-significant. The results showed that interval aerobic training had significant effect on forced expiratory vital capacity (FVC EX) and forced inspiratory vital capacity (FVC IN) (P<0.05). It seems interval aerobic training programs can be used for improving female’s cardio-respiratory function and its efficacy.

Key words: Interval aerobic exercise, Forced vital capacity, Non-active female students

Introduction

It is essential to be involved in physical activity or sports which help in achieving better lung function. Involvement in certain physical activities or sports could help in respiratory muscle strengthening and improvement in pulmonary function. Change in physical activity is associated with change in cardio respiratory fitness [6]. Exercise when performed regularly has benefits on the various systems of the body. Regular exercise has a favorable influence on cardiovascular functions and also lung functions [29]. Sedentary lifestyle and physical inactivity represent the high prevalence and public health concern in developed and developing countries [18].

Lung function typically is measured as forced vital capacity (FVC). The FVC is the maximal volume of air expired during a rapid, forced expiration, starting at full inspiration[8]. Forced vital capacity (FVC) presents the total air volume moved in one breath from full inspiration to maximum expiration or vice versa. FVC varies considerably with body size and body position during the measurement; values usually average 4 to 5 L in healthy young men and 3 to 4 L in healthy young women. FVC of 6 to 7 L are not uncommon for tall individuals and value of 7.6 L has been reported for a professional football players and 8.1 L for an Olympic gold medalist in cross country skiing[22]. Expiration is considered a passive process during quiet breathing, but with an increased breathing effort, expiration can be facilitated by the activation of the abdominal musculature. As the abdominal musculature contracts, the intra-abdominal pressure is increased and the diaphragm is driven upwards, thus actively decreasing thoracic dimensions [5].

A large body of evidence suggests that there is a gradual age related decline in the pulmonary function beginning at about age of forty. It is generally accepted that forced expiratory volume in 1 second (FEV1) and Forced vital capacity (FVC) are strong indicators of lung function, which decline due to obesity and sedentary life style [16, 17]. Review of research evidences shows that aging or obesity combined with sedentary lifestyles has a direct effect on the function of respiratory system by altering lung volume, airway caliber and respiratory muscle strength [16]. On the other hand, physical activity has been known to improve physical fitness and to reduce morbidity and mortality from numerous chronic conditions [31]. A research indicates that men who remained in the active life style during the follow-up (19 months) showed 50 ml improvement in their FEV1 and 70 ml in their FVC, whereas...
subjects who remained in sedentary life style had 30 and 20 ml reduction in their FEV1 and FVC, respectively [12].

Nowadays, most studies on the effects of physical activity on respiratory function are cross sectional ones on special populations such as athletes or respiratory diseases such as asthma or chronic obstructive pulmonary disease (COPD). Furthermore studies aimed at understanding the physiology of respiration during exercise have traditionally used male rather than female subjects. Only recently has there been an appreciable understanding that the respiratory responses to exercise in women may be different from that of men. Trained females may be particularly susceptible to developing expiratory flow limitation by virtue of their smaller diameter airways, smaller lung volumes and lower peak expiratory flowrates relative to age- and height-matched men [24, 2, 23]. These anatomically based differences ultimately result in a smaller maximum flow–volume loop which may cause women to experience expiratory flow limitation at a lower level of minute ventilation ( $\dot{V}_E$) and oxygen consumption ( $\dot{V}_O2$) relative to men [23, 15]. Additionally the results derived from the studies on pulmonary system have only been partially in accordance with each other. So presenting a decisive and comprehensive view concerning the effects of physical activity on pulmonary capacities and function has been of doubt (Chung, huang, 2006, Karimi, M., S. 1993, Khosravi,Nikoo. 2000). Thus the researcher would like to study on the effects of interval aerobic exercise on forced vital capacity among non-athlete female college students

Material and Methods

This study was quasi-experimental with control and experimental groups and taking FVC test before starting exercise program and after 6th, 8th and 12th weeks of exercise plan.

Participant:

The Statistical sample involved 40 non-active female students aged 18-28 years from Islamic Azad universities of Iran that were selected randomly and assigned to experimental (N=20) and control (N=20) groups. According to the health questionnaire all the subjects were healthy and did not have any cardiovascular, pulmonary diseases and skeletal and physical deformities. After selecting and assigning subjects to due groups and prior to performing spirometry maneuvers and exercise program, the subjects got familiarized with different stages of exercise and the proper manner of conducting the spirometry test. In order to measure forced vital capacity LUNG TEST 1000 spiromet which is a static and modifier system designed for pulmonary function test, was applied. Pulmonary function tests were done in four stages: before starting exercise plan, after 18th, 24th and 36th sessions of exercise program. All subjects performed the tests in standing position. At the first stage of testing each subject performed the maneuver 3 or 4 times and the best performance was recorded and the data was analyzed.

Exercise training protocol:

Exercise program involved 12 weeks of interval aerobic running, three 45 minute sessions a week each contained 10 minutes warm up, 4 sets of 5-minute interval running with %65-%80 heart rate reserve,2.5 minutes rest between sets and 7.5 minutes recovery. Heart rate and exercise intensity were controlled by using polar pulse meter sets on subjects’ wrists.

Data analysis:

After recording of data by use of SPSS version 16.5, the means, standard error of means and standard deviation of data were calculated. After making sure about natural distribution of data by use of t-test and leven’s tests, General Linear Model (GLM)-repeated measures and Bonferroni post hoc tests were applied for comparison of variance within the groups, interaction (groups × phases) and between groups. The level of significance was set at P< 0.05.

Results:

Table 1 shows the mean and standard deviation of forced expiratory vital capacity(FVC EX) and forced inspiratory vital capacity(FVC IN) of experimental and control groups in four stages(pre-test, 6th week test, 8th week test, 12th week test).

Table 1: Mean values and standard deviation of FVC EX and FVC IN of experimental and control groups in four stages

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group</th>
<th>Pre-test</th>
<th>6th week test</th>
<th>8th week test</th>
<th>12th week test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean ± S.D</td>
<td>Mean ± S.D</td>
<td>Mean ± S.D</td>
<td>Mean ± S.D</td>
</tr>
<tr>
<td>FVC EX</td>
<td>Experimental</td>
<td>2.53±0.806</td>
<td>3.14±0.789</td>
<td>3.31±0.622</td>
<td>3.46±0.610</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.38±0.634</td>
<td>2.49±0.587</td>
<td>2.50±0.592</td>
<td>2.49±0.584</td>
</tr>
<tr>
<td>FVC IN</td>
<td>Experimental</td>
<td>1.89±0.618</td>
<td>2.22±0.645</td>
<td>2.33±0.629</td>
<td>2.42±0.748</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.83±0.616</td>
<td>1.81±0.611</td>
<td>1.92±0.538</td>
<td>1.95±0.555</td>
</tr>
</tbody>
</table>

The results of ANOVA using a repeated measure design for FVC EX showed that the F and its significance in within subject effect test for stage and stage *group were 40.61, P<0.05, 24.29, P<0.05
respectively. Repeated measure ANOVA indicated that the F and its significance in between subject effect were 10.55 and P<0.05 (Table 2).

The results of ANOVA using a repeated measure design for FVC IN showed that the F and its significance in within subject effect test for stage and stage *group were 33.23, P<0.05, 18.17, P<0.05 respectively. Repeated measure ANOVA indicated that the F and its significance in between subject effect were 5.59 and P>0.005 (Table 2).

### Table 2: Repeated measures mean of FVC IN and FVC EX in experimental and control groups in four stages

<table>
<thead>
<tr>
<th>Variables</th>
<th>Between-Subjects Effect</th>
<th>Within-Subjects Effect</th>
<th>STAGE</th>
<th>P-value</th>
<th>STAGE * GROUP</th>
<th>P-value</th>
<th>F</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC EX</td>
<td></td>
<td></td>
<td>F</td>
<td>40.612</td>
<td>P&lt;0.000</td>
<td>24.29</td>
<td>10.55</td>
<td>P&lt;0.002</td>
</tr>
<tr>
<td>FVC IN</td>
<td></td>
<td></td>
<td>F</td>
<td>33.23</td>
<td>P&lt;0.000</td>
<td>18.17</td>
<td>5.59</td>
<td>P&gt;0.005</td>
</tr>
</tbody>
</table>

**Fig. 1:** Mean differences of FVC EX in experimental and control groups in four stages

**Fig. 2:** Mean differences of FVC IN in experimental and control groups in four stages

**Discussion:**

Physical inactivity and low cardio-respiratory fitness are recognized as important causes of morbidity and mortality [31, 30]. Previous studies have shown that the poor lung function associated with a sedentary lifestyle can significantly predict cardiovascular problems [5]. The aim of this study was to find out the effect of interval aerobic exercise on forced vital capacity among non-active female students.

Many studies have documented differing changes in forced vital capacity (FVC) following various intensities and durations of exercise. This investigation used interval aerobic exercise with intensity of 65% - 80% of heart rate reserve. In the present study, forced expiratory vital capacity (FVC EX) and forced inspiratory vital capacity (FVC IN) increased significantly in the experimental group after 12 weeks of interval aerobic exercise. It can be explained that as both groups had similar conditions at the beginning of the study, interval aerobic
exercise caused the increase among the experimental group. Thus an association between interval aerobic exercise training and improvement of lung function was supported by our data.

The various muscles of respiration aid in both inspiration and expiration, which require changes in the pressure within the thoracic cavity. The principal muscles are the diaphragm, the external intercostal and the interchondral part of the internal intercostal muscles. Both the external intercostal muscles and the intercondral elevate the ribs, thus increasing the width of the thoracic cavity, while the diaphragm contracts to increase the vertical dimensions of the thoracic cavity, and also aids in the elevation of the lower ribs. Maximal inspiration results from contraction of the diaphragm downward and the movement of the ribs upward and outward, both of which expand the chest cavity. Forced expiration is the result of the rapid contraction of chest and abdominal muscles, as well as the relaxation of the diaphragm [33]. With respect to significant increases in FVC IN and FVC EX after 12 weeks of interval training it seems that improvement of these capacities were due to strengthening of respiratory muscles (expiration and inspiration muscles). Muscular exercise increases the rate and depth of respiration and so improves FVC, the consumption of O2 and the rate of diffusion [13]. Breathing exercise promotes a more efficient breathing pattern, improvement in ventilation and increases in FVC, the increase in FVC post exercise might be related to the enhanced strength of respiratory muscles following training, a reduction in air trapping, improvement in lung compliance, reduced air way resistance and the process of motivation which enforces the subject to take deep inspiration and fill all air passages after training [9]. Shashikala [29] showed that the Pulmonary Function Tests values are higher after exercise training. The cause for this could be regular forceful inspiration and expiration for prolonged period during training leading to the strengthening of respiratory muscles. Skeletal muscle control many crucial elements of aerobic conditioning including lung ventilation. There might be increase in the maximal shortening of the inspiratory muscles as an effect of training, which has been shown to improve the lung function parameters [10]. In the Amsterdam Growth and Heart study, physical activity was observed to be positively correlated to changes in FVC between ages 13-27 years over a period of 15 years [30]. Furthermore the result of present study was supported by a number of previous studies as well [1,21,25]. A recent study by Fuster et al. [11] also observed increment in FVC as an effect of increased physical activity. Though a previous study does not show any statistically significant difference in these values as an effect of exercise [14].

Conclusion:

The results of the present study showed interval aerobic exercise improved the forced expiratory vital capacity and forced inspiratory vital capacity. Different types of exercises affect body systems in variable manner. Pursuing an interval aerobic exercise or physical activity which could help in achieving efficient lung function especially FVC is an essential preventive strategy in this busy age when prevalence of sedentary life style is increasing and so are the associated lifestyle disorders. As suggested by Pelkonen et al. [27], a continued high physical activity is associated with lower mortality, and delays decline in the pulmonary functions and therefore should be encouraged.

References

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