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TANAFFOS

Effect of Eight-Week Aerobic, Resistive, and Interval Exercise Routines on Respiratory Parameters in Non-Athlete Women

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Background: There are not many studies about the effects of physical activity on pulmonary function in normal population. However, it seems that strengthening and persevering respiratory muscles is an effective technique for improving pulmonary function.

Objective: The purpose of this study was to evaluate and compare the effects of eight-week aerobic, resistance, and interval exercise routines on respiratory parameters in non-athlete women.

Materials and Methods: Thirty-six non-athlete women between 18-25 years old participated in this prospective quasi-experimental trial. The subjects were randomly divided into three groups (aerobic, resistance and interval exercise, 12 in each group). Each group exercised three times a week for a total of eight weeks (24 sessions in total). Pulmonary function tests (PFT), including tidal volume (VT), inspiratory reserve volume (IRV), expiratory reserve volume (ERV), inspiratory capacity (IC), vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in the first seconds (FEV_1), the ratio of FEV_1/FVC, peak inspiratory flow (PIF), and forced expiratory flow (FEF 25-75%) were recorded before and after the implementation of the exercise program for all participants. Data were analyzed using paired t-test and one-way ANOVA.

Results: The mean age of participants was 20.17 ± 2.13. The results of the paired T-test indicated that VC significantly increased in the group assigned to aerobic exercise (P = 0.028), while IC (P = 0.012) and PIF (P = 0.019) significantly increased in the group assigned to interval training.

Conclusion: Our results showed that interval and aerobic exercise routines could improve pulmonary functions and aerobic and interval training can be used to increase VC, IC, PIF, in non-athlete women.

Key words: Aerobic exercise, Resistive exercise, Spirometry, Physical activity

INTRODUCTION

There are not many studies in the literature about the effects of physical activity on pulmonary function in healthy population (1). Most studies are cross sectional and were performed on specific populations such athletes or patients with COPD (2). Previous studies have shown that lung volumes, particularly FEV_1, are higher in athletes than those observed in healthy non-athlete population (3). This was particularly notable in swimmers.

One cross sectional study reported that physical activity and exercise significantly affected spirometric parameters in both asthmatic and non-asthmatic individuals (4).

Strengthening respiratory muscles is an effective way to improve pulmonary function and standard exercise regimens improve ventilatory mechanics, as evidenced by increases in spirometric indices (ERV, VC, FVC, TLC and FEV_1) of obese patients (5).

A stusy showed that pulmonary distribution volume was more homogenous in athletes compared to non-athletes and that athletes had higher pulmonary distribution volumes. One reasons for this is the improved lung volumes in athletes (6).

Guenette et al. proposed that anatomy and static pulmonary functions differ significantly between men and women and that can affect gas exchange and ventilation during exercise. Adult male athletes have much wider respiratory tracks, higher lung volumes, and a larger surface area for gas exchange compared to non-athlete adult men of same height (7). Similarly, they found that non-athletes had lower respiratory function test indices compared to those of the athletes. Therefore, athletes had lower ventilation per minute than non-athletes but moved the same volume of oxygen (8).

Marlin et al. demonstrated that thoracic volumes change after running (9). Alberti et al. studied the effect of exercise on respiratory parameters in smokers and non-smokers and showed that exercise is significantly related to respiratory function (10).

Astrand and Rodahl showed that exercise increases VC and suggested that VC is an important indicator of functional capacity. He also showed that 40 year-old athletes had VCs equal to those of 20 year old non-athletes (11).

A study by Jakes et al. revealed significant relation between FEV_1 and physical activity such that active individuals had higher FFV_1 values (12).

Pelkonen et al. showed that physical activity can delay the decline in pulmonary function (13). Cheng et al. studied the effect of physical activity on exercise tests as well as respiratory function tests and demonstrated that active men had higher FVC and FEV_1 (forced expiratory volume in first second) values compared to their less active counterparts (14).

Since there are not any studies evaluating and comparing the effects of different training programs on respiratory functions in non-athlete women, we decided to examine our theory about the impact of three different training schedules – aerobic, resistance, and interval exercises - on respiratory volumes, lung capacities, and spirometric parameters in non-athlete women.

MATERIALS AND METHODS

This is a quasi-experimental study and the cases were referred from Pakdasht's Basij organization. Participants filled out questionnaires that inquired about their physical health, past medical history, and demographic information. Inclusion criteria: No prior history of cardiovascular, pulmonary, or musculoskeletal diseases which would prevent them from performing the exercise routines, no corticosteroid use in past three months, and no history of formal athletic activity.

Thirty-six subjects were randomly assigned to three groups (12 participants in each group). After filling the informed consent forms, we measured spirometric parameters before- and after completing the eight-week exercise programs (pre- and post test). All tests were done in Alghadir Hospital (Tehran, Iran).

Each group was assigned one specific training program (aerobic, interval, or resistance).

Group 1:

The first group's routine included resistance training using free weights, resistance machines, and dumbbells and participants performed three sets of 10 repetitions of each exercise. Repetition maximum (RM) was measured for each muscle group and exercise intensity was increased by 60, 65, and 70% of the RM value during each subsequent session.

Group 2:

Group 2 participated in aerobic exercises. Each session was 40-60 minutes, and they were held three times a week.

Each session started with a 10 minute warm up routine, followed by 20 minutes of aerobic activity at 70%-80% of maximum heart rate (calculated by 220 - Age) during the first four weeks. This was increased to 30 minutes for the next four weeks.

Group 3:

Group 3 participated in interval training, which consisted of short periods of running at 85% maximum heart rate. Each session started with warm up, which was followed by five rounds of running 20, 30, 60, and 100 meters, and finished with cool down exercises.

All individuals' heart rates were measured before and after each session. For pretest and posttest pulmonary function tests, subjects' age, sex, weight, and height were entered into the spirometer (ZAN, GmbH Germany) and all steps were observed by a pulmonologist.

For descriptive data, mean and standard deviation values were calculated and reported. The data were normally distributed (Kolmogorov-Smirnov), and equality of variance was checked by Levene's test. Comparison of the effects of different exercise programs between the groups was performed by paired t-test. We used one-way ANOVA as parametric test and Kruskal-Wallis test as non-parametric test for analysis of exercise effects and comparison of demographic characteristics among the three groups. A P-value<0.05 was considered statistically significant.

RESULTS

Thirty-six non-athlete women between 18 - 24 years old (20.17 ± 2.13), with mean body mass index (BMI) of mentioned in table1 were randomly distributed in 3 groups. Groups were equal in age, weight and BMI (p-value > 0.05) (Table 1).

Table 1. Demographic data in participants according to method of exercise

	Group1 (resistive)	Group2 (aerobic)	Group3 (interval)	P-value
Age (yr)	20.9 ±1.9	20 ±2	19.58±2.1	0.30
Weight (kg)	54.3 ± 6.9	58.7 ± 9.2	53.1 ± 7.7	0.29
Height (cm)	158.1±5.2	158.5± 6.1	161.3±5.1	0.21
BMI	21.8±3.2	23.37±3.4	20.37±2.6	0.08

There was no significant difference between spirometeric parameters at the beginning of 8-week exercise program (p-value > 0.05); so the groups were equal in all study parameters. (Table 2)

We did not find any significant differences in spirometric indices between the three groups (interval, resistance, and aerobic exercises) upon the completion of the eight-week exercise routines (P-value > 0.05) (Table 2).

T-Test of paired samples revealed that VC in group 2 individuals significantly increased after eight weeks in comparison to their pre-exercise values (P < 0.05).

Table 2. Spirometric parameters in the 3 groups before and after the program

Spirometric parameters	Before Exercise Program			After Exercise Program			P-Value
	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	
FVC (%)	80.8±12.42	79.8±14.0	82.0±12.4	88.4±16.8	84.0±9.2	85.3±12.2	0.27
FEV_1 (%)	85.0±13.2	85.9±13.4	85.4±17.4	93.6±15.5	84.7±9.5	87.4±15.0	0.91
FEV_1/FVC	92.8±6.9	95.82±5.17	89.3±12.8	92.4±5.4	87.0±5.8	88.5±9.5	0.92
MEF25-75(%)	81.0±24.0	80.6±17.2	77.0±19.9	86.6±15.4	73.8±12.7	82.8±31.1	0.33
PIF (L/S)	2.9±0.64	2.8±0.59	2.7±2.3	3.1±0.85	3.2±0.85	3.4±0.87	0.80
VC (%)	82.6±12.3	80.4±13.4	82.1±12.5	89.4±15.6	84.6±9.2	85.0±12.6	0.99
ERV (%)	61.7±48.0	81.3±44.8	71.5±24.5	62.2±61.1	68.9±64.4	52.6±41.3	0.50
Tidal Volume (lit)	0.85±0.53	0.77±0.50	0.81±0.48	0.73±0.48	0.72±0.50	1.52±0.46	0.22
Inspiration Capacity (%)	105.4±34.8	100.8±49.1	82.5±18.3	107.1±33.2	105.2±44.2	107.1±33.1	0.99

Over the eight week period, interval training was the most effective means of increasing PIF (P = 0.026) and IC ((P = 0.015) in non-athlete women.

DISCUSSION

In accordance with the findings from previous studies, our findings show that interval training and aerobic exercises significantly improving spirometric parameters of non-athletes while weight training (resistance training) has no significant effect on respiratory parameters. We did not find any significant differences in spirometric parameters between the three groups after completing the eight-week exercise programs. Enright et al. showed that eight weeks of high-intensity inspiratory muscle training significantly increased VC (15). Wells et al. demonstrated the effect of 11 weeks of concurrent respiratory muscle training on lung function (16). Hallstrand et al. showed that aerobic training increases ventilation capacity (17). Unlike our findings, other researchers reported that eight weeks of aerobic training had no significant effect on VC (18). In their study, they reported that cycling changed the tidal volume; breathing rate elevation results increasing ventilation rate per minute. During physical activity, the number of lung volume receptors and other receptors in respiratory control center increase, which result in higher ventilation rate. Therefore during an exercise initially tidal volume and subsequently breathing rate increase.

Comparing methodology and findings of Benito's study to those of our study, it appears that our aerobic training might have been more rigorous than theirs and aerobic training reaching 60% of maximum aerobic potential might not significantly change vital capacity. On the other hand genetic factors, age, height, weight, season of training, air pollution, and even training attire are factors that can affect the results. Different studies have revealed that excessive fat around abdomen and chest would decrease flexibility and movement of muscles and lead to lower chest volume during breathing.

Nourry et al. showed that interval training and high intensity training programs can increase lung function (19). The findings of the study by Jake et al. were consistent with ours and showed that physical activity can increase FEV_1 (12). There are other studies of resistance training which also showed that eight weeks of resistance training had no significant effect on spirometric parameters (20). These findings were consistent with ours with exception of PIF values.

Our study's limitations include small sample size and the inability to control for each individual's daily activity levels.

CONCLUSION

According to our findings, physical activity and regular exercise positively affect the respiratory system. There were no significant changes in spirometric parameters in our study that could be attributed to the implemented training programs Perhaps eight weeks is not long enough to result in significant changes in lung function.

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