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The Effects of Aerobic Training on Pulmonary Function in Postmenopausal Women

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Abstract

Purpose: the menopausal transition is associated with a series of physiological changes that can be linked impairment of respiratory function. The purpose of this study was to investigate the effects of aerobic training on pulmonary function in healthy postmenopausal women.
Method: Nineteen healthy postmenopausal women were selected by convenience sampling method and were randomly divided into two active (n=11) and control (n=8) groups. The exercise protocol included aerobic exercise training lasted for 8 weeks and 3 sessions per week. The spirometry test, anthropometric measurement and treadmill test were performed for subjects before and after training program. All statistical analysis was performed with SPSS version 16. General linear-repeated measures for comparison variance of within groups and between groups were used. The level of significance was set at P< 0.05.
Results: After 8 weeks of training, anthropometric parameters and VO2max of active group showed a significant increase. Furthermore, aerobic exercise training causes a significant increase in FVC and FEV1 parameters of pulmonary functions after 2 months of training program.
Conclusion: It seems that aerobic training leads to increasing the strength and/or endurance of the respiratory muscles. We think that exercise training have improving effects on pulmonary function in postmenopausal women.

Key words: Body composition, Exercise, Postmenopausal Women, Spirometry

Introduction

In 2050, the proportion of adults over the age of 65 years will exist to double, to 15.9% of the population with more than half of this elderly population being women, according to Department of Economic and Social Affairs reports (2004). As aging progress, the respiratory system undergoes a measurable decline in the physiological function. With advancing age, the thoracic cage stiffens; And the possibility for increased kyphosis coupled with increased work demand of the respiratory muscles, thus increases the work of breathing. There are significant changes in the functions of the pulmonary system of elderly people, including: decreased FEV1 (forced expiratory volume in 1 second), FVC (forced vital capacity), increased RV (residual volume), and increased FRC (functional residual capacity) (Robergs and Roberts, 2000).
In addition, in postmenopausal women, the menopausal transition is associated with a series of hormonal changes that has been linked to impairment of respiratory function (Hayatbakhsh et al., 2011). Sex hormone plays an important role in women’s lung health (Polly et al., 2009). Many investigators studied lung function during different phases of menstrual cycle. They observed that lung functions are increased during luteal phase of menstrual cycle due to high level of progesterone induced hyperventilation and bronchial relaxation (Pai et al., 2004; Kaygisiz et al., 2003). It has also

been observed that there is a close relationship between female sex hormones and lung function in postmenopausal women. There is evidence that spirometric measures of lung function including FVC, FEV1 FEV1/FVC% are decreased in postmenopausal women. For example, in a cross-sectional analysis of the multicentric and multinational European Community of Respiratory Health Study, Real et al. (2008) found that women don't have menstruation for the last 6 months (n=432) had significantly lower FEV1 and FVC and more respiratory symptoms than women of similar age with regular menstruating. Cheng et al. (2003) found that, after age of 25 years old, the average annual decline of FEV1 will be about 22 ml/year for women.

Furthermore, postmenopausal women are at greater risk of central adiposity (Franklin et al., 2009). The amount of body fat and central pattern of fat distribution might be related to impaired lung function via several mechanisms, such as mechanisms that affects on the diaphragm (impeding descent into the abdominal cavity) and on the chest wall (changes in compliance and in the work of breathing and elastic recoil) (Santana et al., 2001). Obesity is capable of reducing pulmonary compliance, lung volumes, and the diameter of peripheral respiratory airways as well as affecting the volume of blood in the lungs and the ventilation-perfusion relationship (M.El-Baz et al., 2009). In the literature, it was reported that if the increase in body weight is caused by the increase in the amount of fat in the upper body, this especially decreases the effectiveness of FEV1, FVC and FEV1/FVC% capacities (Carey et al., 1999; Wang et al., 1996). All of this change can lead undesirable changes in the respiratory function. Also, studies showed that reduced lung function was associated with increased metabolic risk factor (Steele et al., 2009; Lawlor et al., 2004). Jung et al. (2010) reported that increased C-reactive protein (CRP) levels are strongly and independently associated with impaired pulmonary function and more frequent a low FVC in postmenopausal women

In the postmenopausal age, the prevalence of inactivity progressively increases, and about 30% of postmenopausal women report no physical activity at all (U.S. Department of Health and Human Services, 1996); Physical inactivity in postmenopausal women contributes to the increase risk factors and to low cardiorespiratory fitness (Hulke et al., 2012). By the age of 65 years, aerobic capacity is 30%–40% less than young adult values (Shephard, 1987). But, there are very few studies to investigate the effects of aerobic exercise on pulmonary function. And, the literature about the effects of physical activity on lung health is often contradictory and confusing. Attarzadeh Hosseini et al. (2012) reported that 24 sessions of 45-minute interval aerobic running had no significant effect on TV (tidal volume), IRV (inspiratory reserve volume), and FEV1, FVC, and FEV1/FVC%. But Cheng et al. (2003) showed that active subjects had higher FEV1 and FVC than the sedentary groups. Moreover, Huang and H.Osness (2005) indicated that 10 weeks of aerobic training of moderate or high intensity showed positive effects on pulmonary function in elderly individuals.

Because of an increasing life expectancy, women generally spend one-third of their lives after menopause (Speroff, 1994). And huge number of menopausal women will put pressure on existing health care services; For this reason, the extent and mechanisms that exercise and physical activity can improve health, functional capacity, quality of life, and independence in this population must determine. But, few studies investigated the effects of physical activity on lung function status in postmenopausal women. Therefore, the purpose of this study was to determine the effects of aerobic training on pulmonary function in healthy postmenopausal women.

Material and Method

Participants:

The procedure of this study was semi-experimental. The subjects were twenty healthy and inactive postmenopausal women randomly assigned into the active (n=11) and control (n=8) groups. The subjects were nonsmokers, received no drugs and had no metabolic disease and physical impairment affecting their performance. In addition, women were menopause for more than 2 years and didn't use estrogen hormone replacement therapy.

Study design:

Before starting the program, written informed consents were taken from all subjects. The levels of health and physical activity of the subjects were determined using general health, physical activity questionnaire and medical survey (including electrocardiogram and blood pressure tests) by a specialist physician. All of pulmonary indexes FEV1, FVC, PEF (peak expiratory flow), PIF (peak inspiratory flow) & FEV1/FVC%, VO2max and anthropometric characteristics were measured before starting the program and at the end of 8th week after 48 hours later last session.

Measurements:

Height was measured in centimeters using a height determiner and their weight was calculated using a digital scale produced by a German company called Beurer (PS07-PS06). The percent of body fat (PBF) was calculated by using a In-body (model 720 made in Korea) and based on a method called bioelectrical impedance. $Vo2_{max}$ level measured by treadmill test (naughton protocol). Lung function tests were carried out by using a spirometer (MIR Spirolab, Via Del Maggiolino, 125, 00153, Rome, Italy) with an attached printout of FEV1, FVC, PEF, PIF, FEF25, FEF50, FEF25-75 & FEV1/FVC%. For each assessment a research nurse demonstrated the technique to the participant, after which the participants had the opportunity to do some practice efforts. They were then required to perform a minimum of three reproducible FVC measurements (within 5% of maximum FVC produced). The output which produced the highest sum of FVC and FEV1 was used in the analysis. Women who could not perform three reproducible measurements or who were unable to attempt the lung function assessment were excluded from the study. The spirometry test was performed with the subjects in standing position.

Training:

All subjects having been familiarized with the exercise program, and then the active group followed the aerobic exercise program for 8 weeks- 3 sessions in a week and each session lasted 40 minutes, while control group did not receive exercise. After two weeks and having establishing relative adaptation of the subjects to physical activity, the exercise intensity increased.

The protocol of an aerobic practice session was as follow: Warm up (5 minutes)+ Original activity (the subjects trained 30 minutes with 50% heart rate reserve for the first week and in last week they trained 45 minutes with 70% heart rate reserve) + active rest (3 minutes) + Cool down (5 minutes). Heart rate reserve for every single athlete was respectively calculated based on Karvonen method (equation 1) and was also controlled during exercise by a heart rate monitor (made in Finland–Polar).

Equation 1: Target heart rate = ((heart rate max − heart rate rest) × % intensity) + heart rate rest

Statistical analysis:

All statistical analysis was performed with SPSS version 16. The average and standard deviation of data were calculated after checking the data distribution normally using Kolmogorov-Smirnov test and Homogeneity of variance method. Repeated measure for comparison of variance within groups and between groups was used. Significance was taken as p<0.05 for all tests.

Results

The anthropometric measurements of subjects such as weight, percent body fat, WHR and body mass index (BMI) presented in table 1. There were a significant decrease in all anthropometric values in active group (P<0.05); Variation in variance between groups of variables: weight, percent body fat, WHR and body mass index (BMI) was not significant (P>0.05).

Table 1: Body composition of postmenopausal women

Variables	Group(s)	Pre-test	Post-test	Within groups		Between groups	
		M±SD	M±SD	F	P-value	F	P-value
Weight(kg)	Active	72.45±10.43	71.62±10.11	7.702	0.016*	0.695	0.326
	Control	67.41±11.37	67.48±10.89	0.029	0.871		
BMI(kg/m$^{2)}$	Active	30.84±4.23	30.32±4.20	9.929	0.008*	0.250	0.622
	Control	29.61±4.42	29.93±4.68	4.020	0.101		
PBF(%)	Active	46.56±5.80	42.79±5.63	23.305	0.001*	2.194	0.153
	Control	42.55±3.04	42.23±4.07	0.158	0.708		
WHR(cm)	Active	0.99±0.06	0.98±0.06	12.003	0.004*	0.007	0.934
	Control	0.98±0.05	0.97±0.02	0.122	0.741		

* Significance was found at p<0.05 and results was expressed as mean±SD.

Results of the effect of Aerobic Training on VO2max and spirometric parameters of postmenopausal women showed in table 2. Vo2max, FEV1 and FVC increased significantly in active group (P<0.05). Variance between groups only in FEV1/FVC was significant (P<0.05).

Table 2: VO2max and spirometric parameters of postmenopausal women

Variables	Group(s)	Pre-test M±SD	Post-test M±SD	Within groups F	Within groups P-value	Between groups F	Between groups P-value
VO2max	Exercise	20.57±4.21	26.85±4.21	32.267	0.001*	0.170	0.685
(ml/kg/min)	Control	21.33±3.78	21.66±5.42	0.156	0.709		
FEV1 (L)	Exercise	2.24±0.33	2.33±0.33	5.937	0.029*	0.160	0.693
	Control	2.11±0.51	2.17±0.46	0.432	0.535		
FVC (L)	Exercise	2.66±0.39	2.81±0.42	7.823	0.014*	0.133	0.719
	Control	2.56±0.46	2.64±0.45	0.012	0.916		
FEV1/FVC	Exercise	84.28±2.35	83.04±2.86	3.013	0.105	5.414	0.031*
(%)	Control	81.62±5.57	79.44±8.99	1.027	0.350		
PEF (L/s)	Exercise	4.91±1.10	5.10±0.82	0.899	0.359	3.841	0.064
	Control	4.34±1.71	4.43±1.93	0.003	0.956		
PIF (L/s)	Exercise	2.38±0.78	2.67±1.17	1.152	0.303	0.665	0.426
	Control	2.11±0.41	1.87±0.55	3.428	0.127		
	Control	2.15±1.07	2.13±0.91	0.420	0.541		

* Significance was found at $p<0.05$ and results was expressed as mean±SD.

Discussion and Conclusion

Our data showed that anthropometric parameters significantly decreased in active group. On basis of these results, we can say the training program positively changed the morphological structure of the postmenopausal women. Affecting body fat distribution and waist circumference may have important health implications. Results of the present study is consistent with findings of Irwin et al. (2003), who stated that regular exercise such as brisk walking results in reduced body weight and body fat among overweight and obese postmenopausal women. Velthuis et al. (2009) reported that a 12-month exercise program combining aerobic and muscle strength training did not affect weight but positively influenced body composition of postmenopausal women.

The current study also showed a statistically significant improvement of FEV1 and FVC after exercise program in active group. FVC index is one of the methods to represents airways, expiratory resistance and lung capacity, also FVC index value depends on the lungs elastic and airways resistance (Guyton, 2000). It seems that aerobic training leads to increasing the strength and/or endurance of the respiratory muscles which was supported by Mahler et al. (2001). Our results correspond with El-Kosery's results (2011) who stated that training response of respiratory muscles is similar to that of skeletal muscles as it produced a hypertrophy of muscle fibers & increased the vascularity of muscle fibers (number of capillaries in each fiber). Farid et al. (2005) showed a course of aerobic sport exercise causes an obvious increase in FEV1/FVC% in asthmatic patients, and a regular aerobic sports program is involved in the improvement of pulmonary function. On the other hand, B.Kist et al. (2003) in his plan about changes in pulmonary function following exercise used different duration and intensity of exercises; he stated that bronchial tree, greatly influenced by nor-epinephrine and epinephrine in the circulation that are released into the blood by stimulating the central part of SSR (somatostatin receptor) adrenal glands so increasing the intensity and volume of exercise (aerobic and anaerobic) increases the secretion of these hormones into the blood. Both hormones, epinephrine especially due to the stronger stimulatory effect on beta receptors are causes dilation of bronchial.

Furthermore, in many studies, it was observed that the percentage and distribution of body fat have a significant effect on the pulmonary function (Rossi et al., 2011; Park Jung et al., 2012; Lazarus et al., 1998). The findings of this study also showed that 8 weeks of aerobic training significantly reduced body weight, body mass index (BMI) and percent body fat and cause improvement in FEV1 and FVC. Obesity can affect the thorax, diaphragm, and abdominal muscles and due to increased respiratory effort and impairment of the gas transport system can result in altered respiratory function even if the lungs are normal (Rasslan et al., 2004). W.Jakes et al. (2002) indicated that physical activity is associated with higher levels of FEV1 and stated physical activity might influence either the size or the elasticity of airways; and it is possible that associations between physical activity and respiratory function are mediated through an effect on obesity and fat distribution and, to a lesser extent, through effects on ventilatory muscle strength. FEV1/FVC indicator is another variable that depends on the expiratory and respiratory muscles, when expiratory muscles are weak, the person's ability decreases to drop quickly exhaled and FEV1/FVC index decrease (Ferdowsia et al., 2011). In present study, there was no significant difference in FEV1/FVC. Also, data showed that PIF and PEF increased but

didn't change significantly. However, the possible reason for this can be related to the type and duration of exercise training. It seems that if the aerobic exercise training performs in adequate time and intensity can improve all index of pulmonary function.
In conclusion, our data suggest that aerobic exercise training cause a significant increase in FVC and FEV1 parameters of pulmonary functions after 2 months of training program. Therefore, we think that exercise training have improving effects on pulmonary function in postmenopausal women.

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