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Effect of 8 weeks of Endurance Training on Volume and Capacity of Lungs (FEV1/FVC, FEV1, FVC) and Its Relationship with BMI in Male Smoking students

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Abstract

Purpose: The aim of this study was to investigate the effect of 8-weeks endurance training on volume and capacity of lungs (forced expiratory volume in 1second, Forced vital capacity, ratio FEV1/FVC) and its relationship with BMI in Male Smoking students. **Method:** In order to accomplish this research 20 cigarette addicted men students referred to the smoking cessation clinic were randomly selected and were divided into two groups of experimental (n=10) (age: 15.33 ± 2.07 years and BMI: 25.41 ± 3.55 kg/m2) and the control group (n = 10) (age: 15.10 ± 2.81 years and BMI: 27.26 ± 66 kg/m2). The Spirometry indexes (FEV1/FVC, FEV1, FVC), height and weight were measured Prior and after 8-weeks of endurance training. Experimental group performed 8-weeks of progressive endurance training (3 sessions per week, 60 minutes per session) which included running with the intensity of 75% MHR. Intensity of exercise was controlled by maximum heart rate and the formula of (220-age) and the intensity level and duration of exercises increased in each session. Data analysis was done by using the variance analysis method for repetitive data and the independent T-test. **Results:** The results of this study showed that after eight weeks of endurance

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training, Spirometry indexes (FEV1/FVC, FEV1, FVC) significantly increased ($P<0.05$), and this increase had a negative relation with BMI ($P<0.05$, $r=-0.62$).
Conclusion: the study showed that eight weeks of moderate-intensity endurance training improved volume and lung capacity of Male Smoking students and it could partly remove the damaging effects of smoking on physical and psychological health and it can help them quit smoking as well.
Keywords: Endurance exercise, lung volume, lung capacity, Male Smoking students

INTRODUCTION

Currently, due to smoking cigarettes more than 75000 individuals die in Iran annually (Rendu et al, 2011). According to the available statistical data, each day over 3000 children and teenagers smoke cigarettes and about one third of the world's under-15 years old youth smoke (Price et al, 2003). According to the Department of Health and Medical Education (in Iran), 15% of Iran's population which is around 7 million individuals smokes cigarette. The starting age for smoking in Iran is 12 years old. 3% of women and 28% of men's population smoke in Iran (Emamghoreishi et al, 2009). Smoking is more common among men than women, but despite the fact that only 3% to 4% of women smoke, a larger number of women die due to smoking. This is because women are more exposed to cigarette secondary smoke (Ambrose et al, 2004). A substantial amount of the energy that must be used for daily activities is used for respiratory muscles due to the reduction of the pulmonary performance and respiratory muscle weakness in people who smoke. In such a condition, the person quickly experiences fatigue and disability in doing daily activities. If such complications are not compensated, the person's performance will be reduced. Sport activities, especially endurance and aerobic activities, will reduce the body fat content and increases the respiratory muscles' endurance and power, and also increases the pulmonary performance (Sparrow, 1997). There have been a number of studies conducted to survey the effects of the exercise on the pulmonary performance and its correlation with the BMI.

(Cherly et al, 2010) studied the effect of obesity and fat distribution on the pulmonary performance and concluded that BMI and pulmonary indexes (FEV1/FVC1, FEV1 , FVC) have significant negative relationship. In this study, the examinees consisted of 2000 subjects. They had an age range of 35 to 61 years old. The study's findings showed that BMI, fat distribution, waist size, and the proportion of the shoulder width to the pelvis size have significant negative correlation with pulmonary indexes. The two indexes of FVC and FEV1 are related to the speed of exhale air flow inside trachea and some factors such as increased BMI will have some negative effect on it. (Rupert et al, 2002) showed that there is a significant correlation between the high level of FEV1 and physical activity. (Satta, 2000) showed that FVC and FEV1 parameters increased in the overweight and sedentary middle-aged people while doing short-time daily aerobic activities such as jogging or swimming. In this case, following the rehabilitation of respiratory muscles, the smooth muscles in the respiratory tract expands while taking deep breath, (Chen et al, 1989) in their study surveyed the effect of a 10-week exercise program on some inactive teenagers. The results of this study showed that the group who did a mild exercise program had a significant change in their FVC and the group who did an intensive exercise program had a significant change in their FEV1/FVC, FEV1 and FVC compared to the control group. (Moghadasi et al,, 2010) showed that the patients with pulmonary diseases who suffered from Wheezing, shortness of breath, chest tightness and coughs, improved following exercise activities. (Yue et al, 2007) studied the effect of physical activities on respiratory performance and concluded that active men during the research program had increased forceful vital capacity (FVC), (FEV1) and the ratio of (FEV1) to (FVC); The researcher studied the correlations between the pulmonary indexes of FEV1/FVC, FEV1, FVC and the BMI indexes' changes in Male Smoking students by implementing an endurance exercise program. Since obesity is considered as a threatening factor for the respiratory tract and the respiratory problems are among the serious complications in smoking persons; therefore, the importance of conducting this study has become clearer.

METHOD

This study was a semi-experimental research which included pre-experiment and post-experiment, namely, the exercise and the control groups. Subjects consisted of some teenager Male Smoking students who were qualified for the requirements of the study and were selected through the simple sampling method. The condition for entering this study consisted of not having used any tobacco products in the previous year to the study, and not having any cardiovascular, respiratory, hormonal, muscular, skeletal problems or any other diseases that could have had some negative effects on the research variables.

20 participants who were qualified to participate in the current study were selected and divided into two groups of experimental group (n= 10) and control group(n=10) randomly; however, only 19 participants accomplished the study (a subject from the experimental group gave up) and the final statistical analysis was conducted on these participants. This study was approved by the ethical committee of the medical college of Isfahan University of medical sciences and an informed consent form was signed by subjects before entering the program. The data collection tools for this study included the informed consent form, the demographic questionnaire, and the spirometer device.

All the Subjects went through a Spirometry test at the beginning and in the end of the study and their lung capacity and volume (FVC, FEV in the first second in proportion to the exhale volume in the first second to high pressure vital capacity) were measured. The Spirometry tests were conducted by Spirometer devices which were made in Italy (Rome) and were designed based on the guidelines by the American thoracic society (ATS). The height of the participants was measured without shoes, and their weight was measured with the minimal clothing on. In the phase of performing tests, the subjects were seated and clips were on their noses. They were asked to inhale deeply and then exhale quickly and intensely. Each subject performed numerous tests in order to achieve three tests in accordance with ATS standards; in this phase tests' results were recorded and testing ended. Then the best one of these three trials (the trial with the highest proportion of forced expiratory volume in the first second to the forceful vital capacity) was selected and all the required measured parameters were extracted from this result.

In addition, to calculate BMI, the formula for the ratio of the weight to the square root of the height based on Kg/m2 was used. To measure the height and weight, a digital scale equipped with height measurement device, made in Germany, with an accuracy of ± 0.5 cm for height and ± 0.01 kg for weight was used. To measure the weight of the subjects, they had to take off all their clothes and wear only a swim suit to get the most accurate measurement, and their weight was recorded in kilograms. To measure the height, a measuring tape installed on the wall and a ruler were used.

The subjects of the experimental group performed the exercise protocol which included eight weeks of endurance exercises, three sessions per week and each session lasted 40 to 60 minutes with intensity of 50 to 65% VO2 max. On the other hand, the subjects in the control group did not have any physical activity until the end of research project. The exercise sessions consisted of three separated stages. First, they warmed up and did stretch movements for 10 to 15 minutes, and then they performed some endurance exercises (running) with an intensity level of 50 to 65% VO2 max for 15 to 35 minutes. In each session, the exercise load increased by adding 1 minute to the exercise period and the exercise intensity was controlled constantly. Finally, after completion of the exercise program, participants did 10 minutes of cool-down exercises. Variance analysis method was used for repetitive data. T-test and SPSS version 17 were used to analyze the data. The significance level was 0.05 for all different analyses. Also, Microsoft Excel was used to draw the charts, diagrams and tables.

RESULTS

Table 1 shows the demographic information about the interfering variables. It also shows the distribution of the two groups, which were analyzed by using the T-test. The results show that there is no significant difference in the variable distributions such as age, height, weight and BMI.

Table 1: Demographic information of subjects

Factor	Group	Average	Standard Deviation	T Value	Significance level
Age (year)	Experiment	34.33	5.07	0.98	0.33
	Control	32.10	4.81		
Height (cm)	Experiment	174.44	4.61	0.34	0.73
	Control	173.30	9.05		
Weight (kg)	Experiment	77.55	13.13	-0.57	0.58
	Control	81.88	18.73		
BMI (kg/m2)	Experiment	25.41	3.55	-0.84	0.41
	Control	27.26	5.66		

In table 2, you can find the information about the descriptive data for Spirometry indexes (FEV1/FVC, FEV1 and FVC), BMI and variance analysis test for duplicated data. As it can be seen in the table, interaction in FEV1/FVC and FEV1 were significant ($P \leq 0.05$) but in FVC it was insignificant ($P \geq 0.05$) which shows the affectivity of the exercise program on FEV1/FVC and FEV1.

Table 2. The information about the descriptive data and the variance analysis test for the research variables

Variable	Group	Pre-Test mean ± SD	post-Test mean ± SD	Intra-groups DF (1, 17)	Inter-groups DF (1, 17)	Interaction DF (1, 17)
FEV_1	Experiment	4.00 ± 0.24	4.07 ± 0.33	F=2.55 P=0.12	F=0.07 P=0.78	F=5.95 P=0.02
	Control	3.9 ± 0.75	3.9 ± 0.75			
FEV_1/ FVC	Experiment	80.9 ± 1.04	82.9 ± 0.55	F=114.4 P=0.00	F=2.66 P=0.12	F=133.95 P=0.00
	Control	83.0 ± 1.7	82.9 ± 1.7			
FVC	Experiment	4.80 ± 0.29	4.92 ± 0.40	F = 0.11 P = 0.74	F=0.11 P=0.74	F=1.79 P=0.19
	Control	4.7 ± 0.91	4.7 ± 0.88			
BMI	Experiment	22.87 ± 3.55	22.43 ± 3.25	F=15.25 P=٠/001	F= 0.89 P= 0/35	F= 7.17 P= 0/016
	Control	27.26 ± 5.66	27.17 ± 5.57			

The correlation index between the BMI and the pulmonary indexes (FEV1/FVC, FEV1, FVC) are among the measured scales shown in table 3. The table shows that there is a significant inverse correlation between the BMI and all other pulmonary indexes.

Table 3. The correlation between BMI and pulmonary indexes (FEV1/FVC, FEV1, FVC) by percentage

Variables	Groups	Statistical Sample Size	Correlation Index	Significant Level (P)
FEV_1	Experiment	10 persons	-0.58	0.03
	Control	10 persons		
FEV_1/FVC	Experiment	10 persons	-0.62	0.004
	Control	10 persons		
FVC	Experiment	10 persons	-0.51	0.05
	Control	10 persons		

DISCUSSION

The findings of this study showed that there was a significant correlation between the BMI and pulmonary indexes of FEV1, FVC and FEV1/FVC in Male Smoking students. FEV1, FVC and FEV1/FVC are directly under the influence of the strength and performance of the respiratory muscles and on the other hand, they are inversely correlated to the rib cage's compliance. Accumulation of fat will cause some disorder in the internal organs of the body. In addition, the fat in the chest and rib cage area will reduce the dilation and elasticity of the respiratory muscles which all lead to reduction of pulmonary indexes. Inactivity and low physical activity will result in obesity and malfunction of the respiratory system. Increase in the metabolic needs and breathing frequency in obese people are usually accompanied with low FVC, FEV1, FEV1/FVC, FRC and TV (Moghaddasi et al, 2010). Sutherland and colleagues in a study on breathing efficiency of 1200 patients suffering from asthma, with different BMI levels, and after considering the covariance of age, sex and race factors found out that by increasing every unit of BMI, a significant reduction in FVC, FEV1 and FEV1/FVC occurred (Sutherland et al, 2008) because according to the mechanical theory of Latch (Castro-Rodriguez et al, 2007), accumulation of fat will exert excessive mechanical load on the chest and rib cage walls. In people with high BMI, the hypodermic fat will not only mechanically restrict the respiratory movements of the body, but also because of the high concentration of the fat between the ribs and the diaphragm it will cause disorder in gas exchange inside the lung. These findings were compliant with those by Rupert and colleagues (2002), Cherly and colleagues (2010), Satta (2000), Chen and colleagues (1989), Yue and colleagues (2007). Endurance exercises can reduce the BMI index and this can be translated as the person's body composite gets improved and following that by doing these exercises the net body weight increases and this will lead to more oxygen intake (Kelley et al, 2008). Sport activities cause some changes in the amount and speed of the energy consumption and are effective on losing weight and preventing from getting fat (Kelley et al, 2008). aerobic exercises have better effect on triglyceride plasma of the people with obesity (Dai et al, 2009). physical activity in 3 periods of work, free-time and physical exercising among the people of Finland showed that women with high level of physical activity had lower weight gain compared to those with low activity or inactive people with higher BMI value (Lahti-Koski, 2007).

The measured respiratory indexes in the present study are among the most important dynamic respiratory indexes. The FVC index includes the current volume and the saved volume of the inhale and exhale volume. The forceful vital capacity is part of the dynamic volumes of the lungs that depends on the age, physical activity level, body composite, health status (Fatemi et al, 2009. (The resistance and the elasticity of the lungs, the resistance of the air flow tracts between the alveolar area and the tightening place and expansion of the air flow tracts are among the physiological mechanisms affecting the air flow in this phase. The trends that increase the resistance or elasticity or the tightness of the air flow tracts help to increase the air flow speed in each lung volume level (Ghosh et al,1985 (The reduction of this index is a sign for the reduction of ventilation performance and the increase in air flow tracts resistance (Fatemi et al, 2009). This factor reduces the respiratory performance and energy consumption level for pulmonary ventilation and makes FEV1/FVC to increase. According to the findings by this study, endurance exercises will cause to increased pulmonary indexes (FVC, FEV1, FEV1/FVC) in Male Smoking students. The reason for these changes can be two issues. First, long term endurance activities in the experimental group will strengthen the muscles, especially the inhale muscles and the muscular capillary network. In the second place, aerobic exercises will cause reduction in the fat ratio of the body tissues especially in the rib cage area and will increase the respiratory performance and improve the trachea tract for inhaling and exhaling performance. Accumulation of the fat around the stomach muscle area and the rib cage will reduce the elasticity of these muscles and their harmonic movements. This will lead to reduction of the rib cage volume at the time of inhale and consequently a reduction in pulmonary indexes.

CONCLUSIONS

Doing continuous endurance exercises for 8 weeks had a positive and significant correlation with the BMI. Also, FVC, FEV1, FEV1/FVC in smoking men increased significantly in this study. This improvement was due to the improvement in respiratory muscles, especially the inhaling muscles and the reduction of fat percentage in the BMI.

REFERENCES

Ambrose J, Barua R. (2004). The pathophysiology of cigarette smoking and cardiovascular diseasean update. Journal of the American College of Cardiology. 43(10):173-179

Castro-Rodriguez J; (2007). Relationship between obesity and asthma. Archiveos de bronconeumology. 43(3): 171-175

Chen H; kuo C. (1989). Relationship between respiratory muscle function and age, sex and other factors. Journal of applied physiology, 66(2): 943-948

Cheryl M; Gregory G; Norbert B. (2010). Physiology of obesity and effects on lung function. Journal of Applied physiology, 108: 206-211.

Dai S, Fulton J, Harrist R, Grunba J, Steffen L, Labarthe D. (2009). Blood lipids in children: age-related patterns and association withbody-fat indices: project heartbeat. AM J Prev Med7 (1): 56-64

Emamghoreishi M, Bokaee H, Keshavarz M. (2009). CYP2A6 genetic polymorphism and its relation to risk of smoking dependence in male Iranians. Physiology and Pharmacology. 12(4):296-306.

Fatemi R; Ghanbarzadeh M.(2009). Ralationship between airway resistance indices and maximal oxygen uptake in young teenagers. Journal of human kinetice, 22: 29-34

Ghosh A; Ahuja A; Khanna G. (1985). Pulmonary capacities of different groups of sportsmen in india. British journal of sports medicine, 19(4): 232-234.

Kelley G, Kelley K.(2008). Effects of aerobic exercise on non-HDL-C in children and adolescents: a meta-analysis of randomized controlled trials. Prog. Cardiovasc Nurs. 23(3): 128-132.

Kelley G, Kelley K.(2008). Impact of progressive resistance training on lipids and lipoproteins in teenagers: A meta- analysis of randomized controlled trials. Preventive medicine, 48: 9-19.

Lahti-koski M. (2007). Body Mass Index and Obesity Among Teenagers in Finland. Department of Epidemiology and Health Promotion National Public Health Institute and Department of Public Health.

Moghaddasi B; Moghaddasi Z; Taherinasab P.(2010). The effects od physical exercise on lung function and clinical manifestation of asthmatic patients. Arak medical university Journal, 13(2): 134-140.

Price T, Krishnan-Sarin S, Rothman D. (2003). Smoking impairs muscle recovery from exercise. American Journal of Physiology-Endocrinology And Metabolism. 285(1):E116-E22.

Rendu F, Peoc'h K, Berlin I, Thomas D, Launay J-M.(2011). Smoking related diseases: the central role of monoamine oxidase. International journal of environmental research and public health. 8(1):136-47.

Rupert W; Nicholas E; Bip P; Kay-Tee K; Suzy O.(2002). Physical inactivity is associated with lower forced expriatory volume in 1 second. AM J epidemiol. 156(2): 139-147.

Satta A. (2000). Exercise training in asthma. The journal of sports medicine and physical fitness, 40(4): 277-284.

Sparrow D.(1997). Effects of obesity and fat distribution on ventilatory function. Chest, 111: 891-898.

Sutherland E. (2008). Obesity and asthma. Immunology and allergy clinics of north america, 28(3): 589-602

Yue C; Donna R; Yvon F; James D. (2007). Wist circumference is associated with pulmonary function in normal-weight, overweight, and obese subjects. 85(1): 35-39.