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EFFECT OF RESPIRATORY ENDURANCE TRAINING ON PULMONARY FUNCTION TEST

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ABSTRACT

Background: Respiratory endurance focuses on increasing respiratory muscle resistance with the use of regular endurance training exercise and to prevent respiratory disabilities leading to respiratory failure. Aim: to study the effect of respiratory endurance training exercise on lung volumes and lung capacities in young healthy human adults. **Methods**: Research was conducted on 60 health young adults including randomly selected 31 males and 29 female students of Osmania medical college of Hyderabad (India), studying in final year of graduate program. They were made to exercise 30 minutes thrice a week for 3 times a day for 16 weeks. Research was conducted at post graduate physiology research lab during January- March 2005. **Results**: Lung Capacities were compared pre test and after a completion of 16 weeks of respiratory endurance training in young health subjects of age group 18-30 yrs. Mean weight was 59 kg and mean height was 160 cm, while the mean body surface area was 1.59 m^2. Pulmonary function tests were conducted and determined on these subjects by using Medspirer. First phase of recordings were done before starting of the exercise training and second phase recordings were done at the end of 16 weeks. The following parameters were recorded: Forced Vital Capacity, Forced expiratory volume at 1 second, Maximum Voluntary volume, Inspiratory reserve volume, Vital Capacity and Endurance Test Time). All the parameters have shown significant increase in the second phase when compared to the first phase. Our study has shown that the Pulmonary Function Tests values are higher after exercise training. **Conclusion**: Mechanical efficiency leads to increase in skeletal muscle strength which finally increases respiratory airflow meaning increase in all pulmonary function tests.

Keywords: respiratory endurance, respiratory muscles, lung capacities, pre test and post test

INTRODUCTION

Pulmonary ventilation is generally known to have a linear relationship with oxygen consumption at different levels of exercise. Oxygen consumption is also known to increase the resting state and intense exercise. Lung function parameters tend to have a relationship with lifestyle such as regular exercise and non-exercise[1, 2]. Endurance results from an increase in intensity of work performed in a given unit of time. Work may be intensified by raising the cadence as experiences in running faster or by increasing the resistance against which the muscles contract as experienced in lifting heavier weight. This principle provides the rationale for all progressive resistance exercise program. Endurance is the ability to withstand

fatigue, or the ability of the body to withstand the stresses set by prolonged activity which produces fatigue.

Endurance includes aerobic endurance, anaerobic endurance and muscular endurance. These types of endurance are closely related within the unity of human organism. The effectiveness of each to some extent is dependent upon others and the development of each type compliments the effectiveness of the others, aerobic endurance also known as general endurance or stamina is the general ability to withstand fatigue of entire organism in the presence of sufficient supply of oxygen over a pronged period. It involves the ability to resist fatigue under conditions where oxygen intake and oxygen requirements for activity are kept at a steady and equal level. This quality is called cardiovascular endurance and circulo-respiratory endurance is most evident in work of medium intensity involving the entire organism. Endurance exercises stimulate the mobilization and oxidation of fatty acids to plasma which are delivered to skeletal muscle for fuel. Endurance training leads to increase in plasma epinephrine and non epinephrine concentration, basal plasma insulin concentration increases after exercise training. Lung function tests provide qualitative and quantitative evaluation of pulmonary function and are therefore of definitive value in the diagnosis and therapy of patients with cardiopulmonary disorders as well as those with obstructive and restrictive lung disease[3,4]. The parameters used to describe lung function are the lung volumes and lung capacities. While the various lung volumes reflect the individual's ability to increase the depth of breathing the capacities is simply a combination of two or more lung volumes.

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. Pulmonary function tests measure lung volumes and capacities. Our research focuses on magnitude of the role of endurance development in respiratory muscle and its effect of lung volume and lung capacities. This should be put in practical application on bed side clinics in respiratory care centers and cardio thoracic surgical wards and centers dealing with neuro-muscular disorders. The ultimate goal is to prevent respiratory failure, which may occur in such disorders and to offer the subject a quality of life, with better physical capabilities. The present study was carried out to know the effect of long term stress in the form of exercises and sports activities, on Pulmonary Function Tests.

MATERIAL AND METHODS

A quasi experimental study was conducted on randomly selected 60 healthy young adults between January to march 2005, which included 31 male 29 female individuals in the age group of 18-30 years from Osmania Medical College, Hyderabad (India). Study group comprises students of Osmania medical college and it was conducted at post graduation research laboratory of Osmania medical college, Hyderabad. The subjects were made to exercise for 30 minutes thrice a week for three times a day, for a period of 16 weeks. Candidates were involved in the research after taking informed, verbal and written consent. All subjects were informed about the procedure and demonstration of the procedure was done for incentive spirometer and Med-spirer. Basic anthropometric measurements were recorded before the start of the research and data were analysed using SPSS version 17.0. Lung volumes and capacities were measured according to established methods with the use of spirometer and Medspirer at two different phases. 1st phase recorded before the start of the exercise containing baseline data and 2nd phase was recorded at the end of respiratory endurance

training involving physical exercise at the end of 16^{th} week.

Subjects suffering from hypertension, Diabetes, any respiratory tract infections or lung diseases, recent heart attack and smokers were excluded. The pulmonary function testing was done on Medspirer (automated pulmonary function analyser), which is an advanced microprocessor based on computerized pulmonary function testing device.

Method of determining lung volumes using med spirer:

Data such as height, weight, age, sex and temperature were fed to the Medspirer before recording the lung functions; the subject was made to sit in a comfortable position and the nose clip was put on the nose. A clean mouth piece was placed in breathing tube.

The subjects were then asked to take a single maximum inspiration and exhale fully and rapidly with maximum effort before finally removing the mouth piece. The E key was kept pressed throughout this forced expiration. This was repeated three times and the best of the three readings were recorded. This manoeuvre also recorded FEV, PEFR, FEF 25-75 % and FEV simultaneously and same way other lung volume too.

Precautions taken while conduction research:

1. Care was taken to give through instruction and demonstrations regarding the performance of the tests, records were taken after being fully satisfied.
2. Due care was also taken to avoid operational error on the part of observer and to maintain uniformity as far as possible.
3. The machine was calibrated at the start and in between while the research was going on, to check for accuracy, linearity and resistance.
4. Aseptic precautions including the use of KMNO4 solution for cleaning the mouth piece before and after the use were strictly adhered to.

Below mentioned parameter were evaluated with the use of Medspirer.

FVC – Forced vital capacity

FEV – Forced expiratory volume

FEV1- Forced expiratory volume in 1 sec

FEV1/FC % - forced expiratory volume to forced vital capacity section

FEF 25-75 % - Mean forced expiratory flow during middle half of FVC

PEFR- peak expiratory flow rate

FEF 25 % - Forced expiratory flow after 25 % of FVC has been expired

FEF 50 % - Forced expiratory flow after 50 % of FVC has been expired

FEF 75 % - Forced expiratory flow after 75 % of FVC has been expired

FIVC- Forced Inspiratory vital capacity

PIFR – Peak Inspiratory flow rate

FIF 50 % - Forced expiratory flow after 50 % inspired FVC

Other parameters includes

MVV – Maximum Voluntary Ventilation

ETT – Endurance Test Time

RESULTS

Lung Capacities were compared pre test and after a completion of 12 weeks of respiratory endurance training in young healthy 60 subjects (31 males and 29 females) of age group 18-30 yrs using incentive spirometer and Medspirer. Mean weight was 59 kg and mean height was 160 cm, while the mean body surface area was 1.59 m^2. There was not a significant difference between male and female lung parameters. Table 1 present baseline lung volume measurement which was recorded before the start of the exercise and table 2 represents lung volumes measured at the end of respiratory endurance training. When both the recordings are compared it showed a significant difference.

Forced vital capacity (FVC) (2.15 l pretest while 2.85 l post test), Forced Expiratory volume at 1 second (FEV1) (2.15 l pretest while 2.61 l post test), Maximum Voluntary volume (MVV)(88 lit/min pretest while 118 lit/min post test), Inspiratory reserve volume (IRV)(1995 ml pretest while 2571 ml post test), Vital Capacity (VC)(2035ml pretest while 2571 ml post test) and Endurance Test Time (ETT)(28 seconds pretest while 36 seconds post test) were recorded and found highly significant at the end of endurance training exercise.

Results from the present study showed significant difference in the lung function parameters of male and female subjects pre-test and post-tests.

Table No: 1 1st phase of recording (Baseline lung Volumes)

Sr. No.	Baseline lung parameters	Pre-test recording (Mean ± 2SD)
1	FVC (Lit)	3.15 ± 0.9
2	FEV1 (Lit)	2.15 ± 0.28
3	MVV(Lit/Min)	88 ± 11.2
4	IRV (ml)	1995 ± 215.8
5	VC (ml)	2035 ± 115.7
6	ETT (sec)	28 ± 2.4

Table No: 2 2nd phase of recording for lung parameters

Sr. No.	lung parameters	Post-test recording
1	FVC (Lit)	3.85 ± 0.11
2	FEV1 (Lit)	2.61 ± 0.47
3	MVV(Lit/Min)	118 ± 20.8
4	IRV (ml)	2807 ± 322.9
5	VC (ml)	2571 ± 210.3
6	ETT (sec)	36 ± 3.6

Table No: 3 Comparison of Pre-test and Post-test lung volume recordings

Sr. No.	Lung Parameters	Pre-test results	Post – test results after endurance training sessions	Pre and post test difference in Percentile	P value
1	FVC (Lit)	3.15	3.85	90 %	<0.01*
2	FEV1 (Lit)	2.15	2.61	70 %	<0.01*
3	MVV(Lit/Min)	88	118	100 %	<0.01*
4	IRV (ml)	1995	2807	70 %	<0.01*
5	VC (ml)	2035	2571	75 %	<0.01*
6	ETT (sec)	28	36	70 %	<0.01*

*P<0.05 suggest highly significant

DISCUSSION

Here regular physical activity causes many desirable physical, physiological and psychological changes in an individual consequently raising his level of fitness. Possible explanation for this could be regular forceful inspiration and expiration for prolonged period during training leads to strengthening of the respiratory muscles. This helps the lungs to inflate and deflate maximally. This maximum inflation and deflation is an important physiological stimulus for the release of surfactant[5]. McCurdly and Larsen (1940) in their studies, working with trained subjects and untrained controls have shown that trained subjects had significantly higher vital capacity as compared to untrained[6]. A study by Pansare MS showed one month training is sufficient to bring about increase in Pulmonary Function Test[7]. One of the important outcome of this respiratory endurance exercise is to have its beneficial effects in cardiovascular and respiratory systems. Physical training programme of 8 months is necessary to bring about improvement in Cardio-respiratory function[8].Which is very much in relation to our research findings having a significant difference in pulmonary function test after implementing respiratory endurance training.

CONCLUSION

Results from the present study strongly suggest that the intensity or severity of the sports engaged in by the students probably determines the extent of strengthening of the respiratory muscles with a resultant increase in the lung volumes and that way chronic exercise may cause an increase in the respiratory function which could be due to increased development of respiratory musculature incidental to physical training.

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