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Effects of Physical Exercise on Pulmonary Functions, Respiratory Pressures and Respiratory Endurance

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Abstract: To study effects of regular practice of physical exercise on respiratory functions, respiratory pressures and respiratory endurance 100 healthy volunteers (M68:F32) from age group (17-26) years were included in the study. They practiced some slow walk, calisthenic & stretching exercises daily 1 hour for 3 months. Pulmonary function tests FVC, FEV1, FEV1/FVC, PEFR, FEF25%-75%, RR, TV, MV, MBC or MVV, BR, DI were recorded at start & end of the study. Apart from this MIP, MEP (respiratory pressures), breath holding time (BHT) & 40mmHg endurance test were also recorded. Physical training resulted in improved ventilatory functions in the form of increases in the PEFR, FEF 25-75% and prolongation of breath holding time (BHT) after 3 months of training. Three months Physical training produces a significant improvement in spirometric values. The present data provide more evidence to support the beneficial effect of physical exercise training on respiratory variables in healthy volunteers.

Index Terms **- Physical Exercise, PFT, Respiratory Pressures, BHT & 40mmHg endurance test.**

I. INTRODUCTION

Physical activity, exercises are known to improve one's overall performance and are a reliable method of testing the physical abilities and physiological reactions that form the basis of good health and well-being. The benefits of exercise have been known since antiquity. Marcus Cicero, around 65 BC, stated: "It is exercise alone that supports the spirits, and keeps the mind in vigor." Physical activity has been defined as any bodily movement produced by skeletal muscle contractions that result in energy expenditure. Exercise can be defined as a subset of physical activity that is planned, structured, repetitive, and purposeful in the sense that improvement or maintenance of physical fitness is the objective. Aerobic training is a non specific activity that improves physical and respiratory capacities. It is simple to carry out and includes jogging in place, knee ups, short kick, running, marching and so on. (De Godoy et al, 2006)

Regular indulgence in physical exercises is known to affect the cardiorespiratory status and autonomic functions of the individual (Caballero J et al, 1999; Sharma RK et al, 2006). Players have higher values of lung functions compared to those not playing any games. Exercise has a facilitating effect on the lungs. Especially swimmers have the highest value of lung capabilities amongst all the sportsmen. (Mehrotra PK et al,1998)

The study on the effect of regular practice of physical exercise on respiratory functions and respiratory pressures is important to better understand its effects on healthy individuals. In this respect the present study evaluated the effect of regular practice of physical exercise on pulmonary function tests and respiratory pressures.

II. MATERIAL AND METHOD

This study was conducted on 100 healthy students and volunteers between age of 17-26 years of either sex (M68:F32) from Dr. S.N. Medical College, Jodhpur and other academic colleges. Subjects included in the study were non alcoholic, non smokers, not taking any type of medication and were having similar dietary habits. Subjects involved in heavy physical exercise and previous experience of yoga training, history of any major medical illness and major surgery were not included in the present study. Subjects were allocated to practice physical exercise for 3 months. The volunteers and students were briefed about the outcome of study and a written consent was obtained from them.

Subjects were given physical exercise training for 1 hour under the guidance of physical exercise instructor. This 1 hour session was divided into 4 stages: warm up (10 min.) calisthenics (30 min.) cool down (5min.) & stretching (15 min.).

In warm up stage – subjects performed stretching & low energetic demand aerobic exercise such as slow walk & brisk walk followed by jogging & running (somewhat hard intensity). Warm up followed by calisthenics exercise – like jumping jacks, lunges, sit-ups, crunches, push-ups, squat, flutter kick, mule kick.

Cool down stage (5 min.) includes slow jogging & walking for 5 min. (to decrease body temp. / sweating).

Lastly stretching exercise was done for 15 minutes. These include- neck stretch, upper back stretch, triceps stretch, chest & biceps stretch, quadriceps stretch, calf stretch, butterfly stretch, hamstring stretch, lower back stretch, back extension stretch.

Parameters:-

First anthropometric characteristics (body weight, height, and BMI) were evaluated using an anthropometric scale. (Table-1)

Table-1 anthropometric measurements

Parameter	Pre	Post
Height (m)	1.69±0.09	1.69±.09
Weight (Kg)	59.36±5.96	58.3±5.69
BMI (Kg/m^2)	20.82±1.97	20.39±1.91

Then before starting Physical training & after end of 3 months following parameters were measured.

Pulmonary function tests

Measured using a computerized spirometer (Helios 401, RMS Recorders & Medicare Systems, Chandigarh). For FVC test (FVC, FEV1, FEV1/FVC, PEFR, FEF25%-75%) subject was instructed to take maximum inspiration and blow into the mouthpiece as rapidly, forcefully and completely as possible. It was ensured that a tight seal would maintain between the lips and mouthpiece of the spirometer.

For SVC test {Tidal volume (TV), respiratory rate (RR), minute ventilation (MV)} subject was instructed to breathe normally with a resting tidal pattern, next, the subject inspired maximally, then exhales as completely as possible with a slow, continuous smooth exhalation and returned to tidal breathing.

For MVV subject was instructed to breathe in and out as rapidly and deeply as he can with his maximum muscular efforts for a period of 15 seconds in the mouthpiece of the spirometer with both his nostrils closed. Minute ventilation (MV=TVxRR) Breathing Reserve (BR=MVV-MV), and Dyspnoeic Index (DI=MVV-MVx100/MVV) were calculated for each recording.

Respiratory pressures: Maximum inspiratory pressure (MIP) and Maximum expiratory pressure (MEP) were recorded as follows. MIP was determined by asking the subject to perform maximum inspiratory effort against Aneroid manometer after breathing out fully. The maximum level at which the pressure could be maintained for about 3 seconds was noted. MEP was determined by asking the subject to blow against the Aneroid manometer after taking in a full breath. MEP that could be maintained for about 3 seconds was noted. It was ensured that the subjects did not use oral muscles to develop pressure or use their tongue to block the tubing.

For breath holding time (BHT) subjects were asked to take a deep inspiration after normal respiration and then to hold the breath as long as he could do it. The time of breath holding was calculated by stopwatch.

Respiratory endurance test (40mmHg test) was also determined. It includes maximum time for which subjects can maintain 40mmHg pressure in mercury manometer.

The above-mentioned parameters were measured before and after the 3-month study period. For each parameter, three trials at 3-minute intervals were given and highest of the three values was used for statistical analysis.

Analysis of data

Data obtained for various parameters were subjected to statistical analysis using the Microsoft Excel and OpenEpi software (version 2.3.1). Paired t test was used to compare the data. P value <0.05 was considered significant.

III OBSERVATION AND RESULT

FVC, FEV1 and FEV1/FVC%, were increased but change was not significant after three months of physical training. PEFR was significantly increased (P<.05) after physical exercise training. Similar trend was also observed for FEF 25-75% which also shows significant rise (P<.01). Table 2 of present study shows decrease in RR and improvement in TV but it was statistically insignificant. Table 2 also depicts appreciable rise in MVV, BR, DI after exercise training but statistically it was insignificant.

Table-2 Pulmonary functions

Parameter	Pre	Post
FVC (L)	3.42±0.64	3.5±0.67
FEV1 (L)	3.1±0.59	3.21±0.63
FEV1/FVC (%)	90.64±4.3	91.62±4.2
PEFR (lit/sec)	7.16±1.62	7.73±1.61£
FEF 25-75% (lit/sec)	3.93±0.87	4.37±0.82 ££
R R (breaths/min)	17.47±2.89	16.67±2.03
TV (L)	0.45±0.07	0.46±0.07
MV (L/min)	7.71±1.55	7.71±1.20
MVV (L/min)	116.3±22.3	121.7±22.3
B R (L/min)	108.61±22.3	114.08±22.2
DI (%)	93.16±1.7	93.49±1.42

£ P<.05 on comparing pre and post
££ P<.01 on comparing pre and post.

An increasing trend was observed in MEP and MIP after physical exercise training (p>0.05). BHT showed statistically significant rise after training (P<0.01) while timing of respiratory Endurance was increased yet insignificantly (p>0.05). **(Table- 3)**

Table- 3 Changes in respiratory pressures, BHT & Endurance test

Parameter	Pre	Post
MEP (mmHg)	84.6±24	91.82±23.9
MIP (mmHg)	121.76±19.8	126.48±20.0
BHT (sec.)	54.05±9.32	58.88±8.37[£££]
40 mm Hg Test (sec.)	40.66±11.4	44.45±11.2

££ P<.01 on comparing pre and post.

IV DISCUSSION:

Present study has compared pulmonary functions of healthy volunteers before and after 3 month duration of physical training, result showed significantly higher PEFR, FEF 25-75% and prolongation of breath holding time whereas other PFT parameters did not increase significantly after their training period but a trend toward an increase in these functions was observed. Our findings are consistent with the observation of Hovsepian V et al (2013) who observed significant increase in PEF and PIF but no changes in RR, FEV1, FVC, however all physical fitness parameters improved significantly ($P < 0.05$).

Our results do not agree with those of Rawashdeh A and Alnawaiseh N (2018) and Bagheri MH (2014). Rawashdeh A and Alnawaiseh N (2018) investigated the effect of three weeks of continuous treadmill running on FVC, FEV1, FEV1/FVC, and MVV values for 72 inactive yet healthy male individuals and observed a significant improvement in these parameters. Bagheri MH (2014) showed significant increases in Pulmonary indexes (FVC, FEV1and MVV) and VO2MAX in both yoga and aerobic groups compared to control group ($p<0.05$).

De Godoy et al (2006) compared yoga and aerobics and their effects on spirometery and maximal inspiratory pressure (MIP). They measured MIP, FEV1, and FVC. These variables had no significant improvement in both groups. Their findings support the present study.

The result discussed above confirms that regular exercise has a facilitatory effect on the lungs. The possible explanation for this could be that regular forceful inhalation and deflation of the lungs for prolonged periods leads to strengthening of respiratory muscles. The physical training must have helped in developing reduced resistance to respiration (Armour et al (1993), Birkel and Edgren (2000) Cedric et al (2005)) and greater endurance in respiratory muscles, accounting for increased PEFR, FEF 25-75% and prolongation of breath holding time.

V CONCLUSION:

The present study shows that 3 months physical training produces a significant improvement in Breath holding time and spirometric values.

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