Effect of short term exercise on cardiorespiratory parameters in exercise trained and untrained young adults

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Abstract

Objective: To assess the effect of short termexercise on cardiorespiratory parameters in exercise trained and untrained young healthy adults.

Materials and Methods: 60 medical students of age group 18–25 years without history of regular exercise were recruited for the study. Group I included 30 students who were exercise trained in the form of cycling, aerobics and yoga for 30 minutes every day for 3 months and group II included 30 students without any exercise training. Heart rate and blood pressure were measured before and immediately after short term exercise in the form of cycling for 6 minutes. Similarly pulmonary function testwas performed before and within two minutes after exercise.

Results: There was no significant difference in HR, SBP, DBP, PP, MAP and RPP between exercises trained and untrained individuals. PFT parameters SVC, PEF and MVV were significantly higher in trained individuals (p=0.01, 0.03 and 0.03 respectively). While comparing the effects of short term exercise, HR, SBP, PP, MAP, RPP significantly increased after exercise in both the groups (p value<0.000) while DBP, SVC, FVC, FEF25-75%, FIVC, FIV_1, FIV_1/FIVC and MVV showed no significant difference (p>0.05) in both the groups. PEF showed a significant decrease after exercise in untrained individuals (p=0.05) while not so in trained group (p<0.05).

Conclusion: Short term exercise does not significantly affect the respiratory parameters in exercise trained and untrained individuals. Exercise training for 3 months improves respiratory function and has little to no effect on cardiovascular function.

Keywords: Short term exercise, PFT, Cardiorespiratory parameters.

Introduction

Exercise has become a predominant therapeutic option for a variety of illnesses. Exercise rehabilitation is widely used in treating cardiovascular and respiratory diseases.[1,2] There are several proven benefits of regular exercise despite which people with sedentary life style especially students do not include exercise in their day to day routine. The effect exercise has on cardiovascular and respiratory system varies between health and disease. Even in healthy individuals its effects vary based on the physical fitness of the individuals.[3]

Exercise training improves respiratory function where, regular forceful inspiration and expiration leads to strengthening of the respiratory muscles.[4] The cardiovascular system is mainly under the control of autonomic nervous system. There are studies that prove that regular exercise training can keep the autonomic nervous system healthy.[5] Understanding the basis of effects of exercise on cardiovascular and respiratory system will aid in emphasizing the role of exercise in rehabilitation of cardiovascular and respiratory diseases. Regular exercising training promotes physical fitness and the effects of short term exercise might have variations based on the fact whether the person has trained his system for exercise or not. There are not many studies to explore how exercise training affects the cardiorespiratory response to short term exercise.[6] A better exploration in this aspect would aid in further understanding of the role of exercise on cardiorespiratory rehabilitation in patients. Therefore this study was undertaken to study the effect of short term exercise in exercise trained and untrained young healthy adults.

Materials and Methods

Sample Selection

The study was conducted in the department of Physiology in a private medical college in Chennai, India. Students studying MBBS from first year to internship of age group between 18 and 25 were taken as subjects for the study. To rule out the effect of hormonal changes during menstrual cycle on cardiorespiratory function, only male students are selected for the study. Approval was obtained from the institutional ethical committee and the purpose of the study was explained to the subjects and consent was obtained before the beginning of the study. Detailed medical history was collected from all the participants followed by general examination. Individuals with any history of cardiovascular, respiratory, neurological and endocrine disorderswere excluded from the study. Students with the history of regular exercise and sports training were also excluded. Height and weight were measured and body mass index was calculated using the Quetelet Index,

BMI = Weight in Kg / (Height in m)^2

Individuals with the BMI range from 18.5 to 24.9 were selected and those who were above and below the normal BMI range were excluded. Out of this, 30 students were selected randomly as group I and were exercise trained in the form of cycling, aerobics and yoga every day in the evening for 30 minutes for duration of 3 months and 30 students without exercise training were taken as group II.

Measurement of Cardiovascular and PFT Parameters

Blood pressure and heart rate were measured using OMRON digital BP apparatus and pulmonary function test (PFT) was done using SCHILLER digitalized spirometer in the Research lab of Department of Physiology. The subjects were rested for 5 minutes before the measurement of systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR). Pulse pressure (PP), mean arterial pressure (MAP) were calculated from the values and rate pressure product (RPP) is calculated using the formula, RPP = HR X SBP. The subjects were seated with spine erect and caution was taken not to engage the subjects in any kind of communication while performing the measurements.

After measuring the cardiovascular parameters, PFT was done with the subjects in sitting posture. PFT was done using the computerized spirometer and software. The subjects were instructed to perform acceptable manoeuvres for FVC. The subject was asked to inspire deeply and then blow forcefully into the turbine of the spirometer. The best of the three readings were taken for the study.

Exercise

The participants were instructed to do cycling in bicycle ergometer against a load of 2Kg and a pedalling speed of 16-20 RPM for duration of 6 minutes. Immediately after exercise, the cardiovascular parameters were measured and PFT parameters were recorded within two minutes after ending the exercise.

Statistical Analysis

The data were entered in MS Excel spreadsheet and statistical analysis was done SPSS version 21. Paired t test was used to compare the mean and standard deviation of the cardiovascular and respiratory parameters before and after exercise in both the groups. Unpaired t test was performed to compare the baseline cardiovascular and respiratory parameters before exercise between the two groups. A p value of <0.05 was taken to be statistically significant

Results

In our study, when we compared the baseline cardiovascular parameters before exercise between group I and group II, we found that there was no significant difference between the groups in HR, SBP, DBP, PP, MAP and RPP (p>0.05) [Table 1]. Comparison of Rate pressure product between exercises trained (Group I) and untrained (Group II) individuals is depicted in Fig. 1.

Table 1: Comparison of cardiovascular parameters between exercise trained and untrained individuals

S. No	Parameters	Group I Mean ± SD	Group II Mean ± SD	P value
1	HR	78.08±9.77	80.65±8.52	0.45
2	SBP	121.85±10.21	119.06±10.39	0.47
3	DBP	70.92±8.91	76.18±8.93	0.12
4	PP	45.92±9.78	42.88±10.66	0.09
5	MAP	88±8.12	90.47±7.94	0.41
6	RPP	9.52±1.46	9.61±1.42	0.85

* Significant difference (p < 0.05)

HR – Heart rate, SBP – Systolic blood pressure, DBP – Diastolic blood pressure, PP – Pulse pressure, MAP – Mean arterial pressure, RPP – Rate pressure product

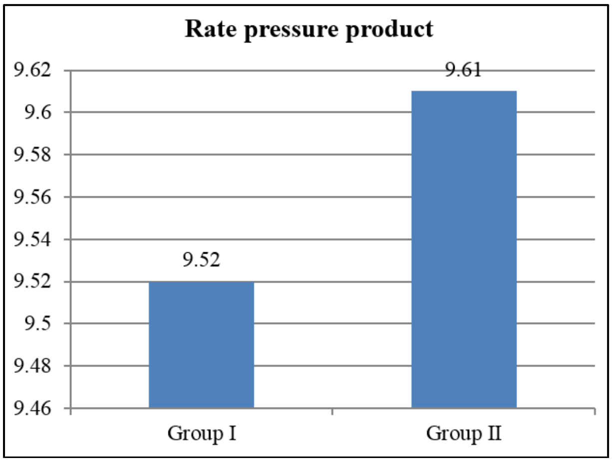

Fig. 1: Comparison of Rate pressure product between exercise trained (Group I) and untrained (Group II) individuals

Upon comparing the baseline pulmonary function parameters, SVC, PEF and MVV were significantly higher in group I than group II (p = 0.01, 0.03, 0.03 respectively) while the other parameters viz FVC, FEF25-75%, FIVC, FIV1, FIV1/FIVC showed no significant difference between the groups. [Table 2]. Comparison of MVV between exercise trained and untrained individuals is presented in the graph 2.

Table 2: Comparison of respiratory parameters between exercise trained and untrained individuals

S.No	Parameters	Group I Mean ± SD	Group II Mean ± SD	P value
1	SVC	4.06±0.84	3.26±0.82	0.01*
2	FVC	3.15±0.82	2.94±0.63	0.44
3	FEF25-75%	5.2±1.92	4.99±1.59	0.74
4	PEF	501.15±67.09	442.12±76.76	0.03*
5	FIVC	2.82±1.08	2.38±0.77	0.21
6	FIV1	2.59±1.11	2.25±0.74	0.33
7	FIV1/FIVC	90.45±11.35	94.97±5.45	0.16
8	MVV	122.95±31.24	98.42±27.61	0.03*

* Significant difference ($p < 0.05$)

SVC – Slow vital capacity, FVC – Forced vital capacity, FEF25-75% - Forced expiratory flow 25-75% of vital capacity, PEF – Peak expiratory flow, FIVC – Forced inspiratory vital capacity, FIV1 – Forced inspiratory volume in 1 second, MVV – Maximal voluntary ventilation

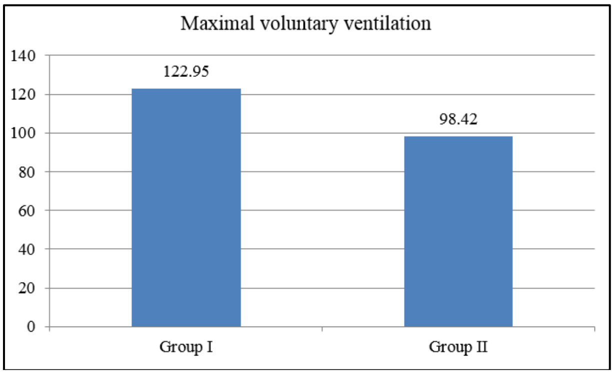

Fig. 2 : Comparison of Minute volume ventilation between exercise trained and untrained individuals

The effect of exercise on cardiovascular parameters in both the groups was that there was a highly significant increase in HR, SBP, PP, MAP, RPP in both the groups (p = 0.000) and no significant difference in DBP [Table 3]. Comparison of Mean arterial pressure before and after exercise in group I and group II depicted in Fig. 3.

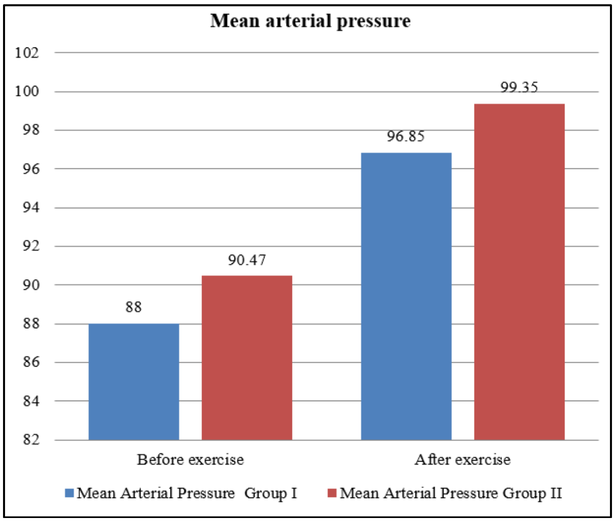

Fig. 3 : Comparison of Mean arterial pressure before and after exercise in group I and group II.

On PFT parameters, there was no significant difference before and after exercise in SVC, FVC, FEF25-75%, FIV1, FIVC, FIV1/FIVC and MVV in both the groups ($p > 0.05$) but there was a significant decrease in PEF in group II alone ($p = 0.05$). [Table 4]. Comparison of Peak expiratory flow before and after exercise in group I and group II depicted in Fig. 4.

Table 3: Comparison of cardiovascular parameters before and after exercise

Variable	Group	Before exercise Mean ± SD	After exercise Mean ± SD	P value
HR	I	78.08±9.77	107.38±13.75	0.000***
	II	80.65±8.52	115.65±12.32	0.000***
SBP	I	121.85±10.21	142.92±6.77	0.000***
	II	119.06±10.39	138.65±10.15	0.000***
DBP	I	70.92±8.91	73.92±8.97	0.18
	II	76.18±8.93	79.70±14.67	0.13
PP	I	45.92±9.78	59.00±9.81	0.000***
	II	42.88±10.66	58.94±12.08	0.000***
MAP	I	88.00±8.12	96.85±7.03	0.000***
	II	90.47±7.94	99.35±11.96	0.000***
RPP	I	9.52±1.46	15.35±2.18	0.000***
	II	9.61±1.42	16.07±2.35	0.000***

* Significant difference ($p < 0.05$), *** Highly significant difference ($p < 0.001$)
HR – Heart rate, SBP – Systolic blood pressure, DBP – Diastolic blood pressure, PP – Pulse pressure, MAP – Mean arterial pressure, RPP – Rate pressure product

Table 4: Comparison of respiratory parameters before and after exercise

Variable	Group	Before exercise Mean ± SD	After exercise Mean ± SD	P value
SVC	I	4.06±0.84	3.81±0.73	0.06
	II	3.26±0.82	3.27±0.92	0.97
FVC	I	3.15±0.82	2.96±0.83	0.48
	II	2.94±0.63	3.05±0.86	0.59
FEF25-75%	I	5.20±1.92	4.77±2.04	0.48
	II	4.99±1.59	4.58±1.6	0.16
PEF	I	501.15±67.09	509±70.56	0.40
	II	442.12±76.76	410±99.51	0.05*
FIVC	I	2.82±1.08	2.43±1.04	0.22
	II	2.38±0.78	2.77±0.82	0.15
FIV1	I	2.58±1.11	2.31±1.05	0.40
	II	2.25±0.74	2.49±0.76	0.25
FIV1/FIVC	I	90.45±11.35	94.28±6.63	0.19
	II	94.97±5.45	90.7±12.41	0.23
MVV	I	122.95±31.24	122.88±43.57	0.99
	II	98.42±27.61	102.26±28.95	0.52

*Significant difference ($p < 0.05$)
SVC – Slow vital capacity, FVC – Forced vital capacity, FEF25-75% - Forced expiratory flow 25-75% of vital capacity, PEF – Peak expiratory flow, FIVC – Forced inspiratory vital capacity, FIV1 – Forced inspiratory volume in 1 second, MVV – Maximal voluntary ventilation.

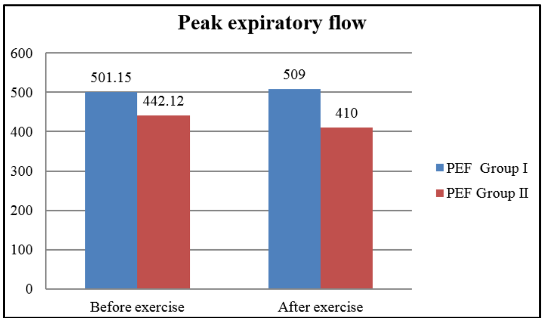

Fig. 4: Comparison of respiratory parameters before and after exercise

Discussion

Autonomic nervous system plays a major role in cardiorespiratory adaptation to exercise. In our study we found that the baseline cardiovascular parameters between exercise trained and untrained individuals showed no significant difference [Table/Fig. 1]. This is in contrary to the study by Davy et al. who found that the baroreceptor reflex function of exercise trained subjects were similar to that of subjects who were moderately active.Quite a few studies have shown that exercise-trained subjects have improved heart rate variability when compared to untrained subjects.[7] The lack of changes in baseline cardiovascular parameters in our study could be attributed to the less duration of exercise training (3 months). A study by Seals and Reiling did not observe any significant change in ambulatory blood pressure after six months of aerobic training, but found that after 12 months of aerobic training, there was a significant reduction in ambulatory blood pressure levels.[8]

Out of the baseline PFT parameters, onlySVC, PEF and MVV showed significantly higher values in exercise trained individuals than untrained individuals. This is in accordance with other studies[9,10] which found that exercise training improved MVV whichcould be attributed to increased contracted diaphragm thickness and lung volumes. A study by Thaman et al. showed that PEF was significantly higher in exercise trained subjects when compared to non-exercise trained medical students.[11] The vital capacity of the athletes were found to be more than that of the non-athletes and this could be attributed to increased respiratory muscle strength due to repeated maximal inflation and deflation during exercise training.[12] Thus in our study, exercise training for 3 months did not significantly alter the cardiovascular parameters but there was improvement in some of the respiratory function. This is in accordance with other studies where exercise training of 8 months was found to be necessary to bring about improvement in Cardio respiratory function[13] whereas even one month of exercise training was found to increase PFT.[14]

While comparing the effect of short term exercise on cardiovascular system, we found that there was a highly significant increase in HR, SBP, PP, DBP, MAP and RPP after exercise while the increase in DBP was not significant in both the groups. Rate pressure product is well correlated to myocardium oxygen consumption in young healthy subjects.[15] The immediate effect of exercise on BP and HR is to increase them and thereby increasing RPP. The physiological basis for this is that exercise stimulates sympathetic nervous system which increases the heart rate and blood pressure.[16] The PFT parameters SVC, FVC, FIV_1, FIVC, FIV_1/FIVC, FEF25-75% and MVV did not alter significantly after exercise. The effect of short term exercise on respiratory function in our study was found to be little in both exercise trained and untrained individuals. This is similar to other studies which similarly found that mild to moderate exercisehas no significant effect on PFT.[17-19] In contrary to our results, certain studies found that there was an increase in dynamic lung volume and capacity which they attributed to the release of catecholamines during exercise.[20] Peak expiratory flow decreased significantly in non-exercise individuals immediately after exercise while not so in exercise trained individuals. Peak expiratory flow rate (PEFR) is nearly independent of the lung size and reflect mainly the calibre of large airways. It is expiratory effort dependent and a useful parameter for assessing patients with obstructive airway disorders.[21] Exercise-induced asthma (EIA), or exerciseinduced bronchospasm (EIB) is a term used for transitory increase in airway resistance, manifesting as > 10% decrease in FEV1 and PEFR or > 35% decrease in FEF25 - 75%.[22] EIB is a marker of bronchial lability to exercise. Patients showing hyperresponsiveness to exercise are at greater risk to develop clinical manifestations of asthma compared to those with normal bronchial response. Probably it is a marker of subclinical asthmatic process.[23] Fall in PEF after short term exercise is also demonstrated by Sager F.[24] PEF in exercise trained individuals increases after short term exercise which was not statistically significant. Increase in expiratory muscle endurance due to regular training could be the cause for this.

Conclusion

With the rise in the awareness of the health benefits of exercise, understanding its role in cardiorespiratory function further accentuates its importance. People with sedentary life style should be encouraged to perform regular exercise. In our study, short term exercise does not significantly affect the respiratory parameters in exercise trained and untrained individuals. Exercise training for 3 months improves respiratory function and has little to no effect on cardiovascular function. Further studies are needed to assess the effect of long term exercise training on cardiorespiratory system.

Conflict of Interest: None.

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