Influence of Exercise on Pulmonary Function tests in young individuals

Soundariya K[1,*], Neelambikai N[2]

[1]Associate Professor, Department of Physiology, Sri Manakula Vinayagar Medical College and Hospital
[2]Professor and Head, Department of physiology, Coimbatore Medical College

***Corresponding author**
E-mail: soundariyapriya@yahoo.com

ABSTRACT

Background and Aim: *Measurement of the ventilatory adaptation to exercise may provide useful information about the functional reserve capacity of the lungs in individuals with respiratory diseases. However it is essential to define the mode of response to exercise in a normal population before identifying the individuals with an abnormal response. Hence the present study aimed to study the influence of acute exercise on pulmonary function tests in normal young individuals.*

Materials and Methods: *A total of 100 students comprising of 50 males and 50 females in the age group of 18-21 years were divided into four groups based on their body mass index as Underweight, normal, overweight and obese individuals. Respiratory parameters (VC, FVC, FEV_1, FEV_1% and PEF) were measured at rest and after an incremental form of acute exercise in the bicycle ergometer.*

Results: *No significant changes were observed in all the four groups before and after exercise in males. However the post exercise values of FVC and VC were reduced than the baseline values in overweight and obese females ($p < 0.01$).*

Conclusion: *Acute exercise did not significantly affect the respiratory parameters. However the body fat distribution of the individual may significantly influence the ventilatory response to acute exercise in otherwise healthy individuals.*

Key words: *Exercise, Pulmonary function tests, Body mass Index*

Access this article online	
Quick Response Code:	Website: www.innovativepublication.com
	DOI: 10.5958/2394-2126.2015.00017.1

INTRODUCTION

The lungs, with their greater surface area, are directly open to the external environment and are heavily influenced by epidemiological, environmental and occupational factors. Pulmonary function testing has been a major step forward in assessing the functional status of the lungs. In conjunction with the clinical assessment and other investigations, they can be used for establishing diagnosis, indicating severity of the disease and also in assessing the prognosis.

Exercise represents a state of physical exertion of the body and it is associated with extensive alterations in the circulatory and respiratory systems. The cardiovascular and respiratory mechanisms operate in an integrated fashion to meet the oxygen demands of the tissues during exercise[1]. Measurement of pulmonary functions after exercise could provide useful information about the functional reserve capacity of lungs both in healthy persons and in patients with respiratory diseases. Exercise is used as a challenge test to make a diagnosis of exercise induced bronchoconstriction in asthmatic patients with a history of breathlessness during or after exertion[2]. However it is essential to define the mode of response to exercise in a normal population before identifying the individuals with an abnormal response. The ventilatory capacity of a healthy individual often exceeds the demands even during strenuous exercise[3]. Despite this enormous reserve, the ventilatory response to exercise may become constrained in obese individuals with normal lungs[4]. Extensive research has been done on various aspects of pulmonary function tests, but surprisingly very few studies had explored the effect of acute exercise on pulmonary function tests in normal individuals and they had revealed controversial results.

Though the association of gender and anthropometric indices on lung functions have been well established,[5,6] their influence on the exercise induced changes on pulmonary function tests in young healthy individuals have received less attention. Aknowledge of the lung volume response to exercise is important for understanding respiratory mechanics and also carry a clinical significance.

Thus the present study aimed to assess the influence of exercise on pulmonary function tests in young healthy individuals.

MATERIALS AND METHODS

A total of 100 students comprising of 50 males and 50 females in the age group of 18-21 years were recruited for this cross sectional study. The study participants were recruited by simple random sampling, from the first year medical students studying at the institution. Students with H/o recent respiratory infections, allergies, H/o smoking, H/o bronchial asthma etc. were excluded from the study. After obtaining permission from the Institutional ethical committee, the procedure and purpose of the study were clearly stated to all the study participants. Informed consent was obtained from them. A detailed review of their medical history was done, followed by general and systemic examination. The participants were instructed to wear light clothing during their study visits. During anthropometric measurements, the participants were instructed to stand erect with abdomen relaxed, arms at their sides and feet together. Weight (in kilograms) and Height (in centimeters) were measured. Body Mass Index (BMI) was calculated as the ratio of weight and square of Height in meters, using Quetelet Index.

The study participants were divided into four subgroups based on their body mass index

(BMI) in both the genders as:

- Group 1 – BMI < 18.5 (Underweight)
- Group 2– BMI – 18.5 – 24.9 (Normal)
- Group 3– BMI – 25.0 – 29.9 (Overweight)
- Group 4 – BMI ≥ 30 (Obese)

Computerised spirometer "Superspiro" was used to measure the pulmonary function tests. The following variables were measured – Vital capacity (VC), Forced vital capacity (FVC), Forced Expiratory volume in 1st second (FEV_1) , FEV_1/FVC ratio (FEV_1%) and Peak expiratory flow (PEF) at rest. The subjects were asked to make atleast three acceptable maneuvers and the best of the three trials was selected for reporting.

Exercise testing was done in a computerized bicycle ergometer, with electronic gear shift of 28 gears as well as an intensity ranging from 25 – 800 watts. Each subject was allowed to take rest for 10 minutes, before starting the exercise. Each subject was allowed toundergo incremental exercise, for first 5 minutes in the bicycle ergometer, by increasing the resistance to pedaling (from 25 watts to 50 watts). Then the subject continued cycling at that fixed power, for a period of ten minutes. At the end of exercise, the subject was asked to relax and the pulmonary function parameters were again measured using the computerized spirometer, within the first 2 minutes after the end of exercise. The results obtained were tabulated and analyzed.

Mean and standard deviation were calculated. One way analysis of variance was used for the comparison of the respiratory parameters within various groups of BMI in both the genders at rest. Student unpaired 't' test was carried out to test the significance of mean between males and females at rest. Student paired't' test was carried out to test the significance of mean before and after acute exercise in both the genders. Statistical software SPSS 16 version was used for the analysis of the data. $p < 0.05$ was considered to be statistically significant.

RESULTS

A total of 100 students were recruited for this cross sectional study, comprising of 50 males and 50 females. Table 1 shows the baseline characteristic of the study participants at rest(before exercise). All the respiratory parameters other than FEV_1% were significantly higher in males compared to the females ($p < 0.001$).Table 2 shows the respiratory parameters before and after acute exercise within the groups in males. Intergroup comparison of the resting values, revealed that VC, FEV_1, FVC and PEF were significantly lower in groups 1(underweight), 3 (overweight) and 4 (obese) compared to group 2 (normal)($p< 0.001$). No significant changes were observed in the respiratory parameters after exercise in all the four groups.

Table 3 shows the respiratory parameters before and after acute exercise within the groups in females. Intergroup comparison of the resting values, revealed that VC, FEV_1, FVC and PEF were significantly lower in groups 1(underweight), 3 (overweight) and 4 (obese) compared to group 2 (normal) ($p< 0.001$). However intragroup comparison of the pre and post exercise values revealed that FVC was significantly reduced in 3(overweight) group after exercise and VC was reduced in 4 (obese) group after exercise ($p < 0.01$).

Table 1: Baseline characteristics of the study participants

Respiratory Parameters							
Gender	**n**	**BMI**	**VC**	**FEV_1**	**FVC**	**FEV_1 %**	**PEF**
Males	50	23.48±3.65	3.42±0.84*	3.30±0.80*	3.41±0.80*	96.52±3.47	6.92±1.72*
Females	50	23.42±3.68	3.14±0.80	3.03±0.77	3.14±0.79	96.38±3.58	6.04±1.67

Values are expressed as mean ± S.D, *$p < 0.001$ – Between males and females

n - No of study participants , BMI – Body mass index , VC – Vital capacity, FEV_1 – Forced expiratory volume in first second, FEV_1 % - FEV_1 / FVC ratio , FVC – Forced vital capacity ,

PEF – Peak expiratory flow rate

Table 2: Comparison of respiratory parameters before and after acute exercise within groups in males

Parameters	Exercise	1 BMI < 18.5	2 18.5 – 24.9	3 25 – 29.9	4 > 30
VC	**Before**	2.51 ± 0.36*	4.12 ± 0.49	3.03 ± 0.52*	2.03 ± 0.08*
	After	2.51 ± 0.47	4.15 ± 0.52	3.03 ± 0.52	1.95 ± 0.09
FEV1	**Before**	2.42 ± 0.39*	3.95 ± 0.50	2.94 ± 0.50*	2.01 ± 0.07*
	After	2.47 ± 0.48	3.97 ± 0.48	2.93 ± 0.50	1.85 ± 0.16
FVC	**Before**	2.47 ± 0.35*	4.05 ± 0.48	3.09 ± 0.52*	2.04 ± 0.07*
	After	2.56 ± 0.51	4.09 ± 0.49	3.03 ± 0.52	1.97 ± 0.15
FEV_1 %	**Before**	97.60 ± 2.88	97.48 ± 2.69	94.74 ± 3.98	98.67 ± 2.31
	After	94.60 ± 4.28	96.65 ± 1.66	96.84 ± 3.37	94.00 ± 1.00
PEF	**Before**	5.41 ± 0.48*	8.27 ± 1.08	6.16 ± 1.23*	3.95 ± 0.11*
	After	5.45 ± 0.45	8.33 ± 1.03	5.84 ± 1.39	3.85 ± 0.15

Values expressed as mean ± S.D, * $p < 0.001$(Intergroup comparison at rest)
BMI – Body mass Index ,VC – Vital capacity, FEV_1 – Forced expiratory volume in first second, FEV_1 % - FEV_1 / FVC ratio, FVC – Forced vital capacity, PEF – Peak expiratory flow rate

Table 3: Comparison of respiratory parameters before and after acute exercise within groups in females

Parameters	Exercise	1 BMI < 18.5	2 18.5 – 24.9	3 25 – 29.9	4 > 30
VC	**Before**	2.22 ± 0.23*	3.40 ± 0.31	2.49 ± 0.47*	1.96 ± 0.24*
	After	2.24 ± 0.19	3.44 ± 0.34	2.47 ± 0.48	1.81 ± 0.21#
FEV_1	**Before**	2.10 ± 0.27*	3.28 ± 0.33	2.49 ± 0.47*	1.75 ± 0.11*
	After	2.10 ± 0.23	3.35 ± 0.32	2.40 ± 0.49	1.68 ± 0.19
FVC	**Before**	2.15 ± 0.25*	3.41 ± 0.35	2.52 ± 0.49*	1.79 ± 0.80*
	After	2.18 ± 0.24	3.42 ± 0.33	2.45 ± 0.51#	1.72 ± 0.22
FEV_1 %	**Before**	97.17 ± 3.06	95.66 ± 3.49	96.53 ± 4.23	97.33 ± 2.30
	After	96.33 ± 2.58	96.92 ± 2.50	98.06 ± 2.53	97.33 ± 2.08
PEF	**Before**	4.71 ± 0.97*	5.57 ± 1.01	4.95 ± 0.92*	3.99 ± 1.45*
	After	4.76 ± 1.22	5.61 ± 0.88	4.67 ± 0.84	3.91 ± 1.85

Values expressed as mean ± S.D, * $p < 0.001$ – Intergroup comparison of resting values
# $p < 0.01$ – Intra group comparison of pre and post exercise values ,BMI – Body mass index , VC – Vital capacity, FEV_1 – Forced expiratory volume in first second, FEV_1 % - FEV_1 /FVC ratio, FVC – Forced vital capacity , PEF – Peak expiratory flow rate.

DISCUSSION

The present cross sectional study aimed to study the influence of exercise on pulmonary function tests in young healthy individuals. The baseline values of the respiratory parameters between the genders showed a significant statistical difference, with males showing the higher values. These results are supported by other studies and could be explained with the greater muscular strength in males[5,7]. A comparison of the respiratory parameters before exercise between the various groups of males and females, revealed a statistically significant influence of body mass index on the pulmonary function. Individuals with a normal body mass index had a significantly higher values compared to the underweight, overweight and the obese individuals. However there was no change in FEV_1 %.These results are consistent with the results of Saxena et al.[8] and Wannametheeet al.[9]These results specify a restrictive mode of impairment in overweight and obese individuals. Further the increased body fat percentage, mechanical restraint to the movement of abdomen and thorax and increased airway resistance in overweight and obese individuals, could explain these results.Poor respiratory muscle strength could contribute to lower values of the respiratory parameters in the underweight individuals as suggested by Muralidhara DV[10].

Considering the effect of acute exercise, overall no significant change was observed in the respiratory parameters after exercise in males and the underweight and normal females. These results are consistent with the results of Chen Y et al who did not observe any significant changes in the post exercise values[11]. However this was in contrast to the findings of Ikram MH, who showed that release of catecholamines during exercise, cause a significant rise in FEV_1after exercise in both the sexes[12].Lakshmi PVV studied the cardiopulmonary changes with exercise in adolescents and observed an increase in FEV_1, but without any changes in FVC. It has also been reported that mild and moderate exercise do not produce a significant alteration in the pulmonary function tests in young individuals[13]. In contrast, Sagher F in his study explored the bronchoconstrictor effect of exercise as a fall in PEF, in healthy Libyan children. The bronchospasm in healthy children was attributed to the low temperature and dry stimulus to the airways during exercise[14]. The disparity in the results could be due to the differences in the mode and intensity of exercise.

In females, a significant reduction was observed in FVC and VC after acute exercise in individuals with a higher body mass index. However Faria AG et al studied the effect of exercise test on pulmonary function of obese adolescents and reported that body fat distribution influence the resting values more than the changes after exercise[15].A decrease in lung volumes in persons with higher body mass index appears to increase respiratory resistance, contributing to exercise induced reduction in FVC in these subjects as observed by Navarro B et al[16] and Kaplan et al[17]. This reduction being significant only in the females could be explained by the fact that they have lesser respiratory muscle strength and therefore prone for a greater reduction of lung volumes and flow rates. This again coincides with the results of Canoy D et al[18].

CONCLUSION

The results of the present study indicates that pulmonary function tests are not altered with acute exercise in normal individuals, however exercise induced changes may be significantly influenced by higher body mass index and respiratory muscle strength. This shows that enormous ventilatory reserve in an individual with normal lungs could be compromised due to many factors like obesity. Although the beneficial effects of continuous physical training has proven effects, more research has to be done to explore the beneficial effects of acute exercise and its effectiveness as a screening tool in assessing the functional capacity of the lungs.

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