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Effect of Physical Training on Pulmonary Function Tests in Border Security Force Trainees of India

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ABSTRACT Regular exercise enhances physical capabilities and physiological responses of the human body and the lungs are no exception. The present study was undertaken to study the effects of physical training and regular exercise on the lung functions. Pulmonary function tests (PFTs) of Border Security Force (BSF) trainees were compared with those of controls.We evaluated PFTs in 100 healthy BSF trainees before and after their rigorous physical training of 9 months duration and compared the values so obtained with 100 healthy medical students who were chosen as controls. Both were in the age group of 18-23 years. The PFTs were carried out with a computerized spirometer "Med-Spiror". The various data was collected, compiled, statistically analysed and valid conclusions were drawn. Higher lung volumes and flow rates were achieved in BSF trainees after their training period, as compared to their own values obtained before their training period and to those of controls. Better mechanical factors and lower airway resistance influenced during the training period might have benefited in improving lung volumes and flow rates.

INTRODUCTION

Physical training is the ability to endure, to bear up, to withstand stress, to carry on in circumstances where an unfit person cannot continue and is a major basis for good health and well- being. Exercise has been a means of testing the physical capabilities and physiological responses of an individual. Buffalo health study concluded that pulmonary function is a long term predictor of overall survival rates in both genders and could be used as a tool in general health assessment (Holger et al. 2000). Exercise is a stressful condition which produces a marked change in body functions and lungs are no exception. Sedentary life styles could be associated with less efficient pulmonary functions. There are several studies that have shown significant improvement in pulmonary functions as a result of the effect of exercise (Chandran et al. 2000; Cedric et al. 2005; Shivesh et al. 2007). However, there are studies which show non - significant change in pulmonary functions as an effect of exercise (Hamilton and Andrew 1976; Kuppu Rao and Vijayan 1988). In this study, we have compared pulmonary functions of BSF trainees before and after their training period and also compared those with age matched sedentary medical students. There are very few studies carried out to elicit the effect of physical training on the pulmonary function tests on the defense personnel of the country (Goyle et al. 1984).

MATERIAL AND METHODS

The subjects chosen for the study were divided into three groups as follows:

Group Ia: It included 100 healthy BSF trainees, at the beginning of their training period, from BSF training camp, Hoshiarpur, Punjab, one of its kind in North India.

Group Ib: It included the same 100 healthy BSF trainees, as in group Ia, but after their training period of 9 months duration.

The BSF trainees included in the study

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belonged to the eastern regions of the country, mainly from Orissa and West Bengal. The subjects were all males in the age group of 18 to 23 years. During their training period they performed different types of exercises (running, drill, various resistance exercises and other moderate to severe exercises) for 4-5 hours every day. They performed exercises for 2-3 hours in the morning and 1-2 hours during the evening. The pulmonary functions of these subjects were assessed twice at the start of their training period (Group Ia) and at the end of their training period (Group Ib).

Group II: It included 100 healthy medical students of the same age group and sex, who did not perform regular exercise and were sedentary. Sedentary lifestyle was defined, as per Center for disease control and prevention; as no leisure time physical activity or activities done for less than 20 minutes or fewer than 3 times per week.

A detailed history and physical examination of each subject was carried out. Subjects with any history of smoking, chronic cough, recurrent respiratory tract infection, history of chest or spinal deformity, obesity, personal history of asthma, chronic obstructive lung diseases were excluded from the study. Once the subjects were included in the present investigation, none were subsequently rejected except when they were unable to give the desired co-operation in the experimental procedures. All tests were carried out in the morning during the post absorptive phase. The ventilatory tests were carried out with a computerized spirometer "Med-Spiror". It records the amount of air and the rate of air that is breathed in and out over a specified period of time. Testing procedures were quite simple, non-invasive and harmless to the patient. The subjects were familiarized with the instrument and the technique used. Only two manoeuvres were required from the subjects to accumulate all test data, a Forced Vital Capacity and Maximum Voluntary Ventilation.

The readings were taken in standing position. Age, height (without shoes), body weight were recorded. Body Surface Area (BSA) was read from" Nomogram" (DuBois and sDuBois 1916).

Each subject was given two trials and three tests runs for each test and best of the three test readings was taken.

The parameters studied from the records were Body Surface Area (BSA), Forced Vital Capacity (FVC), Forced Expiratory Volume in 1second (FEV), FEV_1/FVC%, Peak Expiratory Flow Rate (PEFR), Forced mid Expiratory Flow Rate (FEF_{25-75}) and Maximum Voluntary Ventilation (MVV). The terminology and abbreviations used for the parameters were suggested by Cotes (1965).

Statistical analysis was done for all the parameters. 'P' value was determined. $P>0.05$ was considered as non-significant. Independent student t test was used for between groups comparison. Data obtained was fed to the computer and analysed and valid conclusions were drawn.

RESULTS

Mean values of physical characteristics in BSF trainees before training (Group Ia) were: age (20.84±1.44 years), height (171.68±5.15 cms), weight (60.64±4.67 kgs) and body surface area (BSA) (1.71±0.09 sqms). The mean values in BSF trainees after their training period (Group Ib) were: age (21.02±1.50), height (172.04±5.81), weight (62.99±7.84), BSA (1.74±0.12). The mean values of medical students (Group II) were age (19.33±1.02), height (173.01±6.36), weight (64.35±8.11) and BSA (1.77±0.13) (Table 1).

Mean values of respiratory parameters with standard deviation in BSF trainees (group Ia and group Ib) and medical students taken as controls (group II) are given in table 2.

Comparison of group Ia and group Ib revealed significantly higher values of FVC ($p<0.001$), FEV_1, FEF_{25-75}, MVV and PEFR ($p<0.05$), in group Ib FEV_1/FVC% did not show any variation (Table 3).

Table 1: Mean and standard deviation of four anthropometric parameters in B.S.F. trainees (Group Ia and Ib) and controls (Group II)

Parameters	*Group Ia*		*Group Ib*		*Group II*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Age in years	20.84	1.44	21.02	1.50	19.33	1.02
Height in cms.	171.68	5.15	172.04	5.81	173.01	6.36
Weight in kgs.	60.64	4.67	62.99	7.84	64.35	8.11
B.S.A. in sqms	1.71	0.09	1.74	0.12	1.77	0.13

Comparison of group Ia and group II revealed significantly higher value only in FEF_{25-75}($p<0.05$), in group II, the rest of the lung volumes did not show any significant variation (Table 4).

Comparison of group I b and group II revealed significantly higher values of FVC ($p<0.001$), FEV_1, PEFR, MVV in group Ib. FEF_{25-75} ($p>0.05$) and FEV_1/FVC% did not show any significant variation (Table 5).

DISCUSSION

The BSF trainees have to undergo a rigorous training of 9 months duration. The various

Table 2: Mean and standard deviation of respiratory parameters in B.S.F. trainees (Group Ia and Ib) and controls (Group II)

Parameters	*Group Ia*		*Group Ib*		*Group II*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
FVC (Litres)	3.02	0.30	3.38	0.34	3.13	0.58
FEV_1 (Litres)	2.86	0.37	3.17	0.39	2.90	0.52
PEFR (L/Sec)	7.89	1.66	8.46	1.15	7.55	1.66
FEF_{25-75}(L/sec)	3.81	1.12	4.47	0.92	4.24	1.44
FEV_1/FVC%	94.65	6.80	93.81	8.01	93.31	9.15
MVV (L/min)	134.76	16.79	150.90	21.66	130.69	23.29

Table 3: Mean, standard deviation,'t' value with statistical significance of respiratory parameters between B.S.F. trainees before training (Group Ia) and after training (Group Ib)

Parameters	*Group Ia*		*Group Ib*		*t value*	*p value*	*Significances*
	Mean	*SD*	*Mean*	*SD*			
FVC (Litres)	3.02	0.30	3.38	0.34	7.96	<0.001	HS
FEV_1 (Litres)	2.86	0.37	3.17	0.39	5.78	<0.001	HS
PEFR (L/sec)	7.89	1.66	8.46	1.15	2.82	<0.05	S
FEF_{25-75} (L/sec)	3.81	1.13	4.47	0.92	4.56	<0.001	HS
FEV_1/FVC%	94.65	6.80	93.81	8.01	0.80	>0.05	NS
MVV(L/min)	134.76	16.74	150.90	21.66	5.90	<0.001	HS

HS: Highly Significant; $p<0.001$
S : Significant; $p<0.05$
NS: Not Significant; $p>0.05$

Table 4: Mean, standard deviation,'t' value with statistical significance of respiratory parameters in B.S.F. trainees before training (Group Ia) and controls (Group II)

Parameters	*Group Ia*		*Group II*		*t value*	*p value*	*Significances*
	Mean	*SD*	*Mean*	*SD*			
FVC (Litres)	3.02	0.30	3.13	0.58	1.68	>0.05	NS
FEV_1 (Litres)	2.86	0.37	2.90	0.52	0.62	>0.05	NS
PEFR (L/sec)	7.89	1.66	7.55	1.66	1.45	>0.05	NS
FEF_{25-75}(L/sec)	3.81	1.12	4.24	1.44	2.36	<0.05	S
FEV_1/FVC%	94.65	6.80	93.31	9.15	1.17	>0.05	NS
MVV(L/min)	134.76	16.79	130.69	23.29	1.42	>0.05	NS

Table 5: Mean, standard deviation, 't' value with statistical significance of respiratory parameters in B.S.F. trainees after training (Group Ib) and controls (Group II)

Parameters	*Group Ib*		*Group II*		*t value*	*p value*	*Significances*
	Mean	*SD*	*Mean*	*SD*			
FVC (Litres)	3.38	0.34	3.13	0.58	3.72	<0.001	HS
FEV_1 (Litres)	3.17	0.39	2.90	0.52	4.16	<0.001	HS
PEFR (L/sec)	8.46	1.15	7.55	1.66	4.51	<0.001	HS
FEF_{25-75}(L/sec)	4.47	0.92	4.24	1.44	1.34	>0.05	NS
FEV_1/FVC%	93.81	8.01	93.31	9.15	0.41	>0.05	NS
MVV(L/min)	150.90	21.66	130.69	23.29	6.37	<0.001	HS

moderate to severe exercises, physical training and strength training exercises, involved the movement and strengthening of the whole body including the strengthening of respiratory and chest muscles. The results of the lung function values were recorded and compared amongst the three groups. The results of the study were also compared with the studies carried out previously.

The values of Forced Vital Capacity (FVC), and Forced Expiratory Volume in one second (FEV_1) were found to be statistically highly significant in group Ib, when compared with the values of group Ia and group II. Both group Ia and group II were relatively sedentary and were not performing physical exercises daily. Higher values in group Ib could be explained due to better strengthening of respiratory muscles as a result of physical training. Skeletal muscle control many crucial elements of aerobic conditioning including lung ventilation. There might be increase in the maximal shortening of the inspiratory muscles as an effect of training, which has been shown to improve the lung function parameters (Fanta et al. 1983). In the Amsterdam Growth and Heart study, physical activity was observed to be positively correlated to changes in FVC between ages 13-27 years over a period of 15 years (Twisk et al. 1998). This is supported by a number of previous studies as well (Armour et al. 1993; Lakhera et al. 1994; Mehrotra et al. 1998; Birkel and Edgren 2000). A recent study by Fuster et al. (2008) also observed increment in FVC as an effect of increased physical activity. Though a previous study does not show any statistically significant difference in these values as an effect of exercise (Hamilton and Andrew 1976).

The difference in the values of Peak Expiratory Flow Rate (PEFR) in group Ib and group II is highly significant, while between group Ia and group Ib the difference of PEFR value was statistically significant. PEFR is higher in healthier populations such as Armed Forces Personnel and athletes (Goyle et al. 1984). Another previous study observed that there was insignificant difference in PEFR in Indian athletes and non athlete Indian soldiers, thereby showing that there is no difference in the flow rates in top Indian athletes and moderately trained soldiers (Malhotra et al. 1972).

Forced Mid Expiratory Flow Rate (FEF_{25-75}) values were significantly higher in group Ib as compared to group Ia. But the difference of values between group Ib and group II was non-significant. The measurement is associated with a high co-efficient of variation and requires considerable co-operation of the subject. Some studies in the past have observed higher flow rates in subjects involved in physical training (Chandran et al. 2000; Shivesh et al. 2007).

The mean value of FEV_1 as a percentage of FVC (FEV_1/FVC %) was found to be almost similar in all the three groups. It was probably that there was equal rise in FEV_1 and FVC in the various groups. The difference whatsoever was statistically insignificant. Similar results were seen on some previous studies (Lakhera et al. 1994).

The present study showed the values of Maximum Voluntary Ventilation (MVV) to be much higher in group Ib as compared to group Ia and group II. The difference was found to be statistically highly significant in the comparative groups. The higher MVV was advantageous for physical work capacity of the trainees (Lakhera et al. 1994; Chandran et al. 2000). It was observed in a study by Enright et al. (2006), that high intensity inspiratory muscle training results in increased contracted diaphragm thickness and increased lung volumes and exercise capacity in people who are healthy.

The results discussed above clearly indicate that there is significant difference in the static lung values as well as flow rates between the comparative groups. This 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 that the BSF trainees undergo 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 FVC, PEFR and MVV. This is advantageous for physical work capacity in them. The flow rates have also shown to have higher values in group Ib. These flow rates are effort dependent. During training there is adaptation to frequently higher ventilatory load which might bring about some structural changes that may lead to less compression of airways at lower lung volumes (Joshi and Joshi 1998).

CONCLUSION

The results of the present study showed that physical training and exercise improved the lung function parameters in BSF trainees after their training period. Medical students who had sedentary lifestyles had lower pulmonary function parameters. Buffalo health study revealed FEV_1 as an independent predictor of overall long term survival rates and could be used as a tool in general health assessment (Holger et al. 2000). Pursuing a physical activity or sport which could help in achieving efficient lung function especially FEV_1 is an essential preventive strategy in this busy age when prevalence of sedentary life style is increasing and so are the associated lifestyle disorders. As suggested by Pelkonen et al. (2003), a continued high physical activity is associated with lower mortality, and delays decline in the pulmonary functions and therefore should be encouraged.

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