

## PRE AND POST-EXERCISE CHANGES IN CARDIO-PULMONARY FUNCTIONS IN HEALTHY SCHOOL CHILDREN OF GULBARGA DISTRICT

Malipatil B.S\* and Mohammed Ehtesham Ali Farooqui

Dept. Of Physiology, M R Medical College, Gulbarga, India

E-mail of Corresponding Author: [research.doc11@gmail.com](mailto:research.doc11@gmail.com)

### Abstract

**Background and Objective:** Low physical activity and cardio-respiratory fitness are recognized as important causes of morbidity and mortality. In the present study, the pre and post-exercise changes in cardio-pulmonary functions in healthy school children of Gulbarga district were investigated.

**Materials and Methods:** The present work was conducted after the institutional ethical clearance. In this study, 50 male students of school aged between 9-11 years who are apparently healthy and who were born and brought up in Gulbarga district (Karnataka) with the same socioeconomic status were included. Children with poor nutritional status were excluded from study. Exercise was performed and data were recorded by automatic computerized treadmill. Lung Function Tests and data were recorded by using computerized vitalography. The data were analysed using one-way ANOVA. P value less than 0.05 was the level of significance.

**Results:** The result reflects a Significant increase ( $p < 0.001$ ) in both pre and post exercise changes and a negative correlation ( $r = 0.048$ ,  $p = 0.05$ ) between Body Mass Index (BMI) and Physical Fitness Index (PFI) score was observed. A significant increase ( $t = 5.16$ ,  $p < 0.001$ ) of exercise induced rise in SBP of school children and no significant difference between pre and post exercise Diastolic Blood Pressure (DBP) in school children was found. A non-significant change of vital capacity between pre and post exercise and changes of reduction of Forced Expiratory Volume in one second ( $FEV_1$ ) (%) is found to be statistically significant ( $p < 0.05$ ).

**Conclusion:** The percent recovery of heart rate in school children reflects a better cardiovascular efficiency.

**Keywords:** Cardio-Pulmonary Functions, Systolic Blood Pressure, Diastolic Blood Pressure Body Surface Area, Body Mass Index, Physical Fitness Index, Forced Vital Capacity and Forced Expiratory Volume in one second

### 1. Introduction

Low Physical activity and cardio-respiratory fitness are recognized as important causes of morbidity and mortality<sup>1, 2</sup>. It is generally accepted that people with higher levels of physical activity tend to have higher levels of fitness and that physical activity can improve cardio-respiratory fitness<sup>3</sup>. Although the beneficial effects of physical exercise on psychological processes has a long history, it has only been in the past 100 years that experimental investigations linking physical activity and mind were undertaken and it was not until the 1970s that systematic attempts to link physical activity and mental health were made. However, since then the number of published works has exploded.

Any increase in energy expenditure requires rapid adjustments in blood-flow that affect the entire Cardio Vascular System. For example,

nerves and local metabolites act on the smooth muscle bands of arteriole walls, altering their internal diameter almost instantaneously to meet blood flow demands. In addition, visceral, vasoconstriction and action of the muscle pump divert a large flow of blood into the central circulation<sup>4</sup>.

At the onset of exercise, the ventricular component of the muscles increases by dilation of local arterioles<sup>5</sup>. The small feed arteries to skeletal muscle normally possess well-developed flow mediated and myogenic regulatory mechanisms<sup>6</sup>. During relatively light exercise, blood flow shifts significantly from the abdominal viscera to active muscles, which is due to increased sympathetic nervous system out flow and local chemicals that directly stimulate vasoconstriction or enhance the effect of vasoconstriction<sup>6, 7</sup>.

Blood pressure represents the force or lateral pressure exerted by column of blood against the arterial walls during a cardiac cycle. Systolic blood pressure (SBP), the higher of the two pressure measurements, occurs during ventricular contraction (systole) as the heart propels 70 to 110 ml of blood into aorta. After systole the ventricles relax (diastole), the arteries recoil, and arterial pressure continually declines as blood flows into the periphery and the heart refills with blood. The lowest pressure reached during ventricular relaxation represents the diastolic blood pressure (DBP). The normal systolic blood pressure in an adult varies between 110 and 140 mmHg and diastolic pressure varies between 60 and 90 mmHg. General pattern for systolic and diastolic blood pressure during continuous graded tread mill exercise is that after an initial rapid rise from the resting level, systolic blood pressure increase linearly with exercise slightly at the higher or exhaustive exercise levels. Both sedentary and endurance trained subjects demonstrates similar blood pressure responses. During maximum exercise by healthy, fit men and women, systolic blood pressure may increase to 200 mm Hg or higher, despite significantly reduced total peripheral resistance. This level of blood pressure most likely reflects the heart's large output of blood during maximal exercise by individuals with high aerobic capacity<sup>8</sup>. Systolic blood pressure increases in proportion to oxygen consumption and blood flow during graded exercise, whereas diastolic blood pressure remains relatively unchanged or decreases slightly. After exercise, blood pressure decreases below the pre-exercise level and may remain lower for about 12 hours. In these backgrounds, we wanted to investigate the Pre and Post-Exercise Changes in Cardio-Pulmonary Functions in apparently healthy School Children of Gulbarga District

## 2. Materials and Methods

The present work was conducted in the department of Physiology, M R Medical College, Gulbarga after the institutional ethical clearance in accordance with the Helsinki declaration. In this study, 50 male students of school aged between 9-11years who are apparently healthy and who were born and brought up in Gulbarga district (Karnataka) with the same socioeconomic status were included. Children with poor nutritional status on the basis of their BMI were excluded from study. All the

subjects in both the groups were asked to perform sub maximal exercise on computerized treadmill-Model Quantum-Q5000. For the sub maximal exercise, 6 minute exercises done by using treadmill. Subject prepared for the Tread Mill Test (TMT) were asked to lie down on the cot, during resting conditions. Heart rate (pre-exercise) recorded by automatic computerized treadmill. Then asked the subject to walk on the moving ramp of treadmill for 2 grades (Bruce Speed) i.e., for 6 minutes (each grade lasts for 3 minutes duration). At the end of 6<sup>th</sup> minute the peak exercise heart rate recorded by computerized automatic treadmill. Once again subjects were asked to lie down on cot. After one minute rest, post exercise recovery heart rate was recorded by automatic computerized machine (Treadmill Q-5000).

Weight and height were recorded by using standard weighing machines and stadiometer for calculating Body Mass Index (BMI) and Body Surface Area (BSA). Heart rate was recorded as predicted by the automatic computerized treadmill test. Blood pressure was recorded by mercury sphygmomanometer.

**2.1 Lung Function Tests:** Recorded by using computerized vitalograph. Demographic and anthropometric data of the subjects such as age, height and weights were fed to the instrument before recording each type of lung function test. The predicted value was recorded by automatic display. Similarly, after the test, measured values of all the lung functions in percentages were recorded in the form of graph also. All the subjects were made to sit in a comfortable position; the nose clip was put on the nose. A fresh mouth piece was placed in the breathing tube.

**2.2 For recording vital capacity,** subjects were asked to take deep breath in by mouth and then asked to exhale forcefully through breathing tube, as much as possible. This records the value of vital capacity.

**2.3 For Forced Vital Capacity (FVC) and FEV<sub>1</sub>,** subjects were asked to take a deep inspiration by mouth and asked to exhale as much as fast by breathing tube once and stopped. This will record the FVC and FEV<sub>1</sub>.

**2.4 Recovery Heart Rate** was calculated by the formula,

$$\text{Percent of recovery heart rate (RHR)} = \frac{B \times 100}{A}$$

Here,

A=Peak exercise heart rate-pre-exercise heart rate and

B= Peak exercise heart rate- post-exercise heart rate.

**2.5 Physical Fitness Index** was calculated by the formula,

$$\text{PFI} = \frac{\text{Duration of exercise in seconds} \times 100}{5.5 \times \text{pulse rate (1 - 1.30 min. after exercise)}}$$

Physical fitness index (PFI) score was calculated and represented as Excellent (>90), Good (80-90), High Average (65-79), Low Average (55-54) and poor (<55).

**2.6 Statistical Significance:** The data were analysed using one-way ANOVA. P value less than 0.05 was the level of significance.

### 3. Results

The anthropometrical measurements like age, height, weight, BSA, BMI were shown in Table-1. The value of age groups for school children reflects that they are in pre-adolescence or in paediatric category. The Mean  $\pm$  SD of height, weight, BSA and BMI of school children was  $148.62 \pm 10.70$ cms,  $35.17 \pm 6.66$  Kgs,  $1.29 \pm 0.03\text{m}^2$  and  $15.77 \pm 0.33\text{Kg/m}^2$  respectively.

The different physiological parameters like Pre-exercise Heart rate, Post exercise heart rate, Post exercise recovery heart rate, Percentage of recovery of heart rate, Physical fitness index, SBP and DBP were represented in Table-2. The mean  $\pm$  SD of the heart rate and peak exercise heart rate of school children in pre exercise condition is  $84.45 \pm 8.07$  and  $134.93 \pm 9.71$  respectively. The mean  $\pm$  SD of post exercise recovery heart rate and percentage recovery heart rate of school children are  $95.17 \pm 10.87$  and  $81.30 \pm 11.77$  respectively. The result reflects a significant increase ( $p < 0.001$ ) in both pre and post exercise changes.

The Mean  $\pm$ SD of PFI score of school children was  $94.79 \pm 7.65$ . The percentage of various classification of PFI score shows 75.86% are placed in excellent category and 24.16 are in good category. But, no poor as well as average categories were found in this study. Our study has shown a negative correlation( $r = 0.048$ ,  $p = 0.05$ ) between BMI and PFI score was observed. The mean  $\pm$  SD of SBP of school children before exercise was  $95.24 \pm 6.75$ mmHg and post exercise SBP was  $105.86 \pm 8.67$  mmHg. This shows a significant increase ( $t = 5.16$ ,  $p < 0.001$ ) of exercise induced rise in SBP of school children. The Mean  $\pm$  S.D of pre and post

exercise DBP was  $62.07 \pm 4.1$ mmHg and  $62.07 \pm 4.12$ mmHg respectively. No significant difference between pre and post exercise DBP in school children was found.

The pre and post exercise FVC, pre and post exercise of FEV<sub>1</sub>, was as shown in Table-3. The Mean  $\pm$  S.D of pre exercise and post exercise FVC of school children was  $2.58 \pm 0.51$  and  $3.79 \pm 0.56$  respectively. The results clearly reflect statistically non-significant changes of vital capacity between pre and post exercise condition in school children of Gulbarga district. The Mean  $\pm$  S.D of pre and post exercise FEV<sub>1</sub> of school children was found to be 91.79% and 87.73% respectively. The changes of reduction of FEV<sub>1</sub> (%) is found to be statistically significant,  $p < 0.05$ .

### 4. Discussion:

Body mass index is an important indicator to evaluate whether an individual is overweight or normal. Resting heart rate is the number of beats in one minute when one is at complete rest. It reflects basic fitness of an individual. The healthier condition of an individual, the less effort and fewer beats per minute it takes heart to pump blood to the body at rest. The higher pre-exercise heart rate of subjects may be due to sedentary life-style or less conditioning of their body.

Exercise stress testing is a valuable tool for evaluating physical fitness and cardio-respiratory status of children as well as adults. Aerobic capacity or maximum oxygen up-take capacity (VO<sub>2max</sub>) has been widely considered to be reliable and valid indicator of cardio-respiratory fitness. VO<sub>2max</sub> is a test for assessing the running endurance<sup>9</sup>. There are only a few studies that have established reference standards for pulmonary function of Indian children. Reference standards for pulmonary function that are reported for Indian children are mainly from northern and western parts of the country and there is paucity of data on pulmonary function in normal south Indian children. Pulmonary function tests (spirometry and maximum expiratory flow rates) were carried out in 469 south Indian healthy children between 7-19 years of age to derive regression equations to predict pulmonary function. Peak expiratory flow rate (PEFR), forced mid expiratory flow (FMF) and forced expiratory flow rate at 25%, 50% and 75% of FVC (PEF 25%, PEF 50%, FVC and FEF 75% VC) were all significantly

correlated with physical characteristics (age, height and weight)<sup>10</sup>.

In our study the recovery heart rate has shown normal cardiac fitness. The greater percentage heart rate recovery in school children reflects greater physical fitness due to greater physical activity. A positive correlation between BMI and percent recovery heart rate of school children of Gulbarga district reflects a scope of higher weight gain and also provides a space for improvement of physical fitness<sup>11</sup>.

In our study, the greater mean PFI score of school children reflects a greater cardiovascular fitness. The negative correlation between BMI and PFI score of school children is seem to be interesting. The correlation shows that, greater the BMI of these children is lesser the physical fitness index. Hence, it can be concluded that higher the BMI, the greater the risk of additional health problems. BMI is significantly correlated with fitness in childhood and adolescents, specific for those with the greatest amount of fitness. The correlation between physical fitness, BMI in urban American youth was reported<sup>12</sup>, in which a reduction in physical fitness with increase BMI was observed. No post exercise alterations of FVC and FEV<sub>1</sub> are observed in comparison to their pre-exercise condition. Post exercise significant changes in FEV<sub>1</sub> (%) was observed in comparison to their pre-exercised condition. Exercise induced fall of FEV<sub>1</sub> (%) is reported in earlier studies also<sup>13</sup>. The exercise induced fall of FEV<sub>1</sub> (%) might be due to bronchospasm and this bronchospasm might occur due to release of leukotriene, or release of histamine from mast cells present in respiratory tract during exercise, which also induces inflammation on respiratory tract.

### Conclusion:

The percent recovery of heart rate in school children reflects a better cardiovascular efficiency. No changes in the vital capacity and forced vital capacity but, a significant fall in FEV<sub>1</sub> immediately after exercise might be due to exercise induced bronchospasm. Probably leukotriene and histamine are the causative factors that induce post- exercise bronchospasm.

### References:

1. Physical Activity and Health: A Report of the Surgeon General. Atlanta, GA: Department Of Health And Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996.
2. Twisk JW, Staal BJ, Brinkman MN. Tracking of Lung Function Parameters and the Longitudinal Relationship with Lifestyle. *European Respiratory Journal*. 1998; 12:627-634.
3. Burchfiel CM, Enright PL, Sharp DS. Factors Associated With Variations in Pulmonary Functions among Elderly Japanese-American Men. *Chest*. 1997; 112:87-97.
4. Willmore JH . Endurance exercise training has a minimal effect on resting heart rate the heritage family study. *Med. Sci. Sport. Exercise*. 2001;33: 99.
5. Buck Walter JB. Skeletal muscle vasodilatation at the onset of exercise. *J. Appl. Physio*. 1998; 85: 1648.
6. Jasperse JL and Laughlin MH. Vasomotor responses of soleus feed areteries from Sedentary and exercise in trained rats. *J. Appl. Physio*. 1989;86: 41.
7. McAlister RM. Adaptation in control of blood flow with training splanchnic and renal blood flows. *Med. Sci. Sports Exercise*. 1998;30: 375.
8. Mitchell JH and Raven PB. Cardiovascular adaptation to physical activity-In Physical Activity, Fitness and Health, Champaign IL: Human Kinetics, 1994.
9. Taylor KL, Buskirk R, Henschel A. Maximum oxygen intake as an objective measure of cardio-respiratory performance. *J. Appl. Physiol*, 1955; 8: 73-80.
10. Vijan VK, Reetha AM, Kuppurao KV, Venkatesan P, Thilakvathy S, W.P. Physical fitness and Pulmonary functions. *Indian J. Chest. Dis. Allied Sci*. 2000; Jul-Sept. 42 (3): 147-56.
11. Errikson G. Changes in Physical fitness and changes in mortality, *Lancet*. 1988; 352: 759-62.
12. Gray A Smith C. Fitness dietary intake and body mass index in urban American youth. *J. Am. Diet Association*. 2003; 103(9): 1187-91.
13. Edelman JM, Turpin JA, Bronsky EZ . Oral mouthclast compared with inhaled salmeterol prevent exercise induced broncho-constriction, A randomized double blind trial on exercise for study group. *Ann. Intern. Med.*, 2000; 132(2): 97:104.

**Table-1: Anthropometrical parameters in school children. Values are mean  $\pm$  SD. n=50.**

Anthropometric Parameters	Values in mean $\pm$ SD
Age(years)	10 $\pm$ 1.0
Height (cm)	148.62 $\pm$ 2.00
Weight (Kgs)	35.17 $\pm$ 1.24
BSA (m <sup>2</sup> )	1.29 $\pm$ 0.03
BMI (Kg/m <sup>2</sup> )	15.77 $\pm$ 0.33
PFI	94.79 $\pm$ 7.65

Note: BSA –Body Surface Area,  
 BMI –Body Mass Index,  
 PFI-Physical Fitness Index

**Table – 2: Cardiac Parameters in School children. Values are mean  $\pm$  SD. n=50.**

Parameters	Values in mean $\pm$ SD	P Value
Pre-exercise Heart Rate	84.45 $\pm$ 8.07	p<0.001
Post Exercise Heart Rate	134.93 $\pm$ 9.71	
Recovery Heart Rate	95.17 $\pm$ 10.87	p<0.001
Pre-exercise SBP	95.24 $\pm$ 6.75	p<0.001
Post Exercise SBP	105.86 $\pm$ 8.67	
Pre-exercise DBP	62.07 $\pm$ 4.1	p<0.001
Post Exercise DBP	62.07 $\pm$ 4.12	

SBP-Systolic Blood Pressure, DBP-Diastolic Blood Pressure

**Table-3: Pulmonary Parameters in School children. Values are mean  $\pm$  SD. n=50.**

Parameters	Values in mean $\pm$ SD	P Value
Pre-exercise FVC	2.58 $\pm$ 0.51	p<0.05
Post-exercise FVC	3.79 $\pm$ 0.56	
Pre-exercise FEV <sub>1</sub>	91.79%	p<0.001
Post-exercise FEV <sub>1</sub>	87.73%	

FVC-Forced Vital Capacity, FEV<sub>1</sub>-Forced Expiratory Volume in one second