

# Physical Fitness Index among Runners and Healthy Controls, Its Correlation with Resting Heart Rate

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## Abstract

*Background & Objective:* Practicing exercises on regular basis will reduce the cardiovascular diseases and also reduce death due to cardiac complications. The independent and additional benefit of practicing physical exercises regularly help in improving the aerobic condition of the body and also helps in leading healthy life. Physical fitness index is one of the important parameter which is not given much attention. To measure the physical fitness index among Indian elite runners and compare it with control group, by using Harvard step test. To correlate the PFI of runners with resting heart rate. *Methods:* PFI and BMI, HR of 31 runners at national level was compared with that of 31 controls. Runners were divided into two groups, group A (>2yrs & < 3yrs of training) and group B (>3yrs & < 10yrs of training). Correlation of PFI with resting Heart rate was done. *Results:* PFI was high among runners and showed statistically significant values. Group B players (seniors) showed highly statistically significant PFI value. Correlation analysis has shown negative correlation of PFI with resting Heart rate with statistically significant value in runners. *Conclusion:* Improvement in PFI by regular practice will ultimately improve cardiorespiratory endurance in turn improving the sports performance.

**Keywords:** Runners; Physical Fitness Index (PFI); Harvard Step Test; Heart Rate (HR).

## Introduction

Since ancient times sports has been considered as an important part of extracurricular activity. In India, many competitions are organized to encourage athletes. Many training institutions have been contributing towards the upliftment of an athlete. Due to vast population in sports field whatever contribution is done appears to be less.

Many factors affect the physical fitness of the player like Age group, gender, nutritional status and also the socio economic status. These factors should be properly coordinated so that players can put maximum effort and give the best performance [1].

The physical fitness index (PFI) measures the physical status of the muscle power and nutrition, and also measures the ability of the individual to recover after muscular work. The study was taken up to measure (PFI) using modified Harvard step test [2].

The Harvard step test (HST) was started by Brouha et al (Brouha et al., 1943). From Harvard fatigue laboratory in USA to select soldiers during World War II. HST has become well known to study cardiovascular fitness by American Alliance for Health physical education research and Dance (AAHPERD). They standardized this test to assess physical fitness program in youth [3,4].

Cardiovascular diseases can be diagnosed or detected by cardiac stress tests like Harvard Step Test. It is a better indicator of fitness and also assesses the ability of a person to recover following a strenuous exercise. The faster the heart rate comes back to resting phase; the person's fitness will be better [5].

The sympathetic and parasympathetic nervous system regulates Heart rate (HR) by acting directly on the sinus node. During resting phase, heart rate is predominantly regulated by vagal activity (parasympathetic), which is gradually inhibited by the beginning of the exercise. Many studies have been

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taken up by researchers to study the variations of heart rate in different conditions and during exercises. In last few decades studies have shown acute and chronic effects of exercises on human body such as higher heart rate in the initial stage of exercise and gradual adjustments for training which showed lower heart rate for same intensity of sub maximal exercises. As heart rate can be easily measured, many studies have been taken up by the researchers on variations in heart rate (HR) in different types of exercise and conditions [5].

In the era of competitions winning is what being honored; for which the performance counts. Performance depends on many factors but PFI and its correlation with HR is one among that which is not given that much importance. Resting HR is very important factors which need to be concentrated more along with other fitness parameters when we look for the performance in a sports event. Studies have been conducted in physical fitness index in normal population, in swimmers, school going girls and boys, but to our knowledge there is paucity in literature regarding the relation between PFI and relation with Heart Rate.

## Materials and Methods

The present cross sectional study was conducted in the Department of Physiology, Jawaharlal Nehru Medical College, Belgaum, between January 2010 and December 2010.

### *Description of Participants*

Using universal sampling 31 runners who regularly practiced for a minimum period of 2 years and who were in the age group of 18-25yrs were included and 31 controls age (18-25 yrs) and sex matched participants from first year MBBS, BDS, AHSC and BPT were selected by randomization. Based on the duration of training the participants were split into two groups. Group A consisted of runners with >2yrs and ≤ 3 years of practice and Group B included the players with > 3 years and < 10 yrs of training. On an average practices were held for four to five hours per day, six times per week. Throughout the year apart from running practices all participants were involved in additional sessions of strength training and conditioning, speed and stretching both pre-season and during the competitive season. Similar training regimens were followed by both the groups. Participants with respiratory, neuromuscular, cardiac, endocrine disorders and

students from comparative group who practice regular exercise regime were excluded from study. Descriptive data of the participants age, medical history, training schedule regarding number of years of practice, and dietary history were obtained by questioning the participants. Nature of the study was explained and written informed consent was obtained from them. The study was approved by the Ethical and Research Committee of the institution.

### *Physical Fitness Index (PFI) [4,6,7]*

#### *Equipment Required*

Stopwatch, step or platform of 20 inches height, metronome which gives beat every 2 seconds at a rate of 30 per minute.

#### *Procedure*

The runner steps up and down on the platform at a rate of 30 steps per minute (every two seconds) for 5 minutes or till gets tired. Exhaustion is defined as when the athlete cannot maintain the stepping rate for 15 seconds. After completing the test the participant immediately sits down, and the total number of heart beats is counted between 1 to 1.5 minutes after finishing. Total test time in seconds was noted down.

*Scoring:* the Fitness Index score is determined by the following equations

$$\text{Physical Fitness Index (PFI)} = \frac{100 \times \text{test duration in seconds}}{5.5 \times \text{pulse count between 1 and 1.5 minutes}}$$

#### *Heart Rate [8].*

The radial artery is palpated with the tips of three fingers compressing the vessel against the head of radius bone. The subject's forearm should be slightly pronated and the wrist slightly flexed. The index finger (toward the heart) varies the pressure on the artery, the middle finger feels the pulse, while the distal finger prevents reflections of pulsations from the palmer arch of arteries.

#### *Statistical Analysis*

Statistical analysis involved quantitative variables summarized through mean and standard deviation. Difference between mean of the two groups of runners was tested using Students unpaired, t test, where significance of the p value was < 0.05. To evaluate strength of association between physical fitness index

(PFI) and resting heart rate among runners Karl Pearsons correlation coefficient was used.

**Results**

Table 1 and graph 1 summarize the Harvard step test readings of the runners and controls. Mean Heart rate between 1-1.5 min was less in runners than controls and the difference statistically significant (p <0.05). Physical fitness index (PFI) was found to be more in runners than controls and with statistically

significant value (p<0.05).

Table 2 and graph 2 summarize the Harvard step test readings of the two groups of runners. Mean Heart rate between 1 - 1.5 min was less in group B than group A, which was found to be statistically significant (p <0.05). Physical fitness index (PFI) was found to be more in group B than group A and with statistically significant difference (p<0.05).

Table 3 and graph 3 shows correlation between PFI and HR, Negative correlation was found between PFI and HR in runners and was statistically significant (p<0.01).

**Table 1:** Comparison of Physical Fitness Index (PFI) between runners & controls

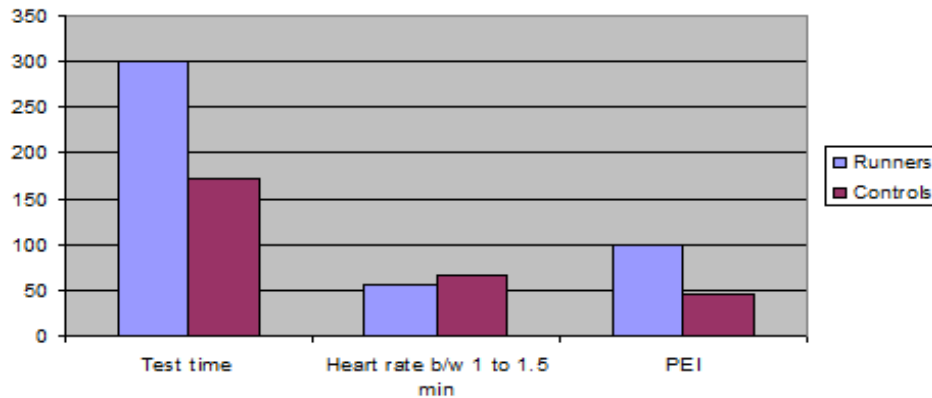
	Runners	Controls	P-value
Test time	300±0	171.9±55.70	0.000*
Heart rate b/w 1 to 1.5 min	56.1±10.16	66.2±6.94	0.000*
PEI	100.4±18.87	46.7±14.35	0.000*

(\*) p value significance<0.05

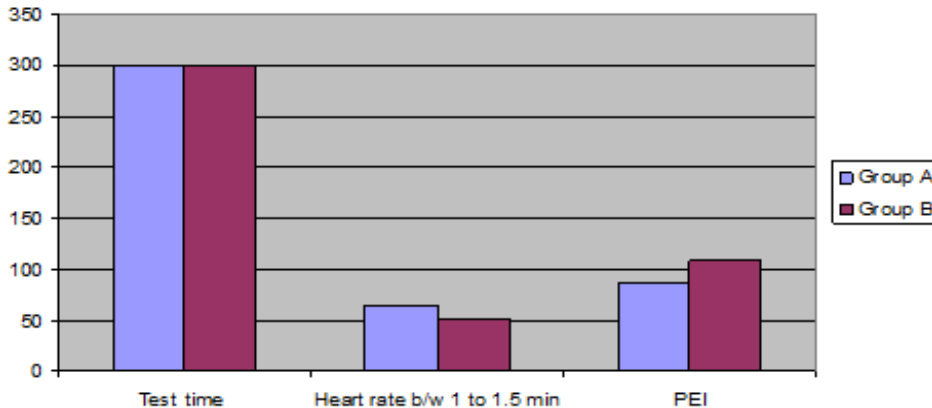
**Table 2:** Comparison of Physical Fitness Index (PFI) between two groups of runners

	Group A	Group B	P-value
Test time	300±0	300±0	1
Heart rate b/w 1 to 1.5 min	64.1±8.51	51.1±7.59	0.000*
PEI	86.5±13.02	109.2±16.70	0.000*

(\*) p value significance<0.05



**Graph 1:** Comparison of Physical Fitness Index (PFI) between runners & controls



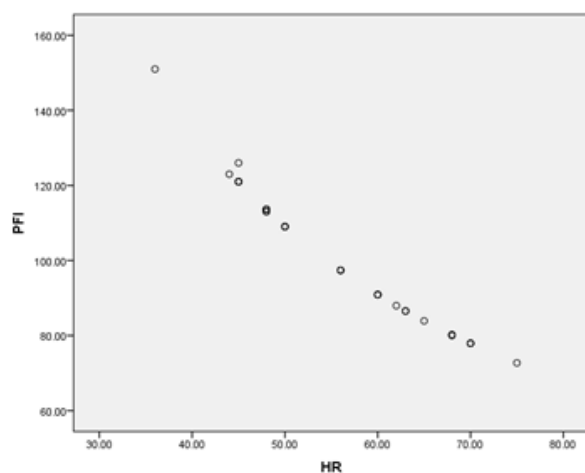
**Graph 2:** Comparison of Physical Fitness Index (PFI) between two groups of runners

**Table 3:** Correlation of Physical Fitness Index with Heart Rate in runners

	Correlations PFI	HR
PFI	1	-.982**
HR	-.982**	1

\*\* . Correlation is significant at the 0.01 level.

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**Graph 3:** Correlation of Physical Fitness Index with Heart Rate in runners

## Discussion

We have done our study on national and international runners. We have got significantly higher PFI in more trained runners and in comparison with controls the mean value is greater for runners.

In our study PFI Score of runners was higher than controls and between runner groups more years of training had a higher PFI score.

Capability of an organism to release higher quantities of energy during the period of time allows elaborating more intensive physical activities. This seems very important to majority of athletes and, what is more, it could be even decisive for one's championship level. It is generally agreed that aerobic capability is best reflected on the cardiopulmonary function and other components of oxygen transport capacity [9]. Many studies have showed aerobic power as the major criteria for assessing physical fitness as it can be measured quantitatively. The maximal aerobic power is defined as the maximum amount of oxygen uptake an individual can attain during physical work at sea level. Physical activity ranging from repeated work periods of a few seconds duration up to hours of continuous work may involve a major load on the oxygen transport organs and there

by induce a training effect. Three tests are used to measure maximal aerobic power namely, - 1) running on a treadmill 2) Bicycle ergometer 3) Step test. The Harvard step is a sub maximal fitness test, as it predicts cardiovascular endurance from the increase in the heart rate during moderate exercise, rather than exercise to exertion [10].

In our study finding of Harvard step test was significant suggesting faster recovery in senior players (B group) due to aerobic training. Longer duration of practice might be contributing to the high PFI in senior group. Fitness index is directly proportional to the duration of exercise and inversely proportional to post exercise pulse counts. The higher PFI score in player group than controls proves that definitely the players are more physically fit than the controls that is attributed to the effect of their training sessions.

There was a statistically significant negative correlation of Physical Fitness Index with resting Heart rate. Lower resting HR reflects a healthy and fit body, whereas higher values are apparently related to a increased risk of morbidity and mortality [11]. In sports, mistake is made in using the resting-HR as an indicator of the degree of aerobic conditioning, since the association between low resting-HR and maximal aerobic power is quite modest, and may be due to higher resting vagal activity [5], reducing diastolic depolarization rate and prolonging duration of the cardiac cycle, primarily on account of a proportionally longer diastole [5,12]. However, can training induce higher resting vagal activity, and therefore be accountable for lower resting-HR [5].

## Conclusion

Physical Fitness Index score improving training sessions have to be held for athletes to develop their cardiorespiratory endurance and in turn to increase the performance. Apparently, in comparison with sedentary individuals aerobically well-fit individuals have more effective autonomic activity, there is indication that individuals with better cardiac vagal

tone have a better response to aerobic training, which lead us to question whether aerobically well-fit athletes have a higher cardiac vagal tone due to training or those individuals with genetically higher cardiac vagal tone have a higher potential to become elite athletes if properly trained.

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