Original Article

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Physiology Section

Physical Fitness Index of Medical Students in Thrissur, Kerala, India: A Cross-sectional Study

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ABSTRACT

Introduction: Physical activity forms an important component of a healthy lifestyle. Inadequate physical activity is a major risk factor for non communicable diseases. It is necessary to identify the status of physical fitness of medical students who are the future professionals of healthcare. There are various parameters available to assess the physical fitness of an individual. Modified Harvard step test is a tool used for assessing cardiopulmonary fitness, which is employed in this study.

Aim: To compare the physical fitness of medical students who were regular basketball players, with sedentary medical students, using cardiovascular parameters.

Materials and Methods: The cross-sectional study was conducted in the Department of Physiology, Government Medical College, Thrissur, Kerala, India, from April 2017 to April 2018. Total 60 medical students of both gender, in the age group 18-25 years, out of which 30 were athletes and 30 were non athletes, selected by simple random sampling. Physical fitness index was measured after the subjects performed modified Harvard step test. The duration of exercise and the recovery heart rates were considered. Statistical analysis was done using Chi-square test, correlation and regression tests, Independent t-test and Paired t-test, for which, p-value <0.05 was considered significant.

Results: The mean age of the athletes were 20.97±1.69 years and non athletes were 21.40±1.42 years. In athletes, lower Body Mass Index (BMI), resting pulse rate and after exercise recovery pulse rates were found to be statistically significant (p-value <0.05). The duration of exercise and Physical Fitness Index (PFI) were found to be higher in athletes than non athletes and was statistically significant (p-value <0.001). Physical fitness was thus found to be higher in athletes compared to non athletes.

Conclusion: The study indicated that students who had routine physical training had better fitness levels than sedentary students.

Keywords: Athletes, Modified harvard step test, Non athletes, Physical activity

INTRODUCTION

Obesity is one of the major health concerns that is affecting people all over the world. World Health Organisation (WHO), defines overweight and obesity as "abnormal or excessive fat accumulation that may impair health" [1]. With increasing obesity, there is an increase in cardiovascular diseases, diabetes mellitus and other non communicable diseases. Our societies are undergoing transformations in various sectors like economy, nutrition and demography. Rapid adoption of urban lifestyle and increase in monthly household income has caused a shift to caloric beverages, egg, meat and other food items with high sugar, salt and fat. The busy schedule of urban working parents has led to the increased demand for ready to cook foods and fast foods which are increasingly replacing homemade food items. In addition, sedentary lifestyle and reduced physical activity are making children prone for obesity [1].

People have to be made aware of the health hazards associated with such lifestyle changes and encouraged to adopt healthy nutrition and exercise habits in order to shape a healthy society. Physical inactivity has been pointed out as the fourth leading risk factor for global mortality, associated with almost 3.2 million deaths globally [2]. According to WHO, around 23% of adults aged 18 and over were found to be physically inactive as of 2010 (men 20% and women 27%) [3]. Physical fitness is defined as "the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy, to enjoy leisure time pursuits, and to meet unforeseen emergencies" [2]. The overall level of physical fitness is determined by aerobic fitness (ability of the heart and lungs to deliver blood to muscles); muscular strength and endurance, (which measures the strength required to perform normal activities easily); Flexibility (the ability to mobilise joints through their proper range of motion) and body composition [4]. A holistic lifestyle encompassing all aspects of fitness is essential for leading a healthy life.

College is an important phase of a person's life where academic, personal, social, physical and emotional aspects collide. In a stressful professional course such as medicine, it is all too common for students to skimp on healthy eating and exercise habits in pursuit of academics. The unhealthy habits picked during this time continue into their adult lives. It is important for medical students to have healthy habits as they are responsible for the future healthcare of the society, and should reflect what they preach. It is also seen that doctors are exposed to early risk factors of non communicable diseases [5]. Generally, medical students know more about healthy lifestyle and dietary habits when compared to other professional courses [6]. But whether this knowledge translates into practice in terms of maintaining good health remains to be seen [6]. In this regard, there is a need to assess the physical fitness of our future doctors and to make them aware of adopting a healthy lifestyle right from the beginning of their career.

Not many studies, which determine Physical Fitness Index (PFI) using modified Harvard step test in basketball players, are available in this part of the country [5,7]. So, the present study aimed to compare the physical fitness index of medical students, who were regular basketball players, with sedentary medical students.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Physiology, Government Medical College, Thrissur, Kerala, India, from April 2017 to April 2018. Clearance was obtained from the Hospital Ethical Committee and informed written consent was obtained for all subjects included in the study.

Sample size calculation: The minimum sample size calculated was 60. Sample size was calculated using the formula:

$$\frac{(z_\alpha+z_\beta)^2\times2\times(SD)^2}{d^2}, \text{ where } SD=\frac{SD1+SD2}{2}$$

z_α=z value for α error (the probability of falsely rejecting a true null hypothesis)

z_β=z value for β error (the probability of failing to reject a false null hypothesis)

SD=Mean standard deviation between two groups

d=Difference in means of PFI in previous study [7].

Confidence level considered was 95%, α was 5% with power of 100%, and the p-value <0.001 highly significant [8].

The students were grouped by simple random sampling methods:

- **Athletes** (n=30): Medical students who palyed basketball regulary
- **Non athletes** (n=30): Medical students who have sedentary lifestyle.

Inclusion criteria: The athletes were basketball players of age group 18-25 years from Government Medical College, Thrissur, being trained in basketball for atleast 2 hours in the morning and evening, 5 days a week, for a minimum of 3 months. The non athletes were age and sex matched medical students from same college, who did not perform regular physical activity in the form of any exercise, and/or their structured physical activity was less than 20 minutes per day.

Exclusion criteria: Subjects with history of acute or chronic respiratory illness, cardiovascular illness or any other medical illness, those on medications, and those with history of smoking or tobacco abuse were excluded from the study.

Procedure

Body Mass Index (BMI): After taking a detailed history and physical examination, height and weight measurements were taken using standard protocol and BMI was calculated (kg/m^2).

Blood pressure: Blood pressure was recorded from the right upper limb in the sitting position, using standard mercury sphygmomanometer by palpatory and auscultatory methods.

Modified Harvard step test: All subjects were familiarised with modified Harvard step test. It is a test of aerobic fitness, developed by Brouha L et al., (1943) during World War II in the Harvard Fatigue Laboratories [9]. Originally, the participants step up and down on a platform of step height 50.8 cm, at a rate of 30 steps per minute (once every two seconds) for 5 minutes, or until exhaustion [9]. Exhaustion was defined as inability to maintain stepping rate for 15 seconds [9]. It is valid and reliable [10]. In this study, authors employed modified Harvard step test where step height was 33 cms for ease of performance from an Indian context [11]. Resting pulse rate was procured by counting the radial artery pulse for one minute in sitting position after 5 minutes of rest. The subjects were made to do modified Harvard step test in a rhythmic manner for five minutes, or until exhaustion. Total duration of the exercise was measured as the time in seconds upto which each subject was able to perform the test. At one, three and five minutes after exercise, pulse rate was recorded.

Physical Fitness Index (PFI): PFI was calculated using the formula:

Physical Fitness Index=(Duration of exercise in seconds×100)÷(P1+P2+P3).

Where P1, P2 and P3 being pulse rates one minute, three minutes and five minutes after exercise respectively [12].

Based on the score, PFI was graded as [13]:

- Excellent (>90),
- Good (80-89),
- High average (65-79),
- Low average (55-64), and
- Poor (<55)

Correlation of PFI with respect to height of individual was also done. Height is an important factor that influences athletic performance especially basketball [14]. But some studies have shown that increase in subject's height can make the step test comparatively easier to perform even if the person is not an athlete [7,15]. That is why in this study, authors have specifically tested for correlation of PFI with height.

STATISTICAL ANALYSIS

The data was entered into Microsoft Excel 13 and analysis of quantitative variables were done using mean, standard deviation and 95% confidence interval. Statistical analysis was done using Chi-square test, correlation test, Independent t-test, Paired t-test for which, p-value <0.05 was assigned significant.

RESULTS

The mean age of athletes was 20.97±1.69 years and non athletes was 21.40±1.42 years [Table/Fig-1] which was comparable (p-value=0.43). The athlete group had more males than females, while the non athlete group had more females (p-value=0.03) [Table/Fig-2]. Mean values and standard deviation of the quantitative variables like height, weight, BMI, systolic and diastolic blood pressure of both the group has been given in [Table/Fig-3]. The BMI of non athletes (22.67±3.34 kg/m^2) was more than athletes (20.80±2.00 kg/m^2) and was statistically significant (p-value=0.01) [Table/Fig-3].

Group	Age (years) (Mean±SD)	Minimum	Maximum	p-value
Athletes (n=30)	20.97±1.69	18	24	0.43
Non athletes (n=30)	21.40±1.42	19	24	
Total (n=60)	21.183±1.57	18.00	24.00	

[Table/Fig-1]: Descriptive statistics of age of the study population.
Test of significance-Independent t test; p-value <0.05 considered significant

Sex	Athletes	Non athletes	Total	p-value
Males	19	7	26	0.03
Females	11	23	34	
Total	30	30	60	

[Table/Fig-2]: Sex distribution among athletes and non athletes.
Test of significance- Chi square test; p-value <0.05 considered significant

Variables	Minimum		Maximum		Mean		Standard deviation		p-value
	Athletes	Non athletes	Athletes	Non athletes	Athletes	Non athletes	Athletes	Non athletes	
Height (cm)	154	145	187	172	170.67	160.53	8.06	5.99	<0.001
Weight (kg)	50	42	85	70	61.03	58.07	10.30	8.53	0.23
BMI (kg/m^2)	18.40	16.40	24.80	27.98	20.803	22.67	2.00	3.34	0.01
Systolic blood pressure (mmHg)	100	100	130	132	113.80	118.93	9.06	10.84	0.22
Diastolic blood pressure (mmHg)	64	70	80	84	73.13	74.67	4.48	5.16	0.18

[Table/Fig-3]: Descriptive statistics of variables for athletes and non athletes.
Test of significance-Independent t test

Resting and recovery pulse rates were lower for athletes, and statistically significant (p-value <0.05) as analysed by Independent t-test [Table/Fig-4]. The mean duration of exercise was more for athletes (274.00 sec) when compared to non athletes (160.63 sec) and was statistically significant (p-value <0.001) [Table/Fig-5]. Physical fitness index was more in athletes (94.31-graded as excellent) than non athletes (47.87-graded poor) and was found to be statistically significant (p-value <0.001) [Table/Fig-6]. Correlation of PFI with respect to height of individual was also done and was positive and statistically significant (p-value <0.001) [Table/Fig-7].

Pulse rate (beats/min)		Mean	SD	t-value	Sig. (2 tailed)
P	Athletes	73.567	8.05	-3.248	0.002
	Non athletes	80.400	8.245	-3.248	
P1	Athletes	112.97	13.868	-2.517	0.015
	Non athletes	122.40	15.135	-2.517	
P2	Athletes	94.53	11.240	-4.564	<0.001
	Non athletes	110.00	14.772	-4.564	
P3	Athletes	85.33	10.430	-5.580	<0.001
	Non athletes	103.33	14.262	-5.580	

[Table/Fig-4]: Comparison of mean resting pulse rate (P), mean pulse rate 1 minute after exercise (P1), mean pulse rate 3 minutes after exercise (P2) and mean pulse rate 5 minutes after exercise (P3) (beats/minute) between athletes and non athletes.
Test of significance-Independent t test

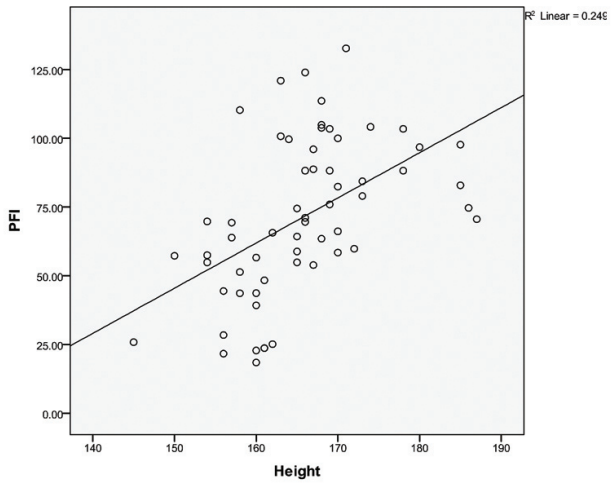
Group	Mean	SD	t	df	Sig. (2 tailed)
Athletes	274.00	34.829	8.507	58	<0.001
Non athletes	160.63	64.141	8.507	44.734	

[Table/Fig-5]: Comparison of mean duration of exercise (seconds) between athletes and non athletes.
Test of significance-Independent t test

Physical Fitness Index (PFI)	Mean	SD	t value	Sig. (2 tailed)
Athletes	94.312	16.529	10.837	<0.001
Non athletes	47.8703	16.666	10.837	

[Table/Fig-6]: Comparison of PFI (%) between athletes and non athletes.
Test of significance-Independent t test

Parameters		Height	PFI
Height	Pearson Correlation	1	0.499**
	Sig. (2-tailed)	-	<0.001
	N	60	60
Physical Fitness Index (PFI)	Pearson Correlation	0.499**	1
	Sig. (2-tailed)	<0.001	-
	N	60	60



[Table/Fig-7]: Correlations between height (cm) and PFI (%) of the study population.

DISCUSSION

It is well-known that physical fitness can be increased by participation in sports activities. The game of basketball requires good level of physical fitness and that too in various aspects like flexibility, neuromuscular efficiency, muscular strength and speed of movements. The extent of an individual's ability to play basketball can be predicted by his/her cardiovascular capacity and physical characteristics. It is a multiple sprint game. Basketball requires strong agility, repetitive jump and land, and sudden change in direction. This involves optimum aerobic and anaerobic power [16].

This study population included 60 participants who were comparable in age. The participation of males in physical activity was found to be higher than females. This is similar to the one study conducted by Bergier J et al., who found that males were more involved in sports than females [17]. Physical activity among females was influenced by socio-ecological factors at the individual, family, educational and environmental levels [18].

In this study, the BMI of athletes was less than non athletes and it was statistically significant (p-value=0.01). BMI is one of the most important determinants of obesity. Overweight and obese individuals tend to have lower fitness levels compared to normal weight individuals as shown by the one conducted by Parmar D and Modh N [19]. In this study, athletes were also taller compared to non athletes, which was statistically significant (p-value<0.001). It is to be noted that height is an important factor which significantly affects performance, especially basketball [14].

In the study, mean SBP and DBP values of both groups were within normal limits as per American Heart Association (AHA) guidelines [20]. The results were comparable (p-value>0.05). A study conducted by Halder K et al., also showed that resting blood pressure holds no statistically significant difference between female athletes and non athletes [21].

In this study, the resting pulse rate of athletes, who were students who regularly played basketball, was lower compared to non athletic group and was statistically significant (p-value <0.05). A similar study by Koley S et al., also found resting pulse rate to be lower in athletes compared to non-athletes [22]. A similar study by Martinelli F et al., suggests that the resting bradycardia observed in athletes could be due to the variability in intrinsic mechanisms acting on the sinus node and the variation in autonomic regulation of the heart [23]. The reduced sympathetic activity or increased vagal tone can contribute in part to resting bradycardia in athletes [24]. These are true for basketball players also. Once the subjects started the physical activity, which in this study was the modified Harvard step test, heart rate increased. The tachycardia at the beginning of exercise occurs during the initial 10 seconds of activity at all levels of exercise [24]. This is due to the sudden reduction of vagal tone in the sinus node [24].

The post exercise pulse rates for athletes showed a comparatively less increase compared to non athletes in this study. This may be due to the regular training sessions they carry out as a part of their athletic involvement. A study by Mikhahil CM et al., showed that the post exercise recovery of the heart rate for athletes was faster than the non athletes [25]. The present study also presented similar findings. Body function during exercise are regulated by sympathetic nervous system, but a shift in the autonomic balance occurs after exercise, and the parasympathetic system returns the body to a resting state [26]. A coordinated interaction of parasympathetic reactivation and sympathetic withdrawal results in post exercise heart rate recovery [26]. Sympathetic system exerts its effect during exercise by increasing the heart rate via an epinephrine mediated stimulation of cardiac beta-1 receptors and during rest, parasympathetic system decreases the heart rate via muscarinic activation by acetylcholine through reactivation of the vagal nerve [27]. The duration of heart rate recovery depends on intensity of exercise and cardiovascular fitness [28].

Physical fitness index is calculated based on the duration of exercise and recovery heart rate values. In this study, PFI was found to be higher in athletes than non athletes and this was statistically significant (p-value<0.05). Athletes are able to prolong the duration of their physical activity while having a faster pulse rate recovery. This translated to a higher PFI value for the athlete group in the present study. A similar study by Katralli J et al., also observed a higher PFI among Judo players compared to sedentary individuals [7]. The height of subjects had a significantly positive correlation to the fitness score and also to the duration of exercise as shown by the study done by Sharma P et al., [15]. They also suggested that shorter individuals undergo muscle fatigue faster, trying to do the step test, and this could be the reason for their lower PFI score rather than cardiorespiratory impairment [15]. But further studies are required to verify this.

The efficiency of the heart, lungs and blood vessels in delivering oxygen to the working muscles for maintaining prolonged physical work is represented by cardiovascular fitness [29]. Variables like resting heart rate, resting blood pressure, cardiac output, stroke volume, maximum oxygen consumption (VO_2 max), endurance capacity, High Density Lipoprotein (HDL) cholesterol, body fat, glucose-stimulated insulin, and total cholesterol levels were the traditional indicators of cardiovascular fitness [29]. It has been identified that heart rate recovery is a powerful and independent predictor of cardiovascular and all-cause mortality in healthy adults [30], in those with cardiovascular diseases [31] and diabetes [32]. It has been described as an independent predictor of endothelial function, an important risk factor for cardiovascular disease, and is delayed due to autonomic dysfunction or imbalance [33]. Heart rate recovery is an important parameter in calculating physical fitness index [12]. The present study has been done with a view to compare the physical fitness index of medical students who played basketball with those who were sedentary.

An increase in cardiopulmonary fitness levels of medical students who practice regular athletic activity was objectively confirmed in this study.

Limitation(s)

The main limitation of the present study was small sample size with only 30 subjects in each group and there was a disparity in number of males and females. Some of the factors that may have an impact on the result of this test like room temperature, noise level and humidity, the subject's emotional state, the amount of sleep the subject had prior to testing, the subject's caffeine intake, the subject's prior knowledge/experience regarding the test and inappropriate warm up were not considered.

CONCLUSION(S)

Physical fitness index was significantly higher in students who were regular basketball players than sedentary students. Regular physical training leads to various cardiopulmonary adaptations that can considerably increase the fitness levels of an individual. Medical students are inherently likely to skip on regular physical activity to find more time for academics and clinical duties. This could lead to a possible unhealthy lifestyle in their subsequent years. As torch-bearers of future healthcare of our society, they should be made aware and adequate measures ensured so as to lead an active and healthy life. Future research studies comparing PFI among different sports can be done in order to showcase the effects of various types of training on cardio-respiratory fitness of athletes.

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