RESEARCH ARTICLE

A Pilot Study to Evaluate the effect of Pre - and immediate Post-Exercise Heart Rate on Physical Fitness in Medical Students.

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Abstract

Background: Resting Heart rate is one of the important vital parameters depicting the cardiovascular status. It has been reported that Resting heart rate is low in trained athletes. Higher Resting heart rate is one of the independent factor for all cause mortality in cardiovascular diseases. Health as a profession is challenging and physically demanding. Identifying the fitness level from RHR (Resting Heart Rate) or PEHR(i) (Immediate Post Exercise Heart Rate) may prove as a tool for future cardiovascular and Exercise physiology research.

Objectives: The Present study was conducted to observe the association of RHR and PEHR(i) with Physical fitness among 1st Professional Medical students who are physically untrained and sedentary.

Materials and Methods: 100 first professional medical students (49 male and 51 female)participated in this study. Subjects underwent the Harvard Step test using the standard protocol. Physical fitness was calculated and relations and predictability of RHR and PEHR(i) were analyzed statistically.

Results: Resting Heart Rate and immediate Post-exercise Heart Rate both inversely correlated with Physical Fitness index. PEHR(i) has better predictability towards physical fitness.

Conclusion: It was observed that the physical fitness index among the first professional students was poor. Students with higher RHR has poor fitness index. The observation was similar with PEHR(i). Post-exercise heart rate predict the fitness level significantly than RHR.

Keywords: Harvard step test, Immediate post-exercise heart rate, Physical fitness, Recovery hear rate, Resting heart rate.

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Introduction

Physical fitness is considered to be an important predictor of all-cause mortality bearing an inverse relationship. Low cardiovascular fitness in young found to have early mortality in later ages.[1] It has been observed that creating awareness of physical fitness significantly motivates people to adopt of better lifestyle with the incorporation of effective exercise practice.[2] Resting heart rate positively associate with mortality and though the tachycardic threshold varies between 90 -100 bpm, it has been reported in a person with heart rate above 60 bpm is exposed to risk.[3] Exercise and training help to reduce the Resting Heart rate significantly and beneficial for reducing the mortality. Still, no data is available regarding the derivation of optimal heart rate for an individual person. In an interesting study, Levine *et al.* concluded that the numbers of heartbeat in a lifetime of mammals is near constant and calculated as an average 7.3 ± 5.6 X 10^8 beats per lifetime.[4] Human is an exception with an extended lifetime due to scientific advancement in the field of medicine and society. The future doctors have a role to develop and protect society from the menace of disease burden and to perform optimally, they require a healthy body with a healthy mind. Several researchers claimed that there is lack of fitness among young medical students in India and other western countries despite the awareness of the benefit of a healthy lifestyle. A day long academic schedule and enormous academic load may be a few reasons for the lack of time among these students. Studies reported that between 50-60% of students lead a sedentary life with less physical activity.[5] In this cross-sectional study, we investigated the relationship and predictability of Resting Heart rate and Post-exercise heart rate towards the physical fitness of 1st year medical students.

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Material and Methods

A cross-sectional observational study was performed on 100 volunteer students of 1st professional MBBS students of both sexes. The study was conducted in the Department of Physiology of Mayo Institute of Medical Sciences, Barabanki, Uttar Pradesh. Institutional Ethical clearance was obtained prior to the conduction of study and informed consent was obtained from all the participants Tests were conducted between 11:00 AM to 12:00 noon.

Table 1: Descriptive Statistics for both sexes including comparison of means (Students T test)

Variables	Female (n =51)	Male (n = 49)	Student's t value	p Value
Age	19.8 ± 1.01	19.9 ± 1.15	-0.426	0.671
Height	158.6 ± 5.69	172 ± 7.41	-9.788	< .001
Weight	54.8 ± 9.76	72.9 ± 12.55	-8.090	< .001
BMI	21.8 ± 3.59	24.7 ± 3.49	-4.185	< .001
Resting Heart rate (RHR)	86.0 ± 9.57	86.4 ± 9.77	-0.201	0.841
Post-exercise Heart Rate (PEHR (i))	163.2 ± 15.69	161 ± 18.32	0.741	0.461
Resting Systolic BP	112.6 ± 10.25	129 ± 11.31	-7.635	< .001
Resting Diastolic BP	69.6 ± 7.92	76.1 ± 8.99	-3.856	< .001
Post-exercise Systolic BP	139.9 ± 13.78	157.6 ± 14.40	-6.290	< .001
Post-exercise Diastolic BP	71.8 + 8.87	79.3 ± 8.00	-4.408	< .001
Recovery Heart rate 1	133.2 ± 14.10	137.1 ± 15.78	-1.313	0.192
Recovery Heart rate 2	120.4 ± 11.43	123.2 ± 15.59	-1.046	0.298
Recovery Heart rate 3	113.2 ± 12.25	112.2 ± 14.59	0.369	0.713
Physical Fitness Index (Long)	41.3 ± 4.25	40.8 ± 4.89	0.516	0.221
Physical Fitness Index (Short)	41.4 ± 4.55	40.3 ± 4.59	1.233	0.607

Significant at $p < 0.05$

Height and weight were obtained using standard stadiometer and calibrated digital weighing scale. Subjects were allowed for 10-minutes rest before collecting the resting pulse rate and O_2 saturation with a pulse oximeter. Resting Blood pressure was obtained using a digital sphygmomanometer (Omro HEM 710). Then the subject was instructed to undergo Harvard step Test using standard protocol[6] for 5 minutes (300 seconds). Two different step heights of 20 inches and 16 inches were used for male and female subjects, respectively. Blood Pressure and pulse rate were recorded just after completion of exercise and pulse rate was recorded between 1 min to 1 min 30 Seconds, 2 min to 2 min 30 seconds and 3 min to 3 min 30 seconds of a recovery period.

The Physical Fitness Index was Calculated using two Standard Formulae

1. Physical fitness index (Long form) = (100 x test duration in seconds) divided by (2 x sum of heartbeats in the recovery periods)
2. Physical fitness Index (Short form) = (100 x test duration in seconds) divided by (5.5 x pulse count between 1 and 1.5 minutes)

Data obtained were processed in Microsoft Excel spreadsheet and analyzed using Jamovi 2.0.0 statistical software. Descriptive analysis, Pearson's product-moment correlation, Student's test and Multiple linear regression were performed to build the statistical conclusion.

RESULTS

51 female volunteers aged 19.8 ± 1.01 years and 49 male volunteers aged 19.9 ± 1.15 years participated in the study. There was no significant difference of age between the male and female participants. A significant difference ($p < 0.001$) was observed for anthropometric parameters between the sexes. No statistically significant difference was observed for Resting Heart Rate ($t = -0.201$, $p = 0.841$) and Post-exercise heart rate ($t = -0.741$, $p = 0.461$) between the sexes. Resting Systolic Blood Pressure ($t = -7.635$, $p < 0.001$) and Immediate Post-exercise Systolic blood Pressure ($t = -6.290$, $p < 0.001$) was significantly high among male students. Resting Diastolic Blood Pressure ($t = -3.856$, $p < 0.001$) and After Exercise Diastolic Blood Pressure ($t = -4.408$, $p < 0.001$) were also significantly high in male students compared to their female counterparts. No significant difference between sexes observed for recovery period Heart rates. The numerical difference of mean Physical Fitness Index was not statistically significant between male and female students (Table 1).

Significant inverse correlation observed between Resting Heart rate and Physical fitness (Female: $r = -0.363$, $p = 0.009$) (male: $r = -0.445$ $p = 0.001$). Immediate Post-exercise Heart Rate also correlated significantly with Physical Fitness index (female: $r = -0.654$, $p < 0.001$) (Male: $r = -0.871$ $p < 0.001$). No significant correlation was observed between pre-exercise and post-exercise blood pressure components and physical fitness index (Table 2).

Multiple linear regression was used and two models were created and compared to measure the relational predictability of RHR and PEHR(i) towards Physical Fitness Index. Both models considered the confounders such as age, height, weight and BMI. Model 1 contained only RHR along with standard confounders. Model 2 contained both RHR and PEFR(i) along with standard confounders, as discussed previously. RHR has shown the predictability in model 1($\beta = -0.212$, $t = -3.302$, $p = 0.002$). In model 2 in the presence of PEFR(I) as an independent predictor RHR loose its significance and PEFR(i) appears as a significant independent predictor

Table 2: Pearson's Correlation coefficient between Physical Fitness Index (PFI) and different heart rate and pressure parameters

Variables	Female	Male
Resting Heart Rate	r = - 0.363, p = 0.009	r = -0.445 p = 0.001
After Exercise Heart Rate	r = - 0.654, p < 0.001	r = -0.871 p < 0.001
Systolic Blood Pressure (Resting)	r = 0.033 p = 0.821	r = 0.029 p = 0.845
Diastolic Blood Pressure (Resting)	r = 0.053 p = 0.712	r = -0.174 p =0.231
Systolic Blood Pressure (After Exercise)	r = -0.239 p =0.091	r = -0.075 p = 0.607
Diastolic Blood Pressure (After Exercise)	r = 0.087 p = 0.542	r = 0.204 p = 0.161

Significant at p < 0.05

(β = -0.223, t = -9.457, p < 0.001). In comparison, Model 2 significantly differ and appear statistically stronger in males (Table 3). Similar observations were made for females too (Table 4).

DISCUSSION

Our observation revealed that the physical fitness among the first professional medical students was poor. It was also observed that female subjects performed marginally better than the male counterpart during the fitness test. Mago *et al*. observed that 95% of medical students have poor physical fitness.[7] Lack of time, laxity, academic burden, and long training hours are few of the identified cause behind lack of exercise among the medical students.[5] Here authors also wish to add that rigorous academic training during the preparation of entrance examination may be another cause behind the lack of physical activity leading to poor fitness among the first-year medical students.

Objective of our study was to find out any existing correlation among the resting heart rate and Immediate post-exercise heart rate with the physical fitness. We observed and significant inverse relationship between the resting heart rate and physical fitness index in both sexes (male, r = -0.44, p =0.001 and female, r = -0.36, p = 0.009). In a 16 years large sample follow up study Jensen *et al*. observed that there was a significant inverse relationship (r = -0.34, p < 0.001) between RHR and VO_2Max and suggested that subjects with higher fitness may have lower resting heart rate and concluded that RHR can be an independent risk factor in middle aged man for cardiovascular outcome independent of fitness and other confounding factors.[8] Despite the difference of methods our study observes similar finding.

Exercise-induced tachycardia is considered to be due to shift between autonomic regulation characterized by withdrawal of vagal tone and sympathetic activation. Post-exercise fall in heart rate is a process involving the withdrawal of central command, baroreceptor activation and restoration of parasympathetic tone.[9] We observed Significant association between Physical fitness index and Post-exercise heart rate (immediate) (male, r = -0.87, p < 0.001; Female, r = -0.65, p < 0.001). We observed several studies exploring the relationship between post-exercise heart rate recovery,

Table 3: Multiple Linear Regression Analysis of Anthropometric and Heart rate parameters considering PFI as dependent parameter in Males

	Model 1 (With out After exercise Heart rate)			Model 2 (with After exercise Heart rate)		
	Estimate (β)	t	p	Estimate (β)	t	p
Intercept	255.352	2.212	0.032	43.7462	0.628	0.534
Age	0.409	0.749	0.458	0.0954	0.304	0.763
Height	-1.232	-1.829	0.074	0.2133	0.515	0.609
Weight	1.477	1.927	0.061	-0.1650	-0.350	0.728
BMI	-4.074	-1.786	0.081	0.4805	0.345	0.731
RHR	-0.212	-3.302	0.002*	-0.0633	-1.583	0.121
PEHR(i)	-	-	-	-0.2227	-9.457	< .001*
	Model Fit measures			Model Fit measures		
	R	R^2	Adjusted R^2	R	R^2	Adjusted R^2
	0.566	0.320	0.241	0.885	0.783	0.752
	Overall Model Test				Overall Model Test	
	F = 4.05		p = 0.004*	F = 25.23		p < 0.001*
Model Comparison (Model 1 – Model 2)						
Δ R^2	F	df1		df2	p	
0.463	89.4	1		42	< 0.001*	

Significant at p < 0.05

Table 4: Multiple Linear Regression Analysis of Anthropometric and Heart rate parameters considering PFI as dependent parameter in Females

Model 1 (Without Post-Exercise Heart Rate)				Model 2 (with Post-Exercise Heart Rate)		
	Estimate (β)	t	p	Estimate (β)	t	p
Intercept	-56.241	-0.403	0.689	29.7578	0.269	0.789
Age	0.414	0.692	0.492	0.4093	0.874	0.387
Height	0.656	0.762	0.450	0.2454	0.362	0.719
Weight	-0.863	-0.710	0.481	-0.1796	-0.187	0.853
BMI	2.160	0.700	0.488	0.3832	0.157	0.876
RHR	-0.167	-2.600	0.013	-0.0717	-1.348	0.185
PEHR(i)	-	-	-	-0.1704	-5.407	< .001
	Model Fit measures			Model Fit measures		
	R	R^2	Adjusted R^2	R	R^2	Adjusted R^2
	0.389	0.152	0.057	0.700	0.490	0.421
		Overall Model Test			Overall Model Test	
	F = 1.61		p = 0.177	F = 7.05		p < 0.001
			Model Comparison (Model 1 – Model 2)			
Δ R^2	F	df1			df2	p
0.339	29.2	1			44	< 0.001

Significant at $p < 0.05$

physical fitness, and mortality among normal and patient populations. But studies linking the immediate post-exercise heart rate and physical fitness is abysmal. Our study also observed that considering Other independent variables such as age, height, weight and BMI and RHR, Immediate post-exercise heart rate has predictable capacity for physical fitness in untrained male ($\beta = -0.2227$, $t = -9.457$, $p < 0.001$) and female ($\beta = -0.1704$, $t = -5.407$, $p < 0.001$) medical students in the studied population.

Limitation

Observations made in this study is limited to untrained first year medical students. Generalization of the results was not carried out on other different young student population and thus gives an opportunity to continue and develop further studies leading to generalization.

Conclusion

Life of a physician is challenging and physically demanding thus require a good fitness level. Physical inactivity due to different alibi not only decrease the physical fitness but also affect the performance. The study assessed the prospectivity of using resting heart rate and immediate post-exercise heart rate for having an estimation of physical fitness. Resting heart rate is inversely associated with physical fitness in untrained medical students and Immediate post-exercise heart rate after a standard exercise is inversely associated and better predictor for physical fitness. The study also revealed the poor fitness level among the first professional medical students and thus conclude with a recommendation for incorporation of regular sports and exercise in the curriculum.

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