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SHORT TERM PHYSICAL TRAINING AND ITS BENEFIT ON CARDIOVASCULAR AND AUTONOMIC RESPONSE

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ABSTRACT

Purpose of the study: Physical training results in favorable cardiovascular changes and that autonomic nervous system "the prime mediator" of these changes. **Aim:** The present study was conducted to test the hypothesis that short duration of physical training may result in improved Cardiovascular recovery profile in humans. **Material and Methods:** Over a two month period, 58 healthy adult volunteers in age group of 17 to 20 years, the study was conducted in the Department of Physiology Gandhi Medical College Bhopal. Cardiovascular physical performance parameters were measured in terms of heart rate and blood pressure during physical exercise (Bicycle ergometery) as well as post exercise period. A standard battery of autonomic function tests including both activity and reactivity was used.Sympathetic reactivity is evaluated by diastolic blood pressure response to hand grip test and Parasympathetic reactivity is evaluated by heart rate variability during deep breathing. **Results and Interpretation:** In the present study heart rate increased with physical exercise linearly upto day 5th, after that increase in heart rate was less. Students ' t' test revealed a statistically significant (P< 0.001) decline in heart rate value recorded on day 1 and day 15th.With training , there is rise in systolic blood pressure with decrease of diastolic blood pressure which is statistically significant, but the observation revealed that the systolic and diastolic pressure values on day 1st and 15th did not show any statistically significant change with exercise. Sympathetic reactivity as evaluated by diastolic blood pressure response to hand grip test showed a decrease at 4th minute though it was not statistically significant. Parasympathetic reactivity is evaluated by heart rate variability during deep breathing which is not statistically significant. **Conclusion:** It could be concluded from our study that a short term physical training improved the cardiovascular status in humans by increased reading of blood pressure at beginning of exercise due to rapid vagal withdrawal and decreased reading of blood pressure after training due to increase in vagal tone. A trend of an increase in parasympathetic tone and decrease in sympathetic tone was observed.

KEYWORDS: Autonomic activity, Blood pressure, Physical activity, Young adults.

INTRODUCTION

Exercise testing has been a means of finding out the physical capabilities and physiological responses of an individual(1). Sufficient information is not available on the extent of change observed in different systems in untrained Indian subjects. It is well known fact that physical training results in favorable cardiovascular changes and that autonomic nervous system is the " Prime mediator" of these changes(2). The blood pressure response during exercise testing is useful in evaluating cardiac status. Physical activity has been shown to decrease the risk of hypertension amongst adults, its role in lowering blood pressure amongst children and adolescents is controversial. Failure of systolic blood pressure to rise with increase in work load or a hypotensive response is one of the signs of significant heart disease. Exaggerated blood pressure response to exercise is a valid risk factor for future hypertension. Previous studies have shown that there is exaggerated blood pressure change to both

isometric and dynamic exercise, cold pressor test and acute psychological stress even in obese adolescents and obese adults[3,4,5,] .Longitudinal studies have revealed significant correlation between exaggerated blood pressure response to exercise and higher incidence of developing in future of resting hypertension in not only normal persons but also in persons with hypertensive parents[6] ..Recently ,the results of Oslo Youth Health study also indicated that physical activity levels do not show any significant relationship with blood pressure among adolescents[7].Physical training in humans results in lowering of heart rates at submaximal workloads Physiologically both Sympathetic and Parasympathetic undergoes changes with regular physical training with the result that a well-trained person performs the work with greater skill, speed and endurance, recovery from exercise is very rapid in such individuals. Changes in cardiovascular variables such as heart rate and blood pressure during exercise as well as recovery are regulated by changes in the activity of sympathetic and parasympathetic nervous system .The present study was conducted therefore to test the hypothesis that a short duration of supervised physical training may result in improved Cardiovascular recovery profile and autonomic status in humans.

MATERIALS AND METHODS

The study was conducted in the Department of Physiology, Gandhi Medical College, Bhopal. Permission was taken from the ethical Committee. Each subject served as its own control. The study included fifty eight asymptomatic healthy medical students aged 19.707±1.22 to perform short term limited duration exercise on bicycle ergograph. We selected participants of the following inclusion and exclusion criteria to meet the study requirements fully.

Inclusion criteria:

1. Only those students were included in the study who were not having any known respiratory, neuromuscular, cardiac or endocrine disorder.
2. Subjects not doing any type of physical exercise training.

Exclusion criteria:

1. Subjects who were doing regular exercise prior to this study.
2. Subjects who developed any kind of discomfort during training schedule

Subjects were introduced a pretested questionnaire for assessing nutritional status, cardiorespiratory profile, status of nervous system, Physical activity and related problems, history of past and present illness to find out any condition affecting physical performance of the subject. The subjects were called to the department two days prior to the exercise for physical anthropometry, assessment of nutritional status, and determination of physical fitness, detailed clinical and cardiorespiratory examination. The height and weight of each student was recorded and Body mass Index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters. Subjects were divided in three groups depending on new BMI cut off point for Indian population by Indian government. All the Participants with underweight BMI<18(n=15), normal weight BMI 18-25(n=33) and overweight BMI>23 to 24.9 kg.m^2 were considered to form the study groups.

Study was carried out in the human experimental laboratory in the department of Physiology GMC,Bhopal .Subjects were briefed about the experiment and were allowed to relax for 15 minutes before the start of exercise. In the present study, physical training was given by using bicycle ergograph. Specifications of work and Power calculation are as follows

Duration of exercise =10 minutes

Resistance against fly=4.3kp

Distance travelled per pedal revolution =1.6 m

Pedaling speed =60 revolutions /minute

Total work= (Resistance against fly wheel x distance travelled per pedal revolution x total number of revolutions for the duration of exercise performed

Hence total work=4.3 x 1.6 x600 =4128kpm.

Determination of maximum and submaximal load

The subjects were asked to exercise on the bicycle ergograph with different loads keeping the speed at 60 rpm. The maximum heart rate achieved with each load was recorded. A maximum load was noted till the subject attained his exhaustion point. The

heart rate achieved with this load was recorded. In the present study the maximal load found out was 5 kg with a maximum heart rate of 170 beats/min. The submaximal load which was 85% of the maximal load was found out to be 4.3 kg at a heart rate of about 144 beat/min after repetitive testing .The time of exercise was determined. The subjects could do the exercise at 4.3 kg load for 10 minutes. During the exercise session, the subject pedaled the bicycle at the rate of 60 revolutions/minute for 10 minutes. It is documented in the literature that at this rate there is lowest oxygen uptake and greater mechanical efficiency. This rate was kept fixed throughout the exercise session.

Physical activity status

Prior to the introduction of physical training schedule the physical fitness level of study population was assessed by testing the following parameters.

(1) Flexibility
(2) Coordination
(3) Equilibrium
(4) Agility
(5) Strength
(6) Endurance

1. **Flexibility:** It is the ability to move the body easily and smoothly during various floor actions such as bending, twisting and stretching. Ease of action and capacity to reach various positions without injury is a measure of flexibility.

Test: The subjects were instructed to stand with their feet together and bend slowly to touch toes and floor without bending knees. They were also instructed not to bounce.

Parameter	Flexibility level
Touch toes easily	Poor
Touched floor	Fair
Touched knuckles to floor	Fair
Touched palms flat to floor	Excellent

2. **Coordination:** It is the smooth working of the entire body. It involves coherent and meaningful movements of the organ to achieve a particular task or goal.

For example the combined action of eyes and hand to hit the moving ball in cricket, Tennis, volleyball, football etc. Coordination improves with practice.

Test: The subject were instructed to stand about six feet from a flat wall. Using one Hand, toss a tennis ball underhand against the flat wall. Catch the ball with the other Hand toss it and quickly toss it back. Repeat this action speedily in succession. Keep a Count of the number of catches in one minute.

Parameter	Coordination ability
48-50 catches	Poor
54-56 catches	Fair
62-64 catches	Good
70-72 catches	Excellent

3. **Equilibrium**: It is the ability to balance oneself without much swaying or losing balance.

Test: The subject were instructed to stand on their toes and stretch their hands in front of or above their shoulder touching their ears and stay in this position as long as they can. They were

Parameter	Equilibrium status
15 seconds	Poor
20 seconds	Fair
25 seconds	Good
30 seconds	Excellent

accordingly timed

4. **Agility**: It is quickness of reaction with fast and sure movements. Springing to you feet, and dodging are examples of being agile.

Test: The subjects were asked to skip in one minute without tripping down.

Parameter	Agility status
90 skips	Poor
110 skips	Fair
130 skips	Good
150 skips	
Excellent	

5. **Strength**: It is the ability to use muscle power to lift, pish, pull. Etc.

Test: The subjects were tested for muscle power by using hand grip dynamometers. Readings were recorded in kilograms.

Reading (Kg)	Muscle power
49-52	Fair
53-55	Good
56-58	Very Good
59+	Excellent

6. Endurance: It the most important test of physical fitness. Even if you are excellent or very good or good in all the other tests, poor endurance can be a sign considered as beings physically unit. It is the ability of the body to withstand stress for a prolonged period of time: the shorter the time. The poorer the endurance; the longer the time, the stronger the endurance. Performance of the heart and oxygen carring capacity of the blood mainly determines the endurance. It depends on the number of times the person can repeat the movement. It was measured in terms o pushups.

The score depended upon the type of movement and strength of the body score: (Number of pushups)

Number of push ups	**Endurance level**
Less than 10	Poor
15	Fair
20	Good
25	Very good
30	Excellent

Depending on the answers gives by the respondents, a scoring scale was developed to classify them in various categories in relevance to their physical fitness measurements

Scoring Scale				Maximum	Minimum
4	3	2	1	24	6

Score	Pre exercise physical fitness status
<10	Poor
10-15	Fair
15-20	Good
>21	Excellent

A pre tested questionnaire was also introduced in relevance to their physical work history containing 18 questions (No. 1-18) to evaluate there working capacity.

A Scoring scale was developed based on the answers given by the respondents

Scoring Scale			Maximum	Minimum
3	2	1	25	11

Score	Pre exercise physical work capacity
<64%	Poor
65-74%	Fair
75-84%	Good
>85	Excellent

Exercise Schedule

The students were asked to report at the department by 8.30 A.M. Subjects were explained the whole procedure in detail and were motivated prior to the start of exercise . They were told to report immediately. If they any discomfort, fatigue or dizziness. Subjects rested in supine position for 15 minutes before the start of exercise.

0 day- following parameters were recorded.

(1) Resting systolic and diastolic blood pressure by mercury sphygmomanometer
(2) Pulse rate at 1 minute and 1.30 minute after exercise.
(3) ECG recording by a 12 lead electrocardiographic machine (for heart rate variability).
(4) Blood pressure response to hand grip test

These parameters were recorded post exercise from day 1st to day 15th.

ASSESSMENT OF AUTONOMIC FUNCTIONS

Evaluation of sympathetic functions

Sympathetic reactivity was evaluated by blood pressure response to sustained hand grip test. The maximum voluntary contraction is determined. The subjects were asked to grip the dyanometer with their dominant hand at 30% of that maximum for 5 minutes. Blood pressure was then measured three times before and at forth minute after hand grip .The result is expressed on 1st day and 15th day of exercise. The difference of

each set of readings was calculated and the significance of difference was calculated statistically.

EVALUATION OF PARASYMPATHETIC FUNCTIONS

1. Parasympathetic reactivity was evaluated by determining heart rate variability (R-R) interval.
2. This is evaluated by taking an electrocardiogram pre-exercise and post exercise for 1 minute in lead II.

Heart rate variability was determined as the mean of difference between maximum and minimum heart rates for the six measured cycles in beats/minute.

HEART RATE VARIABILITY = 1500/MINIMUM R-R INTERVAL-1500/MAXIMUM R-R INTERVAL.

STATISTICAL ANALYSIS

The effect of physical activity training on blood pressure profile and autonomic status was studied after grouping the girls and boys as underweight group (< 18), normal weight group (18-22.9), and overweight group (> 23). A pretested questionnaire was also introduced in relevance to their physical work history containing 18 questions to evaluate their working capacity .A scoring scale was developed based on the answers given by the respondents. Mean and standard deviation were measured for the study variables. One way ANOVA was used to assess if significant ($P < 0.05$) differences exist in the dependent variables between the three groups.

RESULTS

The present study included 58 subjects (10 overweight, 33 normal weight and 15 Underweight) in the age group of 18-22 years. The characteristic of the three groups are shown in table 1. Between the study groups 56.89% subjects were found to have a normal nutritional status on the basis of BMI,25.87% were categorized as having poor nutritional status. Only 17.24% cases were having weight above the standard for that age and sex.

Resting mean level of systolic blood pressure and diastolic blood pressure and heart rate among the three groups were found to be within normal limit during the pre-exercise period but there is an increase in mean heart rate, and systolic blood pressure with exercise while diastolic pressure showed a fall. This is shown in table 2. A statistically significant difference was found between the heart rate and blood pressure pre-exercise and 15 days after exercise, P= 0.001, as shown in table 3. If we see the heart rate during exercise, the study revealed that with training , there was a statistical significant decrease in heart rate after 15 days of exercise (p=0.001), while other parameters of blood pressure (systolic and diastolic) did not show any significant change (p= 0.10), shown in table 4.

Table.1 Classification of study population based on body mass index

Group	No of cases	Percentage	BMI(Kg/m^2) mean± S.D.
I < 18 (Underweight)	15	25.87	16.58± 1.061
II 18-22.9 (Normal weight)	33	56.89	19.90±1.385
III >23 (Overweight)	10	17.24	27.52±1.72
Total	58	100%	20.357±3.83

56.89 % subjects were found to have a normal nutritional status on the basis of BMI. 25.87% were categorized as having poor nutritional status. Only 17.24% cases were having weight above the standard for that age and sex.

Table 2. Blood pressure and pulse rate changes to exercise in the three groups

Parameters	Underweight (< 18) Mean ± SD	Normal weight (18-22.9) Mean ± SD	Overweight (> 23) Mean ± SD
Before exercise			
Heart rate	**77.34±0.80**	**77.43±0.86**	**77.57±0.71**
SBP mmHg	**122.55±1.52**	**118.4±5.198**	**126.43±0.979**
DBP mmHg	**82.31**	**80.01±3.35**	**82.02±2.34**
After exercise			
Heart rate	**136.35±0.820**	**138.62±0.248**	**120.53±12.593**
SBP mmHg	**171.49±1.2**	**169.4±8.96**	**180.24±0.976**
DBP mmHg	**64.82± 1.84**	**66.02± 2.04**	**72±2.217**

Pre exercise parameters of all the subjects studied were found to be within normal limits. As evident from the table post exercise profile of study population showed a rise in heart rate and systolic blood pressure while diastolic pressure showed a fall.

Table 3. Blood pressure and heart rate changes after 15 days of exercise pre and post exercise (n=58)

Group n= 58	Heart rate Beats/minute	SBP (mm of Hg)	DBP (mm of Hg)
Pre-exercise	**77±0.84**	**122±3.98**	**82.08± 1.28**
Post exercise	**134±2.68**	**170±2.3**	**64±1.8**
' t '	**8.68**	**10.02**	**9.14**
' p '	**0.001**	**0.001**	**0.001**

A statistically significant difference was found between all variables Pre-exercise and 15 days after Exercise, P=0.001

Table 4. Change in heart rate and blood pressure profile during exercise

Day	Heart rate (beats/minute)	Blood Pressure	
		SBP (mm of Hg)	DBP (mms of Hg)
1	141.12±1.2	172±2.3	66.02±1.3
5	134± 2.2	172±1.2	66.0±1.2
15	134± 2.2	176±1.2	68.02±1.0
T	4.18	1.62	1.89
P	0.001	0.10	0.10

The study revealed that with training, there was a statistical significant decrease in heart rate after 15 days of exercise, while the other parameters of blood pressure (systolic and diastolic) did not show any significant change.

Table 5. Evaluation of sympathetic reactivity diastolic blood pressure responses to sustained hand grip test (n= 58)

Days	Pre-exercise Mean of 3 Readings (mm Hg)	Post exercise 4th minute (mm Hg)	Mean of Difference	't'	'p'
Day 1	80±2.02	68±1.62	12.0±0.4	1.6	0.10
Day 15	78± 1.2	63±0.2	15±1.0	1.1	0.10

Sympathetic reactivity as evaluated by diastolic blood pressure responses to hand grip test showed significant decrease at 4 minute but statistically it is not significant.

Table 6. Post exercise heart rate variability during deep breathing (N=58)

Days	**Minimum R-R interval (mm) I**	**Maximum R-R interval (mms) II**	**Mean of Difference (I- II) In beats/min 1500/1-1500/2 I-II**	**'t'**	**'p'**
1	**12±0.2**	**15±0.01**	**36+0.2 Beats/min**	**1.82**	**0.10**
15th	**9±0.3**	**13±0.4**	**46±0.1 Beats/min**	**1.28**	**0.10**

As evidenced from the observation table, Parasympathetic activity as evaluated by heart rate variability during deep breathing showed an increase in response after a short term physical training, though it is not statistically significant.

Evaluation of autonomic functions with exercise training showed that sympathetic reactivity as evaluated by diastolic blood pressure responses to hand grip test showed significant decrease at 4th minute but statistically it is not significant, (table 5). Parasympathetic reactivity is evaluated by heart rate variability during deep breathing for the six measured cycles in beats/minute in lead II showing an increase in response after a short term physical training, though it is not statistically significant (table 6).

DISCUSSION

The study was conducted considering that short term physical training would tend to lower blood pressure by lowering adiposity, improving cardiovascular, autonomic balance and enhancing vascular distensibility.

In the present study we studied the heart rate and blood pressure changes to steady bicycle ergograph exercise training of 15 days in underweight, normal and overweight young adults. As recently the Health ministry Of India has reduced the diagnostic cut offs for body mass index (BMI) to 23 kg/m2 as opposed to 25 kg/m2 globally to fight the battle against obesity[8] .

In this study we found that with exercise training there is an increase in heart rate. The observed data revealed that heart rate increased upto day 5th linearly , after that the increase in heart rate over the resting heart rate was less.Students 't' test revealed a statistically significant ($p<0.001$) decline in heart rate value recorded on day 1 (140.24±2.2) and day 15th (1.34±2.2).

The finding is of conformity with that of Scheuer et al.Their findings revealed that decrease in heart rate is a biological adaptation resulting from regular exercise. Clinical researches have shown that maximal heart rates can be decreased by training regardless of the exercise employed [9,10]). Heart rate reductions during exercise may be related to autonomic control, circulating catecholamines, increased stroke volume or a change in the integrating ability of the central nervous system.

In this study we found that there is rise in systolic blood pressure with the training. This could be due to sustained release of catecholamines during submaximal exercise in untrained subjects. The observation revealed a statistically significant difference ($P< 0.001$) in pre-exercise diastolic blood pressure

and post exercise diastolic blood pressure. Decrease in diastolic blood pressure may be due to epinephrine acting on vascular $\beta 2$ receptors. These findings are similar to other studies which have shown the same finding[11]. The observed data revealed that the systolic and diastolic blood pressure values on day 1st and 15th did not show any statistically significant change with exercise.

A standard battery of autonomic function tests including both activity (tone) and reactivity was used. Sympathetic reactivity as evaluated by diastolic blood pressure response to hand grip test showed a decrease at 4th minute, though it was not statistically significant. A similar finding was found by significant decrease in diastolic blood pressure response to hand grip test at 2nd and 4th minute including 25 adult males after 15 days of short exercise training[12].

In the present study parasympathetic reactivity as evaluated by heart rate variability during deep breathing showed no statistically significant change.

The results coincided with that of R. K. Sharma et al[13]. They found no significant change in parasympathetic activity but a trend towards an increase in parasympathetic activity was reported.

Our study aim was to estimate the short duration of physical training results in improvement in the cardiovascular status in humans.

CONFLICT OF INTEREST

Nil.

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