Effect of Exercise on Aerobic Power and Correlation of Aerobic Power with Body Mass Index and Physical Fitness Score in Medical Students

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ABSTRACT :

The present study was conducted to find out the relationship between aerobic power of an individual, its body mass index and its physical performance so as to improve the physical fitness of low body mass index subjects bringing their better performance. The study was carried out in 58 young healthy sedentary medical students who were asked to perform short term limited duration exercise on bicycle ergograph. Each subject served as its own control. 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. Physical activity level was assessed by different tests assessing their flexibility, coordination, Equilibrium, agility, strength and endurance. Physical activity Rating scale and VO2 max was used to assess the physical fitness.Pearson's correlation coefficient was to determine the relation between BMI and VO2max.The observation revealed a positive correlation between physical fitness score and normal BMI value and negative with the value which is higher and lower than normal.A significant positive correlation was also found between BMI and Post exercise VO2 max. A positive correlation was also observed between Physical fitness index and Vo2 max.It could thus be concluded that the study population having normal Body mass Index showed greater improvement in physical capacity as compared to subjects having high or low BMI.The study also revealed that aerobic capacity improves with training.

Keywords: BMI, Physical activity, VO2 max, Young adults.

INTRODUCTION:

Life style, nutritional habits and training volume have positive influence on the risk factors to prevent atherosclerotic heart disease later in life. Overweight and obesity in children and adolescents should no longer be regarded as variations of normality, but as disease with an extremely high risk for the development of atherosclerosis.[1] The poor physical fitness of an individual may be due to poor body composition or inadequate supplementation of diet or lack of physical exercise. Though sufficient information is not available on the extent of changes observed in different systems in untrained Indian subjects but the evidence heavily favours that population or individual with high level of physical activity tend to have a lower prevalence of asymptomatic coronary artery disease. Physical fitness of an individual depends on the amount of oxygen which can be transported by the body to working muscles and the efficiency of muscles to use that oxygen, hence aerobic capacity has been widely considered to be reliable and valid indicator of cardio respiratory fitness.[2] An exercise program conducted three to five times/week, for twenty to sixty minutes per session, at an intensity of about 50% to 85% VO2 max has been shown to cause appropriate Cardiorespiratory function effects. The combination of duration and intensity should result in the expenditure of about 200-300 Kcal/ session and is consistent with achieving weight loss goals and reducing the risk fac-

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tors associated with coronary heart disease. Previous studies have shown that a short term physical training increases the endurance capacity.[3,4,5]

Although many studies from India have reported an increase in prevalence of coronary artery disease in young adults and hypothesized sedentary life style is the most probable culprit along with overweight and obesity. Very few studies have reported the effect of physical activity on aerobic power among the adolescents and there is lack of information concerning changes in overweight and obese young adults during steady dynamic exercise and also studies regarding this in Indian population are very few. Hence this work was undertaken to study the effect of short term exercise analyzing their VO2 max and discussing their co- relation with their body mass index and physical fitness index.

In order to improve the aerobic capacity of sedentary medical students, a short term physical training is advised to increase their endurance capacity. The regular short duration exercise will have beneficial effects on the cardiorespiratory and locomotor system as well as cell metabolism and body functions in general.

MATERIAL AND METHOD

A study was conducted during January 2010 – March 2011 at Gandhi Medical College, Bhopal after the approval from the Human Research ethical committee of the institute and obtaining informed consent from the participants or their Parents/ guardian, Adolescent boys and girls of age group 19±1.22 were included in the Study. Each subject served as its own control. The first year medical students (n=58) were screened for their age, history of hypertension, cardiac or pulmonary diseases. 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.m2 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 through out the exercise session.

Computation of VO2 max or aerobic power

VO2\max or aerobic power represents the standard against which any estimate of cardiorespiratory function is compared. In the present study VO2 max or aerobic power (liters min-1) was determined by Astrand's and Rhyming Nomogram at a work rate of 67.67 watts.

Predicted VO2 max for males was calculated by the given formula

VO2 max (liters min-1) = 0.348 x1 -0.0.36x2+ 3.011

Where X1 = VO2 max from Astrands and Rhyming Nomogram and X2 = age in years.

VO2 max estimated from the above formula is a predicted equation which is influenced by the

Persons maximal heart rate. As heart rate decreases with age Corrected VO2 max values for the age were calculated according to table given below. Corrected VO2 max is calculated by multiplying VO2 value by the correction factor ,when either the maximal HR or age is known.

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

Age	Factor	HR Max	Correction factor
15	1.10	210	1.12
25	1.00	200	1.00
35	0.87	190	0.93
40	0.83	180	0.83
45	0.78	170	0.75
50	0.75	160	0.69
55	0.71	150	0.64
60	0.68		
65	0.65		

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.

The conventional drugs may have various and severe

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 accordingly timed.

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

4. Aglility : 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

Statistical analysis

The effect of physical activity on aerobic power was studied after grouping the subjects as per their BMI. 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.Pearson's correlation coefficient was used to assess the relationship of Physical fitness (PVO2 max)with the physical fitness score and BMI.

RESULTS

The present study included 58 subjects (10 obese, 33 normal weight, 15 underweight) in the age group of 18 to 22 yrs .The characteristic of the three groups are shown in table I. Between the study groups, 56.89% subjects were found to have a normal nutritional status. 25.87% were categorized as having poor nutritional status and 17.24% were having weight above the standard for that age and sex on the basis of BMI. Assessment of preexercise physical fitness of study population was done by testing their flexibility, coordination, Equilibrium, agility, strength and Endurance. Based on the score developed 20.68% subjects secured poor physical fitness score. Majority of the subjects (33%) were classified as having fair physical fitness scores as shown in (table II). An attempt has been made to correlate physical fitness score obtained by a battery of tests applied and the body mass index. The observations indicated a positive correlation between physical fitness score and BMI in the range of 18.04 – 24.29 kg/m^2 The observations revealed a negative correlation between above parameters when BMI values were higher and lower than normal, (15.69-28.55 kg/m2)(Table III).The study revealed that physiological endurance or aerobic capacity as assessed by measuring VO2 max improved with training. A significant increase in VO2 max was found after 15 days of exercise(Table IV). A significant positive correlation was also found between BMI and post exercise VO2 max. The study population having normal BMI showed greater improvement in physical capacity as compared to subjects having high or low BMI(Table v). It was also observed that mean PFI scores of children having low BMI (<18) were lower as compared to other groups. A positive correlation was observed between physical fitness index and VO2 max, suggesting that improvement on VO2 max improves cardiorespiratory fitness.(Table vi).

Group	No. of Cases	Percentage	Body Mass Index (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 (over weight)	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.

Group	No. of cases	Percentage	Physical fitness Score , Mean ±S.D	Body Mass (Kg/m^2) Mean ±S.D.
I < 10 (poor)	12	20.68	5.75±2.2	2.12±6.43
II 10-15 (fair)	19	32.75	12.58±2.00	20.69±3.6
III 15-20 (Good)	14	24.13	19.5±0.824	19.40±1.36
IV >21 (Excellent)	13	22.44	22.38±1.19	19.43±0.543

Table II. Classification of study population based on preexercise physical fitness score

Assessment of Preexercise Physical fitness of study population was done by testing their flexibility, co-ordination, Equilibrium, agility, strength and Endurance. Based on the score developed 20.68% subjects

secured Poor Physical fitness score. Majority of the subjects (33%) were classified as having fair physical fitness scores.

Group (Based on PFS)	PFS	BMI (Kg/m^2) Mean ±S.D.	'r'	' p'
I n = 12, (Poor)	5.75±2.20	22.12 ±6.43	-0.827	0.001
II, n= 19, (Fair)	12.58± 2.00	20.69±3.60	+ 0.525	.05
III, n= 14 (Good)	19.5±0.824	19.40±1.36	+ 0.464	.05
IV, n=13 (Excellent)	22.38± 1.19	19.43±0.54	-0.788	.001

Table III: Correlation of BMI and physical fitness score

PFS=Physical fitness score

An attempt has been made to correlate physical fitness score obtained by a battery of tests applied and the body mass index. The observations indicated a positive correlation

between physical fitness score and BMI in the range of 18.04 -24.29 kg/m^2 .The observation

revealed a negative correlation between above parameters when BMI values were higher

and lower than normal (15.69 -28.55 kg/m^2.)

Day	CVO2 max L/min	't' Day 1vs day 15	'p'
1	3.1928±0.2404		
5	3.147 ± 0.307	4.08	P.001
15	3.44 ± 0.353		

Table 4 : Change in Physiological Endurance (VO2 Max L/Min) During Exercise

The study revealed that physiological endurance or aerobic capacity as assessed by measuring

Vo2 max improved with training .A significant increase in Vo2 max was found after 15 days of Exercise.

Group	Body Mass Index (kg/m2) Mean ±S.D.	Post exercise CVO2 max (liters/min) mean±S.D.	'r'	'P'
I (n=15)	16.58±1.061	3.185±0.217	0.80	0.001
II (n=33)	19.90± 1.385	3.68± 0.94	0.971	0.001
III (n=10)	27.52± 0.27	3.24±0.27	0.982	0.001
Total (n=58)	20.357±3.83	3.52±0.27	0.968	0.001

Table 5: correlation of BMI and mean of corrected VO2 max after 15 days of exercise

A significant positive correlation was found between Body mass index and post exercise Vo2 max. The study population having normal body mass index showed greater improvement in Physical capacity as compared to subjects having high or low BMI.

Group	PFI	CVO2 max Liters/min	'r'	'P'
I (n=15)	3.40±8.66	3.185±0.127	+ 0.700	0.001
II (n=33)	86.28±1.28	3.68± 0.094	+ 0.826	0.001
III (n=10)	86.08±1.63	3.520±0.27	+ 0.800	0.001
Total (n=58)	88.01± 7.02	3.24±.27	0.826	0.001

Table 6: Correlation of PFI and mean CVO2 max after 15 days of exercise

It was observed that mean PFI scores of children having low BMI (< 18) were lower as compared to other groups. A positive correlation was observed between physical fitness index and VO2 max,suggesting that improvement in VO2 max improves cardiorespiratory fitness.

DISCUSSION:

In the present study we studied the aerobic power changes to steady ergograph exercise in Overweight, obese and normal weight young adults.As recently the Health Ministry of India has reduced the diagnostic cut –offs for body mass index (BMI) to 23 kg/m^2 as opposed to 25 kg/m^2 globally and the standard waist circumference to 80 cms for Indian female and 90 cm for Indian male to fight the battle against obesity[6], we have used the recent cutoffs in this study.

In this study we found out that ncrease or decrease in relative body weight above the desired for that age and sex are associated with poor physical fitness which is statistically significant. This finding is similar to other studies done on obese children,adolescents and adults[7,8,9].Obesity, which has reached epidemic prevalence is now recognized as an independent risk factor for increasing blood pressure. Previous studies have shown that obesity presented an increase in the left ventricular mass, cardiac output, blood volume and in the arterial resistance all of which increase the blood pressure[10].

We also calculated physical fitness score by assessing their flexibility ,coordination, equilibrium,agility,strength and Endurance.A scoring scale was developed based on the answers given by the respondents scoring maximum to 25 and minimum to 11.

In this study we also found a positive correlation between Physical fitness score and BMI in the range of 18.04-24.29 kg/m^2.The study also reveals that physiological endurance or aerobic capacity as assessed by measuring VO2 max improves with training. A significant increase in VO2 max was found after 15 days of

exercise .This finding is similar to other studies which has shown a linear increase in VO2 max with training showing prolonged training can increase VO2 max in normal sedentary individuals by more than 40%.[11,12,13,14]. The observation suggested that sedentary medical students engaging in regular endurance training could improve their aerobic work capacity.A significant positive correlation was also found between body mass index and Post exercise VO2 max. The study population having normal body mass Index showed greater improvement in physical capacity as compared to subjects having high or low BMI.

We also found that mean PFI scores of children having low BMI (< 18) were lower as compared to other groups.A positive correlation was observed between physical fitness Index and VO2 max,suggesting that improvement on VO2 max improves cardiorespiratory fitness.

Thus this study demonstrates that there is significant variation in aerobic Power in overweight and obese young adults as compared to normal subjects suggesting that improvement in VO2 max improves cardiorespiratory fitness.Our study is limited by the small number of included subjects and thus requires confirmation in a larger study.

In conclusion we found out that the subjects having normal body mass index showed greater improvement in aerobic capacity as compared to underweight and Overweight subjects.But sedentary medical students need proper nutrition, education and Physical exercise to go a long way.The study came out with the result that statistically significant increase in physiological endurance in untrained sedentary subjects is possible with regular short duration exercise.

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