Original Research Article

Determination of cardiovascular fitness in young healthy medical students

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International Archives of Integrated Medicine, Vol. 3, Issue 10, October, 2016.

Available online at http://iaimjournal.com/
ISSN: 2394-0026 (P) **ISSN: 2394-0034 (O)**
Received on: 26-09-2016 **Accepted on:** 02-10-2016
Source of support: Nil **Conflict of interest:** None declared.
How to cite this article: Khurana E, Oommen ER. Determination of cardiovascular fitness in young healthy medical students. IAIM, 2016; 3(10): 74-78.

Abstract

Background: Cardiovascular fitness refers to the ability of circulatory system to supply oxygen to working muscles during sustained physical activity.
Objectives: To determine the cardiovascular fitness (using predicted VO2 max) among young healthy medical students in the age group of 17-19 years.
Materials and methods: On the basis of physical activity performed subject were categorized into 3 category light, moderate, vigorous exerciser. Cardiovascular fitness was assessed by using treadmill exercise as per Bruce protocol.
Results: Data were analyzed using the paired t-test.Conclusion.it was observed in the study that vigorous exerciser had better cardiovascular fitness than moderate and light exerciser.
Conclusion: Students who had more physical activity were having better cardiovascular fitness. Hence, it is suggested that some physical activity should be mandatory in the curriculum of medical education which would help us to maintain cardiovascular fitness and reduce the risk of cardiovascular morbidity and mortality in the long run of their careers.

Key words

Cardiovascular fitness, Medical students, Bruce protocol.

Introduction

Cardiovascular fitness refers to the ability of circulatory system to supply oxygen to working muscles during sustained physical activity. Cardiovascular fitness can reduce risk of heart disease, lung cancer, type 2 diabetes, stoke and other diseases.

Cardiovascular system is set to various adaptation in body throughout exercise. It must immediately respond to change in cardiac output,

blood flow and blood pressure during exercise. Cardiac output defined as product of heart rate and stroke volume which represent volume of blood being pumped by heart each minute.

Cardiac output increases during physical activity due to increase in both heart rate and stroke volume. At beginning of exercise cardiovascular adapation are very rapid. Within second after muscular contraction there is withdrawal of vagal activity to heart which is followed by increase in sympathetic stimulation to heart. This results in increase in cardiac output to ensure blood flow to muscle which matches with metabolic needs. Both heart rate and stroke volume varies directly with intensities of exercise performed.

Aerobic power or VO2max which involves a full functional support from cardiorespiratory pathway is an appropriate test to study cardiorespiratory fitness [1].

Cardio vascular fitness

It is generally accepted that people with higher levels of physical activity tend to have higher levels of fitness and that physical activity can improve cardiorespiratory fitness. Physical inactivity and low cardiorespiratory fitness are recognized as important cause of morbidity and mortality [2].

Peripheral adaptations that promote increased submaximal exercise performance may include increased capillarisation and increased aerobic enzyme content in skeletal muscle [3]. Thus maintenance of regular aerobic exercise is associated with significant improvements in aerobic power and perhaps more importantly with increased ability to exercise at submaximal load.

Cardiovascular fitness is expressed in form of Vo2max which is the maximum volume of oxygen consumed by the body each minute during exercise, since the amount of oxygen we consume is directly related to the amount of energy we are burning. The physical limitations that restrict the rate at which energy can be released aerobically depend upon the chemical ability of the muscular tissue system to use O2 in breaking down fuels and the combined ability of cardiovascular and pulmonary systems to transport the oxygen to the muscular tissue system. Therefore measurement of O2 consumption is actually a measure of cardiovascular fitness.

Materials and methods

A group of 30 healthy students (18-19 years) took part in the present study conducted at Department of Physiology, Baroda Medical College, Vadodara. Detailed procedure was explained to the participants and informed written consent was collected from the participants. Height and weight of each participant were measured. In order to exclude the condition that might affect the result following criteria was required .No history of hypertension, diabetes mellitus, heart failure, coronary artery disease, heart failure, not suffering from respiratory disease or any acute or chronic disease and not taking any drug that could affect the result.

All the subjects were grouped into 3 category light, moderate, vigorous depending on intensity of exercise according to British Heart Foundation Factfile (September 2008) as per **Table - 1**.

Anthropometric variables like height and weight were obtained and BMI and BSA were calculated. Height was measured to nearest of 0.1 cm and weight was measured to nearest of 0.1 kg with minimum of clothes and no shoes.

BMI was calculated by formula = weight (kg)/ height (m^2)

Subjects were instructed to avoid strenuous exercise a day prior to tests. They were asked to wear light clothes and to have breakfast about 1hr before the test. The procedure was conducted in the morning. The subjects were demonstrated for treadmill test before actual performance. The

temperature of room was around $30^0 \pm 2^0$C. Resuscitative measures like appliances for o2 administration, Emergency drugs, Ambu bags, Defibrillator etc. were kept ready. Participants were asked to lie down in supine position for at least 10 min before exercise.

Table - 1: British Heart Foundation Factfile (September 2008).

Intensity of exercise	Type of exercise	Examples
Light	Aerobic	Normal walking, Walking downstairs, Bowling, General housework: vacuum cleaning carpets, mopping floors.
Moderate	Aerobic	Brisk walking (3-4.5 mph), Lawn mowing, Cycling (5-9 mph), Low impact aerobic dance, Social dancing, Swimming
Vigorous	Aerobic for some, anaerobic for others	Fast walking (≥5 mph), Cycling (≥10 mph), High impact aerobics, Playing competitive sports, Circuit weight training, Heavy digging for others or yard work, Heavy house working, Moving furniture.

Bruce protocol treadmill testing

Treadmill exercise test was performed by using treadmill. The Bruce protocol [4] for multi stage treadmill testing of maximal exercise was used. This begun with stage 1 with walking slowly for three minutes at 2.7 Km/hr at a 10% grade (inclination), speed and grade then increased in every stage of 3 minutes and end at stage 7 or till exhaustion. VO_2 max was estimated using the Bruce protocol. Formula for estimating VO_2 max was as given as per **Table - 2**.

Table - 2: Cardiovascular fitness grading for men aged (17-19) years was done.

VO_2 Max	
Range	**Grade**
Less than 35	**Very poor**
35.0 to 38.3	**Poor**
38.4 to 45.1	**Fair**
45.2 to 50.9	**Good**
51.0 to 55.9	**Excellent**
More than 55.9	**Superior**

The Bruce Protocol Formula for Estimating VO_2 Max

- For Men VO_2 max = 14.8 - (1.379 x T) + (0.451 x T^2) - (0.012 x T^3)
- For Women VO_2 max = 4.38 x T - 3.9
- T = Total time on the treadmill measured as a fraction of a minute (i.e.: A test time of 9 minutes 30 seconds would be written as T=9.5).

Then the cardiorespiratory fitness was graded according to the Bruce protocol norms for calculating cardiovascular fitness.

Results

Statistical analysis was done using paired t-test at level of significance $p<0.001$. Age wise distribution of 3 groups was as per **Table – 3**.

Table – 3: Age wise distribution of 3 groups.

	Sample (n=30)	Age (Years)
Light	9	18±0.8 (17-19)
Moderate	11	18±0.5 (18-19)
Vigorous	10	18±0.8 (17-19)

VO2 max

VO2 max was determined by using Bruce protocol. VO2 max was calculated for all the three exercise groups. In vigorous exerciser mean VO2 max was significantly ($p>0.001$) higher than the moderate exerciser and light exerciser (**Table - 4**). Statistical analysis was done by unpaired 't' test at level of significance of $p<0.001$.

Cardiovascular fitness

Only Light exercise group had subjects with very poor cardiovascular fitness (**Table – 4, 5, 6**). Moderate and Vigorous exercise groups had majority of subjects with Superior cardiovascular fitness.

Table – 4: VO_2 Max in Exerciser groups.

Exercise groups (Mean ± SD) Range	Duration (min)	VO_2 Max (ml/kg/min)
Light	13±4	45±14
	(8-18)	(25-67)
Moderate	16±2	61±6
	(14-19)	(49-69)
Vigorous	17±3	64±9
	(13-20)	(46-70)

Discussion

In the present study mean VO2Max (ml/kg/min) was determined by using Bruce protocol. VO2 max was calculated for all the three exercise groups. In the light exercise group the VO2 max was observed 45±14 (ml/kg/min). In the moderate exercise group the VO2 max was 61±6 (ml/kg/min). In the vigorous exercise group the VO2 max was 64±9 (ml/kg/min).The subject with higher VO2 max had better cardiovascular fitness.

The maximum observed VO2 values by Anabel N. Rodrigeus [5] in 2006 were 42.5 mL/kg/min among the girls and 52.3 mL/kg/min for the boys; and these were defined as the cut off points for excellent cardiorespiratory fitness. This study proposed mean VO2max ranges as a classification parameter for cardiorespiratory fitness, in addition to contributing to a definition of normal values for the Brazilian population.

The study of Glassford, et al. [6] found a Vo2max of 49.30 ml/kg/min by using Astrand - Ryhming nomogram among the sedentary subjects in the age group of 20-29 years. This was followed by the study by Shephard Roy [7], who found a Vo2max of 3.5 L/min among the age group of 20-24years.

Table – 5: Proportion of student in different stages of Bruce protocol with grading of exercise.

Exercise Groups	Stage					Total
	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	
Light	2	1	4	1	1	9
Moderate	0	0	3	7	1	11
Vigorous	0	0	2	1	7	10

Table – 6: Cardiovascular fitness performance.

Cardiovascular fitness	Very poor	Poor	Fair	Good	Excellent	Superior
Light	3	0	0	4	0	2
Moderate	0	0	0	2	0	9
Vigorous	0	0	0	2	0	8

Ekblom Bjorn, et al. [8] and Ross BJ found nearly similar values, 3.58 L/min and 3.52L/min respectively from their studies among untrained subjects. Lars Hermansen, et al. [9] recorded a Vo2max of 3.91 L/min in 19 years male and Kotchen Theodre [10] noted a Vo2max of 3.18L/min in subjects aged 20 years.

Thus it appears that up to 70% of an individual's maximum force, power or capacity is a matter of genetic factor. Endurance of vigorous exerciser was higher than moderate and light exerciser which reflects that vigorous exerciser had better cardiovascular fitness than others.

The results of present study showed that 80% of vigorous exerciser falls under superior category of cardiovascular fitness whereas 33% of light exerciser had very poor fitness. It was found that Vigorous exerciser had better cardiovascular fitness than other groups. Training induces adaptation on O2 transport system, and VO2 max

gives an idea of this capacity and also sets a norm in assessing physical fitness.

Conclusion

The study showed that students who had more physical activity were having better cardiovascular fitness. Hence it is suggested that some physical activity should be mandatory in the curriculum of medical education which would help us to maintain cardiovascular fitness and reduce the risk of cardiovascular morbidity and mortality in the long run of their careers.

References

1. Astrand PO. Quantification of exercise capability and evaluation of physical capacity in man. Prog Cardiovasc Dis., 1976; 19(1): 51-67.
2. Dunn A.L., Marcus BH, Kamber JB, et al. Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: a randomized trial. JAMA, 1999; 281: 3.
3. Saltin B. The aging endurance athlete. In Sutton JR, Brock R, eds. Sports Medicine for the mature Athelete. Indian polis: Benchmark press, 1986; 59-80, 27-34.
4. Bruce RA, Blackman JR, Jones JW, Strait G. Exercising testing in adult normal subjects and cardiac patients. Peadiatrics, 1963; 32(suppl): 742-756.
5. Anabel N. Rodrigues, Anselmo José Perez, Luciana Carletti, Nazaré S. Bissoli, Gláucia R. Abreu. Maximum oxygen uptake in adolescents as measured by cardiopulmonary exercise testing: a classification proposal. Jornal de Pediatria Copyright © 2006 by Sociedade Brasileira de Pediatria doi:10.2223/JPED.1533
6. Glassford RG, Baycroft GHY, Sedgwick AW, Macnab RBJ. Comparison of maximal oxygen uptake values determined by predicted and actual methods. J Appl Physiol., 1965; 20(3): 509-513.
7. Ekblom Bjrn, Per-oldof Astrand, Bengt Saltin, Jesper Stenberg, Brittmari Wallstorm. Effect of training on circulatory response to exercise. J Appl Physiol., 1968; 24(4): 518-528.
8. Shephard RJ, Allen C, Benade AJS, Davies CTM, Prampero PE, Hedman R, Merriman JE, et al., Standardization of submaximal exercise test. Bull Wld Org., 1968; 38: 765-775.
9. Lars Hermansen, Lange Anderson K. Aerobic work capacity in young Norwegian men and women. J Appl Physiol., 1965; 20(3): 425-431.
10. Kotchen TA, Hartley LH, Rice TW, Mougey EH, Jones Lee Roy G, Mason JW. Renin, norepinephrine, and epinephrine responses to graded exercise. J Appl Physiol., 1971; 31(2): 178-80.