

## Assessment of cardiovascular fitness [ $VO_{2\max}$ ] among medical students by Queens College step test

Tauseef Nabi<sup>\*1</sup> Nadeema Rafiq<sup>2</sup> and Ouber Qayoom<sup>1</sup>

<sup>1</sup>Department of Medicine, MMIMSR, Mullana, Ambala, India.

<sup>2</sup>Department of Physiology, MMIMSR, Mullana, Ambala, India.

### \*Correspondence Info:

Dr. Tauseef Nabi

Department of Medicine,

MMIMSR, Mullana, Ambala, India.

E-mail: [dr.tauseefnabi@gmail.com](mailto:dr.tauseefnabi@gmail.com)

### Abstract

**Objective:** Cardio respiratory fitness in terms of maximum oxygen uptake [ $VO_{2\max}$ ] reflects physical fitness of a person.  $VO_{2\max}$  is single best measure of cardio respiratory capacity and is considered as a bench mark to quantify cardiovascular function capacity and aerobic fitness. The main aim of study was to assess and compare the cardio respiratory fitness in terms of maximum aerobic capacity [ $VO_{2\max}$ ] among the young adult male and female medical students of Maharishi Markandeshwar University [MMU], Mullana, Haryana.

**Method:** A total of fifty seven young adult male [n=30] and female [n=27] students, around age group of 18-24 years were recruited by simple random sampling from Maharishi Markandeshwar University, Haryana.  $VO_{2\max}$  was estimated indirectly by following the protocol of Queen's College Step Test [QCT] method. QCT is the simplest one to determine cardio respiratory fitness in terms of maximum oxygen uptake.

**Result:** In present study it was found that mean value of  $VO_{2\max}$  for males was [45.66±8.96] ml/kg/min and for females it was [37.85±4.3] ml/kg/min. The mean value of  $VO_{2\max}$  was found significantly higher in male as compared to female students [P value <0.0001].

**Conclusion:** From the study it was concluded that our subjects fitted in the category of fair on cardio respiratory fitness scale, could be because of the decreased physical activity, unhealthy lifestyle behaviors as are established during the years of gaining education, which may influence adult behavior and health status. Physical fitness performance was better in male students than female students. Health promotion policies and physical activity programs should be designed to improve cardio respiratory fitness.

**Keywords:** Cardio respiratory fitness, step test,  $VO_{2\max}$

### 1. Introduction

Cardio respiratory fitness, also called cardiovascular fitness or maximal aerobic power, is the overall capacity of the cardiovascular and respiratory systems and the ability to carry out prolonged strenuous exercise. The maximal oxygen consumption [ $VO_{2\max}$ ] attained during a graded maximal exercise to voluntary exhaustion has long since been considered by the World Health Organization as the single best indicator of cardio respiratory fitness.[1]

$VO_{2\max}$  is the maximum amount of oxygen a person can intake and the value does not change despite an increase in workload over time period.  $VO_{2\max}$  is expressed as liters/min as an absolute value

or in milliliters /kg/min as relative  $VO_2$  max. The  $VO_{2\max}$  can be estimated using maximal or sub maximal tests, by direct or indirect methods. The most commonly used tests are walking/running tests followed by cycling and step tests.[2]  $VO_{2\max}$  is often estimated using prediction equations rather than direct measurement as it is cost effective and relatively easier.

$VO_{2\max}$  is often used as marker of physical fitness and considered the best indicator of aerobic fitness.[3]  $VO_{2\max}$  estimation by step test is one such test and is considered to be a practical field test for assessing individual aerobic fitness.[4]

Physical fitness is considered as the degree of ability to execute a physical task under various ambient conditions. Fitness is generally considered to have five components: aerobic capacity, muscle strength, muscular endurance, flexibility, and body composition. Physical fitness is presently considered one of the most important health markers, as well as a predictor of morbidity and mortality for cardiovascular disease [CVD] and for all causes.[5]

Hence, the present study emphasizes on cardiovascular fitness in terms of maximum aerobic capacity [VO<sub>2max</sub>] among the young adult male and female medical students of MMU [Maharishi Markandeshwar University], Haryana. There is need for the students to measure and analyze their physical fitness for their own benefit and improvement. For better productivity the students should be healthy and have good physical fitness. Medical students of today are the physicians of tomorrow and a good physician must be physically fit and mentally alert.

## 2. Material and Methods

**2.1 Study design:** Cross-sectional Study

**2.2 Source of data:** Maharishi Markandeshwar University [MMU], Ambala.

The study was conducted in the department of Physiology, Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana [Ambala].

### 2.3 Methodology

#### 2.3.1 Study subjects

The subjects were healthy young male and female medical students of MMU, aged 18–25 years,

#### 2.3.2 Eligibility criteria

The students were recruited based on following inclusion and exclusion criteria.

#### 2.3.3 Inclusion criteria

1. The study included apparently healthy male and female subjects between age group of 18-25 years.
2. Non-smokers and non-alcoholic subjects.

#### 2.3.4 Exclusion criteria

1. Students on any medication.
2. Student's under-going regular physical training.
3. Students with history of any acute or chronic illness.

#### 2.3.5 SAMPLING METHOD AND SAMPLE SIZE:

**Sampling method:** Simple random sampling.

**Sampling size:** 57 subjects.

#### 2.4 Procedure

57 subjects, who fulfilled inclusion criteria, were recruited for the study after obtaining their consent. Initial explanation about the aim and purpose of the study, test procedure, method of testing, instructions on how to perform test was given. All the students were tested under similar

laboratory conditions in comfortable environment. Before the test the subjects were instructed not to indulge in any activities. Subjects were also instructed not to have heavy meals/tea/coffee at least 2 hours before test. Detailed history was taken and clinical examination was done. The Anthropometric data which included age, height, weight was noted and Body Mass Index [BMI] was calculated. Before commencement of test the subjects were asked to rest, then all basal parameters like heart rate, blood pressure and respiratory rate were measured.

Body Mass Index [BMI] was calculated as Body weight in kilograms divided by square root of Body height in meter, using Quetelet index. **Normal weight** was defined as BMI 18.5 to  $\leq 22.9$ , **Under weight** as BMI  $< 18.5$ , **Overweight** as BMI 23 to  $\leq 24.9$  and **Obesity** as BMI  $\geq 25$  kg/m<sup>2</sup>, as per revised body type classification for Indian Population recommended by Health ministry and Diabetes Foundation of India in 2008.[6][7][8]

VO<sub>2max</sub> was estimated indirectly by following the protocol of Queen's College Step Test [QCT] method.[6][8] The step test was performed using a tool of 16.25 inches height. Stepping was done for a total duration of 3 minutes at the rate of 24 steps up per minute for males and 22 steps up per minute for females which was set by a metronome. After completion of exercise, the carotid pulse rate was measured from the fifth to the twentieth second of recovery period. The 15 seconds pulse rate was converted into beats per minute and following equation was used to predict VO<sub>2max</sub>.

#### For males:

$$VO_{2max} = 111.33 - [0.42 \times \text{pulse rate beats/min}]$$

#### For females:

$$VO_{2max} = 65.81 - [0.1847 \times \text{pulse rate beats/min}]$$

[ml/kg/min]

## 3. Results

The study was conducted on 57 healthy students [30 males and 27 females]. The mean age of males was  $19.0 \pm 1.6$  years and that of the females was  $18.5 \pm 1.5$  years [ $p = 0.27$ ]. The mean BMI of males was  $24.5 \pm 4.0$  Kg/m<sup>2</sup> and females was  $23.31 \pm 4.9$  Kg/m<sup>2</sup> [ $p = 0.31$ ] There was no statistically significant difference in the age and BMI of the two sexes. Out of 57 students 22 [38.6%] were found obese, among them 12 were males and 10 were females.

Mean value of VO<sub>2max</sub> for males was  $45.66 \pm 8.9$  ml/kg/min and for females it was  $37.85 \pm 4.3$  ml/kg/min, which was found significantly higher in males than in females [ $p < 0.0001$ ]. On comparison of our VO<sub>2max</sub> value with the standard VO<sub>2max</sub> classification, our subjects fitted in the

category of fair on cardio respiratory fitness scale. Mean values of VO<sub>2max</sub> in non-obese students [42.2 ± 7.9 ml/Kg/min] was slightly higher than in obese [41.3 ± 8.7 ml/Kg/min] but the difference was not statistically significant [ $p = 0.69$ ]

Higher values of VO<sub>2max</sub> was found in non-obese males [46.1 ± 8.8ml/Kg/min] versus obese males [44.7 ± 9.6 ml/Kg/min] [ $p = 0.68$ ] and non-obese females [38.16 ± 3.9 ml/Kg/min] versus obese females [37.12 ± 5.6 ml/Kg/min] [ $p = 0.5853$ ].

**Table 1: Comparative study of some anthropometric parameters along with VO<sub>2max</sub> amongst the male and female medical students**

Variables	Male [mean ± SD]	Female [mean ± SD]
Age [years]	19.0 ± 1.6	18.5 ± 1.5
Height [cm]	166.13 ± 2.3	154.66 ± 2.1
Weight [kg]	68.23 ± 3.2	58.96 ± 2.9
BMI [kg/m <sup>2</sup> ]	24.5 ± 4.0	23.31 ± 4.9
VO <sub>2max</sub> [ml/kg/min]	45.66 ± 8.9	37.85 ± 4.3

**Table 2: Comparison of VO<sub>2max</sub> between various groups of obese with non-obese.**

	Obese [VO <sub>2max</sub> [ml/kg/min]]	Non obese [VO <sub>2max</sub> [ml/kg/min]]
All subjects [Male+ Female]	41.3 ± 8.7	42.2 ± 7.9
Male	44.7 ± 9.6	46.1 ± 8.8
Female	37.12 ± 5.6	38.16 ± 3.9

#### 4. Discussion

The maximum oxygen uptake [VO<sub>2 max</sub>], an internationally accepted parameter to evaluate the cardio respiratory fitness reflects the amount of oxygen utilized by working muscles during maximal exercise. It is the best index of aerobic capacity and gold standard for cardio respiratory fitness. Thus measure of maximum oxygen consumption offer insight into ability of cardiovascular, respiratory and muscular system to deliver and utilize oxygen. During exercise, up to a point the increase in oxygen consumption is proportionate to energy expended and all the energy needs are met by aerobic process. So in a person, the more is the maximum oxygen consumption capacity [VO<sub>2max</sub>], the more will be his/her aerobic capacity. VO<sub>2max</sub> is the measure of the functional limit of the cardio-respiratory system and the single most valid index of maximal exercise capacity.[9]

Decrease in VO<sub>2 max</sub> is therefore an indicator of reduced exercise capacity or tolerance. It is the product of maximum cardiac output and maximal arterio-venous oxygen difference.[10] As direct estimation of VO<sub>2max</sub> is exhaustive, laborious and difficult experimental protocol, a reliable indirect method[6][8] was followed for prediction of VO<sub>2max</sub>. The purpose of our study was to assess and compare

the level of physical fitness among medical college students of Maharishi Markandeshwar University, Haryana. The result of the present study showed that mean value of VO<sub>2max</sub> for males was 45.66 ± 8.96 ml/kg/min and for females it was 37.85 ± 4.3 ml/kg/min, which was found significantly higher in males than in females [ $p < 0.0001$ ]. On comparison of our VO<sub>2max</sub> value with the standard VO<sub>2max</sub> classification, our subjects fitted in the category of fair on cardio respiratory fitness scale.[11]

The reason for reduced VO<sub>2max</sub> in our subjects could be because of the decreased physical activity, unhealthy lifestyle behaviors as are established during the years of gaining education, which may influence adult behavior and health status. Cardio respiratory fitness has also shown a stronger association with total adiposity, as measured by BMI.[12] Overweight and obesity in our subjects could also be the reason for reduced VO<sub>2max</sub>.

The results of this study also suggest that female students have lower levels of aerobic fitness compared with male students. Our findings are in agreement with other studies that have examined aerobic fitness levels in African-American adults.[13] Aerobic capacity of male students was significantly higher compared to that of female participants. This has been confirmed by correlations between considered variables in female and male participants disregarding their physical activity levels.

Studies have suggested that achieving 60 min or more of moderate-vigorous physical activity daily is associated with a healthier cardio respiratory fitness level in adolescents, independently of their adiposity status.[14] Improvements in cardio respiratory fitness have positive effects on depression, anxiety, mood status and self-esteem, and seem also to be associated with a higher academic performance. So, it is suggested that adequate physical activity programmers should be included in the curriculum of educational institutes.

There are a few limitations to the study that need to be considered. First, the motivation of the subjects in performing the physical fitness tests, were uncontrollable. It might affect the results of the study. Secondly, the performance of the subjects might affect due to their physical lifestyle and different physical characteristics.

#### References

- [1] Shephard RJ, Allen C, Benade AJ, Davies CT, Di Prampero PE, Hedman R *et al*. The maximum oxygen intake. An international reference standard of cardio respiratory fitness. *Bull World Health Organ* 1968; 38: 757-764.

- [2] Leger LA, Mercier D, Gadoury C, Lambert J. The multistage 20 metre shuttle run test for aerobic fitness. *J Sports Sci* 1988; 6: 93–101.
- [3] Verma SS, Sengupta J. Regression Model for establishment of maximum aerobic power in man. *Def Sci J* 1990; 40:293-298.
- [4] Chin-Mou Liu, Kuei-Fu Lin. Estimation of VO<sub>2max</sub>: a comparative analysis of post-exercise heart rate and physical fitness index from 3-minute step test. *J Exerc Sci Fit* 2007; 5[2].
- [5] Morteza Jourkesh, Iraj Sadri, Ali Ojagi and Amineh Sharanavard. Comparison of Physical fitness level among the students of IAU, Shabestar. Branch. *Annals of Biological Research*, 2011; 2 [2]:460-467.
- [6] Chatterjee S, Chatterjee P, Bandyopadhyay A. Cardio respiratory fitness of obese boys. *Indian J Physiol Pharmacol* 2005; 49: 353-7.
- [7] Garrow JS, Webster J. Quetlet's index as a measure of fatness. *Int J Obes*. 1985; 9 [2]:147-153.
- [8] Chatterjee S, Chatterjee P, Bandyopadhyay A. Enumeration of validity for predicted VO<sub>2 max</sub> by Queen's college step test in Bangalee boys. *Indian J Physiol allied Sci* 2001; 55: 123-7.
- [9] Ainsworth BE, Berry CB, Schnyder VN, Vickers SR. Leisure time physical activity and aerobic fitness in African American young adults. *J Adolesc Health*. 1992; 13:606-611.
- [10] McArdle WD, Katch FI, Katch VL. Essentials of exercise Physiology. Philadelphia: Lea and Febiger 1994; 271.
- [11] Heyward V. H. Advanced Fitness Assessment and Exercise Prescription, Fifth Edition, 2006, Champaign, IL: Human Kinetics. Original Source: The Cooper Institute for Aerobics Research, the Physical Fitness Specialist Manual. Dallas, TX. 2005.
- [12] Ara I, Moreno LA, Leiva MT, Gutin B, Casaju's A. Adiposity, physical activity, and physical fitness among children from Aragon. *Obesity* 2007; 15: 1918–1924.
- [13] Sidney S, Haskell WL, Crow R, et al. Symptoms limited graded treadmill exercise testing in young adults in the CARDIA study. *Med Sci Sports Exerc*. 1992; 24:177-183.
- [14] Ortega FB, Ruiz JR, Hurtig-Wennlo'f A, Sjo'stro'm M. Physical fitness in childhood and adolescence: a powerful marker of health. *International Journal of Obesity* 2008; 32:1–11.