

Investigation of aerobic capacity in first year medical students

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Abstract

Objective: Measurement of cardiorespiratory fitness in young medical students can be more than just a checkup, carrying educational and motivational values and attitude forming. Aerobic capacity ($VO_2\max$) is believed to be most reliable parameter of physical fitness and cardiorespiratory health.

Method: $VO_2\max$ was evaluated in the students employing submaximal exercise one stage step test, in age matched boys and girls students of first year MBBS enrolling from nationwide domains. 20 each males and females of 18-19 year age were selected with due criteria to take Queens College step test, after converscence. $VO_2\max$ estimation was indirect from post exercise recovery heart rate.

Results: Boys exhibited higher aerobic capacity than girls. The body mass indices (BMI) of boys and girls do not differ but higher BMIs associated with insignificant yet consistently lower aerobic capacities. Estimated $VO_2\max$ in studied sample of medical students finds rating just as “fair” in prevalent standards.

Conclusion: The findings in entrant medical students drawn from nationwide residences emphasize the need for administration of regular exercise programmes in the medical student community toward improved cardio respiratory fitness, better performance and quality of life.

Keywords: $VO_2\max$; aerobic capacity; physical fitness; cardiorespiratory fitness.

1. Introduction

Fitness of individuals is conventionally assessed as aerobic capacity, muscle power and resistance to fatigue, flexibility and body composition. As per contemporary view, the maximum amount of oxygen a person is capable of consuming upon muscle exercise, called $VO_2\max$, is most reliable indicator of cardio respirator fitness [1]. $VO_2\max$ indicates aerobic capacity and fitness [2]. Tests involving maximal or submaximal graded exercises, such as walking, running, cycling or stepping are employed to assess the $VO_2\max$ [3]. Either direct measurement or indirect calculations are used strategically to asses $VO_2\max$ and step tests are particularly suited for field use [4]. In the step tests, subjects step up and down for 3 to 5 minutes on bench of specific height at specific step rate per minute. Consequent post exercise heart rate during recovery is used to estimate cardiorespiratory fitness in terms of $VO_2\max$, by formula based on regression modeling of relevant independent and dependant bodily variables. Conventional single stage Queens college step test reported by McArdley et al in 1972[5] considers variables as recovery heart rate, test duration, age, gender, body weight in the regression model to predict $VO_2\max$. The basic premise of submaximal exercise tests is

that linear relationship exists between heart rate and oxygen consumption[5-7].

2. Subjects and method

Study sample was derived from first year MBBS students of 2014 admission batch at All India Institute of Medical Sciences, Bhopal, MP. The students were drawn from all over the country. Students were informed about the study intention and test procedure for assessment of their aerobic capacity as index of cardiorespiratory fitness. Each one was included after written consent to participate in study that was permitted by the authority. Volunteers from among 100 strong batch were given exposure to the test for converscence. They were shown four steps up/up and down/down process for two legs, keeping knee and back straight. Metronome was used to help maintain required step rate per minute. Heart rate of those able to complete 3 minute test as desired were noted just after the test. Those who attained heart rate close to (± 10) their predictable maximal heart rate as per formula of Tanaka et al[8], were excluded. Finally, 20 boys and 20 girls within 18to 19 year age were selected. These were included on satisfying criteria viz. no

history of any illness or medication over past one month; not consuming cigarettes or alcohol, not devoting to any regular exercise programme. Girls were tested on a day preceding or succeeding the menstrual period.

Height and weight were measured to calculate the body mass index (BMI), using formula:

$$\text{BMI} = \text{body weight in Kg} / (\text{height in Meters})^2.$$

As per the national gradation normal BMI is between 18.5 and 22.9, below this are underweight. Those with BMI between 23 and 24.9 are labeled over weight and persons with BMI 25 and above are obese.

2.1 Step Test:

The students were instructed to

- i) Wear comfortable loose clothes and shoes appropriate for the stepping exercise test;
- ii. Drink plenty of fluids in preceding 24 hours for good hydration;
- iii. Take light breakfast of liquid or thin semisolid food and no tea or coffee before 3 hours of the test;
- iv. Avoid any strenuous physical activity in preceding 48 hours.

Test was carried out during months of October-November 2014 at morning room temperature between 9am to 10 am. The same room was venue of the test which was quiet, and had a comfortable bed, armed chair and the stepping tool. After relaxing the subject for 10 minutes in bed, heart rate, respiratory rate and supine blood pressure were recorded. (Average of two recordings 2 minutes apart).

Step test was conducted on a wooden tool 16.25 inches height. (The stepping tool height is kept to suit subjects of average height and give hip angle of 73.3 degrees adapted as per Francis & Culpepper equation [9] The student were instructed to step upon the same 24 times (boys) or 22 times (girls) per minute for three minutes without break. (They had accustomed themselves to such rate by earlier practice before one week)

Upon finishing the exercise students were immediately seated in the armed chair and their carotid pulse was counted for earliest possible 15 seconds (from 5th to 20th second of finishing exercise). This count was then quadrupled to get heart rate per minute. VO₂max was estimated by following formulae [5]:

For males: VO₂max ml/kg/min = 111.33 - [0.42 x pulse rate beats/min]

For females: VO₂max ml/kg/min = 65.81 - [0.1847 x pulse rate beats/min]

3. Observations and result

Table 1: Distribution of the students in various BMI categories was as under:

BMI Category	Boys (n)	Girls (n)
Obese	7	5
Overweight	5	6
Normal weight	7	7
Underweight	1	2

By rounding off individual BMIs to nearest whole figure the median BMI in boys was 24 and in girls 23. Net mean BMI in boys was 24.4±6.6 and girls 23.6±7.1. There was no significant difference in BMI compositions in male and female groups therefore.

Table 2: Mean values of calculated VO₂max (ml/kg/min) for the obese versus nonobese (combined) were as under

Gender	Non obese	Obese
All 40	42.6±8.1(n=28)	40.8±9.2(n=12)
Males	46.7±9.7(n=13)	45.1±10.2(n=7)
Females	37.9±10.4(n=15)	37.1±8.7 (n=5)

It is obvious that boys exhibited higher aerobic capacities (VO₂max) than the girls, although due to small sample results are not statistically significant on absolute values and t test statistic. The same difference becomes significant on Moods median test statistic. Another aspect is insignificant but consistently lower VO₂max in obese male or females than nonobese counterparts.

4. Discussion

VO₂max assessment provides insight to systemic efficacy of oxygen delivery and consumption. VO₂max is also reliable indicator of maximal exercise capacity [10]. It is product of maximum cardiac output and maximal difference of arteriovenous oxygen concentration [11]. Direct VO₂max measurement by maximal exercise testing and with complex metabolic cart is non-feasible for use as field test. Submaximal exercise tests with indirect prediction of cardiorespiratory fitness are therefore developed. VO₂max is the highest VO₂ measured over any 30 seconds and is presented as ml/kg/min. Validity of indirect prediction of VO₂max from step test may be affected by use of same stepping tool and rate for subjects of different stature. Study by Shamsi et al[12] however did not find height of subjects to influence the VO₂max calculation in Queens college step test. Adjustment of height of stepping tool for individuals of varied stature was found unnecessary also by in an earlier study [13].

The VO₂max values calculated in the study, i.e. boys (all) 45.3±9.9 and girls (all) 37.4±9.7 are wide apart with males exhibiting higher VO₂max. Obesity clearly shows association to lower VO₂max values although small, because these entry level students are in prime of youth. When referred to standard VO₂max grading [14], the whole range of VO₂max found in study subjects falls merely in “fair” category of cardiorespiratory fitness. This is most likely reflection of suboptimal lifestyle and poor exercise in daily routine of these average medical students. Such state is obviously not compatible with challenging professional strains. Studies have indicated successful uplift of VO₂max by regular moderate to heavy exercise both in obese and nonobese people [15]. Even the present mood, quality of life and academic performance should be better with adoption of regular exercise, as stated in the adage, “Healthy mind in healthy body”. Knowledge of cardiorespiratory fitness from

such baseline assessments can be educational, motivational and useful for identifying progress and strife to improvement.

References

- [1] Shephard RJ. Tests of maximum oxygen intake. A critical review. *Sports Med.* 1984 Mar-Apr; 1(2): 99-124.
- [2] Verma SS, Sengupta J. Regression model for establishment of maximum aerobic power in men *Defence Science Journal* 1990; 40: 293-298.
- [3] Léger LA, Lambert J. A maximal multistage 20-m shuttle run test to predict VO₂ max. *Eur J Appl Physiol Occup Physiol.* 1982; 49(1):1-12.
- [4] Latin RW, Berg K, Kissinger K, Sinnett A, Parks L. The accuracy of the ACSM stair-stepping equation. *Med Sci Sports Exerc.* 2001 Oct; 33(10): 1785-8.
- [5] McArdle WD, Katch FI, Pechar GS, Jacobson L, Ruck S. Reliability and interrelationships between maximal oxygen intake, physical work capacity and step-test scores in college women. *Med Sci Sports.* 1972 Winter; 4(4):182-6.
- [6] Chatterjee S, Chatterjee P, Bandopadhyay A. Enumeration of validity for predicted VO₂ max by queens college step test in Bangalee boys. *Indian Journal of Physiology and Allied Sciences* 2001; 55:123-127
- [7] Gupta R, Chaudhuri A, Bansod N. A study of physical fitness of trained individuals of an urban population in Pune. *Saudi Journal of Sports Medicine* 2014; 14:103-108.
- [8] Tanaka H, Monahan KD, Seals DR. Age-predicted maximal heart rate revisited. *J Am Coll Cardiol.* 2001 Jan; 37(1):153-6.
- [9] Francis K, Culpepper M. Height-adjusted, rate-specific, single-stage step test for predicting maximal oxygen consumption. *South Med J.* 1989 May; 82(5): 602-6.
- [10] Ainsworth BE, Berry CB, Schnyder VN, Vickers SR. Leisure-time physical activity and aerobic fitness in African-American young adults. *J Adolesc Health.* 1992 Nov; 13(7):606-11.
- [11] McArdle WD, Katch FI, Katch VL. Essentials of exercise physiology. Philadelphia, Lea & Febiger 1994,271
- [12] Shamsi MM, Alinejad HA, Ghaderi M, Badrabadi KT. Queens college step test predicted VO₂max: the effect of stature. *Annals of Biomedical Research* 2011; 2:371-377.
- [13] Ashley CD, Smith JF, Reneau PD. A modified step test based on a function of subjects' stature. *Percept Mot Skills.* 1997 Dec; 85(3 Pt 1):987-93.
- [14] Heyward VH. Advanced fitness assessment and exercise prescription, 5th Edn. Cooper Instt. for Aerobics Res.: Physai fitness specialist manual. Dallas TX 2005.
- [15] Ruiz JR, Castro-Piñero J, Artero EG, Ortega FB, Sjöström M, Suni J, Castillo MJ. Predictive validity of health-related fitness in youth: a systematic review. *Br J Sports Med.* 2009 Dec; 43(12):909-23.