

Research article

# Cardiopulmonary fitness test among Nepalese students

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## ABSTRACT

**Background and Objectives:** Maximum Oxygen uptake ( $VO_2$  max) is a good predictor of cardiopulmonary and muscle fitness. Maximum oxygen uptake is defined as the highest rate at which oxygen can be taken up and utilized by the body during severe exercise. The present study aims to find out the level of  $VO_2$  max using the McArdle equation and to compare obtained values from Chatterjee's equation in the Nepalese population.

**Methodology:** Maximum oxygen uptake was determined by using the Queen's college step-test of 16.25 inches and the popular McArdle equation. Stepping was done for a total duration of 3 minutes at the rate of 24 cycles per minute for males and 22 cycles per minute for females. After completion of the exercise, subjects remained standing while the carotid pulse rate was taken as heart rate. Maximum oxygen uptake was calculated using the obtained heart rate.

**Results:** Queen's college step test (QCT) was used as a submaximal exercise and the estimated  $VO_2$  max in boys and girls was  $48.8 \pm 7.3$  ml/kg/min and  $37.4 \pm 2.7$  ml/kg/min respectively with the McArdle equation and the value was higher when compared with Chatterjee's equations. The value of  $VO_2$  max was observed and found to be less in smokers and sedentary individuals.

**Conclusion:** As the values of  $VO_2$  max obtained from different equations are different, this research strongly argues the need of developing a prediction equation specifically for the Nepalese population.

**Keywords:** Cardiopulmonary fitness, Submaximal exercise,  $VO_2$ max

## INTRODUCTION

Nepal Health Research Council (NHRC) estimated that 38% of the adult population in Nepal suffers from cardiovascular diseases with about half suffering from hypertension [1]. The prevalence is highest in the Central

development region where people have a more sedentary lifestyle [2]. Studies have shown that there is a strong relation between cardiopulmonary fitness and mortality due to cardiovascular diseases including hypertension, myocardial infarction and also the complications

of diabetes [3]. Cardiovascular fitness is also of interest in relation to rehabilitation of cardiac problems, improved performance in neuropsychological test, increasing fitness concern of people.

As the values of  $VO_2$  max varies among different populations, the present study aims to estimate the level of  $VO_2$  max in young healthy Nepalese adults using a well-established submaximal exercise test, the Queen's College Step test. Since different prediction equation have been proposed, the outcome with these equations will be compared.

#### MATERIAL AND METHODS

The study was conducted in the Department of Physiology, Kathmandu Medical College, Duwakot. One hundred and sixty medical students of MBBS I and II year volunteered for the test. Study was approved by Ethics committee of Kathmandu Medical College and written consent was taken from volunteers. The protocol was fully explained and written consent was taken from the volunteers. Individuals with cardiac and lung diseases, those having problems in the lower limbs or using drugs known to influence the cardiovascular system were excluded from the study. The subjects were asked to refrain from physical activity on the day of the test. All experiments were done in room temperature with participants dressed in suitable clothes. Anthropometric parameters like height and weight was measured using stadiometer with barefoot and in light clothes. BMI was categorized according to classification for Asian population [4].

To determine  $VO_2$  max, the Queen's college step-stool of 16.25 inches was used. Stepping was done for a total duration of 3 minutes at the rate of 24 cycles per minute for males and 22 cycles per minute for females.

A metronome was used to pace the stepping cycle in four step cadences; up-up, down-down continuously for 3 minutes. After completion of the exercise, subjects remained standing while the carotid pulse rate was monitored for 15 seconds from the 6<sup>th</sup> second of the recovery period. The carotid pulse rate was taken as heart rate.

$VO_2$  max was calculated from the measured heart rate, using the internationally accepted Mc Ardle equations:

**For Males:**

$VO_2$  max (ml/kg/min)=111.33-(0.42 x pulse rate in beats per min) [5]

**For Females:**

$VO_2$  max (ml/kg/min)=65.81-(0.1847 x pulse rate in beats per min) [5]

For comparison, the following equations for the  $VO_2$  max determined for Indian adults were used (Chatterjee et al.).

**For Males:**

$VO_2$  max (ml/kg/min)=55.23-(0.09 x pulse rate in beats/min) [6]

**For Females:**

$VO_2$  max (ml/kg/min)=54.12-(0.13 x pulse rate in beats/min) [7]

For classification of aerobic fitness Katch et al. [5] categories were used as shown in Table 1. Statistical analysis was done using Microsoft Excel 2003. Values are given as Mean  $\pm$  Standard Deviation (SD). Student's t- test was used to compare results, taking  $P < 0.05$  as significant.

**Table 1: Aerobic fitness classification according to Katch et al. [5]**

Category	Male		Female	
	13-19 years	20-29 years	13-19 years	20-29 years
Poor	<35- 38.3	<33.0 -36.4	<25.0-30.9	<23.6-28.9
Fair	38.4 - 45.1	36.5 - 42.4	31.0 - 34.9	29.0 - 32.9
Good	45.2 - 50.9	42.5 - 46.4	35.0 - 38.9	33.0 - 36.9
Excellent	51.0 - 55.9	46.5 - 52.4	39.0 - 41.9	37.0 - 41.0
Superior	>55.9	>52.4	>41.9	>41.0

**RESULTS**

A total of 158 healthy Medical students participated in the study, 79 females and 79 males. Anthropometric and cardiovascular variables for the study groups are summarized in table 2. Most participants were in the age group 18 to 21 with males slightly older than females. As shown in table 2, they were also taller and heavier as expected. Significant difference is seen for anthropometric parameters and blood pressure variables with lower values found for females. No difference was found for heart rate.

**Table 2: Values for anthropometric parameters and cardiovascular variables in males and females**

Variables	Males Mean ± SD	Females Mean ± SD	P value
Age (yrs)	20.00 ± 1.00	19.00 ± 1	0.002*
Height (m)	1.69 ± 0.06	1.56 ± 0.05	0.000*
Weight (Kgs)	63.50 ± 10.40	52.30 ± 6.90	0.000*
BMI	22.20 ± 3.20	21.50 ± 2.60	0.028*
Systolic (mmHg)	121.00 ± 10.00	111.00 ± 9.00	0.000*
Diastolic (mmHg)	72.00 ± 9.00	67.00 ± 9.00	0.017*
Resting Heart rate	77.00 ± 8.00	77.00 ± 9.00	0.50 <sup>ns</sup>

\*, significant at p<0.05; <sup>ns</sup> not significant

The BMI was significantly higher in males than in females. Since the number of obese participants was very few, they were included in overweight category for the analysis.

**Table 3: Estimated VO<sub>2</sub> max according to different prediction equations in male and female**

VO <sub>2</sub> max	Male (ml/kg/min)	Female (ml/kg/min)
Mc Ardle equation	48.80 ± 7.30	37.40 ± 2.70
Chatterjee's equation	41.90 ± 1.57	34.00 ± 1.90

Estimated VO<sub>2</sub> max using Mc Ardle equation was significantly higher in males (48.8 ± 7.3) than in

females (37.4±2.7; P<0.001) (Table: 3). The VO<sub>2</sub> max obtained from Chatterjee's equation was significantly lower both for males (41.9 ± 1.57 ml/kg/min) and female (34 ± 1.9 ml/kg/min) compared to the Mc Ardle estimates. However the values for males and females were still significantly different (P < 0.001) using Chatterjee's equations.

**Figure 1: Comparison of VO<sub>2</sub> max obtained from Mc Ardle equation with Chatterjee's equation in males**

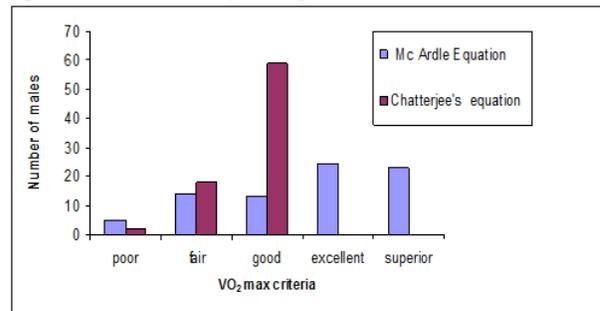
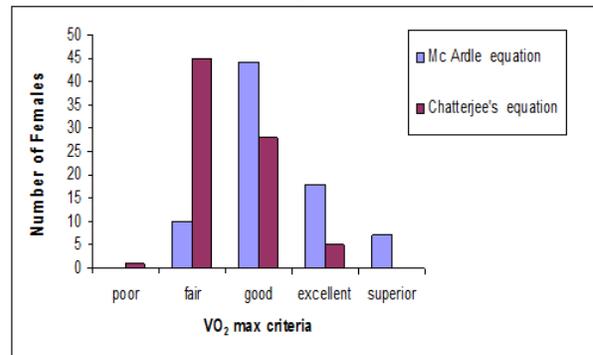


Fig 2 and 3 shows the comparison of VO<sub>2</sub> max obtained from Mc Ardle equation with Chatterjee's equation in males and females. For comparison, VO<sub>2</sub> max was classified into different categories as shown in table 1. Much lower values were observed in using Chatterjee's equation.

**Figure 2: Comparison of VO<sub>2</sub> max obtained from MC Ardle equation with Chatterjee's equation in females.**



Of studied males, 16/69 reported that they were cigarette smokers. A significant difference was observed in VO<sub>2</sub> max of these compared to non smoking males (P < 0.01; Table 4). None of the studied females were smokers. The participants who played games (football, cricket), perform yoga, danced and were jogging were considered to be physically active. For both males and females this group differed significantly in VO<sub>2</sub> max from their more sedentary counterparts (Tables 5 and 6). There were also significant differences in VO<sub>2</sub> max between overweight/obese and normal weight groups, both for males and females.

**Table 4: Comparative study of VO<sub>2</sub> max between smokers and non smokers according to Mc Ardle equations**

Variables	No of participants	VO <sub>2</sub> max (Mean ± SD)	P value
Smokers	16	45.10 ± 7.48	0.009
Non smokers	63	49.90 ± 6.99	

**Table 6: Comparative study of VO<sub>2</sub> max with different behavioural parameters in females according to Mc Ardle equations**

Variables	No of participants	VO <sub>2</sub> max (Mean ± SD)	P value
Physically active	13	39.10 ± 3.07	0.004
Physically inactive	66	36.90 ± 2.50	
Normal	59	37.70 ± 2.70	0.008
Overweight/Obese	17	35.90 ± 2.49	

**Table 6: Comparative study of VO<sub>2</sub> max with different behavioural parameters in females according to Mc Ardle equations**

Variables	No of participants	VO <sub>2</sub> max (Mean ± SD)	P value
Physically active	13	39.10 ± 3.07	0.004
Physically inactive	66	36.90 ± 2.50	
Normal	59	37.70 ± 2.70	0.008
Overweight/Obese	17	35.90 ± 2.49	

## DISCUSSION

Physical fitness is not only required in sports but also to sustain ordinary life. Males had

higher values of estimated VO<sub>2</sub> max than their female counterparts as has been observed previously in studies from this country and abroad [6-8]. This difference is attributed to body composition. Untrained young female possess 25% of body fat whereas the corresponding value for men averages 15%. Due to higher level of testosterone men also shows 10-14% increases in haemoglobin. Therefore the resulting increase in blood oxygen carrying capacity increases VO<sub>2</sub> max in male [5, 9].

The values of VO<sub>2</sub> max obtained in the study were higher than the values obtained for other South Asian populations in the same age group suggesting a higher aerobic capacity in Nepalese adult [9-11]. Such result could be predicted because of life style and geographical differences (Kathmandu: 1400 meters, Kolkata: 1.5-9 meters).

Estimated VO<sub>2</sub> max of smokers was less than that of non smokers which is similar to the result obtained in other studies [11, 12]. However, the difference was smaller here, presumably because the volunteers recruited were recent, moderate smokers.

While comparing VO<sub>2</sub> max of volunteers who are involved in some kind of physical activity like sports, dance, yoga etc with those who never exercise, the value is higher in those who involve in any kinds of physical activities. Variations in VO<sub>2</sub> max during different mode of exercise reflect quantity of activated muscle mass. Aerobic exercise can only produce cardiovascular conditioning. Aerobic capacity with training improves between 6-20% although it has been reported above 50% [5]. A study conducted by Gromley et al. (2008) on

effect of intensity of aerobic training on  $VO_2$  max found that improvement of  $VO_2$  max was significant in those young adults who exercise in higher intensity [13].

The largest  $VO_2$  max improves occurs among sedentary individuals.

The values of  $VO_2$  max estimated from Mc Ardle equations were much greater than that from Chatterjee's equations. There were appreciable numbers of males in the "excellent" and "superior" categories with Mc Ardle equations whereas with Chatterjee's equations, they are limited to the "good" category. Similarly in females, there are only a few in the "excellent" and none in the "superior" category using Chatterjee's equation (Fig 1 and 2). According to our result it can be speculated that Mc Ardle equations overestimated  $VO_2$  max while Chatterjee's equation underestimated  $VO_2$  max, especially in males. Whatsoever is the reason is, this discrepancy points to there is a strong need to find a prediction equation for the Nepalese population, as there are difference in health, ethnicity and socioeconomic background compared to Indians as well as to western populations.

## CONCLUSION

This study shows that there are significant differences in  $VO_2$  max between the genders and between adults with different behavioural habits. The result obtained from Chatterjee's equations does not seem to be realistic in our group of population as Nepal is a hilly region and walking in such landscape is different from walking in plain land as in India. Also in this study group, no males were categorized as excellent even though male are more athletic

study group, no males were categorized as excellent even though male are more athletic than females. It seems that the value of  $VO_2$  max in Nepalese population is overestimated by Mc Ardle equations and underestimated by Chatterjee's prediction equations.

The discrepancy of  $VO_2$  max among different population underlines the need to derive a prediction equation specific for our population.

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