



**Research Article**

**VO<sub>2</sub> MAX AND ITS ASSOCIATION WITH PERCENTAGE BODY FAT AMONG UNIVERSITY PHYSIOTHERAPY STUDENTS**

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**ABSTRACT**

**Objective:** Cardiorespiratory fitness in terms of VO<sub>2</sub>max is a best measure of cardio respiratory capacity. The main aim of the present study was to assess and compare the cardiorespiratory fitness in terms of VO<sub>2</sub>max among male and female students of Teerthanker Mahaveer University, Moradabad and to find its correlation with % body fat and % lean body mass.

**Method:** A total of 62 young adult males and females (n= 31 each) were randomly selected from Teerthanker Mahaveer University, Moradabad. VO<sub>2</sub>max was calculated using Queen's College Step test. Height, Weight, BMI, four skinfolds, upper arm and hip circumference, % body fat and % lean body mass were also measured.

**Result:** In the present study, VO<sub>2</sub>max for male students was found to be 43.11 ml/kg/min and 36.28 ml/kg/min for female students. The mean value of VO<sub>2</sub>max was found to be significantly higher in males as compared to the females (p< 0.001). It was found to be negatively correlated with % body fat (non-significant).

**Conclusion:** The VO<sub>2</sub>max value of males was found to be more than females and it was found to be negatively correlated with percent body fat

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**INTRODUCTION**

Performance of daily tasks without undue fatigue requires a certain degree of physical fitness. A high level of physical fitness has been found to be associated with lower risk of developing hypertension.<sup>[1]</sup> Aerobic or cardiovascular fitness forms one of the most important components of overall fitness because it represents the ability of body to take up and use oxygen to supply energy throughout the body. The highest rate of oxygen consumption (VO<sub>2</sub>max) attained during maximal or exhaustive exercise is an internationally accepted parameter to evaluate cardiorespiratory fitness and its direct measurement is restricted in well equipped laboratories due to its difficult experimental protocols.<sup>[2-4]</sup>

Anthropometry involves systematic measurements of physical properties of human body. These measurements are useful in describing the body composition of an individual or population. Anthropometric variables have been found to be good predictors of cardiovascular risk factors.<sup>[5]</sup> BMI is a measure of body fat based on height and weight and is used as a measure of health of males and females. It is frequently used in estimation of fatness.<sup>[6]</sup>

Anthropometric measurements or body composition and cardiorespiratory fitness or aerobic capacity are frequently used in association with each other as studies by Minasian *et. al.*<sup>[7]</sup> and Goran *et. al.*<sup>[8]</sup> suggest that when body composition and cardiovascular fitness are good, then person is at a lower and reduced risk of factors affecting individual's health. Study on cardiovascular fitness of college students was reported by Rai *et. al.*<sup>[9]</sup>

In the present study, VO<sub>2</sub>max and anthropometric variables of students of Teerthanker Mahaveer University, Moradabad were measured and a correlation of VO<sub>2</sub>max was found with % body fat and % lean body mass.

**MATERIALS AND METHODS**

A total of 62 university students (31 males and 31 females) aged 18-25 years were randomly selected from Physiotherapy Department, Teerthanker Mahaveer University, Moradabad. All the subjects were apparently healthy and free from any kind of illness. Age of the subjects was recorded from the institutional records. Height, weight, BMI, four skinfolds (Biceps, Triceps, Subscapular, Suprailiac), upperarm circumference, hip circumference, % body fat, % lean body mass and VO<sub>2</sub>max were measured. Height was recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm, and weight was measured by digital standing scales (Model DS-410, Seiko, Tokyo,

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Japan) to the nearest 0.1 kg. B.M.I was calculated using formula-Weight (Kg)/ (Height in m<sup>2</sup>).

Skinfold measurements were taken from four sites, viz. biceps, triceps, subscapular and suprailiac using Harpenden skinfold caliper (Holtain Ltd, Crosswell, Crymych, UK) to the nearest 0.2 mm. Percent body fat was calculated using the Siri<sup>[10]</sup> and Durnin and Womersley<sup>[11]</sup> skinfold equation. Percentage lean body mass was calculated using the formula:

$$\% \text{ lean body mass} = 100 - \% \text{ body fat}$$

Upper arm circumference and hip circumference were measured using a steel tape and the reading was recorded in cm. Estimation of VO<sub>2</sub>max was done by using Queen’s college step test. The test was performed by stepping up and down on a wooden box of 41.3 cm height for 3 minutes at the following rate: 24cycles/min for males and 22 cycles/ min for females. The cycle rate was set up by a metronome. After completion of the test, the subject remained standing and the carotid pulse rate was measured from 5-20 seconds of the recovery period. This 15 second pulse rate was converted into beats/min. Following equations were used to predict VO<sub>2</sub>max:

Males: VO<sub>2</sub>max (ml/Kg/min) = 111.33-(0.42 x heart rate in beats/min)

Females: VO<sub>2</sub>max (ml/kg/min) = 65.81 – (0.1847 x heart rate in beats/min)

Statistical analysis was done using SPSS version 20. The analysed data were explained by using descriptive statistics (Mean and Standard Deviation) and coefficient of correlation “r”. The level of significance was set at p< 0.05.

## RESULTS

The statistical analysis of data showed that males recorded higher mean values for height (164.25 cm), weight (62.02 Kg), BMI(23.01 Kg/m<sup>2</sup>), biceps skinfold (11.41mm), suprailiac skinfold (20.20 mm), percent lean body mass (77.81%), and VO<sub>2</sub>max (43.11 ml/kg/min) as compared to females. Females recorded higher mean values for hip circumference (94.20 cm), triceps skinfold (16.33 mm), subscapular skinfold (20.64) and % body fat (31.21%). Statistically significant differences were observed for height, weight, upper arm circumference, % body fat, % lean body mass and VO<sub>2</sub>max between males and females (Table 1). A negative correlation of VO<sub>2</sub>max with % body fat and a positive correlation with % lean body mass were found in both males and females though it was non-significant for both (Table 2).

**Table 1** Descriptive statistics of VO<sub>2</sub>max and anthropometric variables between male and female university students.

Variables	Males (n= 31)		Females (n= 31)		t value	p value
	Mean	Standard Deviation	Mean	Standard Deviation		
Height	164.25	7.44	152.32	5.24	7.299	<0.001
Weight	62.02	7.82	52.45	5.97	5.414	<0.001
BMI	23.01	2.71	22.57	1.99	0.729	0.469
Upper arm circumference	28.11	2.44	24.51	1.85	6.536	<0.001
Hip circumference	90.51	13.40	94.20	4.73	1.447	0.153
Biceps skinfold	11.41	1.28	11.09	1.64	0.862	0.392
Triceps skinfold	15.08	3.86	16.33	3.91	-1.273	0.208
Subscapularis skinfold	20.32	5.77	20.64	1.72	-0.298	0.767
Suprailiac skinfold	20.20	7.19	20.00	2.11	0.156	0.877
% Body fat	22.18	2.73	31.21	1.60	15.884	<0.001
% Lean body mass	77.81	2.73	68.78	1.60	15.884	<0.001
VO <sub>2</sub> max	43.11	3.63	36.28	3.09	8.243	<0.001

**Table 2** Correlation of VO<sub>2</sub>max with % body fat and % lean body mass

	MALES		FEMALES	
	r	p	r	p
% Body Fat	-0.165	0.374	-0.024	0.899
% Lean Body Mass	0.165	0.374	0.024	0.899

## DISCUSSION

VO<sub>2</sub> max is the measure of functional limit of cardiorespiratory system and a single most valid index of maximal exercise capacity<sup>[12]</sup>. Due to exhausting and difficult protocol as well as equipped lab, the use of direct method to use VO<sub>2</sub>max is restricted<sup>[13]</sup>. Among various protocols, Queens College Step test has established as the best indirect method to evaluate fitness in young Indian Individuals<sup>[14]</sup>.

A decrease in the VO<sub>2</sub>max value is an indicator of reduced exercise capacity or tolerance. Clinical studies have established a strong association between low cardiorespiratory fitness and mortality<sup>[15-17]</sup>. On comparison of VO<sub>2</sub>max with standard VO<sub>2</sub>max classification, the subjects of present study fitted in the good category<sup>[18]</sup>. It is in contrast with the findings of Heyward<sup>[18]</sup> whose subjects fitted in the fair category. It could be due to the regular participation of or subjects in some degree of physical activity. The higher value of VO<sub>2</sub>max in males as compared to females is in accordance with the findings from previous studies.<sup>[2,13,19]</sup> Difference in the aerobic capacity between males and females might be due to different types of distribution of fat free mass in males and females.

A negative correlation of VO<sub>2</sub>max was found with % body fat and a positive correlation with % lean body mass in both males and females though it was not significant (Table 2). It indicates that an adult person with increased % body fat would have less aerobic capacity compared with a person with increased % body fat as is supported by Watanabe *et. al.*<sup>[20]</sup>, Minasian *et. al.*<sup>[7]</sup> and Amani *et. al.*<sup>[21]</sup> Our findings are similar to previous studies showing negative correlation of VO<sub>2</sub>max with % body fat.<sup>[20,22]</sup> Chatterjee *et. al.*<sup>[23]</sup> used Queens College Step test in their study to assess cardiorespiratory fitness in obese and non obese boys aged 10-16 years and found that VO<sub>2</sub>max /kg of body weight was relatively less in obese subjects indicating reduced aerobic capacity. They concluded that during exhaustive exercise, the excessive hyperactive body musculature fails to uptake sufficient amount of oxygen due to deposition of proportional high amount of fat mass. Bandyopadhyay<sup>[24]</sup> studied cardiorespiratory fitness in obese girls and found that VO<sub>2</sub>max was less in obese girls. This was probably due to excess deposition of fat that led to the hindering effects. Inadequate physical activity and sedentary lifestyle is not only associated with increase in body fat percent but it is also a cause of decrease in relative muscle mass. More the muscle mass involved in exercise, greater the contribution of muscle pump to venous return. Hence, increase in muscle mass helps to receive an increased cardiac output. Increase in regular physical activity or exercise may help to decrease the body fat percent which may help in relative increase in fat free mass and an increase in VO<sub>2</sub>max. Beneficial effects of exercise on increment of VO<sub>2</sub>max has also been established.<sup>[25]</sup>

## CONCLUSION

The VO<sub>2</sub>max values of males as found to be more than females and it was found to be negatively correlated with percent body fat. Hence, regular physical activity should be recommended for individuals in order to maintain physical fitness. The study may further be extended to a larger sample size including obese as well as athletes.

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