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Original Research Article

Effect of Body Mass Index on Peak Oxygen Consumption (VO_2max) in Young Healthy Males

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Abstract

Background: Cardiorespiratory fitness (CRF) is not only objective measure of habitual physical activity, but also a useful diagnostic and prognostic health indicator for patients in clinical settings. CRF is a strong and independent predictor of cardiovascular disease mortality. Low CRF in young adults has emerged as an important factor for developing cardiovascular comorbidities later in middle age. ***Aims:*** To determine the peak oxygen consumption (VO_2max) by Queen's college step test in young male subjects. To study the relation between body mass index and VO_2max. ***Methods:*** One hundred young healthy male subjects in the age group of 18 to 25 years were included in this study group. Body mass index (BMI) was measured using standard calibrated instruments. VO_2max was assessed by following the protocol of Queen's College Step Test (QCT). ***Results:*** Data was statistically analysed by using Pearson's correlation. There was a significant negative correlation between Body mass index and VO_2max (ml/kg/min) ($r= -0.418$, $p<0.01$). ***Conclusion:*** The results suggest excessive amount of body fat exerts an unfavourable burden on cardiac function and oxygen uptake by working muscles. In our study BMI has significant negative correlation with VO_2max and can be used in clinical settings to estimate cardiorespiratory fitness as it is a rapid and inexpensive method.

Keywords: VO_2max, QCT, BMI, CRF.

INTRODUCTION

The prevalence of cardiovascular disease has increased substantially over the past few decades in younger population [1]. VO_2max is internationally accepted parameter to evaluate cardiovascular fitness [2]. CRF is an important component of physical fitness, representing the body's ability to take oxygen in and deliver this oxygen to muscle cells throughout the body during physical activity. Previous studies have emphasized the importance of CRF, providing convincing evidence that CRF is closely related to all-cause mortality [3, 4]. Earlier studies have established the use of Queen's college step test to predict VO_2max indirectly [5].

Obesity is considered one of the most important medical and public health problems of our time. Excess body fat has been identified as a major risk factor for several common disorders including diabetes and cardiovascular diseases and imposes a substantial burden on health care systems [6]. Obesity can be measured in various ways. Body mass index (BMI) is the most commonly used measure of relative weight. It can be used both at individual level to asses body weight in a clinical setting and at population level where it would be impractical or too expensive to measure (excess) body fat accurately and consistently [7].

Earlier studies have demonstrated the importance of low VO_2max in young adulthood as a factor for developing cardiovascular comorbidities later in middle age [8]. This study is designed to evaluate VO_2max and its relation with body mass index in young healthy male subjects.

METHODS

The study group comprises of 100 young healthy males in the age group of 18-25 yrs. Ethical clearance for the study protocol was obtained; subject's clinical history and details were taken according to the standard proforma. Informed written consent was taken from all subjects in the study. The study involved non-invasive procedures and was performed at room temperature.

Subjects with history of cardiac disease, lung disease, Smoking history, those on regular medications affecting cardiovascular and respiratory system and those who are undergoing any physical conditioning programme were excluded from the study. The experimental protocol was fully explained to the participants to allay apprehension. The subjects were refrained from any energetic physical activity for 3 hours before the test.

Experimental design

Data was collected by calculating body mass index and assessing VO_2 max indirectly by Queen's college step test. Weight and height were measured using standard calibrated instruments. Subject's height was measured without shoes in centimeters and weight was measured in kilograms with subject in minimal clothes and bare foot. The BMI was calculated using the below formula [9].

$$BMI = \frac{\text{weight in kgs}}{(\text{Height in meters})^2}$$

Step test was performed using a stool of 16.25 inches (41.30cms) height. Stepping was done for a total duration of 3 minutes at the rate of 24 cycles per minute which was set by a stop watch. After completion of the exercise the subjects were asked to remain standing comfortably and carotid pulse rate was measured from 5^{th} to 20^{th} second of recovery period. This 15 second pulse rate is converted into beats per minute and VO_2max is predicted using the following equation [10].

$$VO_2 \text{ max} = 111.33 - (0.42 \times \text{pulse rate in beats per minute})$$

RESULTS

VO_2max was evaluated and then the effect of BMI on cardiorespiratory fitness was studied in 100 young healthy males. Data was statistically analysed by Pearson's correlation and results are shown in tables and graphs. The data profile of subjects including name, age, height, weight, body mass index, QCT pulse rate and VO_2max with their mean and standard deviation are shown in table 1.There was a significant negative correlation between BMI and VO_2max (ml/kg/min)) r= -0.626, $p<0.01$ (figure 1 and table 2).

Table-1: Profile of the study group

Parameters	No	Mean	Standard Deviation
Age (yrs)	100	19.06	1.269852
Weight (kg)	100	63.04	11.78762
Height (m)	100	1.7047	0.062465
BMI (Kg/m^2)	100	21.66074	3.719306
QCT pulse rate	100	170.04	16.08558
VO_2max(ml/kg/min)	100	39.9132	6.755943

Table-2: Correlation between BMI and VO_2 max.

Variable		VO_2max
BMI	r	-0.626**
	p	<0.01*

*--Significant

**--the correlation between BMI and VO_2max is negative .i.e., as BMI increases the VO_2max is decreasing and vice versa.

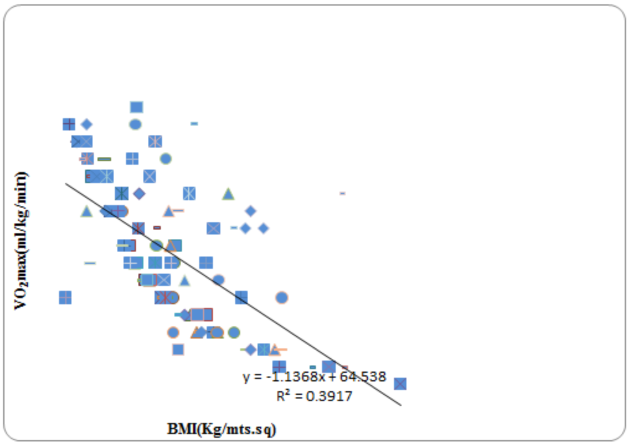

Fig-1: Scatter diagram showing relationship between BMI and VO_2max.

DISCUSSION

VO_2max is a measure of the functional limit of cardiorespiratory system and single most valid index of maximal exercise capacity. The absolute value of VO_2max is one of the indices of individuals CRF to transport oxygen to working muscles. Earlier studies have used VO_2max values in ml/kg/min to examine the performance of CRF.

Excessive amount of body fat exerts an unfavorable burden as well as hindering action towards cardiac function, particularly during exhaustive exercise, when excessive hyperactive body musculature fails to uptake sufficient amount of oxygen due to deposition of proportionately high amount of fat mass. Loss of weight during weight reduction program of obese increased their VO_2max (ml/kg/min) due to withdrawal of fat induced inhibitory action towards oxygen utilization by body musculature [11].

Elevated myocardial oxidative stress has been reported in patients with obesity. In obese individuals there is increase in type II muscle fibers and decrease in type I muscle fibers which may have important effect on reduced oxygen uptake. Overweight subjects have much greater increase in sympathetic nerve firing rate than normal subjects. Obesity is said to produce a state of chronic volume overload because heart is required to continuously circulate blood through the large and relatively low resistance depot of adipose tissue. Increased preload and stroke volume are associated with hypertension. Combination of overweight and hypertension leads to thickening of ventricular wall and larger heart volume and thus a greater likelihood of cardiac failure [12].

Body mass index (BMI) has traditionally been used to identify individuals who are the most likely to be overweight or obese. It was developed by Belgian polymath Adolphe Quetelet in course of working out his systems of “Social Physics” between 1830 and 1850 (also known as Quetelet index). Generally, a high value indicates excessive body fat and consistently relates to increased health risks and mortality. Unusually large muscle mass, as in trained athletes, can increase BMI to 30, but rarely above 32. BMI categories and cut-offs are commonly used to guide patient management [9].

Welch *et al*. reported that VO_2max was significantly decreased in overweight individuals when fat mass was taken into account which suggests the possibility of deconditioning and changes in cardiorespiratory function in severely overweight individuals [13]. Watanabe K *et al*. reported that obesity accentuates exercise intolerance and low aerobic capacity [14]. Similar results were observed by Rowland TW *et al.* [15]

Norman *et al.* studied influence of excess adiposity on exercise fitness and performance in overweight children and adolescents and found that overweight and non-over weight adolescents had similar absolute CRF but the functional impairment was significantly associated with increased energy demands needed to move their excess bodyweight [16]. Several previous studies have found no significant differences in VO_2max between obese and non-obese.

CONCLUSIONS

There was a significant negative correlation between BMI and VO_2max (ml/kg/min). This suggests the effect of body fat on cardiorespiratory functions. These findings demonstrate the importance of low CRF in young adults with increased body fat is a factor for developing cardiovascular comorbidities later in middle age. BMI can be used in clinical settings to estimate CRF as they are rapid and inexpensive methods. Given the current obesity trend and observations of a decline in daily energy expenditure among the people, improving peak oxygen consumption in young men by engaging in physical activities is important.

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