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TO EVALUATE CARDIORESPIRATORY FITNESS & THE EFFECT OF BODY MASS INDEX ON CARDIORESPIRATORY FITNESS IN YOUNG HEALTHY MALES

V. Prabha[1], B.R. Doddamani[2], Sureshbalaji[3]

[1]Department of Physiology, Vinayaka Mission's Kirupananda Variyar Medical College and Hospitals, Salem, Tamil Nadu
[2]Department of Physiology, Kamineni Institute of Medical Sciences, Narketpally, Andhra Pradesh
[3]Department of Physiology, Chennai Medical College Hospital & Research Centre, Trichy, Tamil Nadu

E-mail of Corresponding Author: prabhavsetty@gmail.com

ABSTRACT

Background and objective: Obesity is a serious & widespread problem globally. Reduced cardio respiratory fitness in young adults has emerged as an important factor for developing cardiovascular co morbidities later in middle age. Maximum oxygen consumption (VO_2max) is the internationally accepted parameter to evaluate cardio respiratory fitness. Numerous clinical investigations have established a strong association between low cardio respiratory fitness and mortality. Increased body fatness is an additional factor for developing cardiovascular diseases. Hence, the current study was designed to evaluate cardio respiratory fitness in terms of VO_2max in young healthy males and to study the relation between body mass index and cardio respiratory fitness. **Methodology:** Hundred young healthy male subjects in the age group of 18 to 25 years were included in this study group. Body mass index was measured as weight in kilograms divided by height in meters square. Cardio-respiratory fitness in terms of VO_2max was assessed by following the protocol of Queen's College Step Test. **Results:** There was a significant negative correlation between body mass index (BMI) and VO_2max (ml/kg/min) ($r = -0.66$, $p<0.01$). **Conclusion:** The results suggest the striking effect of body fatness on cardio respiratory functions. Excessive amount of body fat exerts an unfavorable burden on cardiac function and oxygen uptake by working muscles. Low cardio respiratory fitness in young adults with increased body fatness could be a factor for developing cardiovascular co morbidities later in middle age.

Keywords: VO_2max, QCT, BMI

INTRODUCTION

Obesity is a serious & widespread problem globally. Technological developments & modern day commodities have driven most people into sedentary life style leading to chronic diseases like hypertension, heart disease, chronic low backache & obesity. Maximal oxygen consumption is considered the gold standard of cardio-pulmonary and muscle cell fitness. Maximal oxygen uptake (VO_2max) is the highest rate of oxygen consumption attainable during maximal or exhaustive exercise. VO_2max is internationally accepted parameter & is the first choice in measuring a person's cardiopulmonary status & it is a fundamental measure of physiological functional capacity to exercise. Those who are more fit have higher VO_2max and can exercise more intensely and longer than those who are not as well conditioned. The prevalence of cardiovascular disease has increased substantially over the past two decades in younger population (1). Reduced

cardiopulmonary fitness is associated with increased cardiovascular disease (2).

Unfavorable cardiovascular risk profiles are found in youth with low levels of cardiovascular fitness and high percentage of body fat. Numerous risk factors for cardiovascular diseases including hypertension, diabetes and hypercholesterolemia are suspected to be influenced by fitness (3, 4) and these factors may mediate the association between low cardio respiratory fitness and mortality. Obesity is an independent risk factor for cardiovascular disease. Earlier studies have demonstrated the importance of low cardio respiratory fitness in young adulthood as a factor for developing cardiovascular co morbidities later in middle age (1). Hence, the current study was designed to evaluate cardio respiratory fitness in terms of VO_2max and its relation with body mass index in young healthy male subjects.

MATERIALS AND METHODS

The study group comprises of hundred young healthy males from Kolar city in the age group of 18-25yrs.

Hundred apparently healthy male subjects were selected from Kolar city and examined. They were asked to fill a questionnaire to assess their physical activity status. The experimental protocol was fully explained to the participants to allay apprehension. They refrained from any energetic physical activity for 2 to 3 hours before the test. Informed consent was taken from all the subjects. The study was approved by institutional Ethical Committee.

Experimental design:

Data is collected by calculating body mass index and assessing VO_2max indirectly by Queen's college step test. Weight was measured using calibrated weighing machine in light clothing and bare feet and height was measured using measuring scale in centimeters which was fixed to the wall. All experiments were performed at room temperature. Body mass index was calculated using the formula:

$$BMI = \text{weight (kg)}/\text{height (m}^2\text{)}$$

Measurements of body weight (anthropometry) are used to reflect body fat in clinical settings as these measurements provide rapid and cheap way to estimate body fat.

Queen's College Step Test:

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 metronome. After completion of the exercise the subjects were asked to remain standing comfortably and the carotid pulse rate was measured from the 5^{th} to 20^{th} second of recovery period. This 15 second pulse rate was converted into beats per minute and the following equation was used to predict VO_2max (5).

PVO_2max (ml/kg/min) = 111.33 - (0.42 x pulse rate in beats per min)

Statistical analysis:

The results were expressed as mean ± standard deviation (SD). A p value of <0.05 was considered statistically significant. Statistical analysis was performed using the statistical package for social & sciences. Pearson correlation was applied to correlate between parameters.

RESULTS

Hundred young healthy males, in the age group of 18-22 yrs (19.38±1.49) were subjected to treadmill jogging test. Cardio respiratory fitness in terms of VO_2max was evaluated and then the effect of BMI on cardio respiratory fitness was studied.

BMI (22.04 ± 3.96) shows a highly significant direct correlation with treadmill heart rate (171 ± 12.61), $r = 0.66$ $p<0.01$ (Table 1). In contrast, BMI (22.04 ± 3.96) shows highly significant

negative correlation with VO_2max (39.45 ± 5.29) r = -0.66 p<0.01 (Table 2).

DISCUSSION

Physical fitness & its awareness have assumed more importance in the present day scenario. This is because of overweight & obesity is associated with many chronic diseases. Younger men with greater BMI are at greater risk of high blood pressure, high blood glucose levels, and high total cholesterol than older men.

Obesity is an epidemic disease. Increased free fatty acids results in insulin resistance. The release of cytokines particularly IL-6 stimulate proinflammatory state that characterizes obesity. Increased secretion of prothrombin activator inhibitor- 1 from fat cells plays a role in procoagulant state of obesity and along with changes in endothelial function increases risk of cardiovascular disease and hypertension. Production of estrogen from stroma mass plays a role in risk of breast cancer. Combined effects of these consequences of increased fat stores in an increase risk of shortened life expectancy.

Rocchini et al studied that, blood pressure is increased in overweight individuals. Overweight subjects have much greater increase in sympathetic nerve firing rate than normal subjects. There is also increase in peripheral resistance. Obesity is said to produce a state of chronic volume overload because heart has 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 left ventricular hypertrophy and larger heart volume and thus a greater likelihood of cardiac failure. Other causes of left ventricular hypertrophy in obese include trophic effects of fat secreted hormones and a training effect on heart because of extreme amount of body weight that has to be lifted during normal activities(6).

Coronary artery disease is increased in 3.3 fold with a BMI greater than 29kg/m^2 compared with that in women with a BMI less than 21kg/m^2(7). A BMI of 27-29kg/m^2 increases relative risk of 1.8. The all cause mortality and cardiovascular mortality were higher in men with a BMI greater than 30 kg/m^2 and lowest in those with a BMI between 18.5 and 24.9 kg/m^2. Dyslipidemia may be important in relationship of BMI to increased risk of heart disease. There is positive correlation between BMI and triglycerides. However the inverse relationship between HDL cholesterol and BMI is more important because low HDL carries greater risk.

VO_2max is a measure of the functional limit of cardio respiratory system and single most valid index of maximal exercise capacity. The absolute value of VO_2max is one of the indices of an individual's cardio respiratory fitness to transport oxygen to working muscles.

Ozcelick et al showed high aerobic fitness is associated with a reduction in risk factors related to cardiovascular diseases (8). Fitness promotes muscle insulin sensitivity (9), insulin mediated transport of glucose from blood to muscle (10), improved nervous system function (11), and lower heart rates. Increased lipoprotein lipase activity in skeletal muscle which results in an enhanced clearance rate of plasma triglycerides, increased transport of lipids and lipoproteins from the peripheral circulation and tissues to the liver, and enhanced high density cholesterol are mechanisms by which lipids may improve with fitness (12).

Mercedes et al have demonstrated the importance of low cardio respiratory fitness in young adulthood as a factor for developing cardiovascular co morbidities later in middle age (1). As QCT is a simple test & does not require specialized equipment. It is obvious, that wherever the test is to be used in field conditions, QCT would be the preferred method. Large number of individuals can be tested and

they are easily performed by untrained individuals.

In this study we found a significant negative correlation between BMI and VO_2max (ml/kg/min) ($r = -0.66$, $p<0.01$). This indicates the striking effects of increasing BMI on cardio respiratory fitness. We also found a significant positive correlation between BMI and heart rate during test ($r = 0.66$ & $p < 0.01$).

Chatterjee et al studied 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 (13). 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. Reduced cardiac performance during progressive work rate exercise has been reported in obese individuals.

Watanabe K et al have reported that VO_2max was significantly decreased in overweight individuals. Greater the BMI, more severe will be the functional impairment. Excess body fat impairs cardio respiratory functions and decreases mechanical efficiency for a given workload. Obesity accentuates exercise intolerance and lowers aerobic capacity (14).

CONCLUSION

1. There was a significant negative correlation between BMI and VO_2max (ml/kg/min). This suggests the possibility of effect of body fat on cardio respiratory functions & significant positive correlation between heart rate and VO_2max.
2. These findings demonstrate the importance of low cardio respiratory fitness in young adults with increased body fat which could be a factor for developing cardiovascular co morbidities later in middle age.
3. BMI can be used in clinical settings to estimate body fat as it is a rapid and inexpensive method.
4. Queen's College Step Test is a valid method for the estimation of VO_2max in young males. Step test does not require specialized equipment & can be used in field conditions, untrained individuals.
5. Given the current obesity trend and observations of a decline in daily energy expenditure among the people, improving cardio respiratory fitness in young men by engaging in physical activities is important.

Scope for further study:

Additional study including detailed measurement of cardiac function is needed to clarify whether cardiac impairment (or initial stages of impairment) exists.

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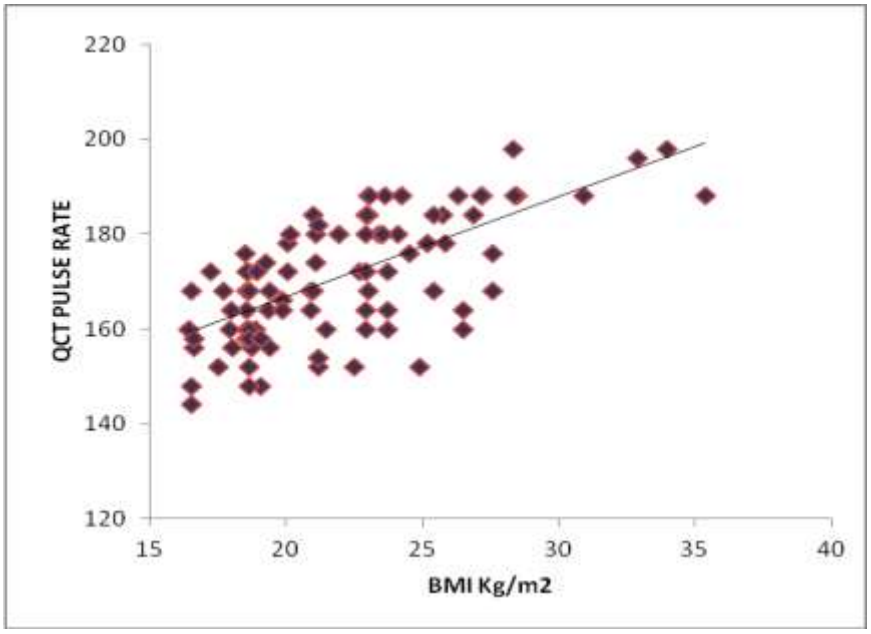
Table :1 Correlation between BMI and Heart rate

BMI (Mean ± SD)	VO_2max ml/kg/min (Mean ± SD)	r	P
22.04 ± 3.96	39.45 ± 5.29	0.66	< 0.01

Table: 2. Correlation between BMI and VO_2max

BMI Kg/m^2 (Mean±SD)	HR beats/min (Mean ± SD)	r	P
22.04 ± 3.96	171 ± 12.61	-0.66	< 0.01

Scatter diagram showing relationship between BMI and Heart rate



Scatter diagram showing relationship between BMI and VO_2max