Research Article

Study of relationship between cardiorespiratory fitness and obesity in young individuals

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Abstract

Introduction: Obesity and cardiorespiratory fitness are considered as modifiable and independent risk factors for cardiovascular mortality. **Aims and Objective:** The current study was designated to evaluate cardio respiratory fitness in terms of VO_2max in young healthy males and to correlate between obesity and cardio respiratory fitness. **Material and Methods:** Sixty young healthy male subjects in the age group of 20 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 predicted by standard Bruce Treadmill protocol. **Results:** There was a highly significant negative correlation between obesity and VO2max, r= -0.84 $p<0.05$. In contrast, obesity shows a highly significant direct correlation with maximal heart rate, r=0.82 $p<0.05$. **Conclusion:** The result proved that cardiorespiratory fitness was significantly affected by obesity. In view of current obesity trend and increasing cardiovascular diseases, it's advisable to decrease the daily calorie intake and also to improve cardiorespiratory fitness in young individuals by methodical and scientifically validated exercise regimen.

Keywords: Body Mass Index, Cardiorespiratory fitness, Obesity, VO_2max.

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INTRODUCTION

Cardiorespiratory fitness is a health-related component of physical fitness defined as the ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity[1]. Reduced cardiopulmonary fitness is associated with increased cardiovascular disease. VO_2max is a very good indicator of cardio respiratory fitness[2-6].VO_2max is the maximum capacity to transport and utilize oxygen during incremental exercise. It is also known as aerobic capacity, which reflects physical fitness of a person[7]. Those individuals who are more fit have higher VO_2max and can exercise more intensely and longer than those who are not as well conditioned. Obesity is characterized by excessive accumulation of fat in almost all the adipose tissues in the body. The cause of excess subcutaneous and visceral fat deposition in an individual is the cumulative effect of an imbalance between the energy of ingested food and that of expended in the course of daily activities. Easy way to access things by motor vehicles, prolonged physical inactivity sitting in front of the computers, consumption of junk foods, all these factors contribute to less energy expenditure. According to World Health Organization reports, obesity has reached epidemic state worldwide[8]. Obesity is becoming a global epidemic in both children and adults and is associated with numerous co-morbidities such as cardiovascular diseases (CVD), hypertension, type 2 diabetes mellitus and sleep apnoea[9]. In fact, obesity is an independent risk factor for cardiovascular diseases and is associated with reduced life expectancy. In India, the prevalence of overweight state and obesity is increasing in children and young adults which is reflected by various studies[10]. The journey from early life obesity to cardiovascular disease will be

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evident by slow regression of their cardiorespiratory efficiency. Obesity and cardiorespiratory fitness are considered as modifiable and independent risk factors for cardiovascular mortality[11]. As per our knowledge much of the data is not available on relation between cardiorespiratory fitness and obesity in young Indian population. Hence the present study was undertaken to evaluate the relationship between VO_2max and obesity among young individuals.

METHODOLOGY

Selection of participants

Sixty male medical students of Jagadguru Sri Shivarathreeshwara Medical College aged between 20 and 25 years were selected after screening for age, history of hypertension, cardiac or pulmonary diseases, smoking and alcohol consumption. The Ethical committee of the JSS University had approved the study and each participant provided informed consent. All the experiments were performed in the research laboratory of Physiology department, JSS medical college, Mysore.

The following Parameters were studied,

Body weight of the subject was measured (to the nearest 0.5kg) with the subject standing motionless on the weighing scale with feet about 15cm apart and weight equally distributed on each leg. Subjects were instructed to wear minimum outerwear (as culturally appropriate) and no foot wear while their weight was measured. The weighing machine was calibrated with a standard weight of 500 grams and necessary corrections were made from time to time.

Height was measured (to the nearest 0.005meter) with the subject in an erect position against a vertical surface, with the head positioned so that the top of the external auditory meatus was in level with the inferior margin of the bony orbit.

Body mass index was calculated for each subject using Quetelets formula:

$$Body\ Mass\ Index = \frac{Weight\ in\ Kilograms}{Sqaure\ of\ Height\ in\ Meters}\ (Quetelets\ formula)$$

Estimation of VO_2max using Bruce treadmill test.

The standard Bruce protocol has been widely used and found to be reliable and valid in estimating maximal oxygen uptake using predicted equations [8,9]. The exercise was performed in a well-ventilated room. Participants were instructed not to consume beverages and not to eat a heavy meal or participate in any vigorous activity 24 hours before the test. They were properly acquainted with the experimental protocol. A trained physician was present during the study and all the necessary resuscitation equipment was kept ready to deal with the complications if any occurred. It was first demonstrated to the subjects how to walk on the moving belt. Then they were asked to step on and start walking on the slowly moving belt. Once the subject adjusted to walking on the treadmill, the exercise was started as per the standard Bruce protocol. The treadmill was started at 2.74 km/hr (1.7 mph) and at a gradient (or incline) of 10%. At every three minute intervals the speed and inclination was increased as per the protocol used. Whenever the speed was increased, subjects were notified about the same and were asked to report if they had any problem. ECG was monitored continuously by paying due attention to the changes that may warrant premature termination of the test. The end point of exercise test was complete exhaustion of the subjects or attainment of 90% of the predicted maximum heart rate (220-age in years). The total time of exercise test (T) was noted in fraction of a minute.

Predicted equations for estimating VO_2max:

For Men $VO_2max = 14.76 - (1.379\times T) + (0.451\times T^2) - (0.012\times T^3)$

For Women $VO_2max = 4.38 \times T - 3.9$

Where 'T' is Test time in fraction of minute.

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 and sciences. Pearson correlation was applied to correlate between the parameters.

RESULTS

Cardio respiratory fitness in terms of VO_2max was estimated and then the effect of obesity on cardio respiratory fitness was studied. Obesity in terms of BMI (22.12 ± 2.96) Kg/m2 shows highly significant negative correlation with VO_2max (49.10 ± 4.16) ml/kg/min, r= -0.84 p<0.05 (Table-1). In contrast, obesity shows a highly significant direct correlation with maximal heart rate (166.42 ± 15.17) beats/min, r=0.82 p<0.05 (Table-2).

Table 1: Correlation between Obesity and VO2max

Variable		VO_2max
BMI	r	-0.84
	p	<0.05

Table 2: Correlation between Obesity and Heart Rate

Variable		VO_2max
BMI	r	0.82
	p	<0.05

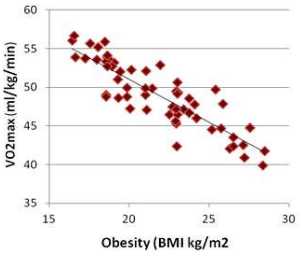

Figure 1

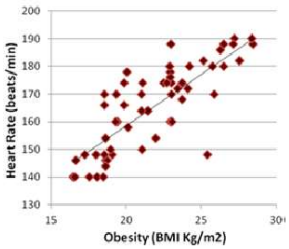

Figure 2

Legend:

Figure 1: Scatter Diagram Showing Relationship between Obesity and VO_2max

Figure-2: Scatter Diagram Showing Relationship between Obesity and Maximal Heart Rate

DISCUSSION

High cardiorespiratory fitness is associated with a reduction in risk factors related to cardiovascular diseases[12]. VO_2max is a measure of the functional limit of cardio respiratory system and single most valid index of cardiorespiratory fitness. The absolute value of VO_2max is one of the indices of an individual's cardio respiratory fitness to transport oxygen to working muscles. Earlier studies have used VO_2max to examine the performance of cardio respiratory fitness. Fitness promotes muscle insulin sensitivity[13], insulin mediated transport of glucose from blood to muscle[14], improved nervous system function[15] 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[16]. Improvements in cardio respiratory fitness have positive effects on depression, anxiety, mood status and self-esteem and also to be associated with high academic performance. Direct measurement of VO_2max is restricted within a well-equipped laboratory because of its exhausting, cumbersome, hazardous, complicated, and expensive and the time spent to measure it and standardization. Therefore VO_2max was estimated indirectly by using predicted equations for standard Bruce protocol that has been widely used and found to be reliable and valid in estimating maximal oxygen uptake[8,9]. Obesity is an epidemic disease. Body weight depends on balance between calorie intake and utilization of calories. Obesity results in obstructive sleep apnea syndrome and osteoarthritis. Increased free fatty acid synthesis from fat cells results in increased insulin resistance. Increased secretion of prothrombin activator inhibitor-1 from fat cells plays a role in procoagulant and along with changes in endothelial function increases risk of cardiovascular disease, hypertension and shortened life expectancy. Coronary artery disease is increased many folds compared with normal BMI. Dyslipidemia may be important in relationship of BMI to increased risk of heart disease. There is positive correlation between BMI and triglycerides and inverse relationship with HDL cholesterol. Increased cardiac work results in cardiomyopathy and heart failure in absence of diabetes mellitus and hypertension. The duration of obesity is important while assessing effects of BMI on heart. Those with early onset of obesity had major effects. Overweight individuals have increased sympathetic nerve firing rate than normal subjects. Blood pressure is increased in overweight individuals. Obesity results in a state of chronic volume overload. Increased pre-load and stroke volume is associated with hypertension and thus greater likelihood of cardiac failure. In this study we found a significant negative correlation between obesity and VO_2max (ml/kg/min) ($r = -0.84$, $p<0.05$). This indicates the striking effects of increasing body fat on cardio respiratory fitness. Excessive amount of body fat exerts an unfavourable burden as well as hindering action towards cardiac function particularly during exhaustive exercise. Loss of weight during weight reduction program in obese, increased their VO_2max due to withdrawal of fat induced inhibitory action towards oxygen utilization by body musculature[6]. Elevated myocardial oxidative stress has been reported in patients with obesity. In obese individuals there is increase in type II muscle fibres and decrease in type I muscle fibres which may have important effect on reduced oxygen uptake[17]. Studies have reported that VO_2max was significantly decreased in overweight individuals when fat mass was taken into account which suggests the possibility of deconditioning and or changes in cardio respiratory function in severely overweight individuals. Greater the BMI, more severe will be the functional impairment. Demsy *et al* reported that excess body fat impairs cardio respiratory functions and decreases mechanical efficiency for a given workload. Watanabe K *et al* reported that obesity accentuates exercise intolerance and lowers aerobic capacity[18]. Similar results were observed by Welch *et al*[19], Ozcelick *et al*[12] and Rowland *et al*[20]**.** In this study we also found a significant positive correlation between BMI and maximal heart rate during Treadmill test ($r = 0.82$ and $p < 0.05$). Chateerjee *et al* reported significantly higher value of peak heart rate Queen's College Test in obese group which indicates greater cardiac load among them[6].

CONCLUSION

There was a significant negative correlation between obesity and VO_2max, suggesting excessive amount of body fat on cardio respiratory functions and oxygen uptake by working muscles. There was a

significant positive correlation between BMI and maximal heart rate during Treadmill test. 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. In view of current obesity trend and increasing cardiovascular diseases, it's advisable to decrease the daily caloric intake also; improving cardio respiratory fitness in young men by engaging in physical activities is important. Improvements in cardio respiratory fitness have positive effects on depression, anxiety, mood status and self esteem and also to be associated with high academic performance. Health promotion policies and physical activity programs should be designed to improve cardiorespiratory fitness.

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