RESEARCH ARTICLE

CORRELATION BETWEEN OBESITY AND CARDIO RESPIRATORY FITNESS

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DOI: 10.5455/ijmsph.2013.2.298-302 Received Date: 05.01.2013 Accepted Date: 09.01.2013

ABSTRACT

Background: Maximal oxygen consumption (VO_2max) is considered the gold standard of cardio-pulmonary and muscle cell fitness. Reduced cardiopulmonary fitness is associated with increased cardiovascular disease. Low cardio respiratory fitness in young adults has emerged as an important factor for developing cardiovascular comorbidies later in middle age. Obesity is a serious & widespread problem globally. Increased body fat as predicted by body mass index is an additional factor for developing cardiovascular diseases.

Aims & Objective: The current study was designed to evaluate cardio respiratory fitness in terms of VO2max 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 18 to 22 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 following the protocol of Treadmill Jogging Test (TMJ).

Results: There was a highly significant negative correlation between obesity and VO_2max, r= -0.88 $p<0.05$. In contrast, obesity shows a highly significant direct correlation with Treadmill Heart Rate, r=0.80 $p<0.05$.

Conclusion: The result suggests that the reduced cardiac performance during progressive work rate exercise in obese individuals. Greater the BMI, more severe will be the functional impairment, suggesting excessive amount of body fat on cardio respiratory functions and oxygen uptake by working muscles.

KEY-WORDS: Body Mass Index; Cardio Respiratory Fitness; Maximal Oxygen Consumption; Treadmill Jogging Test

Introduction

Cardiovascular disease (CVD) is the leading cause of mortality and morbidity worldwide. Obesity and cardio respiratory fitness (CRF) are modifiable & independent risk factors for cardiovascular mortality. Technological developments & modern day commodities have driven most people into sedentary life style leading to chronic diseases like hypertension, heart disease, diabetes mellitus, metabolic syndrome, chronic low backache & obesity. Obesity is a serious & widespread problem globally. 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.[1] VO_2max is internationally accepted parameter & is the first choice in measuring a person's cardiopulmonary status.[2] 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.[3] Reduced cardiopulmonary fitness is associated with increased cardiovascular disease.

Unfavourable cardiovascular risk profiles are found in youth with low levels of cardiovascular fitness and high percentage of body fat. Risk factors for CVD including hypertension, diabetes and hypercholesterolemia are suspected to be influenced by fitness[4,5] and these factors may mediate the association between low cardio respiratory fitness and mortality. Obesity can be assessed in several ways. 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. 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.[3] Hence, the current study was designed to evaluate cardio respiratory fitness in terms of VO_2max and to correlate between obesity and cardio respiratory fitness in young healthy male subjects.

Materials and Methods

Sixty apparently healthy male subjects in the age group of 18-22yrs from Kolar city were selected for the study and examined. They were asked to fill a questionnaire to assess their physical activity status.[6] 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 assessing VO_2max indirectly by Treadmill jogging test. Weight was measured using calibrated weighing machine in light clothing and bare feet. All experiments were performed at room temperature.

Treadmill Jogging Test

Subject is initially familiarized with the instrument and a trial is given before performing for the study. After adequate rest with the limb leads in place and with minimal support on side rails subject was made to walk at a self-selected brisk walking speed at zero level grade for 3min. This was followed by jogging at a self-selected, sub maximal jogging speed between 4.3 and 7.5 mph at zero level grade for 3min or until a steady state HR (between 140-180 beats/min) was achieved. Lead II ECG recording is taken for the documentation of heart rate. Heart rate was measured and the following equation is used to predict VO_2max.[7]

PVO_2max (ml/kg/min) = 54.07 + 7.062 x Gender (0=female; 1=male) – 0.1938 x Weight (kg) + 4.47 x Speed (miles/hr) – 0.1453 x Heart Rate (beats/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 the parameters.

Results

Sixty young healthy males in the age group of 18-22 (18.92 ± 1.15) years were subjected to treadmill jogging test. Cardio respiratory fitness in terms of VO_2max was evaluated and then the effect of obesity on cardio respiratory fitness was studied. Obesity in terms of BMI (21.92 ± 3.32) Kg/m^2 shows highly significant negative correlation with VO_2max (48.90 ± 4.24) ml/kg/min, r= -0.88 p<0.05 (Table-1).

Table-1: Correlation between Obesity & VO_2max

Variable		VO_2max
BMI	r	-0.88
	p	< 0.05

Table-2: Correlation between Obesity & Heart Rate

Variable		Heart Rate
BMI	r	0.80
	p	< 0.05

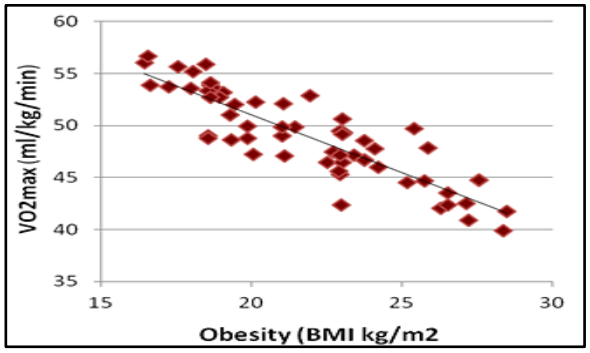

Figure-1: Scatter Diagram Showing Relationship between Obesity and VO_2max

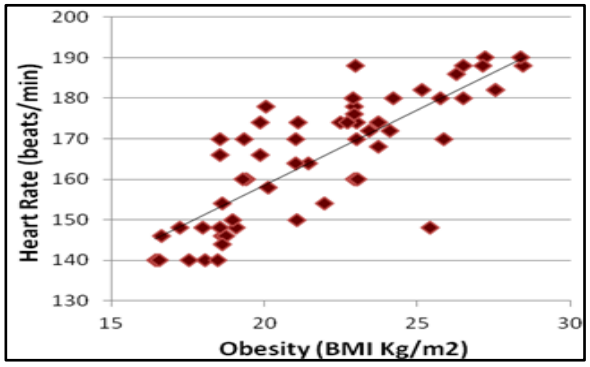

Figure-2: Scatter Diagram Showing Relationship between Obesity and TMJ Heart Rate

In contrast, obesity shows a highly significant direct correlation with treadmill Heart Rate (165.73 ± 15.27) beats/min, r=0.80 p<0.05 (Table-2).

Discussion

High aerobic fitness is associated with a reduction in risk factors related to cardiovascular diseases.[8] 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. Earlier studies have used VO_2max to examine the performance of cardio respiratory fitness. 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] Improvements in cardio respiratory fitness have positive effects on depression, anxiety, mood status & 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. Moreover it requires maximal exertion and is not advisable for compromised and debilitating advancing cardio respiratory individuals. Therefore methods able to predict fair degree of reliability using sub maximal or milder grade of exercise is employed. As jogging is a popular form of exercise and treadmills are often used as a trial modality; treadmill protocols are easy to administer and control; individualized programs can be based on the results of the treadmill jogging test, the sub maximal single stage treadmill jogging test also provides a valid and consistent method for estimating VO2max.[7]

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 & 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.

According to the WHO, body fatness is classified based on body mass index & is considered healthy if BMI > 18.5, overweight if BMI > 25, obese if BMI > 30 and morbidly obese if BMI > 40. Weight gain leads to greater adverse metabolic changes in certain ethnic groups. As a result Asians should be considered overweight if BMI > 23 and obese if BMI > 27.5.

In this study we found a significant negative correlation between obesity and VO_2max (ml/kg/min) (r = -0.88, 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.[13] 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.[14] 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.[15] Similar results were observed by Welch et al[16], Ozcelick et al[7] & Rowland et al[17] In this study we also found a significant positive correlation between BMI and TMJ heart rate during Treadmill Jogging test ($r = 0.80$ & $p < 0.05$). 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.[18]

Conclusion

1. There was a significant negative correlation between obesity and VO2max, suggesting excessive amount of body fat on cardio respiratory functions and oxygen uptake by working muscles.
2. There was a significant positive correlation between BMI and TMJ heart rate during Treadmill Jogging test.
3. Treadmill jogging Test is a valid method for the estimation of VO2max in young males. As jogging is a popular form of exercise and treadmills are readily available in laboratories, can be employed for exercise prescription.
4. BMI can be used in clinical settings to estimate body fat as it is a rapid and inexpensive method.
5. 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.
6. In view of current obesity trend and increasing CVD, it's advisable to decrease the daily caloric intake also; improving cardio respiratory fitness in young men by engaging in physical activities is important.
7. Improvements in cardio respiratory fitness have positive effects on depression, anxiety, mood status & self esteem and also to be associated with high academic performance.
8. Health promotion policies & physical activity programs should be designed to improve CRF.
9. Schools play an important role by identifying children with low physical fitness & by promoting positive health behaviors such as encouraging children to be active, with special emphasis on the intensity of the activity.

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Cite this article as: Praveen G, Srinivasa BS. Profile and clinical features of HIV positive patients attending Integrated Counseling and Testing Centre in a Medical College Hospital of Hassan, Karnataka. Int J Med Sci Public Health 2013; 2:300-304.
Source of Support: Nil
Conflict of interest: None declared