Original Article

# Effect of increased adiposity on cardiorespiratory fitness of young Indian individuals

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**Abstract**

Incidence of obesity in early life is increasing nowadays because of faulty food habits and lack of exercise. This study was aimed to find out whether obesity affects cardiorespiratory efficiency of young adults. As $VO_2$max is the most accepted indicator of cardiorespiratory efficiency it was compared between 30 obese and 30 non-obese subjects aged around 20-25 years. $VO_2$ max was estimated by Standard Bruce treadmill test. Various other parameters measured and calculated are weight, height, BMI, heart rate. The results showed that cardiorespiratory fitness was significantly affected ($P<0.001$) among obese individuals. Therefore the exercise programs can be best designed to increase caloric expenditure and thus to decrease body fat in order to improve cardiorespiratory fitness.

**Key words:** Body Mass Index, Cardiorespiratory fitness, Obesity, $VO_2$max.

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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 risk of cardiovascular disease. $VO_2$max is a very good indicator of cardio respiratory fitness[2-6].$VO_2$max 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 will have higher $VO_2$max and can exercise more intensely and longer than those who are not as well conditioned. In India, the prevalence of overweight state and obesity is increasing in children and young adults which is reflected by various studies[8]. The journey from early life obesity to cardiovascular disease will be evident by slow regression of their cardiorespiratory efficiency. Obesity and cardiorespiratory fitness are considered as modifiable and independent risk factors for cardiovascular mortality[9]. Hence the study was aimed to evaluate the cardiorespiratory fitness in terms of $VO_2$max in young obese individuals and to compare the data with their non obese counterparts.

## METHODOLOGY

### Selection of participants

Thirty obese (15 male and 15 female) and thirty non obese (15 male and 15 female) 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. Categorization of obese and non obese groups was done based on BMI cut off for Indian population.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:

$$\text{Body mass index} = \frac{\text{Weight in kilograms } \textit{(Quetelets formula)}}{\text{Square of Height in meters}}$$

**Estimation of $VO_2$max 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 [10,11]. 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 $VO_2$max**

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 was done using following test,

**Unpaired t-test** was used to test the significance of difference between mean values of $VO_2$max of obese and non obese subjects, to test the significance of difference between mean values of $VO_2$max in obese females and non obese females and to test the significance of difference between mean values of $VO_2$max in obese males and non obese males.

## RESULTS

There was no significant variation in age between obese and non-obese participants. Though body height did not show any significant inter-group variation but body weight was significantly higher ($P<0.001$) in obese group, and BMI score was also significantly higher ($P<0.001$) among obese. There was no significant variation in resting heart rate and maximal heart rate achieved between obese and non obese groups. $VO_2$max was significantly lower among obese compared to non obese ($P<0.001$). Among males $VO_2$max was significantly lower among obese males compared to non obese males ($P<0.001$). There was no significant variation in $VO_2$max between obese female and non-obese female participants. All results are tabulated in Table 1.

**Table 1:** Anthropometric and other parameters of obese and non-obese groups

| Parameters | Obese (n=30) | Non-obese (n=30) | P- value |
|---|---|---|---|
| Age | 23.5 | 23.3 | 0.054 |
| Height (cm) | 164.27±8.07 | 161.77±6.10 | 0.181 |
| Weight (kg) | 75.00±8.57 | 55.13±6.25 | 0.001* |
| BMI | 27.79±2.25 | 21.00±1.27 | 0.001* |
| Heart rate | 75.27±3.50 | 73.93±3.38 | 0.139 |
| HR max | 195.67±3.40 | 193.67±4.75 | 0.066 |
| $VO_2$max (ml/kg/min) | 40.33±1.61 | 44.07±4.76 | 0.001* |
| | **Obese male (n=15)** | **Non-obese male (n=15)** | |
| $VO_2$max (ml/kg/min) | 40.91±1.50 | 48.35±1.75 | 0.001* |
| | **Obese female (n=15)** | **Non-obese female (n=15)** | |
| $VO_2$max (ml/kg/min) | 39.76±1.50 | 39.79±2.15 | 0.967 |

Data presented as Mean±SD.

## DISCUSSION

$VO_2$max indicates an individual's cardiorespiratory fitness to transport oxygen to working muscles[6]. $VO_2$max is the single most valid index of cardiorespiratory fitness. The present study showed a significant difference in $VO_2$max (ml/kg/min) of obese

and non-obese subjects, with obese subjects having lower values than the non-obese subjects. This indicates the striking effects of increasing body fat on cardiorespiratory fitness, probably because 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 programme in obese, increased their $VO_2$max 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 fibers and decrease in type I muscle fibers which may have important effect on reduced oxygen uptake[9]. The functional consequence of lower $VO_2$max (ml/kg/min) among obese individuals than among non-obese individuals could be their poorer performance in weight-dependent activities. In running, walking, stair-climbing etc they have more body mass to transport, which requires and costs energy, while in non-weight dependent activities eg swimming, rowing and paddling absolute $VO_2$max could be more important. Since most activities in daily life are weight bearing, relative $VO_2$max seems to be more important than absolute $VO_2$max when comparing obese and non-obese individuals. In our study there was no significant difference in $VO_2$max values between obese and non obese female subjects. The reason for this may be girls selected for the study were purely sedentary without any physical activity. Our results were similar to that of Berry S *et al*[12]. In our study there was significant difference in $VO_2$max (ml/kg/min) between obese and non-obese male subjects, with obese males having lower values than non-obese males. This is probably because of difference in body mass and physical activity levels between them.

## CONCLUSION

Cardiorespiratory fitness was significantly affected among young obese individuals compared to non obese individuals. Hence obese individuals are at increased risk of hypertension and other cardiovascular co morbidities later in life. 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 among young individuals by methodical and scientifically validated exercise regimen.

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