# AN ASSESSMENT OF CARDIO-RESPIRATORY FITNESS IN NORMAL WEIGHT, OVERWEIGHT AND OBESE YOUNG ADULTS

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**Abstract**: **Background & Objectives:** There has been a worldwide increase in obesity among people of all ages. With increase in Body Mass Index (BMI) in overweight & obese individuals, body's ability to cope-up with physical stress of exercise can be impaired. The objective of present study was to evaluate the cardio respiratory fitness in terms of maximum oxygen uptake (VO2max) in normal weight, overweight, and obese young adults of, Mullana, Haryana, India. **Methods:** 210 healthy students of Maharishi Markandeshwar University (MMU), between the age group of 18-30 years were randomly selected for this cross-sectional study. The selected subjects, which include equal number of male and female students, were divided into three groups (70 in each group), according to BMI classification of WHO. Group I- subjects with BMI 18.5-24.9 kg/m² - (Normal weight),Group II- subjects with BMI 25.0-29.9kg/m²- (Overweight),Group III- subjects with BMI ≥30kg/m²- (Obese). Cardio respiratory fitness ($VO_2$max)was measured indirectly by the Queen's College Step Test (QCT). **Results:** $VO_2$max was significantly decreased in normal to overweight subjects ($p<0.01$), and overweight to obese subjects ($p<0.05$), and very highly significantly ($p<0.001$) decreased in normal to obese subjects. $VO_2$max was also found to be very highly significantly ($p<0.001$) less in females as compared to males in all the three groups. **Interpretation & conclusion:** It is thus concluded that there is an adverse effect of obesity and lack of exercise on cardio respiratory parameters. A significant reduction in $VO_2$max was seen with increase in BMI.

**Key Words**: Body Mass Index, Queen's College Step Test, $VO_2$max.

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**Introduction:**

Obesity in relation to physical fitness is of major concern especially now a days as the prevalence of childhood obesity is increasing rapidly worldwide and India is no exception to it.[1, 2] Modern sedentary lifestyle and switch over to junk food habits are leading to development of early life obesity.[3] Obesity is associated with wide range of diseases, including cardio respiratory disease such as chronic obstructive pulmonary disease and coronary heart disease.[4, 5]

As many as 250 million people or about 7% of the current world population are obese and 2 to 3 times more people are overweight.[6]According to WHO the number of overweight and obese people worldwide will increase to 1.5 billion by 2015 if current trends continue. Clearly, overweight and obesity place a large public health burden on society.[7]In obese people there is an increase of cardiac work at rest, estimated at 40-190 percent relative to that of subjects of ideal body weight.[8]

Obese subjects use a greater amount of $O_2$ to accomplish an equal external workload when compared to non-obese subjects.[9] $VO_2$ max is the measure of functional limit of the cardio respiratory system and the single most valid index of maximal exercise capacity.[10] Maximum $O_2$ uptake ($VO_2$ max) is an internationally accepted parameter to evaluate the cardio-respiratory fitness.[11] The "Queen's college step test" or "QCT" is an indirect way to estimate the subject's cardio respiratory fitness in terms of $VO_2$max. $VO_2$ max reflects the amount of oxygen utilized by working muscle during maximal exercise.[12-14]It is also known as aerobic capacity which reflects physical fitness of a person.[15]

Excess body fat impairs cardio respiratory functions and reduces mechanical efficiency for a given work load.[16] The ability of obese to perform physical work is reduced because the greater part of one's cardiovascular and respiratory reserve will be consumed to support the movement of the enlarged body.[17]

Sound health and physical fitness are positively associated with good mental health & well-being.

The present study was thus conducted to assess cardio respiratory fitness in normal weight, overweight & obese young adults of MMU, Mullana which could alert them at proper time to take necessary action suitable for their health needs.

**Material and Methods:**

The study was conducted in the Department of Physiology, Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala, Haryana, (India). 210 healthy students of Maharishi Markendeshwar University (MMU), between the age groups of 18 to 30 years were randomly selected for this cross-sectional study.

The selected subjects, which include equal number of male and female students, were divided into three groups, 70 students in each group according to body mass index (BMI) classification of WHO.[18]

Group I- Seventy subjects with BMI 18.5-24.9 kg/m² - (Normal weight)

Group II- Seventy subjects with BMI 25.0-29.9kg/m²- (Overweight)

Group III- Seventy subjects with BMI ≥30kg/m²- (Obese)

The anthropometric data (age, weight, height & BMI) was noted, medical history was taken and clinical examination was also being done for the selected subjects. Informed and written consent of all the subjects was taken before conducting the study. The Ethical clearance was obtained from the institutional human clinical committee.

**INCLUSION CRITERIA:**

1. Subjects between 18 to 30 years.
2. Healthy male and female subjects.
3. Untrained subjects.

**EXCLUSION CRITERIA:**

1. Subjects below 18 years and above 30 years.
2. Smokers.
3. Subjects with respiratory illness, cardiovascular disease, musculoskeletal disease or any chronic illness which can affect the performance.
4. Subjects undergoing regular physical training.
5. Pregnancy

The subjects were explained about the whole procedure and a demonstration was given before readings. All the subjects were asked to refrain from eating for 2 hours prior to procedure.

Cardio respiratory fitness **($VO_2$max)** was measured indirectly by the **Queen's College Step Test (QCT).**[9] the step test was performed using a stool of 16.25 inches (or 41.30cm) height. Subject stepped up and down on a stool for three minutes at the rate of 24 steps per minute for males and 22 steps per minute for females which was set by a metronome. After 3 minutes of exercise, recovery pulse rate was taken for 5 to 20 seconds, i.e. 15 seconds. This 15 second pulse rate was converted into beats per minute and the following equation was used for calculating the $VO_2$max.[8, 19-21]

For males- $VO_2$max (ml/kg/min) = 111.33 – (0.42 x pulse rate in beats per minute).

For females- VO2max (ml/kg/min) = 65.81 – (0.1847 x pulse rate in beats per minute).

**Statistical analysis**

The data was expressed as mean ± Standard Deviation. The variation in parameterswas tested using student's independent t- test. A p value of <0.05 was considered as significant (S), p <0.01 highly significant (HS), p <0.001 very highly significant (VHS) and p >0.05 as not significant (NS). SPSS software was used for the statistical analysis.

**Result:**

The comparative study of anthropometric parameters and $VO_2$max are summarized in tables 1, 2 &3.

The mean age in normal weight group (group I) was 19.84±2.75 years, in overweight (group II) was 19.5±1.77 years, and in obese (group III) was 19.45±1.99 years and age was comparable in all the three groups (p>0.05). The mean BMI of normal weight group was 21.92±1.70 kg/m², of overweight group was 27.06±1.34kg/m², and of obese group was 32.69±3.08kg/m². On comparison BMI was very highly significantly increased in overweight vs. normal weight (p<0.001), obese vs.

Over weight (p<0.001), and in obese vs. normal weight groups (p<0.001) (Table1).

**Table: 1 Comparison of anthropometric parameters in three different groups of total study subjects.**

| Parameters | Group I Normal weight groups n=70 (mean±SD) | Group II Over weight group n=70 (mean±SD) | Group III Obese group n=70 (mean±SD) | Statistical significance | | |
|---|---|---|---|---|---|---|
| | | | | Group I vs. II p-value | Group II vs. III p-value | Group I vs. III p-value |
| Age (years) | 19.84±2.75 | 19.5±1.77 | 19.45±1.99 | >0.05 N.S. | >0.05 N.S. | >0.05 N.S. |
| Weight (kg) | 57.7±7.85 | 73±9.71 | 83.65±13.34 | <0.001 VHS | <0.001 VHS | <0.001 VHS |
| Height (m) | 162.09±7.97 | 163.8±9.76 | 159.54±10.52 | >0.05 N.S. | <0.05 S | >0.05 N.S. |
| BMI (kg/m²) | 21.92±1.70 | 27.06±1.34 | 32.69±3.08 | <0.001 VHS | <0.001 VHS | <0.001 VHS |

**Table: 2 Comparison of $VO_2$ max (ml/kg/min) in three different groups.**

| Groups | Mean $VO_2$ max (mean± SD) | Normal vs. overweight (p-value) | Overweight vs. Obese (p-value) | Normal vs. obese (p-value) |
|---|---|---|---|---|
| Normal weight n=70 | 48.51±8.41 | <0.01 S | <0.05 S | <0.001 VHS |
| Overweight group n=70 | 44.65±8.83 | | | |
| Obese group n=70 | 41.21±8.32 | | | |

Mean $VO_2$max in normal weight, overweight, and obese groups (table 2) was 48.51±8.41 ml/kg/min, 44.65±8.83 ml/kg/min and 41.21±8.32 ml/kg/minrespectively. It was significantly (p<0.01) decreased in overweight vs. normal groups, significantly (p<0.05) decreased in obese vs. overweight groups and very highly significantly (p<0.001) decreased in obese vs. normal weight groups.

Mean $VO_2$ max (ml/kg/min) in males and females in normal weight group was 54.85±7.44 and 42.17±2.33 respectively, in overweight group was 50.65±8.58 and 38.65±3.28 respectively and in obese group was 46.68±8.78 and 35.74±1.33 respectively. It was also found that VO2max was decreased with increase in BMI in both sexes. $VO_2$max was also found to be very highly significantly (p<0.001) less in females as compared to males in all three groups (Table 3).

**Table: 3 Comparison of $VO_2$ max (ml/kg/min) in males & females in three different groups.**

| Groups | Males (mean±SD) | Females (mean±SD) | Statistical significance (p value) |
|---|---|---|---|
| Normal weight (n=35+35) | 54.85±7.44 | 42.17±2.33 | <0.001 VHS |
| Overweight group (n=35+35) | 50.65±8.58 | 38.65±3.28 | <0.001 VHS |
| Obese group (n=35+35) | 46.68±8.78 | 35.74±1.33 | <0.001 VHS |

**Discussion:**

$VO_2$max is a measure of the functional limit of the cardio respiratory system and the single most valid index of maximal exercise capacity.[10]

In the present study, obese, overweight and normal weight subjects were examined andit was found that $VO_2$max was higher in normal weight subjects as compared to overweight and obese subjects. And the difference was very highly significant ($p<0.001$) between normal weight, overweight and obese subjects which indicated reduced aerobic capacity and ability to perform exhausting work. The present study agreed with Dempsy et al. who suggested that excess body fat impairs cardio respiratory functions and reduces mechanical efficiency for a given work load.[16] Similarly Chatterjee et al[14] and Buskirk and Taylor[22] also observed that $VO_2$max/kg body weight was less in obese than non-obese.

The present study agreed with Babb TG et al, who investigated the effect of moderate obesity on ventilatory responses to graded exercise and found significantly greater heart rate ($P<0.05$) and smaller $VO_2$max (ml/kg/min) in the obese women and suggested lower ventilatory threshold for the obese women.[19]Gutin et al, found that the ability of obese children to perform physical work is reduced because the greater part of one's cardiovascular and respiratory reserve will be consumed to support the movement of the enlarged body.[17]

Similarly Chatterjee et al evaluated the cardio-respiratory fitness in terms of maximal oxygen uptake (VO2max) in obese boys of West Bengal, India by Queen's College Step Test. They found low$VO_2$max in obese groups and suggested that excessive fat mass imposes unfavorable burden on cardiac function and oxygen uptake by working muscles and indicated that reduced oxygen utilization by adipose tissue during exercise reduces overall $VO_2$max.[14] Thepresent study was also similar with Patkar KU et al, who found that cardio-respiratory efficiency ($VO_2$max/kg body weight) to do exhausting work was less in obese group in both sexes compared to non-obese groups.[3]

In present study an inverse relationship was found between fitness and fatness in both sexes but $VO_2$max was found to be significantly higher in males compared to females. Coinciding with our finding, Koley S also found significantly higher mean values of $VO_2$max in boys in comparison to girls.[23] Similarly Prajapati R et al. reported that cardio respiratory fitness, measured by $VO_2$max, was more in male than in the female counterpart.[21]Salvadori A et al. suggested that obese and normal males appeared to have a greater working capacity compared to normal and obese females and tended to consume more oxygen at similar workloads, probably due to a larger muscular mass.[24]

**Conclusion:**

Though our study is by no means exhaustive it does provides a glimpse into the variety of alterations in cardio respiratory fitness that occur as excessive adipose tissue accumulates, even in the absence of overt disease. The individuals with obesity are more likely to find it physiologically difficult to participate in physical activities that require movement of their increased body mass. Further research is recommended to have a more complete understanding of this condition. Promoting physical activity is a priority in this context and attention should not just be focused on more participation in sports but should also stimulate normal outdoor activities, such as awalking and cycling and discouragement of 'sedentary behavior'.

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