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Original Article

Comparison of Maximal Oxygen Consumption [VO_2max] in Obese and Non-obese Young House Wives

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Abstract

Background: Cardiopulmonary fitness is a powerful predictor of all causes of cardiovascular disease and resultant mortality. Maximum oxygen consumption is the internationally accepted parameter to evaluate cardio respiratory fitness. VO_2 max is affected by many factors one among them is BMI. Increase in body mass leads to obesity. Early life obesity has become one of the leading global public health problems and one of the underlying causes of non communicable chronic diseases which is developed due to modern sedentary life style and faulty food habits.This study was aimed to find out whether obesity affects cardio respiratory efficiency of young house wives or not.

Materials and Methods: A total of 80 subjects – 40 in each of the two body mass index (BMI) categories, i.e., obese, and normal weight young house wives were taken for comparing of maximal oxygen consumption (VO_2) by Astrand Sub Maximal Mortin Bicycle Ergo meter test.

Results: Present study showed highly significant lower values of mean Vo_2max/kg body weight (37.98±4.45 vs 48.63±4.48; P<0.001) and VO_2max/kg lean body mass (60.77±7.19 vs 68.06±7.17; P<0.001) of young obese participants as compared to young normal weight participants.

Conclusion: There was a detrimental effect of obesity was seen on ability to do exhausting work in obese young house wives when compared to normal weight house wives. The study is an attempt to bring awareness about increase in BMI and fat accumulation.

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Introduction

Maximal Oxygen Consumption (VO_2 Max) is the maximal attainable rate of oxygen consumption during exercise using large muscle groups. It indicates the

aerobic capacity. VO_2 max is internationally accepted parameter and first choice in measuring a person's cardiopulmonary status (1). It is one of the most widely obtained variables in exercise physiology. It is deemed to have implications for both health and exercise performance. It is a measure of the functional limit of the cardio respiratory system and single most valid index of maximal exercise capacity (2). The absolute value of VO_2 max is one of the best indices of an individual's cardio respiratory fitness to transport oxygen to working muscles. It is useful when changes in maximal aerobic capacity of children are assessed during the period of pre-puberty to adolescence. An increase in VO_2 max is a common method of demonstrating a training effect in endurance training studies (2). Factors that influence VO_2 max are Mode of exercise, Hereditary, State of training, Gender, Body size and composition, Age, Altitude, Temperature, ageing, disease, muscle mass, age, sex and body mass index. A person's state of aerobic training contributes significantly to the VO_2 max it normally varies between 5 and 20% depending on a person's fitness at the time of testing. In some cases of very sedentary individuals or long term bed rest, it has been increased by 100% (3).

Increase in body mass leads to obesity. Obesity is defined as abnormal or excessive fat accumulation in adipose tissue, to the extent health may be impaired (4). Early life obesity is developed due to modern sedentary life style and faulty food habits (5). It has become one of the leading global public health problems and one of the underlying causes of non communicable chronic diseases. It has become one of the leading causes of morbidity and mortality in both developed and developing countries (6). Obesity in adult is defined as having a body mass index (BMI) that is 25-30 kg/m^2. The normal range of BMI is between 18.5 and 24.99 (kg/m^2) (7). Overall picture in India is less 6% in the population. There are substantial differences in the prevalence of obesity by age, race and socio-economic status (7, 8). Studies have shown that overweight and obesity are associated with medical disorders such as hypertension, diabetes, cardiovascular diseases, stroke, certain cancers, premature mortality, and respiratory diseases (9). People are prone to develop cardiovascular diseases and other chronic diseases at young age of their life because of early life obesity (10).

Obese have higher absolute VO_2 max expressed per unit surface area as compared to non-obese. However, VO_2 max per kg of body weight was actually less in obese than in non-obese indicating reduced aerobic capacity. In obese it is probably because of the excessive amount of body fat that appeared to exert an unfavorable burden as well as hindering action towards cardiac function, it fails to uptake sufficient amount of oxygen due to deposition of proportionately high amount of fat. The journey from early life obesity to cardiovascular disease will be evident by slow regression of their cardio respiratory efficiency. Cardio respiratory efficiency refers to the ability of the circulatory and respiratory system to supply oxygen to skeletal muscles during sustained physical activity. 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 (11).

Cardio respiratory fitness and body composition are associated with the risk of emergence of cardiovascular diseases. Accordingly, these factors are related to health and relationships existing between the two have been focus of researchers in the field of sports sciences. The incidence of cardiovascular disease is statistically and physiologically related to obesity (12). For example, the obese individual has a mortality rate from cardiovascular disease is 2½ times greater than the individual with an average or below average body weight (13). It is considered that VO_2 max or maximal aerobic capacity is only a single measure of the functional capacity of the oxygen system or cardio-respiratory system or the oxygen transport system (14).

Peak VO_2 increases with age in both boys and girls, both in absolute terms and with body size and composition accounted for but boy's value are higher than the those of girls even during the pre pubertal years (15). It is estimated that 69% of the differences

in max VO_2 scores among individual can be explained simply by differences in body mass 4% by differences in stature and 1% by variations in lean body mass (16). Thus it is not meaningful to compare exercise performance or the absolute value for oxygen consumption among individuals who differ in body size or body composition. This has led to common practice of expressing VO_2 max in terms of body composition either in relation to body mass, lean body mass or live volume (3). Both stature and mass are highly correlated with peak VO_2 in children and adolescents with coefficients typically in range 0.6-0.8 (17). As the correlation is normally stronger with mass than stature, and as physical activity most often requires the body mass to be moved, it is conventional to accommodate size differences by expressing peak VO_2 in ratio with body mass i.e. ml/kg per min. Thus it is assumed, enables fair comparison between individual and or groups differing body mass e.g. children vs adults boys vs. girls etc (18). Both the high body fatness and low aerobic fitness have been shown to be risk factors for cardiovascular disease. It is still unclear, whether these factors are related to each other or if they are independent risk factors.

Early life obesity has become more prevalent in house wives due to sedentary life style, post partum and food habits, because of this they are prone to cardiovascular diseases and various chronic diseases at an early age. Our study concentrated on young house wives who hardly find time for physical activity due to various commitments. This study can be helpful, so that early intervention in the form of lifestyle modification and fitness education is provided to prevent the adverse effects and alert them at proper time to take necessary action and will also help to plan the type of exercise suitable for their health need.

Aim:

This study was aimed to find out whether obesity affects cardio respiratory efficiency of young obese house wives or not.

Objectives

- To assess the influence of body composition on dimension of VO_2 max of obese and non-obese sedentary young house wives.
- To compare the physiological characteristics and responses of obese and non-obese young house wives.

Methods and Materials

The present study was carried out in department of Physiology at Sri Venkateswara Institute of Medical Sciences (SVIMS) during the period from 2011-2012. After taking medical ethical committee of the institute after being thoroughly informed about the purpose, requirements and the experimental protocols of the investigation data was collected. Subjects were selected stratified random sampling technique after applying the inclusion and exclusion criteria. Sample Size Was estimated by Kshitija et al (11) using the mean VO_2 max in obese and non obese with 99% Confidence interval and 95% power sample size of 40 was obtained in each group.

Sample Size For Comparing Two Means

Input Data			
Confidence Interval (2-sided)			99%
Power			95%
Ratio of sample size (Group 2/Group 1)			1
	Group 1	**Group 2**	**Difference***
Mean	47.906	41.342	6.564
Standard deviation	7.287	6.5455	
Variance	53.1004	42.8436	
Sample size of Group 1	40		
Sample size of Group 2	40		
Totalm sample size	80		

*Difference between the means.

Results from Open Epi, Version 3, open source calculator—SS Mean

Sample size was estimated based on formula

$$\text{Sample size} = \frac{2SD^2(Z_{\alpha/2}+Z_{\beta})^2}{d^2}$$

SD – Standard deviation = From previous studies or pilot study

$Z_{\alpha/2} = Z_{0.05/2} = Z_{0.025} = 1.96$ (From Z table) at type 1 error of 5%

$Z_{\beta} = Z_{0.20} = 0.842$ (From Z table) at 80% power

d = effect size = difference between mean values

So now formula will be

$$\text{Sample size} = \frac{2SD^2(1.96+0.84)^2}{d^2}$$

Selection of Subjects:

Inclusion criteria:

- 40 obese and 40 normal young house wives, healthy volunteers were recruited.
- Age group 25-30 years were recruited.
- Subjects are categorized into two groups based on body mass index (BMI) (7).

BMI	CLASSIFICATION
≥18.5	Under weight
18.5-25	Normal
25-30	Obese I
30-35	Obese II
35-40	Obese III
40≤	Obese IV

Among them normals and obese 1 are taken into consideration for the present study

Exclusion criteria:

- Subjects are excluded from participating if their BMI (or) age fell outside of the prescribed ranges.
- If they had history of cardiovascular, metabolic, hepatic, renal and thyroid disease, were not sedentary, were taking blood pressure (or) cholesterol lowering medication.
- Pregnant (or) lactating, genetically disorder subjects were excluded from this study.

Testing protocol:

Height and Weight were measured by tape and weighing machine and expressed in cm and kg respectively. Blood pressure and Heart rate were recorded at basal condition and before exercise test by using “Electronic BP monitor”.

Omron Body Fat Analyzer:

The Omron Body Fat Analyzer is a small handheld body fat analyzer device that uses a method called Bioelectrical Impedance Analysis to calculate body fat percentage and body mass index. Thanks to its functionality and small dimensions, it has become one of the most popular Omron body analyzers.

The Astrand Sub Maximal Bicycle Ergo Meter Test:

To perform this test subjects are asked to come to the laboratory in the morning at their convenience after having light breakfast at least 2-3 hours prior to the test and refraining activity during that period. This test is done on “Mortin Bicycle Ergo meter” to calculate the VO_2 max.

Prediction of VO_2 Max:

It is a sub maximal tests, the heart rate should cross 120 bpm. If at the end of 2nd minute HR does not reach 120 bpm, increase the load by 50% for untrained and 100% for trained or young subjects. If load has to be increased during the test, at least 3 minutes should allowed for the HR to plateau in relation to the work rate. The average heart rate of the 5th and 6th minute is required. The Astrand-Rhyming Nomogram is used to predicted the VO_2 max from peak HR and WD (11).

Statistical Analysis:

Statistical analysis was carried out using SPSS software. The normality of the distribution of data for each group was checked by Kolmogorov–Smirnov test. Independent t-test was used to compare mean

differences and standard deviation of variables between obese and non-obese groups. 'P' value of <0.001 was considered as significant.

Results

According to Table I The body height did not show any significant variation but body weight, % body fat, fat mass, lean body mass (LBM) were significantly higher (P<0.001) in obese group, and BMI score was also significantly higher (P<0.001) among obese young house wives.

TABLE I: Physical and physiological parameters of obese and non-obese young house wives.

	Obese		*Non obese*		*P*
	Mean	*SD*	*Mean*	*SD*	*value*
Height	156.3	5.98	157.87	5.67	0.25
Weight	67.93	5.11	53.90	4.95	0.000*
BMI	27.76	1.26	21.64	1.72	0.000*
Body fat%	37.45	3.45	28.72	3.22	0.000*
Fat mass (kg)	25.42	3.16	15.43	2.26	0.000*
Lean body mass (kg)	42.50	3.78	38.43	3.96	0.000*

*Indicates statistically significant.

According to Table II heart rate does not showed any changes at rest in obese and non obese young wives but soon after exercise it increased values are statistically significant. The blood pressure does not show any change.

According to Table III VO_2 max/kg body weight was less in obese than non-obese. VO_2 max per kg lean body mass shows significant difference in obese and normal weight group.

TABLE III: VO_2 max/kg body weight and VO_2 max /kg lean body mass in obese and non-obese young house wives.

	Obese		*Non obese*		*P*
	Mean	*SD*	*Mean*	*SD*	*value*
VO_2 max/kg body weight	37.98	4.45	48.63	4.48	0.001*
VO_2 max/kg lean body mass	60.77	7.19	68.06	7.17	0.001*

Discussion

Absolute VO_2 max indicates an individual's cardiorespiratory fitness to transport oxygen to working muscles. The present study shows that there was significant difference in absolute VO_2 max of obese and non-obese group indicating there is extra stress on cardiorespiratory system because of excess fat (11).

According to Table I, the present study shows the body height did not show any significant inter group variation but body weight, LBM, FM, % Body fat were significantly higher (P<0.001) in obese group, and BMI score was also significantly higher (P<0.001) among obese females. Satipati Chatterjee and Pratima chatterjee et al also have similar findings in their studies (2). Similar findings were observed in Kshitija Umesh Patkar et al study (11). Satipati Chatterjee et al also found body mass, BMI, Body fat % were significantly (P<0.001) higher for the sample of obese boys when compared to their non-obese counter parts but Height (cm) showed no significant inter-group variation (19). A study done on school children showed that excess LBM is one of the major factor for obesity. Similar findings are observed in our study (20).

TABLE II: Heart rate ,SBP and DBP changes in before and after exercise of obese and non-obese young house wives.

		Obese		*Normal*		*P value*
		Mean	*SD*	*Mean*	*SD*	
Heart rate	At Rest	82.1	7.02	83.05	6.91	0.54
	After 6 min exercise	146.65	7.55	140.7	6.01	0.00*
SBP mmhg	At Rest	110.25	9.13	107.4	7.74	0.14
DBP mmhg	At Rest	72.45	5.50	71.35	6.78	0.44
SBP mmhg	After 6 min exercise	116.97	9.04	115.97	8.07	0.60
DBP mm hg	after 6 min exercise	74.53	9.44	71.2	6.77	0.07

*Indicates statistically significant.

According to Table II, the present study showed increased heart rate which was statistically not significant. The blood pressure does not show any change. The values are statistically not significant. Satipati Chatterjee et al found significantly (P<0.001) higher value of peak heart rate in obese group also indicated the greater cardiac load among them. In exercise, changes in heart rate are due to emotional and reflex factors. As the work conditions are similar, not many changes are found in heart rate and blood pressure among the two groups (1).

Masomeh Kamyabnia et al studied the physical fitness level among normal weight and obese female university students and found there were no significant differences between the means for the obese and normal weight groups for resting and training heart rate and blood pressure (P<0.05) (21).

The obese participants had more fat mass compared to normal weight participants. The determinants of blood pressure are cardiac output and peripheral resistance. So, the work done for both group volunteers is same. Volunteers are house wives with similar food habits, exercise. This maybe the reason for non-significant changes in B.P.

According to Table III, the present study shows highly significant (P<0.001) lower values of mean VO_2 max/kg body weight and VO_2 max/kg lean body mass of obese participants as compared to normal weight participants. Inspite of having significantly (P<0.001) higher value of VO_2 max the oxygen consumption per unit of body mass was significantly less (P<0.001) in the obese group.

Kshitija umesh Patkar et al also observed that VO_2 max/kg body weight was less in obese than non-obese (11). Similarly Chaterjee et al found the excessive amount of body fat that appeared to exert an unfavorable burden as well as hindering action towards cardiac function, particularly during exhausting exercise when excessive hyperactive body musculature fails to uptake sufficient amount of oxygen due to deposition of proportionately high amount of fat mass (1).

Amann et al, found excess body fat impairs cardio respiratory functions and reduces mechanical efficiency for a given work load (22, 23).

In this study VO_2 max per kg lean body mass shows significant difference in obese and normal weight group.

Kshitija Umesh Patkar et al, found no significant difference in obese and normal weight group indicating same cadiorespiratory performance in both the groups (11).

Chaterjee et al, found in their study grossly reduced oxygen utilization by adipose tissue during exercise that reduces the overall VO_2 max[2] (1).

Conclusion:

The present study confirms that Cadiorespiratory efficiency was not affected in obese group as compared to normal weight group; however ability to do exhausting work was less in obese group. Preventive health care programs to reduce risk of obesity in women should be applied, considering their occupation for achieving more effectiveness. Awareness to maintain normal BMI by lifestyle modifications and interventions might help us in moving forward for eradication of obesity. Therapeutic exercise programs for obese young adults can be best designed to increase caloric expenditure and thus to decrease body fat rather than to improve aerobic fitness. Thus incorporation of activities need not beat high sustained intensities. This will increase their compliance for exercise programs.

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