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SHORT COMMUNICATION

COMPARISON OF VO_{2max} IN OBESE AND NON-OBESE YOUNG INDIAN POPULATION

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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_{2max} is the most accepted indicator of cardiorespiratory efficiency it was compared in 30 obese and 30 non-obese subjects aged around 18-20 years. VO_{2max} was estimated by Queen's college step test. Various other parameters measured and calculated are weight, height, BMI, skin fold thickness, percentage body fat, lean body mass, fat mass. The results showed that cardiorespiratory efficiency (absolute VO_{2max} & VO_{2max}/kg lean body mass) was not affected ($P>0.05$) in obese group in both sexes. Ability to do exhausting work (VO_{2max}/kg body weight) was less in obese group ($P=0.001$) compared to non-obese group & in obese males ($P<0.01$) as compared to non-obese males. Percentage body fat ($r = –0.416$), triceps skin fold thickness ($r = –0.427$) and calf skin fold thickness ($r = –0.381$) strongly correlate to VO_{2max}/kg body weight. Therefore the exercise programs can be best designed to increase caloric expenditure and thus to decrease body fat rather than to improve aerobic fitness.

Key words : obesity VO_{2max} cardiorespiratory efficiency young adults body mass index skin fold thickness

INTRODUCTION

Modern sedentary life style and faulty food habits are leading to development of early life obesity (1). People are prone to develop cardiovascular diseases and other chronic diseases at young age of their life because of early life obesity (2). The journey from early life obesity to cardiovascular disease will be evident by slow regression of their cardiorespiratory efficiency. Cardiorespiratory efficiency refers to the ability of the circulatory and respiratory system to supply oxygen to skeletal muscles during sustained

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physical activity. 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. As VO_{2max} is an accepted measure of cardiorespiratory efficiency (3, 4, 5, 6), it is used in this study to estimate the same. This study was aimed to find out whether obesity affects cardiorespiratory efficiency of young adults or not. This will alert them at proper time to take necessary action and will also help to plan the type of exercise suitable for their health need.

METHODS

Thirty (30) obese and thirty (30) non-obese volunteers aged between 18 and 20 years were selected. They were classified as obese and non-obese according to obesity classification based on Body Mass Index (BMI) (Center for Disease Control and Prevention, USA) (WHO)

Inclusion criteria for both groups

1) Healthy young adults aged between 18-20 yrs, 2) Sedentary life style.

Exclusion criteria for both groups

1) Subjects with history of cardiopulmonary disease, 2) Chronically ill, 3) Medication for long duration, 4) History of any major surgery (cardiac, pulmonary, abdominal) related to study, 5) Subjects undergoing any physical conditioning program.

The following Parameters were studied,

1) **Weight –** It was recorded to the nearest 0.5 kg with clothing using a standard scale.

2) **Height –** It was measured to the nearest 1 cm without footwear

3) **BMI** was calculated using Quetlet's index as weight (kg) over height (m^2).

4) **Percentage body fat** was calculated by a formula (7)

For Boys % body fat = 0.735 (Tskf + calf skin fold thickness) + 1.0;

For Girls in whom (Tskf + Sskf) < 35 millimeter % body fat = 1.33 (Tskf + Sskf) –0.013 $(Tskf + Sskf)^2$ – 2.5;

For Girls in whom (Tskf + Sskf) > 35 millimeter % body fat = 0.546 (Tskf + Sskf) + 9.7;

where Tskf, Triceps skin fold thickness and Sskf, Subscapular skinfold thickness

5) **Fat mass** (FM) was calculated in kilograms by a formula, (8) FM (kg) = (% body fat 7100) x body weight (kg)

6) **Fat Free mass** (FFM)/**lean body mass** (LBM) was calculated in kilograms, (8) FFM (leg) = body wt. (kg) – body FM (kg)

7) Estimation of VO_{2max} by Queen College Step Test (9) – It was performed using stepping bench of 16.25 inches height. Stepping was done for total duration of 3 minutes at the rate of 24 steps ups/min for boys and 22 Steps ups/min for girls, which was set by a metronome. After completion of exercise subjects were allowed to remain standing comfortably and carotid pulse rate was measured from

5th to 20th sec. of recovery period. This 15 sec. pulse rate counted to beats/min. and the following equations (9) used to predict VO_{2max}.

For males – VO_{2max} (ml/kg/min.) = 111.33–(0.42 × pulse rate in beats/min)

For females – VO_{2max} (ml/kg/min) = 65.81–(0.1847 × pulse rate in beats/min)

Statistical Analysis was done using following tests,

1) Unpaired t-test was used to test the significance of difference between mean values of VO_{2max} of obese and normal weight group, to test the significance of difference between mean values of VO_{2max} in obese females and normal weight females and to test the significance of difference between mean values of VO_{2max} in obese males and normal weight males.

2) Pearson's correlation test is used to find out correlation between VO_{2max}/kg body wt and body weight, lean body mass, % body fat, fat mass, skinfold thickness.

RESULTS

TABLE I: Anthropometric & other parameters of subjects of normal & obese groups.

Parameter	*Normal (n=30)*	*Obese (n=30)*	*P-value*
BMI	20.875±1.8224	27.2397±2.8584	<0.01
Height (cm)	167.33±9.22	164.65±9.32	0.267
Weight (kg)	58.70±7.93	73.93±11.10	<0.01
Triceps skin fold thickness (mm)	14.547±5.325	21.320±5.977	<0.01
Subscapular skin fold thickness (mm)	15.757±5.105	24.017±6.595	<0.01
Calf skin fold thickness (mm)	15.160±6.413	21.317±7.708	<0.01
Basal HR	79.53±4.78	82.07±5.24	0.055
Heart rate	142.80±16.14	154.53±15.98	<0.01
Percentage body fat	22.678±7.1085	31.8427±8.6436	<0.01
Lean Mass (kg)	45.332±6.840	50.3747±9.5188	0.02
Fat Mass (kg)	13.368±5.039	23.5553±7.8569	<0.01
Absolute VO_{2max} (ml/min)	2836.33±658.66	3054.71±616.16	0.190
VO_{2max}/kg body weight (ml/min/kg)	47.906±7.2870	41.342±6.5455	0.001
VO_{2max}/kg lean body mass (ml/min/kg)	62.05±8.52	61.18±9.98	0.717
	Normal Males	Obese Males	
VO_{2max}/kg body weight (ml/min/kg)	50.6973±6.1762	44.0367±6.1652	0.002
	Normal Males	Obese Males	
VO_{2max}/kg body weight (ml/min/kg)	40.230±3.7047	37.300±4.9500	0.171

Data presented as Mean±SD.

TABLE II: Correlation Coefficient between VO_{2max}/kg body weight & other parameters.

Parameter	*Normal (n=30)*		Obese *(n=30)*	
	r-value	*P-value*	*r-value*	*P-value*
BMI	0.073	0.702	−0.292*	0.118
Height	0.515**	0.004	0.245	0.192
Weight	0.434*	0.017	−0.026	0.891
Triceps	−0.336	0.069	−0.427**	0.019
Subscapular	−0.378*	0.039	−0.251	0.181
Calf	−0.528**	0.003	−0.381**	0.038
BHR	−0.250	0.183	−0.130	0.493
Heart rate	−0.606**	<0.01	−0.309*	0.097
% body fat	−0.510**	0.004	−0.416**	0.022
Lean mass	0.675**	<0.01	0.257*	0.170
Fat mass	−0.233	0.214	−0.349	0.059

*Correlation is significant at the 0.05 level.
**Correlation is significant at the 0.01 level.

DISCUSSION

Absolute VO_{2max} indicates an individual's cardiorespiratory fitness to transport oxygen to working muscles (10). The present study shows that there is no significant difference in absolute VO_{2max} of obese and non-obese group indicating there is no extra stress on cardiorespiratory system because of excess fat. Buskirk and Taylor (11), Davies et al (12), and Anne-Caroline Norman et al (1), also have similar findings in their studies. In a recent study conducted by Wood et al (13) in overweight and obese adults also found results supporting present study. In their study comparison of VO_{2max} in non-obese and obese was not done but they observed that VO_2platue was reached in 85% of overweight and obese adults after performing continuous incremental exercise and some tests fulfilling criteria for reaching VO_2platue. Chatterjee et al (10) have contradictory finding, in which absolute VO_{2max} is higher in obese indicating higher cardiac load during working.

According to Table I, the present study shows highly significant lower values of mean VO_{2max}/kg body weight of obese participants as compared to normal weight participants. This probably indicates that ability to perform exhausting work is less in obese individuals. Buskirk and Taylor (11), Chatterjee et al (10) also observed that VO_{2max}/kg body weight was less in obese than non-obese. Thus the obese individual is under a substantial handicap in physical performance requiring exhausting work because of the load of fat, which does not contribute to his performance, which he must carry with him.

Ideal reference for the VO_{2max} as a test of cardiovascular-respiratory performance might well be the weight of muscles actually performing the work. In this study VO_{2max} per kg lean body mass shows no significant difference in obese and normal weight group indicating same cardiorespiratory performance in both the groups. Chatterjee et al (10) and Dempsey (14) also found similar results in their study. Davies et al (12) found contradictory result.

In this study there is no significant difference in VO_{2max}/kg body weight in females of obese and normal weight group. But there is significantly low value in obese males as compared to normal weight males. The reason for this gender difference can't be explained. Less number of females in this study may be one of the possibilities According to Table-II, in normal weight group strongest positive correlation to VO_{2max} per kg body weight was observed to lean body mass. Similar results were found in study reported by Welch (15), Buskirk and Taylor (11), Chatterjee (10). In obese group strongest negative correlation was observed for VO_{2max}/kg body weight to triceps skin fold

thickness. In both the groups strong negative correlation was observed for VO_{2max} per kg body weight to percentage body fat. This indicates that as severity of obesity increases VO_{2max}/kg body weight decreases.

In conclusion cardiorespiratory efficiency was not affected in obese group as compared to normal weight group, however ability to do exhausting work was less in obese group.

There was no detrimental effect of obesity on cardiorespiratory efficiency in both sexes. However detrimental effect of obesity was seen on ability to do exhausting work in obese males when compared to normal weight males.

– Percentage body fat, triceps skinfold thickness and calf skinfold thickness showed strong negative correlation with VO_{2max}/kg body weight in obese.

Considering these findings of the study, 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 be at high sustained intensities. This will increase their compliance for exercise programs. In addition accurate guidance regarding the type of food consumption will increase the tolerance for maximum exercise and reduce the incidence of obesity related health hazards in later years of life.

REFERENCES

1. Norman A, Drinkard B, Duffie JRM et al. Influence of excess adiposity on exerciser fitness& performance in overweight children & adolescents. *Pediatrics* 2005; 115: 690–696.
2. Krauss RM, Winston M, Fletcher BJ, Grundy SM. Obesity Impact on Cardiovascular Disease. *Circulation* 1998; 98: 1472–1476.
3. Anderson KM, Shephard RJ, Denolin H, Varnauskas E, Masironi R. *Fundamentals of exercise testing* (WHO, Geneva) 1971.
4. Astrand. Textbook of work physiology, *Physiological Bases of exercise*, 3rd edition (McGraw Hill).
5. Shephard RJ. World standards of cardiorespiratory performance. *Archieves of Environment Health* 1966; 13: 664–672.
6. Banerjee PK, Chatterjee S, Chatterjee P, Maitra SR. Maximal oxygen uptake in boys. *Indian Journal of Medical Research* 1982; 75: 380–386.
7. Slaughter MH, Lohman TG, Boileu RA. Skin fold equations for estimating body fatness in children & youth. *Human Biology* 1988; 60: 709–723.
8. Gibson, Principles of nutritional assessment, New York, New York Oxford University Press (1990).
9. McArdle WD, Katch IF, Katch LV. Exercise Physiology: Energy, Nutrition and Human Performance; 5th Ed. 2001.
10. Chatterjee S, Chatterjee P, Bandyopadhyay A. Cardiorespiratory fitness of obese boys. *Indian Journal of Physiology & Pharmacology* 2005; 49.
11. Buskirk E, Taylor HL. Maximal oxygen intake &its relation to body composition with special reference to chronic physical activity & obesity. *Journal of Applied Physiology* 1957; 11: 72–78.
12. Davies CTM, Godfrey S, Light M, Sageant AJ, Zeidifard E. Cardiopulmonary responses to exercise in obese girls & young women. *Journal of Applied Physiology* 1975; 38: 373–376.
13. Rachel E Wood, Andrew P Hills, Gary R Hunter, Neil A King, Nuala M Byrne, Vo_{2max} in overweight and obese adults: do they meet the threshold criteria? *Medicine and Science in Sports and Exercise* 2010; 42(3): 470–477.
14. Dempsey JA, Reddan W, Balke B, Rankin J. Work capacity determinants & physiologic cost of weight supported work in obesity. *Journal of Applied Physiology* 1966; 21: 1815–1820.
15. Welch BE, Riendeau RP, Crisp CE, Isenstein RS. Relationship of maximal oxygen consumption to various components of body composition. *Journal of Applied Physiology* 1957; 12: 395–398.