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Correlation of body composition to aerobic capacity; A cross sectional study

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Abstract
Background: Anthropometry is generally considered as the single most easily obtainable, inexpensive, and noninvasive method that reflects body composition and VO2 max is an indication of the physical fitness of the subject. There is a paucity of data on the age related changes in the body composition parameters and VO2max and the association between them in the Indian adult population. Hence, the present study was conceived to assess and find the association between these parameters in the adult age group of 25-35 years.
Objective: purpose of this study to establish the relationship of body mass index, waist/hip ratio, % body fat to aerobic capacity of young age males.
Materials and Methods: 30 adult males who undergo irregular physical activities and ranging the age from 25-35 years participated as subjects of the study. Selected parameters for the study were body mass index (BMI), waist/hip ratio, %body fat and aerobic capacity (vo2 max). Body composition was assessed using anthropometric measures (Height, weight, BMI, waist circumference, hip circumference and skin fold thickness) and aerobic capacity was assessed by using predicted VO2max from Queen's college step Test.
Results: The mean values for body mass index (24.59±4.29) kg/m^2, w/h ratio (1.13±0.041), % body fat (16.11± 4.09) and predicted VO2 max were (44.11 ±7.46) ml/kg/min respectively. There was a significant negative correlation of body mass index (-0.868, p-value= 0.012) and % body fat (-0.929, p-value=0.046) and a highly significant negative correlation of w/h ratio (-0.987, p-value=0.0041) observed in this study. The level of significance was set at 0.05.
Conclusion: The results suggest that cardio respiratory fitness in terms of aerobic capacity (vo2 max) are affected by composition of body. Excessive amount of waste fat exerts an unfavourable burden on cardiac function and oxygen uptake by working muscles. Low cardio-respiratory fitness in young adults with increased body fat could be a factor for developing cardiovascular comorbidities later in middle age and old age.

Keywords: aerobic capacity, vo2 max, body composition, cardio-respiratory fitness, body mass index

Introduction
Body composition and aerobic fitness are frequently used in association with each other, and it is often implied that these physiological parameters are strongly inter-related. Both Body fatness and aerobic fitness have been shown to be risk factors for future health outcome but it is unclear whether these effects are related to one another or are independent risk factors. Some recent studies have shown that there are separate and independent health effects of aerobic fitness and fatness [1].
Therefore the purpose of this study was to examine the body composition (% BODY FAT, BMI,W/H ratio) on Aerobic fitness, Aerobic capacity is usually expressed in terms of maximal oxygen uptake (vo_2max) Capacity. Previous pertinent studies indicated body mass, fat free mass, % body Fat, and body surface area, are the best predictor of vo2max.
Several studies have suggested that regular physical activity and cardio respiratory fitness confer a reduction in the risk of coronary heart disease (CHD) and overall mortality in healthy subjects. The relationship has also been confirmed in diabetic and hypertensive subjects. Furthermore, programs that improve physical fitness appear to induce a significant reduction in CHD and any- Cause mortality among patients who suffered from myocardial infarction. In fact, exercise capacity and Activity status have become well-established predictors of cardiovascular and overall Mortality [2].

Obesity, impaired glucose tolerance, type 2 diabetes, hyperlipidemia, and hypertension are well-known components of metabolic syndrome. All these conditions are characterized by Insulin resistance and are associated with increased cardiovascular morbidity and mortality. Low Physical activity and poor physical fitness are frequent findings in subjects with metabolic syndrome. Lifestyle modification, such as diet and physical training, may improve some of these CHD risk factor [3].

Maximal oxygen consumption is considered the gold standard of cardio-pulmonary and muscle Cell fitness. Maximal oxygen uptake (vo2 max) is the highest rate of oxygen consumption Attainable during maximal or exhaustive exercise. Vo2max is internationally accepted parameter & is the first choice in measuring a person's cardiopulmonary status. Those who are more fit Have higher vo2max 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 and 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 and these factors may mediate the association between low cardio respiratory fitness and Mortality. Obesity can be assessed in several ways. Measurements of body composition (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 [4].

Both the high body fat 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 hence, the current study was designed to evaluate cardio respiratory fitness in terms of vo2 max and to correlate between % body fat, BMI and W/H ratio, to cardio respiratory fitness in healthy adult male subjects.

Materials and Methods

The study group comprised of 30 young healthy males in the age group of 25 to 35 yrs.

1. Inclusion criteria

a. Males
b. Age between 25-35 yrs
c. Otherwise healthy

2. Exclusion criteria

a. Male subjects below 25 and above 35yrs
b. History of cardiac disease
c. History of lung disease
d. Smoking
e. Not on regular medications affecting cardiovascular and respiratory system
f. Not undergoing any physical conditioning programme.

30 apparently healthy male subjects in the age group of 25-35 yrs from the departmental staff, PG students of M.L.N. Medical College were selected for the study. They were asked to fill a questionnaire to assess their physical activity status [5]. 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 was collected by taking Ht and Wt of the subjects using a standardized Height and Weight machine known as Seca-Vogel and Helke Hamburg balance.

Standing Ht was taken to the nearest 0.5 cm. Body Wt was recorded in kilograms on an empty bladder and before lunch on a standardized weighing scale. The Wt measurement was recorded to the nearest 0.1 kg. body mass index measured by Quetlet"s index (wt in kg/h in mtrs^2) and VO2max predicted indirectly by Queen's college Step test (Mcardles *et al.*).

Waist and hip circumference were measured after asking the subject to remove the garments of the upper half of the body, waist circumference was taken at the lowest possible circumference at abdomen after normal expiration while the subject is standing with his feet together and arms by the side of the body. Hip circumference was taken as the maximum girth around the hip with minimum clothes. The waist-to-hip ratio is calculated using the below formula [6].

WHR= Waist circumference (cm) /Hip circumference (cm)

A variety of methods were used to estimate the percentage of fat such as three-point skin fold method (triceps, abdominal, and suprailiac) and Jackson-Pollack equation (density determination) and Brozok equation (fat percentage) [7].

% Body fat = (0.39287 × sum of three skinfolds) – (0.00105 × [sum of three skinfolds]2) + (0.15772 × age) – 5.18845(8)

Queen's College Step Test

Step test was performed using a stool of 16.25 inches (41.30 cms) height. Stepping was done for a total duration of 3 minutes at the rate of 24 cycles per minute which was set by mobile metronome. After completion of the exercise the subjects were asked to remain standing comfortably and the carotid pulse rate was measured from the 5th to 20th second of recovery period. This 15 second pulse rate was converted into beats per minute and the following equation was used to predict VO2 max.

VO2max (ml/kg/min) = 111.33 - (0.42 x pulse rate in beats per min)

All experiments were performed at room temperature.

Statistical Analysis

The results were expressed as mean ± standard deviation (SD). A p value of < 0.05 was considered statistically significant. Statistical Analysis was done by using Microsoft office excel 2007 software. Pearson correlation was used to correlate BMI, % body fat and w/h ratio to VO2 max (ml/kg/min).

Results

30 young healthy males in the age group of 25-35 years (28.83 ± 4.02 yrs) were subjected to Queen's College Step

Test. the profile of study group is shown in table-1. Cardio respiratory Fitness in terms of VO2max was evaluated and then the effect of Body mass index (24.59±4.29) kg/m^2, w/h ratio (1.13±0.041), %body fat (16.11± 4.09) on cardiorespiratory Fitness was studied.

Table 1: Profile of study group

Body composition Parameters	Mean ± Sd
1. Age	28.83±4.02
2. Height(Mtr)	1.63±0.059
3. Weight(Kg)	64.33±14.50
4. Waist(Cm)	108.11±10.70
5. Hip(Cm)	95.68±8.89
6. Bmi(Kg/Mtr^2)	24.59±4.29
7. W/H Ratio	1.13±0.041
8. Body Fat(%)	16.11±4.09
9. Vo2max(Ml/Kg/Min)	44.11±7.46

There was a significant negative correlation of body mass index (-0.868, p-value=0.012) table-4 and % body fat (-.929, p-value=0.046) table-2 and a highly significant negative correlation of w/h ratio (-0.987, p-value=0.0041) table-3 observed in this study. The level of significance was set at 0.05.

Table 2: Correlation between %Body fat and VO2max

Variable		VO2 MAX
%Body Fat	r-value	-0.929
	p-value	0.046

Discussion

VO2 max is a measure of the functional limit of cardio respiratory system and single most valid index of maximal exercise capacity. The absolute value of VO2 max is one of the indices of an individual's cardio respiratory fitness to transport oxygen to working muscles. Earlier studies have used VO2 max values in ml/kg/min to assess the level of cardio respiratory fitness.

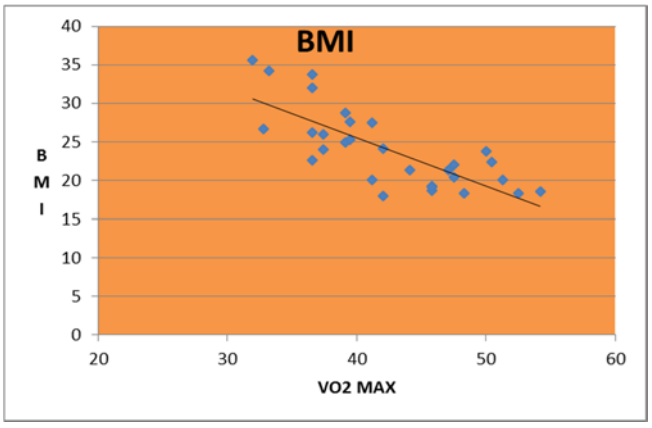

Fig 1: Scatter Diag of Bmi & Vo2 Max

Table 3: Correlation of w/h ratio& vo2 max

Variable		VO2 MAX
W/H Ratio	r-value	-0.987
	p-value	0.0041

Table 4: correlation of BMI& vo2 max

Variable		VO2 MAX
BMI	r-value	-0.868
	p-value	0.012

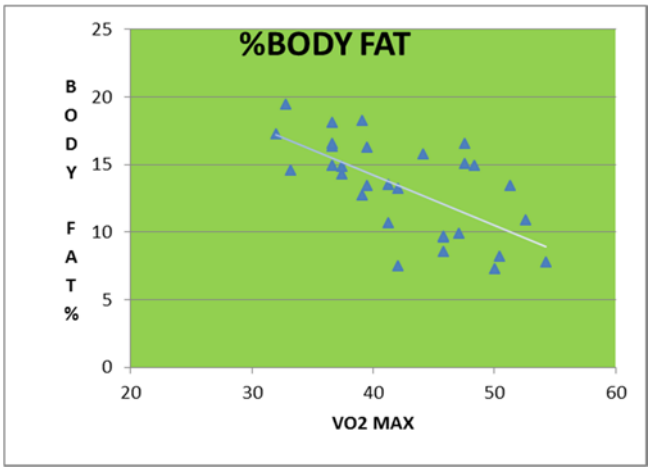

Fig 2: Scatter Diag. of % Body Fat & Vo2 Max

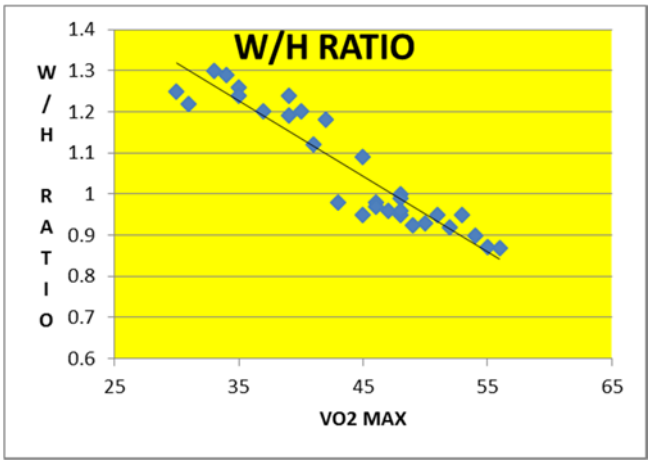

Fig 3: Scatter Diag. of W/H Ratio & Vo2 Max

Chatterjee *et al*. in 2005 used Queens College step test in their study to assess cardio respiratory fitness in obese and non-obese boys aged 10-16 yrs and it was found that VO2 max per kg of body weight was relatively less in obese subjects indicating reduced aerobic capacity. They concluded that during exhaustive exercise, the excessive hyperactive body musculature fails to uptake sufficient amount of oxygen due to deposition of proportionately high amount of fat mass [9]. It was found that during of weight reduction program in obese, their VO2 max (ml/kg/min) increased due to withdrawal of fat induced inhibitory action toward oxygen utilization by body musculature [10]. Bandyopadhyay studied the cardiorespiratory fitness in obese girls and found that VO2max was less in obese girls. This was probably due to hindering effects imposed due to excess deposition of fat [11]. P Setty *et al*. 2012 in their study used treadmill exercise test in adults and found that there was negative correlation between obesity and cardiorespiratory fitness [12]. Similar results were observed by Welch *et al*. [13], Ozcelick *et al*. [14] & Rowland *et al*. [15].

Our findings are similar to previous studies which have found that BF% is negatively correlated to VO2 max [16, 17] but contradictory to other studies which have found that BF% is not related to VO2 max [18, 19]. Present study shows highly negative correlation between VO2max and BMI. These are the probable reasons why, BMI, have negative correlation with maximal oxygen uptake (VO2 max). Measurements of body weight and body dimension (anthropometry) are used to reflect body fat in large (epidemiological) studies or in clinical settings. Body mass

index (BMI) has traditionally been used to identify individuals who are the most likely to be overweight or obese. Body masindex (BMI) is employed globally to classify humans as normal, overweight and obese [21]. Compared with assessment methods of body fat percent (BF %), it is inexpensive and easy to administer.

Obesity is an epidemic disease. Body weight depends on balance between calorie intake and utilization of calories. Increased free fatty acids from fat cells results in insulin resistance. The release of cytokines particularly IL-6 stimulate pro-inflammatory state that characterizes obesity. Increased secretion of prothrombin activator inhibitor- 1 from fat cells plays a role in procoagulant state of obesity and along with changes in endothelial function increases risk of cardiovascular disease and hypertension. Combined effects of these consequences of increased fat stores in an increase risk of shortened life expectancy [22]. Our study have been supported by studies of Chatterjee *et al.* [9], Shazia *et al.* [23], Ozcelik *et al.* [24], Salbatori *et al.* [25], Watanabe *et al.* [26].

Most of the study found significant negative correlation Welch *et al.* (1958) [27], Watanabe K *et al.* (1994) [28], Rowland TW *et al.* (1991) [29] of w/h ratio to aerobic capacity. Norman *et al.* studied influence of excess adiposity on exercise fitness and performance in overweight children and adolescents and found that overweight and non-over weight adolescents had similar absolute cardiorespiratory fitness but the functional impairment was significantly associated with increased energy demands needed to move their excess bodyweight [20]. Several previous studies have found significant differences in VO2max between obese and non obese. This study we found that there was a highly significant negative correlation between WHR and VO2max (ml/kg/min) (r=-0.987, p=0.0041)

Conclusions

There was a significant negative correlation of body mass index (-0.868, p-value= 0.012) and %body fat (-0.929, p-value=0.046) and a highly significant negative correlation of w/h ratio (-0.987,p-value=0.0041) observed in this study. The level of significance was set at 0.05.

This suggests the effect of body fat on cardiorespiratory functions. These findings demonstrate the importance of low cardiorespiratory fitness in young adults with increased body fat is a factor for developing cardiovascular comorbidities later in middle age. Queen's college step Test is a valid method for the estimation of VO2max in young males. BMI, % Body fat& WHR can be used in clinical settings to estimate cardiorespiratory fitness as it is a rapid and inexpensive methods. Additional study including detailed measurement of cardiac function is needed to clarify whether cardiac impairment (or initial stages of impairment) exists. Given the current obesity trend and observations of a decline in daily energy expenditure among the people, improving cardiorespiratory fitness in young men by engaging in physical activities is important.

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