ASSOCIATION OF BODY MASS INDEX WITH VO_2 MAX IN INDIAN ADULTS

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Abstract: Background: Cardio respiratory fitness is one of the best methods for assessment of individual's fitness. Aerobic fitness is reduced in overweight and obese. Aerobic fitness is also reduced in individual with sedentary life styles. **Aims & objectives**: The present study was undertaken to check association of overweight with aerobic fitness (VO_2 max) in Indian Adults. **Methodology**: Our study was done on 100 healthy Indian adults (50 males and 50 females) of 18-60 years of age group from staff members of Pramukhswami Medical College, Karamsad, Gujarat, India, after their voluntary consent. All participants were apparently healthy at the time of Treadmill exercise test. Body compositions of all participants were done using Omron body fat monitor HBF-302. Estimation of VO_2 max was done by treadmill exercise test following Bruce protocol. **Results**: All the participants were grouped into normal weight (BMI 18.5 to 22.9) and overweight (BMI > 23). In normal weight females (n=30) VO_2 max values obtained by Treadmill exercise test following Bruce protocol was 32.74 ± 12.82 ml/kg/min while in overweight female (n=20) it was 28.67 ± 9.78. VO_2 max in normal weight males (n=15) was 39.50 ± 11.28 ml/kg/min while in overweight males (n=35) it was 35.17 ± 8.87 ml/kg/min. VO_2 max was best correlated with total body fat percentage in males (r = -39) and females (r = -33) than total body mass in our study. **Conclusion**: VO_2 max was significantly less in overweight adults in comparison to normal weight adults. High body fat rather than high body weight played main role for reduction of VO_2 max in Indians.

Key words: Aerobic capacity, VO_2 max, Treadmill test, Bruce protocols, overweight Indians.

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Introduction:

Physical fitness is measure of proper functioning of cardiovascular, respiratory, neuroendocrine, muscular and haematocirculatory system[1]. Physical fitness, daily routine physical activity and task oriented physical exercises are outcome of integrated functioning of all bodily system. Hence, when physical fitness is checked, the functional status of all system is actually being assessed. Due to this reason physical fitness is considered as very useful health markers[1].

Cardiorespiratory fitness is a powerful predictor of cardiovascular and all-cause mortality[2]. Low aerobic fitness is one of the modifiable cardiovascular risk factor[2,3,4]. Effect of body fatness and leanness with aerobic fitness has remained unexplored. Body composition parameters affect cardiovascular fitness[5,6]. Cardiovascular fitness is different in individual with different body mass. Lean individual with high body fat is very common trend in India. In lean individual, high mortality is seen in association with smoking and other diseases.

Cardiorespiratory fitness should be assessed to check association between body composition and mortality[7,8]. Overweight and obesity have increased very fast in India in last few decades[9]. Cardiovascular mortality is very common in overweight and obese. Unwanted premature cardiovascular deaths are also common in lean individual. Body mass index is commonly used tool to check all cause morbidity and mortality[2,3,4]. In obese individuals, more body weight is seen for particular height but fat mass and fat free mass are ignored. Increased body mass index reflects high body fat and fat free mass and they have differentassociation with cardiovascular fitness. Physiological effects of overweight on height and body composition in relation to cardiovascular fitness needs further research. Least documents available between the body fatness and aerobic fitness for Indian community

Assessment of cardiorespiratory fitness by the maximum rate of oxygen consumption (VO_2 max) by Bruce protocol is the most commonly usedexercise stress test[2]. VO_2 max by Bruce

protocol is reliable and valid test for functional assessment of cardiovascular system[2,10]. This test has few drawbacks, like it is time consuming and expensive test. It is very difficult to get motivated participant for this type of research study. Exercise screening for large population is difficult and risky for few groups of participants.

Materials and methods:

A cross sectional study was conducted on 100 healthy Indian adults (50 males & females) of 18 to 60 years of age group from staff members of Pramukhswami Medical College, Karamsad, Gujarat and from nearby community after approval of Institutional Ethical Committee. All participants were informed about the type of study, their usefulness to the community, risk associated with study. All participants were enrolled for the current study after their written consent. All the participants were apparently healthy and diseases free at the time of the study. Participants with history of cardiovascular disease, joint problems and arthritis were excluded from the study. Participants with habit of alcohol and any other chronic diseases were also excluded from the study. All participants underwent ~~for~~ body composition parameters and treadmill exercise testing on same time of the day after following all standard precautions. Detailed history and pre-exercise heart rate and blood pressure were taken, and those who were unfit for the exercise test, were excluded from the study.

Body Composition

The body composition was done with light weight of clothing. The body weight was recorded in kilograms on an empty bladder on a standard weighing machine. The body weight was recorded bare footed to the nearest 0.1 kg. The height was measured using meter scale without footwear to the nearest 0.1 cm. BMI was calculated as the weight (kg) divided by the square of height (m^2). Total body fat percentage (TBF %) and visceral fat were assessed by bioelectrical impedance technique using Omron HBF-302, a body fat monitor. Fat mass was calculated on the basis of total body fat percentage into body weight. Fat free mass was calculated by subtracting fat mass from total body weight. FMI was calculated as the FM (kg) divided by the square of height (m^2). FFM was calculated by deducting FM from the body weight, and FFMI was calculated as the FFM (kg) divided by the square of height (m^2)[11,12].

Estimation of VO_2 max by Bruce Protocol:

Estimation of maximum oxygen utilization by heart was done by using motorized treadmill machine by following Bruce protocol[2,13]. Bruce's treadmill exercise test is a continuous, incremental test which consists of total 7 stages and each stage lasts for 3 minutes[2]. During treadmill test, exercise speed and grade are increased every 3 minutes. During first stage of TMT, participants walk at speed of 2.7 km/hour at incremental grade of 10%, then during second stage speed increases to 4.0 km/hour at grade of 12%. Heart rate and blood pressure were recorded during each stage. Participants were done exercise on the basis of maximum heart rate for their respective age. During each next stage speed and grade increase until the participants reaches volitional exhaustion. At the end of test, total time of exercise was recorded and VO_2 max was calculated by following formula:

VO2max (ml/kg/min), Male = 14.76 - (1.379 × T) + (0.451 × T2) - (0.012 × T3)

VO2max (ml/kg/min), Female = 4.38 × T - 3.9

Statistical analyses:

Standard descriptive data (means ± standard deviations) were computed to describe the sample. T tests were performed to confirm statistical association among the study and control groups. Pearson Correlation (R) was used to test the hypothesis to determine the relation between VO_2 max and body composition parameters. A p-value <0.05 was considered significant.

Results:

Descriptive characteristics of the Indian adults were shown in Table no. 1. Weight and fat free mass were more in male as compared to females. Total body fat% and fat mass were more in females as compared to males. VO_2 max values obtained by Treadmill exercise test following Bruce protocol in males was 36.47 ± 9.7 and in females was 31.11 ± 11.76.

VO_2 max in males was more and statistically significant ($P < 0.05$) than females.

As per table no 2, all the participants were grouped into normal weight (BMI 18.5 to 22.9) and overweight (BMI > 23). In normal weight females (n=30) VO_2 max values obtained by Treadmill exercise test following Bruce protocol was 32.74 ± 12.82 ml/kg/min while in overweight female (n=20) it was 28.67 ± 9.78. VO_2 max in normal weight males (n=15) was 39.50 ± 11.28 ml/kg/min while in overweight males (n=35) it was 35.17 ± 8.87 ml/kg/min. VO_2 max values in overweight males and females were less than normal weight males and females respectively. Total body fat% and fat mass were negatively associated with VO_2 max in both gender. There was direct positive association of VO_2 max with fat free mass in females.

Table 1: Showing descriptive characteristics of the participants (N=100)

	Male (n=50)	Females (n=50)
Age (in years)	35.26 ± 11.8	33.4 ± 11.27*
Height (cm)	169.15 ± 5.15	153.38 ± 6.8**
Weight (kg)	70.55 ± 10.5	55.62 ± 10.69**
BMI	24.62 ± 3.31	23.54 ± 4.22
Total body fat% (TBF)	25.32 ± 6.42	33.78 ± 6.39**
Fat mass (FM)	18.18 ± 6.31	19.20 ± 6.79
Fat Free Mass (FFM)	52.36 ± 6.70	36.42 ± 5.29**
Visceral fat (VF)	9.6 ± 3.8	5.92 ± 4.57*
VO_2 Max by Treadmill Test	36.47 ± 9.7	31.11 ± 11.76*

Table 2: Showing descriptive characteristics of normal and overweight Indians (N=100)

	Male (n=50)		Females (n=50)	
	Normal (n=15)	Overweight (n=35)	Normal (n=30)	Overweight (n=20)
Age (years)	33.06 ± 14.9	36.2 ± 10.32	29.7 ± 11.05	38.95 ± 9.32**
Height (cm)	170.3 ± 5.4	168.65 ± 5.04	153.35 ± 7.4	153.42 ± 5.9
Weight (kg)	60.89 ± 5.21	74.68 ± 9.52**	49.21 ± 6.07	65.25 ± 8.71**
BMI	20.96 ±1.14	26.19 ± 2.62**	20.85 ± 1.28	27.59 ± 3.85**
Total body fat%	20.91 ± 7.82	27.2 4.69**	30.43 ± 5.15	38.80 ± 4.55**
Fat mass	12.76 ± 5.02	20.50 ± 5.34**	14.99 ± 3.19	25.52 ± 5.77**
Fat free mass	48.13 ± 5.90	54.18 ± 6.26*	34.21 ± 4.69	39.73 ± 4.41*
Visceral fat	5.4 ± 1.95	11.4 ± 3.02**	3.26 ± 1.14	9.9 ± 4.91**
VO_2 Max by Treadmill Test	39.5 ± 11.28	35.17 ± 8.87*	32.74 ± 12.82	28.67 ± 9.78*

Table 3: Showing association of VO2 max with body composition parameters in males and females by Pearson's correlation

	Age	Height	Weight	BMI	TBF%	VF	FM	FFM
Males	-0.25	-0.04	-0.26	-0.26	-0.39**	-0.29	-0.37**	-0.07
Females	-0.40**	0.49**	0.08	-0.16	-0.33**	-0.21	-0.11	0.31**

* Indicate $P < 0.05$,** Indicate $P < 0.01$.

Discussion:

Aerobic fitness or capacity is defined as estimation of maximum oxygen consumption which varies with body weight, body fat mass, lean body mass, aging and physical activity status[14]. VO_2 max shows participant's ability to transport oxygen to the exercising muscles[14,15]. The present study showed statistically significant higher level of VO_2 max in normal weight males and females as compared to overweight Indian adults. Body mass, fat mass and fat free mass were more in overweight as compared to normal weight males and females.

Bandyopadhyay A and Chatterjee S reported body mass as a predictor of VO_2 max[16,17,18]. But in the present study, body mass index was negatively association with VO_2 max in males (r = -026) and in females (r = -0.16). VO_2 max decreased in both gender with high body mass index but statistically not significant. While fat mass was also negatively association with VO_2 max in males (r = -0.37) and in females (r = -0.11). Total body fat percentage played a key role for reduction of VO_2 max in both gender. Significant negative association was found between the VO_2 max and total body fat percentage, in males (r = -0.39) and in females (r =-0.33).

According to table 1 and 2, present shows highly significant lower values of VO_2 max in overweight as compared to normal weight participants. This shows less exercise performing capability and work done on overweight. Buskirk and Taylor[19], Chatterjee et al[18] and Patkar K. and Joshi A[20], reported less VO_2 max in overweight and obese than normal weight individuals. Thus the overweight individual is not able to perform exercise and not able to bear exercise load due high body fat mass. Supply of oxygen to the working muscles is decreased in overweight due to fatness[2]. In overweight individual, physical inactivity or high calorie intake leads to accumulation of more and more fatty tissue instead to muscle mass. A person with normal muscle mass is able to sustain exercise load effectively than person with high fat mass. So VO_2 max is more in trained athletes and person with high muscle mass.

Role of regular physical activity in prevention of cardiovascular diseases are well established[21]. A person with sedentary behaviour becomes fatty and overweight and it leads to low aerobic fitness. Stevens et al. reported low fitness as a potent risk factor for mortality than fatness[2]. They also reported interrelation of fitness and body mass index on all-cause and cardiovascular mortality[3,4]. Our study shows low aerobic fitness in females than males and it is supported by Stevens et al. Females with low fitness have more risk for all-cause mortality. Risk of all-cause mortality reduces with increase in each MET workload during exercise stress test in both males and females. Maintenance of fitness and prevention of fatness are important factors for reduction cardio-metabolic risk factors over a long time[22].

Conclusion:

To conclude, out study shows, cardiorespiratory fitness was less in overweight Indian adults in comparison to normal weight adults. High body fat percentage plays a vital role for reduction of aerobic fitness. Aerobic fitness was less in females as compared to males. Body fat mass was higher in females as compared to males.

Limitation:

We have estimated aerobic fitness by cross-section study in Indian adults. A long cohort study is need of time to establish better relationship between the aerobic fitness and body composition parameters. Inclusion of cardiovascular risk factors and its association with low fitness is welcome step.

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