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Aerobic fitness and body composition of trained and untrained Indian college students

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ABSTRACT

The present study aimed to compare the level of aerobic fitness and body composition of trained and untrained male college students of West Bengal, India. Trained students (N = 250) in the age range of 19-25 years were separated from their untrained counterparts (N = 250) according to their level of physical activity. Aerobic fitness in terms of maximum oxygen uptake capacity ($\dot{V}O_{2max.}$) was estimated by Queen's College Step Test. In order to evaluate the body composition variables (body mass index, % body fat, lean body mass, % skeletal muscle mass, % skeletal mass and body surface area) researcher applied a testing procedure that included measurements of height (cm), body weight (kg), three muscle girths (upper arm, thigh and calf) in cm, four bone diameters (humerus, bistyloid, femur and bimalleolus) in cm, and eight skinfolds thickness (triceps, sub-scapular, suprailiac, pectoral, axilla, abdominal, thigh and calf) in mm. Results found statistically significant ($p<0.01$) higher values of $\dot{V}O_{2max.}$ in trained college students compared to untrained students. The body composition variables have been compared between both groups and found trained college students possess better body composition in each variables than their counterpart. A negative correlation was found to $\dot{V}O_{2max.}$ with % body fat ($p<0.01$) and body surface area ($p<0.05$) of both trained and untrained groups. The BMI, lean body mass and % skeletal muscle mass have the significant ($p<0.01$) positive correlations with $\dot{V}O_{2max.}$ Finding suggest that beneficial effects of regular exercise on $\dot{V}O_{2max.}$ and body composition variables in college students.

Keywords: $\dot{V}O_{2max.}$, Lean body mass, % Body fat, Physical activity.

INTRODUCTION

Aerobic fitness is a major component of fitness for good health as well as for optimal performance in many sports. Aerobic fitness is best described as the maximal rate of whole body oxygen consumption ($\dot{V}O_{2max.}$) of an individual. The measure of the maximal rate of whole body oxygen consumption during exercise ($\dot{V}O_{2max.}$) has a history dating back to the pioneering work of A.V. Hill in the 1920. Traditionally, $\dot{V}O_{2max.}$ has been interpreted as a measure of the maximal capacity of the cardiorespiratory system to acquire oxygen, circulate it to working muscle, where muscle can the extract and utilize oxygen in mitochondrial respiration to meet the energy needs of muscle contraction. The measure of $\dot{V}O_{2max.}$ has therefore been invaluable in quantifying endurance fitness and the status of the cardio-respiratory and muscular systems for all individuals ranging from the athlete to the sedentary and diseased.

$\dot{V}O_{2max.}$ varies among individuals in a same population, such as the trained runners or untrained individuals [1]. The variables that can be used to explain the variance in $\dot{V}O_{2max.}$ include training status, genetic predisposition, body mass, body composition, maximal arteriovenous oxygen content difference, maximal heart rate, maximal cardiac output, and somatotype components [2,3]. Previous pertinent studies indicated body mass [4-6], fat free mass [7], % body fat [8] and body surface area [9] are the best predictor of $\dot{V}O_{2max.}$ The available studies, which primarily consist of $\dot{V}O_{2max.}$ and lean body mass (LBM) measurements in sedentary subjects, are difficult to interpret due to the confounding effects of age associated changes in body fat and muscle oxidative capacity [10]. Additionally, many studies of the decline in $\dot{V}O_{2max.}$ with aging, particularly in trained subjects, have not statistically adjusted $\dot{V}O_{2max.}$ for age or gender differences in body composition [11,12]. Finally, it is unclear what relevance indicators of whole body muscle mass have as determinants of $\dot{V}O_{2max.}$ when most of the O_2 consumed during $\dot{V}O_{2max.}$ testing is used by the limb muscles [13,14]. It is well known that absolute $\dot{V}O_{2max.}$ is strongly influenced by change in body size. For that reason body size should help to explain the aerobic capacity of an individual [16]. Some recent studies have shown that there are separate and independent health effects of aerobic capacity and fatness [17-19].

There have been several publications in previous years reporting on the quantity of physical activity performed by college students [19,20]. In the recent decade, a decline in physical activity among college students has been observed [20,21]. Regular physical activity is an important part of a healthy lifestyle. It is associated with decreased risk of heart disease [22], obesity [23], and cancer [24] and related to psychological well-being with lower levels of stress [25-27] and better cognitive functioning [28]. The purpose of this study was to compare the level of aerobic fitness and body composition of trained and untrained college student.

MATERIALS AND METHODS

Subjects

The present study was conducted on 250 trained and 250 untrained (total 500) young college levels male students. Age range of the subjects was 18 to 25 years (Mean 22.57 years, SD ±2.34). The age of the subjects were calculated from the date of birth as recorded in their institution. Trained students were completed one year Bachelor of Physical Education (B.P.Ed) course and took part in obligatory physical activities under their course of study whereas, untrained students were not participated regular physical activity. All the subjects were non-smoker. Subjects were selected from nineteen colleges located in nine different districts of West-Bengal in India irrespective of their caste, religion, dietary habits and socio-economic status. The investigator received ethical approval from the Visva-Bharati University Research Degrees Ethics Committee.

Measurements

The anthropometric measurements were carried out using standard instruments and in accordance with the methodology recommended by the International Society for the Advancement of Kinanthropometry [29]. Body height was evaluated in cm, along with body weight in kg, three muscle girths (upper arm, thigh and calf) in cm, four bone diameters (humerus, bistyloid, femur and bimalleolus) in cm, and eight skinfolds thickness (triceps, sub-scapular, suprailiac, pectoral, axilla, abdominal, thigh and calf) in mm were measured. For calculating body density of the subjects Jackson and Pollock [30] equation was adopted. The Siri equation [31] was used to convert body density to percent body fat of each participant. Poortman’s [32] and Drinkwater et. al. [33] formula was taken up for assessing skeletal muscle mass and skeletal mass respectively. Measurement of Body Surface Area (BSA) of the subjects Mosteller’s formula [34] was used. All subjects undertook Queen College Step Test [35] for estimating $\dot{V}O_{2max.}$

Statistical analysis

The Statistical Package for the Social Sciences (SPSS; version 18.0) was used for the data analysis. Descriptive statistics (mean, ± standard deviation) and Student t-test for independent samples were used for compared between the trained and untrained college students. Pearson's correlation of coefficients was used to establish the correlations of $\dot{V}O_{2max.}$ with body composition variables in trained and untrained of college students.

RESULTS

Mean, S.D. and t-value of body composition variables and aerobic fitness of trained and untrained college students were shown in table- 1. The trained subjects had significantly greater value of body mass index ($p<0.01$) as compared to untrained students. Lean body mass ($p<0.01$), % skeletal muscle mass ($p<0.01$) and body surface area ($p<0.01$) were found significantly higher in trained students when compared to the untrained students. No significant difference was reported between the two groups in relation to % skeletal mass. The trained college students had significantly higher amount of $\dot{V}O_{2max.}$ ($p<0.01$) than the untrained students.

Table- 1: Body composition and aerobic fitness of trained and untrained college students

Variables	Trained		Untrained		t-Value
	Mean	S.D.	Mean	S.D.	
Weight (kg)	60.44	5.53	58.43	6.48	3.71**
Height (cm)	168.33	5.59	168.82	5.63	0.97
BMI	21.31	1.35	20.51	2.06	5.11**
% Fat	12.37	3.01	14.36	3.69	6.58**
Lean Body Mass (kg)	52.9	4.55	49.95	5.23	6.70**
% Skeletal Mass	13.57	1.34	13.38	0.98	1.80
% Skeletal Muscle Mass	49.79	3.22	48.35	3.32	4.90**
Body Surface Area (m^2)	1.68	0.09	1.65	0.10	3.51**
$\dot{V}O_{2max.}$ ($ml.kg.^{1}min.^{-1}$)	54.83	5.38	40.91	6.51	36.78**
** indicates $p< 0.01$.					

Table- 2: Pearson correlation of body composition with aerobic fitness of both trained and untrained students

Variables	$\dot{V}O_{2max.}$ ($ml.kg.^{-1}min.^{-1}$)	
	Trained	Untrained
Weight (kg)	0.657**	0.476**
Height (cm)	0.466**	0.385**
BMI	0.338**	0.337**
% Body Fat	-0.344**	-0.516**
% Skeletal Muscle Mass	0.364**	0.297**
% Skeletal Mass	0.068	0.056
Lean Body Mass (kg)	0.763**	0.539**
Body Surface Area (m^2)	-0.135*	-0.124*
** indicates $p< 0.01$ and * indicates $p< 0.05$.		

Table- 2 comprises the coefficients of correlation for both trained and untrained groups of $\dot{V}O_{2max.}$ with various body composition variables. Significant positive correlation ($p < 0.01$) was observed in both group when aerobic fitness was correlated with BMI, % skeletal muscle mass, lean body mass; whereas, negatively correlated with % body fat ($p<0.01$) and body surface area ($p<0.05$). On the other hand, % skeletal mass was found insignificant correlation with aerobic fitness in both groups.

DISCUSSION

The trained college students have significantly ($p<0.01$) higher value of $\dot{V}O_{2max.}$ than untrained students as also reported in previous studies from the country and abroad [36-38]. So untrained college students have lower aerobic capacity and poor physical fitness in respect to their trained counterparts. The $\dot{V}O_{2max.}$ of active subjects reported by Banerjee et. al. [39] was comparable to the trained students of the present study. On the other hand the aerobic fitness of the untrained college students obtained in the present was similar with the findings of Bandyopadhyay, A. and Bandyopadhyay, P. [40].

Various body composition variables showed significant correlation with $\dot{V}O_{2max.}$ Previous pertinent studies indicated body mass as the best predictor of $\dot{V}O_{2max.}$ [4,5,9,41]. In the present study body mass exhibited higher value of correlation coefficient (r=0.657) with $\dot{V}O_{2max.}$ than height (r=0.466) in case of trained students, while untrained students depicted lower value of correlation coefficient (r=0.476) between body mass and $\dot{V}O_{2max.}$ than that of between height and $\dot{V}O_{2max.}$ (r=0.385). Verma et. al. [41] in their studies proposed that physical characteristics were good predictors of maximal oxygen uptake in Indian males and more importantly they obtained highest value of correlation coefficient when body mass was considered as an independent parameter.

In accordance with the results published by Sporis et. al. [42], present study also found negative correlation to body fat percentage with $\dot{V}O_{2max.}$ This is probably because of the excessive amount of body fat that appeared to exert an unfavourable 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 [7,43]. Similarly, Dempsy et. al. [44] found excess body fat impairs cardiorespiratory functions and reduces mechanical efficiency for a given work load. Finding of the present study was in accordance with the work of Lang et. al. [45] who described a significant relationship between skeletal muscle mass and $\dot{V}O_{2max.}$ Other authors [46] found a significant relationship between $\dot{V}O_{2max.}$ and thigh muscle cross-sectional area. Therefore, it may be concluded that skeletal muscle mass is an important variable for determining $\dot{V}O_{2max.}$ of an individual. Lean body mass had highly significant correlation with $\dot{V}O_{2max.}$ in both trained and untrained group [10]. These findings provide additional support for expressing dependence of $\dot{V}O_{2max.}$ to lean body mass.

CONCLUSION

Present study showed beneficial effects of regular exercise on $\dot{V}O_{2max.}$ and body composition variables in college students. Therefore, regular physical exercise can be included as a part of curriculum for college students.

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