

Correlation between Body Fat Percentages and VO2 Max in Young Males

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Abstract

Background: Aerobic capacity is one of the elements of physical fitness that describes the ability of the respiratory system and circulation to provide oxygen for muscle work during physical activity. It is generally considered the best indicator of cardio respiratory endurance. Body fat percentage affects VO2 max and thus the cardiovascular status. The present study was undertaken to study the relationship between body fat percentage and VO2 max.

Methods: Observational analytic quantitative research with a Cross-Sectional approach.

Twenty two male 22 students of medical faculty of Jenderal Soedirman University of age group 18-23years were selected for the study. Body fat percentage was determined by Bioelectrical Impedance Analysis (BIA) and VO2 max by Queen's college step test. The statistical analysis was done by Pearson correlation test.

Results: The mean body fat percentage was $25.22 \pm 3.85\%$ and the mean VO2 max was 51.69

± 8.04 ml/kg/min. The body fat percentage and VO2 max in young male showed statistically significant negative correlation by Pearson test (p 0,045, R -0,432)

Conclusion: The present study showed a statistically significant negative correlation between body fat percentage and VO2 max in young male.

Keywords: Body fat percentage, Young male, VO2 max.

Introduction

Obesity is a health problem that continues to increase, both in developed and developing countries(1). Until recently, it was perceived that obesity mostly affected middle age adults. However, a steadily increasing trend of obesity among young adults, especially college and university students, is becoming evident(2). The prevalence of overweight and obesity among adolescents has widely increased worldwide, making it one of the most common chronic disorders in this age group and in adulthood (3). approximately 35% of young adults at college or university students are overweight or obese (4). Young adults between the ages of 18–25 are in a period of ‘transition’ from adolescence to adulthood.

Obesity is defined as excess or abnormal fat mass (5). Body fat percentage (BF) predict fat mass better than body mass index (BMI) (6). We used Bioelectrical Impedance Analysis (BIA) method to estimate the Body fat %. BIA is known to provide a rapid, non-invasive and relatively accurate measurement of body composition.

Excessive body fat is associated with increased metabolic risk(6). Youth with severe obesity have a worse cardio metabolic risk profile, and a more extreme risk profile including higher blood pressure (BP), more dyslipidemia, more inflammation and cancer(7). With increase in body fatness, there is decrease in aerobic capacity (4).

Aerobic capacity is one of the elements of physical fitness that describes the ability of the respiratory system and circulation to provide oxygen for muscle work during physical activity. It is generally considered the best indicator of cardio respiratory endurance (8). VO₂ max refers to the intensity of aerobic process and actually denotes the maximum capacity to transport and utilize oxygen during exercise done at increasing intensity. VO₂ max is the highest rate of oxygen consumption attainable during maximal exercise (4).

There is inconsistency in relation of body fat percentage and VO₂ max. Many studies show the body fat percentage affects VO₂max (5,6), but research (9) is not significant.

The study assessed the relation of body fat percentage and VO₂ max and in young adult male groups.

Methods

Twenty two male students of Medical faculty, Jenderal Soedirman University, in the age group of 17-22 years not doing any regular exercise were selected as subjects. All research subjects were healthy and fit to examine cardiorespiratory resistance as evidenced by Physical Activity Readiness Questionnaire (PARQ). All the subjects were well explained about the nature of the study and the detailed procedure of the study. Consent was taken from all of the participant. The detail history was taken to exclude the cases with smoking history and any major illnesses.

The subjects were called early in the morning. Body weight, measured by standard weighing machine. Standard Height, taken by measuring tape. Body Mass Index was calculated as – Body Mass Index (BMI) = Weight in Kilograms (kg)/ (Height in meter)². Total body fat percentage (BF %) was estimated by using a commercially available, bio impedance analyzer system (BC-451, Tanita Corp, Tokyo, Japan). All measurements were taken during morning hours (0830–1200) and the subjects didn't have any vigorous activity during the preceding 12 hours of the measurement. The system consisted of a footplate with four electrodes. All procedures carried out according to manufacturer instructions.

Determination of VO₂ max: Subjects were asked to come three hours after their meal.

They were asked not to indulge in any kind of vigorous exercise within 48 h prior to the test. They were asked to wear comfortable clothing. Queens College Step Test was used to predict maximal aerobic capacity. It is a standard method to measure one's maximal oxygen uptake using sub maximal exercise in the form of bench stepping, suitable for adults. Prior to the test, subjects were asked to warm up for 5-7 min consisting of brisk walking and stretching of lower limb muscles. A wooden stepping bench of 41.3 cm was used along with metronome and stop watch. Metronome was used to monitor the stepping cadence, which was set at 96 beats per minute (24 complete steps per minute). The step test began after a brief demonstration and practice period. The subjects were asked to perform each stepping cycle to a four step cadence, up-up- down-down continuously for 3 min. After completion of test, subjects remained standing while pulse rate (radial artery) was measured for 15 sec, from 5th to 20th second of the recovery period. Fifteen second Recovery heart rate was converted to be expressed as beats per minute (15 sec Heart Rate x 4) Following equation is used: $VO_2 \text{ max (ml/kg/min)} = 65.81 - (0.1847 \times \text{step test PR}) / \text{min}$.

Pearson correlation test was computed for correlation between body fat percentage and $VO_2 \text{ max}$. P-value of 0.05 was taken as statistically significant.

Results

The characteristics of the subjects are shown in Table 1. The mean age in subject was 20.14 ± 0.94 years. The mean body mass Index in subject was $25.15 \pm 5.01 \text{ kg/m}^2$. The mean body fat percentage in subject was $25.22 \pm 3.85\%$. The mean $VO_2 \text{ max}$ in subject was $51.69 \pm 8.04 \text{ ml/kg/min}$.

Pearson correlation test computed for assessing the relation between body fat percentage and $VO_2 \text{ max}$. It showed statistically significant negative correlation with $r -0.432$. (Table 2).

Discussion

This study showed subjects who were medical students had an average BMI of 25.15 ± 5.01 , included in the category 1 grade obesity based on WHO criteria for Asia in 2000 with a maximum value of 40.63 kg / m^2 and a minimum value of 19.62 kg / m^2 . In this study the average body fat percentage of the subjects of 25.22 ± 3.85 showed that the average subjects had body fat percentage in the Obesity category with a maximum value of 31.20% and a minimum value of 17.60%. This is in line with several other studies that show a high percentage of body fat in the student population. Mohebbi and Azizi (2011) in Iran showed a mean body fat percentage of 29.9 ± 5.3 (10). Ekelund et al (2004) studied at The School Health Care System in Örebro in Sweden showed an average body fat percentage of 34.8 ± 4.8 (11).

The present study showed a significant Correlation between Body Fat Percentages and Vo2max in medical college student. A high percentage of body fat indicates a high fat mass in the body. Increased fat mass is stored in subcutaneous, visceral and intra-muscular tissues. A high percentage of body fat inhibits oxygen uptake in muscle tissue. This is supported by an increase in vo2max in obese individuals who are undergoing a weight loss program. In obese individuals there is an increase in type 2 muscle fiber and a decrease in type 1 muscle fiber which causes a decrease in oxygen uptake (12–14).

There are various studies in which similar results were shown. Amani et al (2010) showed a significant negative correlation between body fat percentage and VO2max in young adult men(15). Shete et.al (2014) also reported a negative correlation between body fat percentage and VO2max in young women subject(4).

Our study had several limitations. Firstly, this was a cross-sectional study, therefore, causal relationships of body fat percentage and VO2max could not be determined and

explained. Secondly, the number of study subjects was limited, relatively small, and recruited from a single population. Thirdly, we used the BIA method for measuring the body fat percentage which was not the gold standard. This was, however, easy to perform, simple, cheap, and had good sensitivity (85%) and specificity (100%) compared to Dual Energy X-Ray Absorptiometry (DXA)(5).

Conclusion

In conclusion, we demonstrated that body fat percentage had a significant negative correlation with Vo₂max value.

References

1. Inchley J, Currie D, Jewell J, et al. *Adolescent Obesity And Related Behaviours: Trends And Inequalities In The WHO European Region 2002-2014: Observations From The Health Behaviour In School-Aged Children (HBSC) WHO Collaborative Cross-National Study*. Copenhagen: WHO Regional Office for Europe; 2017: 87. hal.
2. Poobalan A, dan Aucott L. *Obesity Among Young Adults In Developing Countries: A Systematic Overview*. Current obesity reports [Internet]. 2016 [dikutip 21 Mei 2019];5(1):2–13. Tersedia pada: <http://www.ncbi.nlm.nih.gov/pubmed/26883372>
3. Bibiloni MDM, Pons A, dan Tur JA. *Prevalence Of Overweight And Obesity In Adolescents: A Systematic Review*. ISRN obesity [Internet]. 2013 [dikutip 21 Mei 2019];2013:392747. Tersedia pada: <http://www.ncbi.nlm.nih.gov/pubmed/24555142>
4. Shete AN, Bute SS, dan Deshmukh P. *A Study Of VO2 Max And Body Fat Percentage In Female Athletes*. Journal of Clinical and Diagnostic Research : JCDR [Internet]. 2014 [dikutip 20 Mei 2019];8(12):BC01. Tersedia pada: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4316241/>
5. Kurniawan LB, Bahrin U, Hatta M, dan Arif M. *Body Mass, Total Body Fat Percentage, And Visceral Fat Level Predict Insulin Resistance Better Than Waist Circumference And Body Mass Index In Healthy Young Male Adults In Indonesia*. Journal of clinical medicine [Internet]. 2018 [dikutip 21 Mei 2019];7(5). Tersedia pada: <http://www.ncbi.nlm.nih.gov/pubmed/29723977>
6. Ranasinghe C, Gamage P, Katulanda P, Andraweera N, Thilakarathne S, dan Tharanga P. *Relationship Between Body Mass Index (BMI) And Body Fat Percentage, Estimated By Bioelectrical Impedance, In A Group Of Sri Lankan Adults: A Cross Sectional Study*. BMC public health [Internet]. 2013 [dikutip 21 Mei 2019];13:797. Tersedia pada: <http://www.ncbi.nlm.nih.gov/pubmed/24004464>
7. Shah AS, Dolan LM, Khoury PR, Gao Z, Kimball TR, dan Urbina EM. *Severe Obesity In Adolescents And Young Adults Is Associated With Subclinical Cardiac And Vascular Changes*. The Journal of clinical endocrinology and metabolism [Internet]. 2015 [dikutip 21 Mei 2019];100(7):2751–7. Tersedia pada: <http://www.ncbi.nlm.nih.gov/pubmed/25974736>
8. Kenney W, Wilmore J, dan Costill D. *Physiology Of Sport And Exercise*. 6 th. USA: Human Kinetics Publisher; 2015:
9. Salehi S, Shekari MJ, dan Shahpar FM. *Factors Affecting Maximal Aerobic Capacity (VO2Max) In Iranian Non Athletic Women*. Advances in Environmental Biology. 2014;8(4):1077–81.
10. Mohebbi H, dan Azizi M. *Maximal Fat Oxidation At The Different Exercise Intensity In Obese And Normal Weight Men In The Morning And Evening*. Journal of Human Sport and Exercise [Internet]. 2011 [dikutip 17 Juni 2019];6(1):49–58. Tersedia pada: <http://rua.ua.es/dspace/handle/10045/16863>
11. Ekelund U, Franks PW, Wareham NJ, dan Åman J. *Oxygen Uptakes Adjusted For Body Composition In Normal-Weight And Obese Adolescents*. Obesity Research [Internet]. 2004 [dikutip 17 Juni 2019];12(3):513–20. Tersedia pada: <http://doi.wiley.com/10.1038/oby.2004.58>
12. Mondal H, dan Mishra SP. *Effect Of BMI, Body Fat Percentage And Fat Free Mass On Maximal Oxygen Consumption In Healthy Young Adults*. JOURNAL OF CLINICAL AND DIAGNOSTIC

- RESEARCH [Internet]. 2017 [dikutip 17 Juni 2019];11(6):CC17–20. Tersedia pada: <http://www.ncbi.nlm.nih.gov/pubmed/28764152>
13. Laxmi CC, Udaya IB, dan Vinutha Shankar S. *Effect Of Body Mass Index On Cardiorespiratory Fitness In Young Healthy Males | IJSRP February 2013 Publication*. Nternational Journal of Scientific and Research Publications [Internet]. 2014 [dikutip 17 Juni 2019];4(2). Tersedia pada: <http://www.ijsrp.org/research-paper-0214.php?rp=P262246>
 14. Keller K, dan Engelhardt M. *Strength And Muscle Mass Loss With Aging Process. Age And Strength Loss*. Muscles, ligaments and tendons journal [Internet]. 2013 [dikutip 17 Juni 2019];3(4):346–50. Tersedia pada: <http://www.ncbi.nlm.nih.gov/pubmed/24596700>
 15. Amani AR, Somchit MN, Konting MM, dan Kok L-Y. *Relationship Between Body Fat Percent And Maximal Oxygen Uptake Among Young Adults*. Journal of American Science. 2010;6(4).

Figures/Tables

Table 1. Characteristics of Subjects

n= number of sample **= highly significant

Subjects (n = 22)	Mean±SD	Median(Min-Max)
Age (y)	20.14±0.94	20 (18– 22)
BMI (kg/m ²)	25.15±5.01	24.38 (19.62-40.63)
Body Fat (%)	25.22±3.85	26.45 (17.60-31.20)
VO2 Max (mlO ₂ /Kg/min)	51.69±8.04	50.85 (37.41-64.29)

Continuous variables (Age, BMI-Body Mass Index, Body Fat %) are given as mean values with their standard deviations (SD). Number of participants (n)

Table 2 Correlation Between Body Fat Percentages and Vo2max

	Mean±SD	R	<i>P Value</i>
Body Fat Percentages	25.22±3.85	-0.432	0.045
Vo2max	51.69±8.04		