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Effect of body mass index on the VO_2 max in female AMU students

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Abstract
Title: Effect of body mass index on VO_2 max in female AMU students.
Background: According to previous studies done, the correlation study of BMI and VO_2 max mainly done among male, healthy and obesity population. Thus, so far there is no any study conducted mainly on females and different category of BMI. Therefore the main aim of this study selected is to find out the relation between 3 categories of BMI: underweight, normal, overweight and the VO_2 max for each of the group among female students with the inclusion criteria.
Objective: To find out the effects of different types of BMI on VO_2 max.
Methods: This study was conducted among 30 female AMU students with different body mass index. Those 30 individuals were divided into 3 groups according to underweight, normal, and overweight. Heart rate at rest taken for all subject. Then make the subject to walk on treadmill until they exhausted reach their maximum heart rate (maintain for 5 second) were noted. VO_2 max were calculated by using heart rate at rest and heart rate max.
Results: There was a significant difference between VO_2 max (ml/kg/min) and body mass index (BMI). ($p \leq 0.05 = 0.00$) which shows a statistically significant difference. Thereby the alternative hypothesis is accepted.
Conclusion: In this study there was a significant difference between the three groups of BMI on VO_2 max. The individuals with underweight BMI demonstrated increased VO_2 max when compare to the normal and overweight individuals. The results suggest the possible effect of body fat on cardio respiratory functions.

Keywords: BMI, VO2 Max, over weight females etc.

Introduction
Body mass index is a measure of weight adjusted for height. It is calculated as weight in kilograms divided by the square of height in meters. Although BMI is an imperfect tool, it does not distinguish overweight due to excess fat mass from overweight due to excess lean mass, it is the most commonly used measure for assessing obesity in adults. Other methods of determining adiposity are more accurate but have limited applicability to screening or studying large populations [1]. According to the World Health Organization body mass index (BMI) is used to classify nutritional state with following criteria: BMI <18.5 – underweight person, BMI 18.5 – 24.9 – normal nourished person, BMI 25 – 29.9 – overweight, BMI >30 – obesity, BMI 30-34.9 – I degree (moderate) obesity, BMI 35-39.9 – II degree (extreme, severe) obesity, BMI >40 – III degree(extreme, morbid) obesity [2]. The BMI is well correlated with these more direct fatness measures and weight and height are simple, inexpensive, non-invasive measurements that are recorded routinely in clinical and research settings. The VO_2 max is the maximum oxygen uptake or maximum volume of oxygen that is consumed in one minute during maximal exercise. It is presented in the milliliters of oxygen consumed in one minute per kilogram of body weight (ml/min/kg). It is often used as a parameter for the assessment of cardiovascular (aerobic) capacity [4]. The most reliable parameter for evaluating an individual's cardio respiratory fitness is the measure of maximal oxygen consumption (VO_2 max). The measurement of VO_2 max as a parameter of cardio respiratory fitness is useful when educating individuals about their overall fitness status, considering cardiovascular risk such as physical inactivity and overweight status [6]. Physiologist have found that the determination of the amount of oxygen received is the best measure for determination of the

Aerobic work. Direct measurements of oxygen uptake (VO_2 max) during maximal work provide the most accurate value for this parameter. However technically demanding and require access to expensive laboratory equipment and skilled personnel. Therefore, VO_2 max can be estimated indirectly from the measured HR max to HR rest ratio with accuracy that compares favorably with that of other common indirect tests [8].

Material and Methods

Study design: A Quasi experimental design

Study location: This study was conducted in Physiotherapy Gym, Asia Metropolitan University, Batu 9, Jalan Kemacahaya Cheras, and Malaysia.

Sampling: Purposive sampling

Inclusion Criteria

- Females
- Age between 20-30
- BMI (underweight , normal and overweight)

Exclusion Criteria

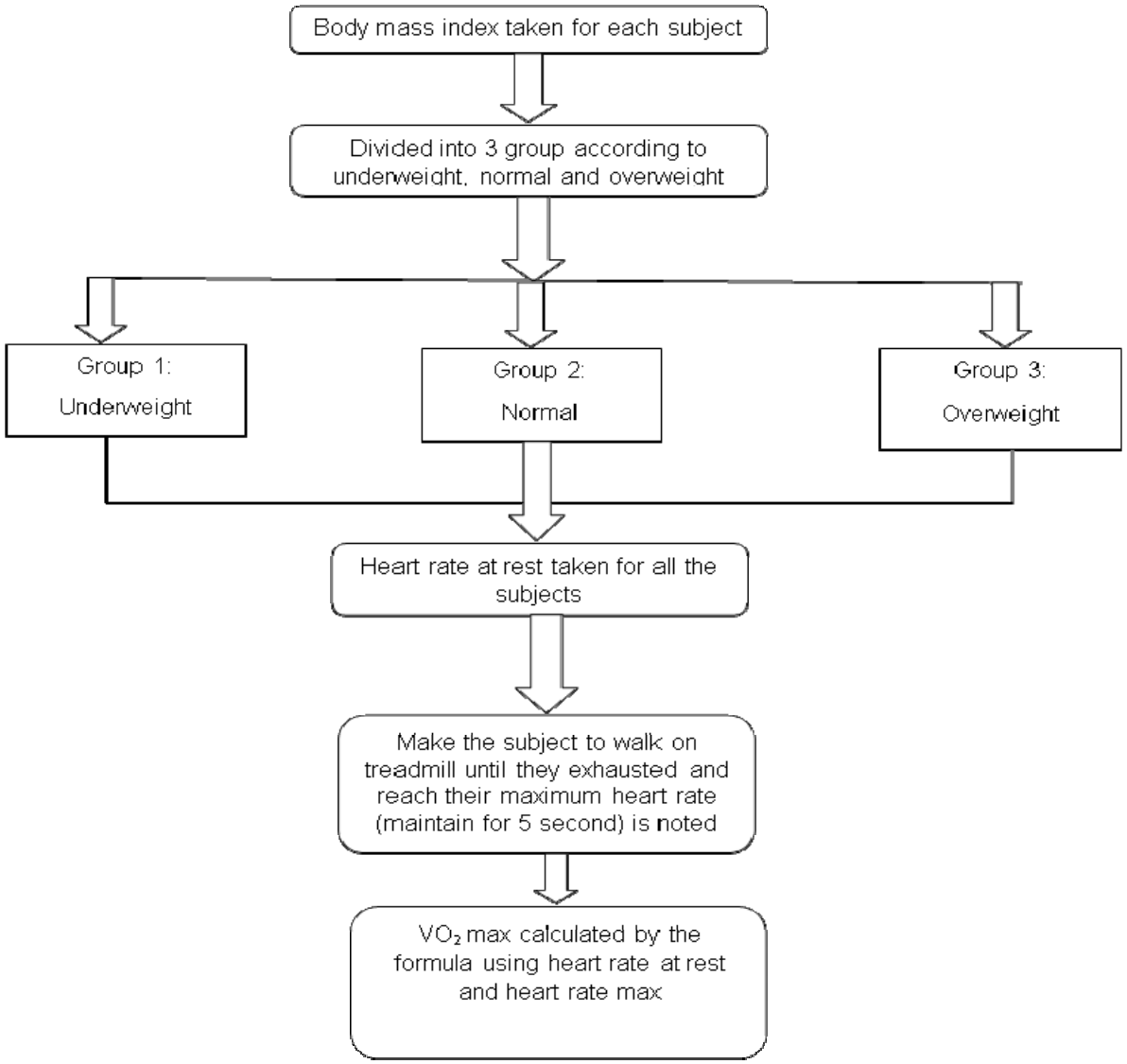
- History of any chronic disease
- Smoking
- On regular medication affecting cardiovascular and respiratory system
- Undergoing any physical conditioning programme

Procedure: A 30 subjects were screened for the study based on the selection criteria. Subjects were given screening form to fulfill the inclusion and exclusion criteria. BMI was calculated for each subject and divided them according to the BMI category (underweight, normal and overweight) group.

The procedure was explained to the subjects. Then resting heart rate of the subjects taken using a heart rate watch. Make the subject to walk on treadmill until they exhausted and reach their maximum heart rate (maintain for 5 second) is noted. Then VO_2 max of the subject calculated by the formula using heart rate at rest and heart rate max.

$$VO_2\ max = 15\frac{HR_{max}}{HR_{rest}}$$

Study methodology flow chart



Data Analysis

A data collection was done in Asia Metropolitan University (AMU) from July 2015 to August 2015. 30 samples of data was collected according to the inclusion criteria and divided into 3 different BMI group, 10 sample each group. The data analysis was done by using statistical package for social sciences (SPSS), version 2.0 software. The significance level will be set at $p \leq 0.05$. Descriptive statistic in this study calculated by using mean $\pm$ standard deviation (SD). ANOVA used to identify the significant difference between VO_2 max and BMI. The analysis method after using ANOVA followed up by the Post Hoc (Tukey HSD) test to determine which group has more influence on the significant differences between VO_2 max and BMI. Throughout July 2015 to August 2015 a total of 30 sample data was collected from AMU female students. The demographic information and selection based on inclusion criteria was obtained from the samples by using a screening form.

Descriptive Statistical Representation

Table 1

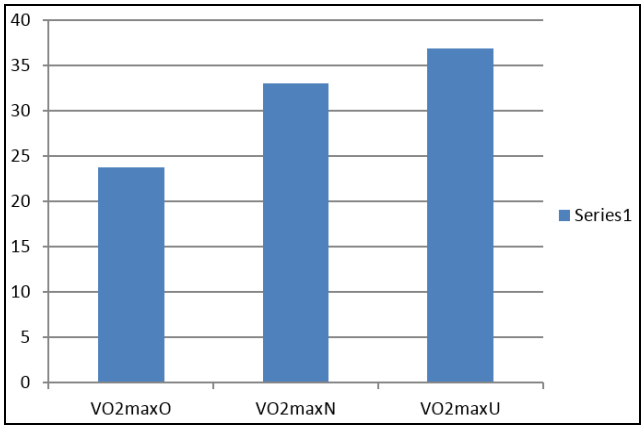
Descriptive Statistics								
vo2max								
	N	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
					Lower Bound	**Upper Bound**		
Normal	10	33.01	2.905	.919	30.94	35.09	29	38
overweight	10	23.75	1.184	.374	22.90	24.59	22	26
underweight	10	36.90	1.470	.465	35.85	37.95	35	40
Total	30	31.22	5.935	1.083	29.01	33.44	22	40

The above Table 1 shows the mean value for the normal BMI is 33.01. The mean for the overweight BMI is 23.75 and the mean for the underweight BMI is 36.90. The standard deviation for the normal weight is 2.90, the standard deviation for the overweight BMI is 1.18 and the standard deviation for underweight BMI is 1.47. The number of participants in each BMI category (N) is 10. Therefore, significant difference was found between the means of VO_2 max for the normal, overweight and underweight BMI. In this study the mean of VO_2 max in underweight BMI shows the highest mean value compare to the VO_2 max of normal BMI and overweight BMI. Overweight BMI shows the lowest mean value of VO_2 max. Thereby, to identify the significant differences between BMI and VO_2 max, we used ANOVA.

Table 2

ANOVA					
vo2max					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	913.343	2	456.672	114.162	.000
Within Groups	108.005	27	4.000		
Total	1021.349	29			

Above shows that there are differences between VO_2 max of overweight, VO_2 max of normal and VO_2 max of underweight. Thus the graph conclude that VO_2 max in underweight BMI individuals has the highest VO_2 max compare to the normal and overweight BMI individuals.



Distribution of means of VO_2 max on BMI

It shows that, at the degree of freedom of (2, 27) the "F" value for the ANOVA shows = 114.162 and "*P*" $\leq$ 0.05 = 0.000 which shows a statistically significant difference. Thereby the alternative hypothesis is accepted.

Post Hoc Tests

Table 3

Multiple Comparisons						
vo2max Tukey HSD						
(I) bmi	**(J) bmi**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Normal	overweight	9.266*	.894	.000	7.05	11.48
	underweight	-3.888*	.894	.001	-6.11	-1.67
Overweight	Normal	-9.266*	.894	.000	-11.48	-7.05
	underweight	-13.154*	.894	.000	-15.37	-10.94
Underweight	Normal	3.888*	.894	.001	1.67	6.11
	overweight	13.154*	.894	.000	10.94	15.37

*. The mean difference is significant at the 0.05 level.

The result shows that there is significant difference between BMI and VO_2 max by using ANOVA. Therefore we used Post Hoc Multiple Comparisons test (Tukey HSD) to identify the statistical significance between the different BMI groups. This will show which group is highly significant. In this study the above table 3 shows that, there is significant difference of VO_2 max between each BMI group.

Discussion

The purpose of this study was to find out the effects of different types of BMI on VO_2 max among female AMU students. In this study, the result shows that, there is significant difference on VO_2 max among subject with different BMI group. The underweight group shows the highest VO_2 max value compare to the normal and overweight BMI. The data analysis and result of this study proves to be relevant with the other studies done by comparing the normal individuals and overweight individuals. K. Masomeh *et al* (2011) [22] has done a study on comparing the physical fitness level in normal and obese individual proving that VO_2 max is lowest in obese individuals. In the present study the result has showed that underweight had the highest VO_2 max value compare to the normal weight and overweight is due to less body fats which give a positive effect on cardio respiratory fitness level. So greater the body mass index, lesser the value of VO_2 max in an individual. Thus % body fat in an individual plays the main factor in determining cardio respiratory fitness (VO_2 max). Ibrahim. E. H. Maize *et al* (2013) [13]. According to previous study done by Satipati Chatterjee *et al*, (2005) [13] found that VO_2 max per kg of body weight was relatively less in obese subjects indicating reduced aerobic capacity. These were concluded that during exhaustive exercise, the excessive hyperactive body musculature fails to uptake sufficient amount of oxygen due to deposition of high amount of fat mass. Thus, the overweight BMI in the present study had the lowest VO_2 max compare to the normal and underweight group.In addition, a study done by Laxmi CC *et al* (2014) [9] has stated that the physiology factor plays an important role in the reduction of oxygen consumption in individuals with high body mass index. This mainly due to the type of muscle fiber in the human body, increase in type II muscle fibers and decrease in type I fibers may reduce the oxygen consumption during perform maximal exercise. The result of this study demonstrated a significant negative correlation between BMI and VO_2 max which indicates a striking effect of increasing BMI on cardio respiratory fitness. This is in line with the results of current study, which shows that underweight BMI has more VO_2 max. Other than that, a study done on comparison of body mass index and heart rate (beats/min) between obese individual and non-obese individual. In this study, there was a statistically significant increase in heart rate in obese subjects compared to non-obese. There was a positive correlation with increasing BMI causing increase heart rate. The result indicates activation of the sympathetic nervous system occurs early in the course of obesity and the autonomic nervous system is an important contributor to the regulation of both the cardiovascular system and energy expenditure. S. R. Kanavi *et al* (2011). Hence according to this study, the body mass index has a direct influence on the heart rate.

Conclusion

In this study there was a significant difference between the three groups of BMI on VO_2 max. The individuals with underweight BMI demonstrated increased VO_2 max when compare to the normal and overweight individuals. The results suggest the possible effect of body fat on cardio respiratory functions. It also demonstrates the importance of low cardio respiratory fitness in young females with increase body fat which could be a factor for developing cardiovascular disease later in middle age. Hence taken into consideration this study shows the importance of engaging young females in physical activities in improving cardiovascular fitness**.**

Limitation

The limitations of this present study are mainly the number of subjects that involved in the study. I was not able to find more than 30 female students at the moment of my data collection due to time factor. Secondly, it was done using digital heart rate watch with low calibrations due to financial factor. In addition, this study was done at air conditioner environment, which may affect the VO_2 max outcome of an individual.

Recommendation

On the basis of the findings of the present study, the following recommendations are made: a). Similar study may be conducted with comparison of male and female or with only female participation with large population. b). Further study can be taken up by adding other cardio respiratory parameter as an outcome of the study. c) Similar study may conducted at outdoor environment with larger population.

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