A STUDY TO CORRELATE BETWEEN BMI AND CARDIORESPIRATORY FITNESS AMONG COLLEGIATE STUDENTS: A CORRELATIONAL STUDY

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Abstract

BACKGROUND: Cardiorespiratory fitness is the most important part of healthy lifestyle. Body fat can be measured by BMI. CRF and body composition are related to health have been the focus of researchers in the field of health and physical education. Over the past four decades, there has been an increase in prevalence of overweight and physical fitness declination in adult across all genders. Physical inactivity and sedentary lifestyle lead to accumulation of adipose tissue.

AIM: The effect of body mass index on cardiorespiratory fitness among collegiate students.

METHOD: The present study was carried out in the students of age group 18 to 25 years with collegiate students. 132 students were selected based on inclusion and exclusion criteria. They were assessing with McArdle step test.

RESULT AND DISCUSSION: Normal distribution of data was assessed. BMI and VO_{2max} were analyzed with Pearson's correlation test using SPSS version 21. It is shown statistically significant negative correlation between BMI and VO_{2max}.

CONCLUSION: This was reported that VO_{2max} increased as the value of BMI decreased and VO_{2max} decreased as the value of BMI increased. So, the appropriate planning should be made to maintain normal BMI and Cardiorespiratory fitness.

KEY WORDS: *Body Mass Index, Cardiorespiratory Fitness, VO_{2max}, Collegiate Students*

INTRODUCTION

Cardiorespiratory fitness is one of the most important components of physical fitness. It is also known as aerobic capacity. Which is the ability of the body to perform dynamic, large –muscle exercise, for prolonged periods, at moderate – to high intensity [1]. CRF is an important marker of physical and mental health in youth. Low or unhealthy CRF is a strong predictor of CRF. Over the past 6 decades, CRF is declined internationally [2]. Maximum oxygen consumption (VO_2 max) is considered to be the most widely accepted measure of CRF. Which gives a baseline estimation of one's heart and lung capacity. It can be used to follow the progress of daily physical exercise [1].

The cardiovascular system consists of the heart, blood vessels and blood. It provides several essential functions necessary for life, such as transporting oxygen and nutrients, removing carbon dioxide and wastes, fighting disease and maintaining body temperature. Cardiovascular disease (CVD), the number one cause of death worldwide, which refers to any disease that affects the cardiovascular system. Many risk factors have been found to be associated with CVD, such as hypertension, diabetes, unhealthy diets, smoking, alcohol, obesity and low CRF. Among these risk factors obesity has received particular attention [3]. High levels of CRF in young adults is associated with a lower risk of having calcification in the coronary arteries. Which prevents the development of early atherosclerotic vascular disease. [1]

CRF and body composition are related to health have been the focus of researchers in the field of health and physical education. Given the fact that CRF and obesity are to important risk factors for CVD, it is of interest to examine the relationship between CRF and obesity.[3] Over the past four decades, there has been an increase in prevalence of overweight and physical fitness declination in adult across all genders.[4] physical inactivity and sedentary lifestyle leads to accumulation of adipose tissue.[5] Regular physical exercise increases CRF level and suppresses the chronic inflammatory state of obesity.[1] Compared with obesity, the impact of CRF on human health has often ignored, even though it appears to be one of the most important determinants of overall health status and a powerful predictor of CVD mortality and morbidity. [3]

Body fat can be measured by BMI. It is based on height and weight that applies to both adult men and women. [6] Obesity is a major global public health challenge of our time.[9] BMI does not measure body fat directly but BMI is moderately correlated with more direct measure of body fat. BMI is strongly correlated with various metabolic and disease outcome as these are more direct measures of body fatness. [7]

With increasing prevalence of severe obesity, more information is needed about health expectancy at the extreme of BMI distribution. That is obesity and severe obesity which typically associate with excess morbidity and mortality. [9]

The calculation of BMI is based on the following formulation.

$$\textbf{BMI} = \textbf{Weight(kg)/Height(m)}^2$$

BMI is interpreted using standard weight status categories. These categories are the same for men and women of all body types.

Measurement of VO_2max is considered an important part in the evaluation of CRF and aerobic fitness. [2]

Aerobic fitness is a very good indicator of CRF and exercise tolerance for everyday activities which are largely aerobic for general population. It is considered that VO_2 max or maximal aerobic

capacity is only a single measure of the functional capacity of the oxygen system or cardiorespiratory system or oxygen transport system. [4]

Sophisticated laboratory equipment is required to measure aerobic capacity directly. However, it can reliably be estimated indirectly by performance submaximal exercise protocol such as the McArdle step test. [2] McArdle step test is use to measured oxygen consumption (VO_2max) and used to measured CRF. It is a submaximal test VO_2 max is an internationally accepted reference standard for assessing CRF. A lower maximal oxygen capacity is a strong predictor of CVD. Variable measured in McArdle step test are heart rate (HR), rate of perceived exertion (RPE), and VO_2 max. McArdle step test is a useful to for improving mental performance of young adult population. [8]

The evolution from hunting and gathering to agriculture, followed by industrialization, has had a profound effect on human physical activity patterns (PA). Current PA patterns are undoubtedly the lowest they have been in human history. The modern statistic and epidemiology methods has made it possible to quantify the independent effects of Cardiorespiratory fitness (CRF) and PA on health outcome. Cardiorespiratory fitness is the important health indicator. Any physical activity will effect on lungs. Decrease in cardiorespiratory fitness may cause diseases like heart disease, cancer, diabetes, hypertension, stroke, osteoarthritis, respiratory problems etc. Lower level of Cardiorespiratory fitness is associated with highest risk of this type of diseases.

So, the need of this study is to find out the effect of BMI on Cardiorespiratory fitness among Collegiate students.

METHEDOLOGY

- **STUDY DESIGN**: A Correlational study
- **STUDY SETTING**: RK University, Kasturbadham, Bhavnagar highway
  District- Rajkot
- **STUDY SAMPLE**: 132 Subjects
- **STUDY DURATION**: 4 Months
- **STUDY POPULATION**: Male & Female Collegiate Student
- **STUDY TECHNIQUE**: Purposive sampling

INCLUSION CRITERIA

- Male and Female
- Collegiate students
- Age between 18 to 25 years
- Underweight, Normal, Overweight BMI Category

EXCLUSION CRITERIA

- Subjects below 18 years and above 25 years
- History of Cardiac disease
- History of Lung disease
- History of Neuromuscular disease
- History of any Acute or Chronic illness
- Obese Category
- Smokers
- Uncooperative subject
- History of any Acute or Chronic illness

MATERIALS USE IN STUDY

- Pen, Paper, Chair & Table
- Consent Form & Assessment Form
- Stop Watch
- Weighing Machine
- Stediometer
- Measure Tap
- Stool

METHOD

- In this study 132 samples were selected according to the inclusion criteria, the data was obtained from RK University and measured in 18 to 25 years old collegiate students.
- The procedure was explained to all the subjects and written consent form was taken from them, Weight was measured by weighing machine and height was measured by stediometer.
- Then BMI was calculated which is based on weight and height.

  $BMI = weight(kg) / height^2 (m^2)$
- Then the McArdle step test was performed.
- In this the following instructions were given to them:
- Do warm up first, then do step up and down on a 41.7 cm step for 3 minutes in time with metronome, after 3 minutes heart rate was measured.

OUTCOME MEASURES:

1. BMI:

- The BMI was introduced in the early 19th century by the Belgian named Lamert Adolphe Jacques Quetelet.[10]

- He was mathematician, not a physician. The body mass index (BMI) is the metric currently in use for defining anthropometric height/weight characteristics in adults and for classifying (categorizing) them into groups. The common interpretation is that it represents an index of an individual's fatness.[11]
- Body Mass Index is a simple calculation using a person's height and weight. The formula is BMI = kg/m^2 where kg is a person's weight in kilograms and m^2 is their height in meters squared.[12]

Table:5.1 BMI CATEGORY

BMI	Weight status
Below 18.5	Underweight
18.5-24.9	Normal weight
25.0-29.9	Overweight
30.0-34.9	Obesity class I
35.0-39.9	Obesity class II
Above 40	Obesity class III

2. McArdle STEP TEST:

- The McArdle step test developed by McArdle, Katch, Pechar, Jacob- son, and Ruck (1972).[13]
- The step test requires that the individuals step up and down and on a standardized step height of 16.25i in (41.25cm) for 3 minutes.[14]
- Men step at a rate(cadence) of 24 per minute, whereas women step at a rate of 25 per minute. This cadence should be closely monitored and set with the use of an electronic metronome. A 24 step per minute cadence means that the complete cycle of step up with one leg, step up with the other, step down with the first leg, and finally step down with the lastly leg is performed 24 times in a minute. commonly the metronome is set at a cadence of 4 times the state rate, in this case 96 bpm for men, to coordinate each leg's movement with a beat of the metronome. The women's step cadence would be 88 bpm. Although it may possible to test more than one client at a time, the group would need to be of the same gender.[14]
- At the conclusion of 3 min. the client stops and palpates the pulse (typically at the radial site) while standing within the first 5 seconds. A 15 second pulse count is then taken and multiplied by four to determine heart rate in bpm. This recovery HR should occur within the first 30 sec. immediate recovery from the end of the step test. The subject's vo_{2max} is determined from the recovery HR by following formulas.[14]

FORMULA AND CALCULATIONS:

For men, VO_{2max} = 111.3 – (0.42 x HR)

For women, VO_{2max} = 65.81– (0.1847 x HR)[14]

NORMATIVE / COMPARATIVE DATA:

Table:5.2 Normative data of VO_{2MAX}

	Males (mls/kg/min)						Females (mls/kg/min)					
	18-25	26-35	36-45	46-55	56-65	66+	18-25	26-35	36-45	46-55	56-65	66+
Excellent	80-63	70-58	77-53	60-47	58-43	50-38	71-58	69-54	66-46	64-42	57-38	51-33
Good	59-53	54-50	49-44	43-40	39-37	36-33	54-48	51-46	44-39	39-35	36-32	31-28
Above Average	51-47	47-44	42-40	38-35	35-33	32-29	46-42	43-40	37-34	33-31	31-28	27-25
Average	46-43	42-40	38-35	35-32	31-30	28-25	41-39	38-35	33-31	30-28	27-25	24-22
Below Average	41-38	39-35	34-32	31-29	29-26	25-22	37-34	34-31	30-28	27-25	24-22	22-20
Poor	35-31	34-31	30-27	28-26	25-22	21-20	32-29	30-26	26-23	24-21	21-19	18-17
Very Poor	29-20	28-20	25-19	23-18	21-16	18-15	26-18	25-20	21-18	19-16	17-14	16-14

STATISTICAL ANALYSIS

Data was coded in Microsoft excel and word were used to generate graphs and tables.

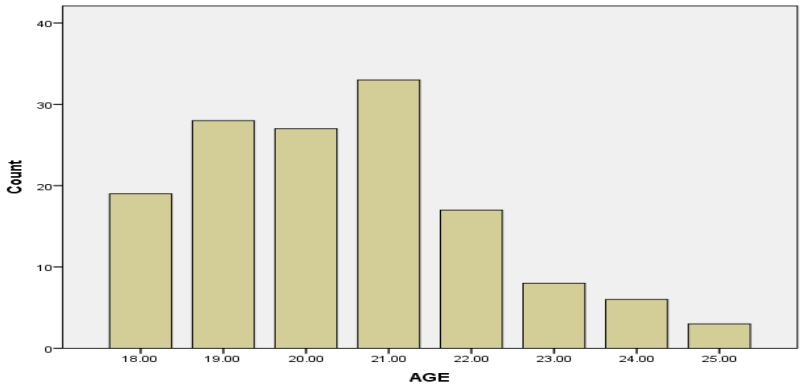
All the statistical analysis was done by the **STASTICAL PACKAGE FOR THE SOCIAL SCIENCE (SPSS)** software version **21** for windows. Normality of data was checked by using a Kolmongorov – smirnov test, Shapiro wilk test, Skewness, Kurtosis and Q-Q Plot.

A PEARSON'S CORRELATION is carried out in order to measure correlations between the variables such as BMI & VO2Max. An Independent samples t-test is carried out to assess the Age and Gender. **Level of significance** (p-value) was set to **0.05** levels. And **Confidence interval (CL)** was considered to be **95%**.

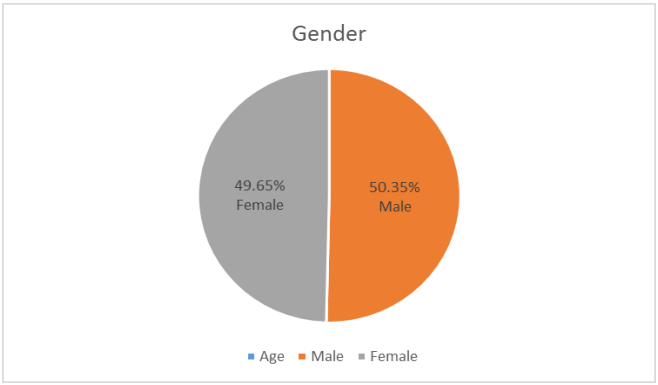
Table: 6.1 Mean Distribution of Age

Mean	N	Std. Deviation
20.4539	141	1.72989

Graph:6.1 Mean Distribution of Age

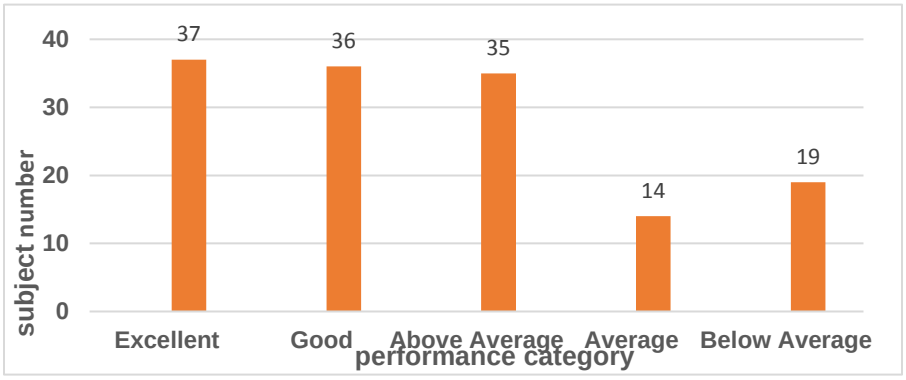


GRAPH:6.2 Mean Distribution of Gender



Interpretation: the above graph shows the number of participator and percentage according to gender. There is male has more participated compare to male.

GRAPH:6.3 Mean Distribution of subject Performance

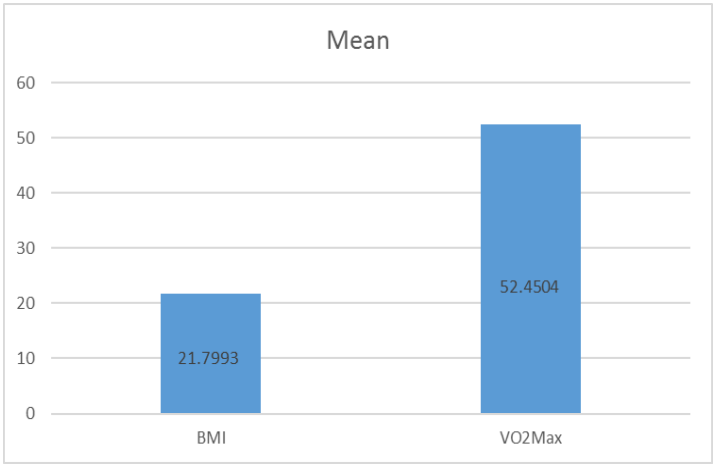


Interpretation: The above graph shows the number of participator and their performance category of McArdle step test. Most of subjects have excellent performance and very less subjects have average performance.

Table:6.2 Mean distribution of BMI and VO_{2Max}

	Mean	Std. Deviation
BMI	21.7993	4.81051
VO2Max	52.4504	11.74613

GRAPH:6.4 Mean distribution of BMI and VO_{2Max}



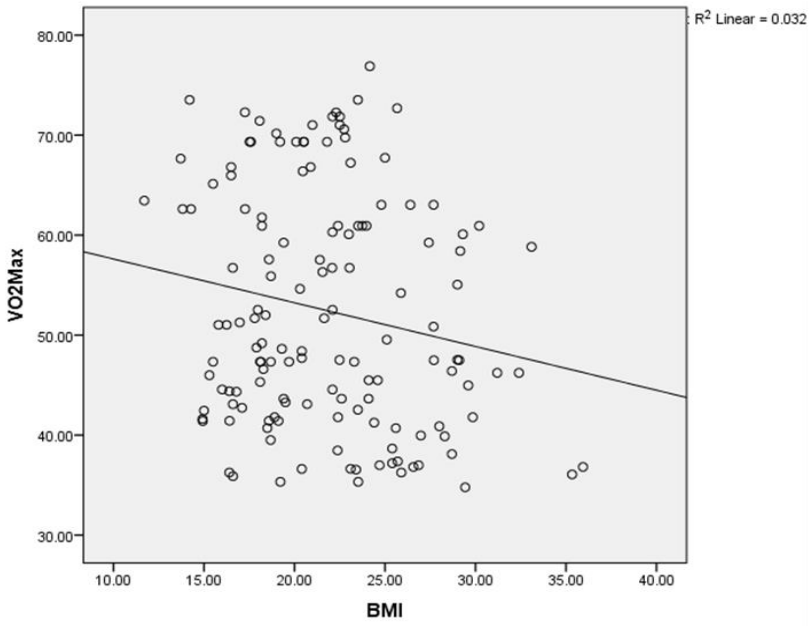
Interpretation: The above graph shows the mean Distribution of BMI andVO2 Max.

Table:6.3 Pearson's correlation of BMI and VO_{2Max}

		BMI	VO2Max
BMI	Pearson Correlation	1	-.179*
	Sig. (2-tailed)		.034
	N	141	141
VO2Max	Pearson Correlation	-.179*	1
	Sig. (2-tailed)	.034	
	N	141	141

Interpretation: The above table is shown Pearson's Correlation of BMI and VO2Max sig. P value is 0.034 it means data is statistically significant that shows correlation between BMI and VO_{2Max}.

Graph: 6.5 Scatter Diagram



Interpretation: Above graph is scatter diagram of BMI and VO2Max. That shows a statistically significant negative correlation between BMI and VO2Max.

DISCUSSION

The aim of the present study was correlate BMI and cardiorespiratory fitness among collegiate students.

A correlational study was carried out in 141 students between the age group of 18 to 25 (male and female) in college. The BMI of the subjects was measured and the McArdle step test was performed by the subjects.

Outcomes of BMI and McArdle step test were done using by statistical test Pearson's correction.

The result of the present study was accepted Alternative hypothesis (H_1) and rejected Null hypothesis (H_0). According to the result, there is a negative correlation between BMI and CRF which means when BMI increases, CRF will decrease and if BMI decreases, CRF will increase.

There are many different theories about the BMI and cardiorespiratory fitness. According to Jiun-Hao Wang, Tai-husing Hung, the most important theory includes Overweight and obese male and female adults had substantially reduced CRF. increased body mass is associated with decreased exercise tolerance and aerobic capacity.[15]

According to Emmanuel Bonney, Gillian Ferguson and Bouwien Smits-Engelsan, the relationship between body mass index, cardiorespiratory and musculoskeletal fitness in a cohort of South African female adolescents, BMI was negatively associated with cardiorespiratory fitness. [16]

According to T.Takken, H.J.Hulzebos, Marcel Schmitz and Pieter-Jan van oi, they revealed that the underweight and obese groups scored lower than the normal weight and overweight group. CRF was lower in obese females compared to females with a BMI between 18.5 and 29.9kg/m2. [17]

According to Pei An Liao, Hung -Hao chang they revealed that overweight and obese adults had much lower levels of cardiorespiratory fitness as compared to their normal weight counterparts.[18]
According to Laxmi Cc, IB Udaya, S Vinutha Shankar, they showed that There was a significant negative correlation between body mass index (BMI) and VO2max.[19]
According to Bibek Koju, Shaligram Chaudhary, Lok Raj Joshi, Anupama Shrestha, they showed that the reason for reduced VO2max in female subjects participated in their study may be due to sedentary lifestyle, decreased physical activity, unhealthy lifestyle behaviors, etc. Increase in regular physical activity or exercise may help in increasing muscle mass as well as VO2max.[20]
According to Candi D. Ashley, Joe F. Smith, Paul D. Reneau the study showed that non-obese participants have better cardio-respiratory fitness than obese. Thus, increased BMI was associated with decreased level of VO2max in young adults.[21]

CONCLUSION

The study concludes that the statistically significant Negative Correlation between BMI and VO_{2max}. This study was reported that VO_{2max} increased as the value of BMI decreased and VO_{2max} decreased as the value of BMI increased. So, the study suggested lower level of Cardiorespiratory Fitness in subjects with high BMI value and good level of Cardiorespiratory fitness in subjects with lower BMI value. It is important to help overweight subjects to become more fit and reach their healthy weight in order to improve Cardiorespiratory Fitness and reduce risk of Cardiovascular disease. Subjects with normal BMI value should maintain their weight. Exercise program like aerobics and healthy diet useful to achieve normal weight and good Cardiorespiratory Fitness.

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