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Original Research Article

# A cross-sectional study of the association of Body Mass Index and Physical Fitness Index of college students of Madpur region of West Midnapore district of West Bengal, India

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ABSTRACT

Physical Fitness Index (PFI) is a measure of the fitness of an individual. PFI reflects the cardiopulmonary status of an individual and his ability to recover after exercising. On the other hand Body mass Index (BMI) is an index for determining the stage of obesity and it is also used as a cardiopulmonary risk assessment factor. BMI is evaluated using weight and height of an individual. BMI is an index which is age and sex independent and a known epidemiological marker of nutritional status of adolescents. International obesity task force (IOTF-2000) has proposed the standards for adult's obesity in Asia and India as follows: A cut off point of 18.5 kg/m$^2$ is used to define thinness or acute under nutrition and a BMI of 23 kg/m$^2$ indicates over nutrition. A BMI of over 25 kg/m$^2$ refers to obesity. In this study we have checked if there exists any significant interrelationship of PFI and BMI of the college students of Madpur Region of West Midnapore District of West Bengal, India.

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## 1. Introduction

The Body Mass Index (BMI) is also termed as the Quetelet index is a measure of the relative ratio of the body mass and height of an individual. The index was created by Adolphe Quetelet during the course of developing what he called "social physics", between 1830 and 1850. BMI was created for measuring population and not an individual. A frequent use of the BMI is to assess how much an individual's boy weight departs from what is normal or desirable for a person of his or her height. The weight excess or deficiency of an individual may in part be a reference for body fat (adipose tissue) content, although other factors like muscularity also effects BMI significantly. The World Health Organization (WHO) regards a person with BMI of less that 18.5 as underweight and may indicate malnutrition, an eating disorder or other health issues. While a person with BMI greater than 25 is considered overweight and above 30 is considered obese. Various other factors like person's age, gender, fitness, and ethnicity needs to be taken into account while considering BMI for assessing the obesity of a person.[1]

Physical Fitness Index (PFI) is considered as one of the significant index to assess the cardio-pulmonary efficiency of a subject. PFI is correlated with various health parameters of a person. PFI is used to ascertain the status of cardiovascular risk, obesity, mental health, bone

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density etc., a good PFI indicates overall good health status of an individual.[2,3] A study conducted on children and adolescents reveals that PFI has a relationship with obesity.[4] PFI is measured by the Harvard Step Test. The Harvard Step Test is a type of cardiac stress. It helps to determine the aerobic fitness of a person. It also is a good measurement of fitness and a person's ability to cope with increased physical work stress.[5] Thus both BMI and PFI are indirect determinants of obesity and cardio-vascular and cardio-pulmonary status of an individual and are also interrelated to each other.

The aim of this cross-sectional study is to find the association between cardiovascular response to exercise in male and female teenage students of Government General Degree College, Kharagpur II of the Paschim Midnapore District of West Bengal, India by correlating the Physical Fitness Index (PFI) score obtained by Harvard's Step Test and the body mass index (BMI).

## 2. Materials and Methods

In the present study 25 male and 25 female undergraduate students were selected from Government General Degree College, Kharagpur II, of West Midnapore districts of West Bengal, India. All the subjects were in the age group of 18 to 21 years. As this was a non-invasive study and primarily survey based, informed consent was obtained from the participating subjects.

### *2.1. Inclusion criteria*

Only apparently healthy students in the age group of 18-21 years, who volunteered to participate in study were included.

### *2.2. Exclusion criteria*

Individuals suffering from any medical conditions such as diabetics, hypertension and other cardiac, renal, respiratory disease and chronic disease, neuromusculoskeletal disorders were excluded from the study. Also, subjects with any reported pre-medical or contemporary medical condition were excluded.

### *2.3. Measuring and computing BMI*

Height and weight of the subjects were recorded. Height was taken with the help of measuring tape to the nearest 0.1 cm. The weight was recorded to the nearest 0.5 kg using portable weighing machine and wearing minimum clothing. Body mass index (BMI) was computed by using the standard equation

**BMI= weight (in kg)/height$^2$ (in meters).**

BMI is used for assessing obesity in an individual which also reflects the current nutritional status of an individual and potential cardiovascular risk status of the individual corresponding to his obesity condition.[6]Table 1 represents the BMI score as per WHO.

**Table 1:** BMI Score as per World Health Organization (WHO)

| BMI Score | |
|---|---|
| **BMI** | **Weight Status** |
| Below 18.5 | Underweight |
| 18.5 – 24.9 | Normal or Healthy Weight |
| 25.0 – 29.9 | Pre-Obesity/Over weight |
| ≥30 | Obese |
| 30.0 -34.9 | Obesity class 1 |
| 35.0-39.9 | Obesity class 2 |
| Above 40 | Obesity class 3 |

### *2.4. Measuring and computing PFI*

The physical fitness of the subjects was tested in lab conditions with the help of step test to identify maximal performance of an individual. This test required a 18 inch stepping platform. Each subject was given the demonstration of the correct stepping procedure. The subjects were instructed to stand close to the stepping platform and place the foot completely onto the platform while stepping on it. They were asked to keep the knee straight and to keep the body erect while standing on the platform. They were asked to step up and down on the platform at a rate of 20 steps per minute for 5 minute or until exhaustion. (Exhaustion is defined as when the subject cannot maintain the stepping rate for 15 continuous second). The rate of 20 steps per minute was maintained by the rhythm of the metronome. After completion of the test, the subjects were allowed to sit comfortably on a chair. The post exercise pulse rate was counted and recorded immediately after completion of exercise. Pulse rate was also counted between 1 to 1.5 minutes, 2 to 2.5 minutes, and 3 to 3.5 minutes.[7] The Physical Fitness Index score was determined by the following equation:

$$PFI\ Score = \frac{100\ X\ Test\ duration\ in\ secs}{2X\ Sum\ of\ heart\ beats\ in\ recover}$$

Table 2 represents the standard value for PFI.

**Table 2:** Physical fitness index (PFI) rating (Edward L. Fox. et al., 1973)

| PFI Rating | Physical Fitness Index | |
|---|---|---|
| **(Fitness status)** | **Male** | **Female** |
| Excellent | >115 | >91 |
| Good | 103-115 | 84-91 |
| Fair | 91-102 | 77-83 |
| Poor | <91 | <77 |

### *2.5. Statistical analysis*

Statistical analysis included descriptive statistics (mean, standard deviation) and analyzed by Spearman's correlation

test. Statistical test were performed using Microcal origin version 7.0 for windows. Data were analyzed on Microsoft Excel version 8 for making tables and bar graphs. Pearson's correlation (R) was used to test the hypothesis to determine the relation between PFI and BMI. $P < 0.05$ was considered statistically significant.[8]

## 3. Results

### 3.1. BMI

Table 3 represents the weight, height and BMI of the male and female subjects considered for the study. The mean of the BMI of both group is compared with the standard value and thus the health status of the subjects is predicted. Physical fitness of an individual is dependent on the obesity status of the person. Our study shows that both male and female subjects have BMI within the normal range and hence, have normal or healthy weight.

### 3.2. PFI

Table 4 prepresents the PFI and corresponding fitness status of the subjects. It is evident from our studies that both the male and female subjects have fair physical fitness status.

### 3.3. Correlation between PFI A & BMI

The correlation between PFI and BMI of the male and female students were computed and analyzed. It was found that there is an association between the PFI and BMI of both the male and female subjects of our study. Also, we observed a clear correlation between the PFI and BMI in both the groups (Figures 1 and 2).

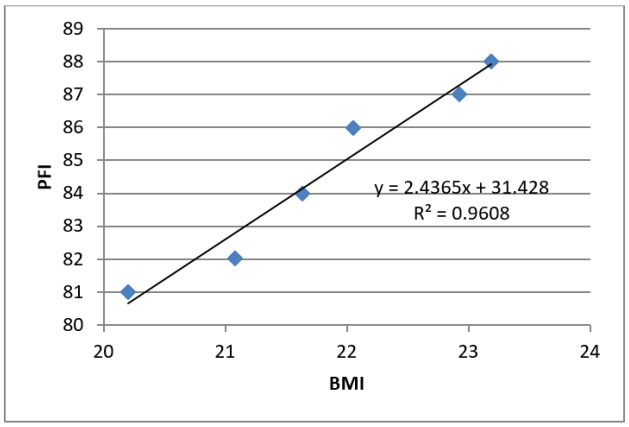


**Fig. 1:** Correlation between PFI and BMI of the female subjects considered for study

Figure 1 shows that there exists a positive correlation between the PFI and BMI of the female subjects. Both the BMI and the PFI are in the normal range. The correlation coefficient is +0.980. Thus, the finding reveals that the PFI of those individuals increase with an increase in their BMI.

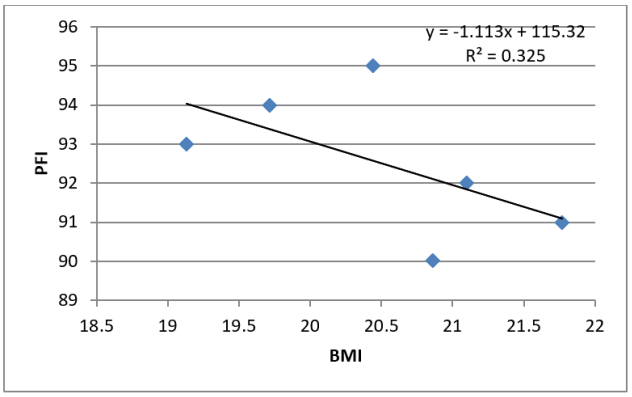


**Fig. 2:** Correlation between PFI and BMI of the male subjects considered for study

Figure 2 reveals that there exists a negative correlation between the PFI and BMI of the male subjects. Their correlation coefficient is -0.54143. Thus, an increase in the BMI causes a decrease in the PFI of those individuals.

## 4. Conclusions

It is thus concluded from our studies that both PFI and BMI are dependent variables. In Figures 1 and 2 we noted that R is the direct measure of the goodness of fit of the regression lines to the joint distribution of PFI and BMI, that is R gives a direct measure of the concentration of probability mass near the Regression lines. So, we can say that the tendency of having linear relation y = 2.436x + 31.42 (Figure 1) increases as R increases and linear relation y =.- 1.113x + 115.3 (Figure 2) decreases as R decreases. Now, we know that, $0 \leq |R| \leq 1$. So, if R is maximum, i.e., $R = \pm 1$, the above tendency is maximum and in this case, the total probability mass is concentrated on the regression line which coincide. Again the minimum possible value of R is 0. And, so if R=0, the above tendency is minimum i.e., if R=0, we get the least possible concentration of the probability mass near the Regression lines, Figure 1. Shows that R-0.980193>0, then the equation, y = 2.436x + 31.42, indicates that it is most likely to get the relation between PFI and BMI to be directly proportional i.e., PFI increases and as BMI increases for the female subjects considered for our study. The reverse is evident for Figure 2 where R <0 where PFI decreases with increase in BMI in the male subjects considered for our study.

Thus, there exists a correlation between both. In females of the age group 18-21 years considered for our study the PFI and BMI were found to have a positive correlation whereas the PFI and BMI of the male subjects of the same age group as that of the female students showed a negative correlation. This may be due to gender variation and impacts of the different sex steroids in the two groups. Body

**Table 3:** Body weight, height BMI and corresponding health status of the subjects

| S. No. | Gender | Mean Body Weight (Kg) | Mean Height (cm) | BMI | Health Status |
|---|---|---|---|---|---|
| 1. | Male | 57.67 | 167.67 | 20.50 | Normal or Healthy Weight |
| 2. | Female | 52.17 | 154.67 | 21.80 | Normal or Healthy Weight |

**Table 4:** PFI score and corresponding fitness status of the subjects

| S. No. | Gender | Mean Body Weight (Kg) | PFI | Fitness Status |
|---|---|---|---|---|
| 1. | Male | 57.67 | 92.50 | Fair |
| 2. | Female | 52.17 | 84.67 | Fair |

composition is influenced by the hormones in circulation. Testosterone in men is responsible for an increased muscle mass and bone formation whereas the female hormone estrogen is known to cause fat deposition and change the lipid profile in an individual after sexual maturation.[8,9] Studies show that testosterone level is inversely related to BMI.[10] Thus it seems that the presence of testosterone in male subjects is responsible for reduced PFI with increased BMI. Increased BMI means increased body mass which may actually influence the fitness and level of performance of a person. Underweight, overweight and obese students are reported to have poor PFI.[11] Whereas, individuals with normal BMI are reported to have good PFI.[12] In our study also, we found that the range of PFI is normal in both the groups, and they both have normal BMI. The variation in the correlation coefficient in male and female subjects is thus inferred to be due to their hormonal variations.

## 5. Source of Funding

None.

## 6. Conflicts of Interest

None.

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