# Physical Fitness Index and Body Fat Percentage in Students - A Cross Sectional Study 

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#### Abstract

: Background: Studies show that students who are physically active tend to have better grades, attendance, cognitive performance (e.g., memory), and classroom behaviours (e.g., on-task behaviour). This study was conducted to evaluate the distribution and relationship between physical fitness index and body fat percentage among students at Government Medical College, Thrissur. Methods: This was a cross-sectional study conducted among 210 students in the Department of Physiology, Government Medical College, Thrissur, from January 2020 to January 2021. PFI and body fat percentage were recorded. Descriptive statistics were used in the study. Results were expressed as percentages and proportions within appropriate confidence intervals. Results: The majority (28.1\%) of the study population ( $\mathrm{n}=59$ ) had a poor PFI. Males had a higher mean PFI of 74.4 when compared to the females' mean PFI of 66.0 . Males had a higher mean body fat-free mass of 52.7 when compared to the females' mean fat-free mass of 43.7. Conclusion: Majority of the students have a poor physical fitness index, which is not a good sign. It is high time that the students take care of their physical health so as to live a life free of diseases.


 Keywords: Physical Fitness Index, Body Composition, Harvard Step TestThis is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0) and the Budapest Open Access Initiative (http://www.budapestopenaccessinitiative.org/read), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

## Introduction

Physical fitness is known to be a powerful predictor of chronic disease morbidity and mortality. Prospective observational studies in adults have shown that low physical fitness is strongly associated with a higher risk of developing coronary heart disease, hypertension, and type 2 diabetes mellitus, as well as mortality from cardiovascular disease, cancer, and all causes of mortality.[1] In youth, low physical fitness
is associated with unfavorable chronic disease risk factor profiles. Previous studies have demonstrated that physical fitness in youth is typically observed to be positively associated with physical activity level and negatively associated with body fatness.[2] Also, it is known that low physical fitness in adolescence tends to track into adulthood. Hence, low physical fitness during adolescence is a threat to both the
immediate and long-term health of young people.
Amongst this college population, medical students are facing more stressful times, especially during their first-year studies, as they are exposed to new study and examination patterns. It is assumed that medical students have greater knowledge about healthy lifestyles and dietary habits when compared to other students. However, there is no evidence to indicate that this knowledge translates into practice in terms of maintaining good health. Healthy habits among medical students are even more important as they are future physicians and the students who personally ignore adopting a healthy lifestyle are more likely to fail to establish health promotion opportunities for their patients. Also, medical students have been shown to exhibit early risk factors for chronic diseases.[3] With this background in mind, the current study was designed to assess the body composition and physical fitness among students entering medical college.
In this study, we wanted to evaluate the distribution and relationship between physical fitness index and body fat percentage among students at Government Medical College, Thrissur.

## Materials \& Methods

This was a cross-sectional study conducted over a period of one year from January 2020 to January 2021 in the Department of Physiology, Government Medical College, Thrissur, among students of Government Medical College, Thrissur, attending the Department of Physiology between the age group of 17-22 years. Institutional ethical committee clearance was obtained before starting the study. Written informed consent was obtained from the study participants.

## Inclusion Criteria

- All students of Government Medical Thrissur attending the Department of

Physiology, and consenting to take part in the study.

## Exclusion Criteria

- Physically handicapped students
- Students with cardio-pulmonary diseases
- Students not consenting to the study


## Sample Size Calculation

Sample size was calculated by the formula
$>\mathrm{n}=4 \mathrm{~S}^{2} / \mathrm{d}^{2}$
Where
$>\mathrm{n}$ is the size of the sample, $\mathrm{S}=$ standard deviation $\mathrm{d}=$ absolute precision
$>\mathrm{d}=1.2$
$>\mathrm{S}=8.7$
Hence $\mathrm{n}=4 \mathrm{x} 8.7 \times 8.7 / 1.2 \times 1.2=210.25$
So, the sample size of the study is taken as 210.

## Study Procedure

All subjects were familiarized with the modified Harvard step test. The detailed procedure of the test was explained to the subjects and the actual demonstration was given before starting the test to allay apprehension. The resting pulse rate was recorded after 5 minutes of rest. Then the subjects were made to do a modified Harvard step test in a rhythmic manner. The subjects were advised to step up on the modified Harvard step of 33 cm in height once every two seconds ( 30 per minute) for five minutes, for a total of 150 steps. At one, three, and five minutes after the exercise, the pulse rate was recorded. BFP (Body Fat Percentage) was estimated using the Bioelectric Impedance method using the Omron Body Fat Analyzer. The instrument was suitably calibrated. Quality checks as required by the manufacturer was followed to ensure accurate measurements.

From the above data, FFM (Fat-Free Mass) and FFMI (Fat-Free Mass Index) were calculated by (109): Body fat percentage
$(\%)=[$ Body fat mass $(\mathrm{kg}) \div$ Body weight $(\mathrm{kg})] \times 100$.

Fat free mass $(\mathrm{kg})=$ Body weight $(\mathrm{kg})-$ Body fat mass (kg) Fat free mass index $=$ Fat free mass $(\mathrm{kg}) \div$ Height in $\mathrm{m}^{2}$.
Body mass index was calculated as $\mathrm{BMI}=$ Weight $(\mathrm{kg}) /$ Height $\left(\mathrm{m}^{2}\right)$.
Physical fitness index was calculated using the formula (110): $\mathrm{PFI} \%=$ Duration of exercise in seconds $\times 100 \div 2(\mathrm{P} 1+\mathrm{P} 2+\mathrm{P} 3)$ where P 1 was the pulse rate during the first minute, P2 was the pulse rate during the third minute and P3 was the pulse rate during the fifth minute.

## Statistical Methods

Categorical and quantitative variables were expressed as frequency (percentage) and mean $\pm \mathrm{SD}$ respectively. Independent t-test was used to compare quantitative
parameters between categories. Karl Pearson Correlation Coefficient was used to find out the relationship between quantitative parameters. For all statistical interpretations, $\mathrm{p}<0.05$ was considered the threshold for statistical significance. Statistical analyses were performed by using the statistical software package SPSS, version 20.0.

## Results

Of the 210 study subjects, most of them $(\mathrm{n}=144)$ were in the age group of $19-20$ years, which constituted $68.6 \%$. $30.5 \%$ $(n=64)$ of the study population were between 17-18 years. $1 \%$ of the study population $(\mathrm{n}=2)$ were between 21-22 years. The mean age group of the study sample was $19 \pm 1.1$ years. Out of the 210 study participants, $56.7 \% \quad(\mathrm{n}=119)$ were females and the remaining $43.3 \% \quad(\mathrm{n}=91)$ were males.

Table 1: Distribution of Physical Fitness Index among the Study Population

| Physical Fitness Index | Count | Percent |
| :--- | :--- | :--- |
| Excellent | 51 | 24.3 |
| Good | 22 | 10.5 |
| High Average | 47 | 22.4 |
| Below Average | 31 | 14.8 |
| Poor | 59 | 28.1 |

Analysis shows that the majority ( $28.1 \%$ ) of the study population ( $\mathrm{n}=59$ ) had a poor PFI. 51 participants (24.3\%) of the study population had excellent PFI. 47 participants ( $22.4 \%$ ) had a high average PFI. 31 participants (14.8\%) had a below average PFI. 22 participants (10.5\%) had a good PFI.

Table 2: Distribution of Physical Fitness Index, Body Fat Percentage, Fat Free Mass, and Fat Free Mass Index among Students

|  | Mean $\pm$ SD | Median (IQR) | Minimum | Maximum |
| :--- | :--- | :--- | :--- | :--- |
| Physical Fitness Index | $69.6 \pm 22.4$ | $71.26(54.15-89.29)$ | 18.4 | 132.7 |
| Body Fat Percentage | $21.9 \pm 6.2$ | $20.6(17.18-26.33)$ | 11.1 | 40.8 |
| Fat Free Mass | $47.6 \pm 6.4$ | $47.18(43.16-51.64)$ | 34.3 | 66.2 |
| Fat Free Mass Index | $17.9 \pm 1.2$ | $17.87(17.05-18.77)$ | 14.4 | 21.2 |

Among the students who participated in the study, the median PFI was 71.26 (54.1589.29). The minimum PFI was 18.4 and the maximum PFI was 132.7. The mean PFI was $69.6 \pm 22.4$. Among the students who
participated in the study, the median body fat percentage was 20.6 (17.18-26.33). The minimum body fat percentage was 11.1 and the maximum body fat percentage was 40.8. The mean body fat percentage was
21.9土 6.2. Among the students who participated in the study, the median fatfree mass was 47.18 (43.16-51.64). The minimum fat-free mass was 34.3 and the maximum fat-free mass was 66.2 . Mean fat-free mass was $47.6 \pm 6.4$.

Among the students who participated in the study, the median fat-free mass index was 17.87 (17.05-18.77). The minimum fat-free mass index was 14.4 and the maximum fatfree mass index was 21.2. The mean fat-free mass index was $17.9 \pm 1.2$.
correlated as the r -value was -0.562 . This finding was statistically significant (pvalue $=<0.01$ ).
The study shows that physical fitness index and fat-free mass were positively correlated as the $r$-value was 0.172 . This finding was statistically significant ( p -value $=0.012$ ). The study shows that physical fitness index and fat-free mass index were negatively correlated as the r -value was -0.255 . This finding was statistically significant ( p -value $=<0.01$ ).

The study shows that physical fitness index and body fat percentage were negatively
Table 3: Comparison of Physical Fitness Index, Body Fat Percentage, Fat Free Mass and Fat Free Mass Index among Students based on Gender

|  | Male |  |  |  | Female |  |  | $\mathbf{p}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Mean | SD | $\mathbf{N}$ | Mean | SD | $\mathbf{N}$ |  |  |
| Physical Fitness Index | 74.4 | 22.1 | 91 | 66.0 | 22.0 | 119 | 0.007 |  |
|  | Male |  |  | Female |  |  | $\mathbf{p}$ |  |
|  | Mean | SD | $\mathbf{N}$ | Mean | SD | $\mathbf{N}$ |  |  |
| Body Fat Percentage | 23.4 | 6.4 | 91 | 20.9 | 5.8 | 119 | 0.003 |  |
|  | Male |  |  | Female |  |  | $\mathbf{P}$ |  |
|  | Mean | SD | $\mathbf{N}$ | Mean | SD | $\mathbf{N}$ |  |  |
| Fat Free Mass | 52.7 | 5.1 | 91 | 43.7 | 4.1 | 119 | $<0.01$ |  |
|  | Male |  |  | Female |  |  |  | $\mathbf{P}$ |
|  | Mean | SD | $\mathbf{N}$ | Mean | SD | $\mathbf{N}$ |  |  |
| Fat Free Mass Index | 18.1 | 1.1 | 91 | 17.7 | 1.3 | 119 | 0.007 |  |

Analysis shows that the mean PFI among the 91 male students was 74.4 with a standard deviation of 22.1. Among the 119 female students, the mean PFI was 66.0 with a standard deviation of 22.0 . Hence, in this study, the males had a higher mean PFI of 74.4 when compared to the female's mean PFI of 66.0. This finding was statistically significant $(\mathrm{p}=0.007)$.

Analysis shows that the mean body fat percentage among the 91 male students was 23.4 with a standard deviation of 6.4. Among the 119 female students, the mean body fat percentage was 20.9 with a standard deviation of 5.8. Hence, in this study, the males had a higher mean body fat percentage of 23.4 when compared to the female's mean body fat percentage of 20.9.

This finding was statistically significant ( $\mathrm{p}=0.003$ ).

Analysis shows that the mean fat-free mass among the 91 male students was 52.7 with a standard deviation of 5.1. Among the 119 female students, the mean fat free mass was 43.7 with a standard deviation of 4.1. Hence, in this study, the males had a higher mean body fat-free mass of 52.7 when compared to the female's mean fat-free mass of 43.7. This finding was statistically significant ( $\mathrm{p}<0.01$ ). Analysis shows that the mean fat-free mass index among the 91 male students wass 18.1 with a standard deviation of 1.1. Among the 119 female students, the mean fat free mass index was 17.7 with a standard deviation of 1.3 . Hence, in this study, the males had a higher mean body fat free mass index of 18.1 when
compared to the female's mean fat-free mass index of 17.7. This finding was statistically significant $(\mathrm{p}=0.007)$.

## Discussion

College life is a period during which individuals are for the most part exposed to stress and lack of time, posing a barrier to the adoption of healthy practices like exercises and sports activities. Physical activity among adolescents is consistently related to higher levels of self-esteem and self-concept and lower levels of anxiety and stress and vice versa.

Amongst this college population, medical students are facing more stressful times, especially during their first-year studies, as they are exposed to new study and examination patterns. It is assumed that medical students have greater knowledge about healthy lifestyles and dietary habits when compared to other students. However, there is no evidence to indicate that this knowledge translates into practice in terms of maintaining good health. Also, medical students have been shown to exhibit early risk factors for chronic diseases.[4] With this background in mind, the current study was designed to assess body composition and physical fitness among students entering medical college.

Our study population included 210 medical students between the age group of 17-22 years. Of the 210 study subjects, the majority of them ( $\mathrm{n}=144$ ) were in the age group of 19-20 years, which constituted $68.6 \%$. $30.5 \% \quad(\mathrm{n}=64)$ of the study population were between 17-18 years. $1 \%$ of the study population ( $\mathrm{n}=2$ ) were between 21-22 years. The presence of the majority of students between the age group of 17-20 years may be due to the fact that we considered students attending the Department of Physiology in our study, which is a first-year MBBS subject. The result was in accordance with a study published in the International Journal of Preventive Medicine (Practice of Physical Activity among Future Doctors: A Cross

Sectional Analysis by Chythra R Rao, BB Darshan, Nairita Das, Vinaya Rajan, Meemansha Bhogun and Aditya Gupta).
Out of the 210 study participants, 119 were female and the remaining 91 were male. This may be due to the fact that more number of female students are opting for medical courses compared to males. The result was in accordance to the study done by Suzana Savić, Larisa Gavran, Gordana Tešanović (Assessment of physical activity and body weight among medical students in Banja Luka, Bosnia and Herzegovina) where the number of female study participants outnumbered their male counterparts.
Physical fitness has been defined in several ways, but the generally accepted definition is the ability to carry out daily tasks with vigour and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and meet unforeseen emergencies. In our study, PFI was measured by the modified Harvard Step Test. Our study showed that the majority ( $28.1 \%$ ) of the study population $(\mathrm{n}=59)$ had a poor PFI. 51 participants (24.3\%) of the study population had excellent PFI. 47 participants ( $22.4 \%$ ) had a high average PFI. 31 participants (14.8\%) had a below average PFI. 22 participants ( $10.5 \%$ ) had a good PFI. The minimum PFI was 18.4 and the maximum PFI was 132.7. This shows that a normal BMI may not always correlate with an excellent or a high average PFI as our study showed that the majority ( $74.2 \%$ ) of the study population ( $\mathrm{n}=156$ ) had a normal BMI. However, the majority ( $28.1 \%$ ) of the study population ( $\mathrm{n}=59$ ) had a poor PFI. The result of our study is not in accordance with other studies which show that a normal BMI is associated with excellent or high average PFI. ("Correlation between physical fitness and body mass index" IJCRR- Varun Malhotra). The values of the PFI obtained are comparatively lower in the Indian subjects of this investigation than those obtained in Western subjects. These findings are in
agreement with the results of Fox Edward et al., who studied the fitness index in students in American colleges. The reason for the higher PFI in western students can be explained on the basis of their sturdy bodies compared to Indian subjects.

Our study showed that the mean PFI among the 91 male students was 74.4 with a standard deviation of 22.1. Among the 119 female students, the mean PFI was 66.0 with a standard deviation of 22.0. Hence, in this study, the males had a higher mean PFI of 74.4 when compared to the females' mean PFI of 66.0. This may be because of the effects of androgen and lower fat levels in male students. The reason for the higher physical fitness index among the male students may also be due to the fact that males have a larger number of RBC which in turn leads to higher VO2 max and a higher PFI among males. The result of this study was in accordance with the study "A gender-based comparative cross-sectional study of physical fitness index using Harvard's step test in the medical students of Western India" by Narayan et al.[5]
The BFP (Body Fat Percentage) of a human or other living being is the total mass of fat divided by total body mass, multiplied by 100; body fat includes essential body fat and storage body fat. Essentials are necessary to maintain life and reproductive functions. The percentage of essential body fat for women is greater than that for men, due to the demands of childbearing and other hormonal functions. In our study, the minimum body fat percentage among the students was 11.1 and the maximum body fat percentage was 40.8 . The study also showed that physical fitness index and body fat percentage are negatively correlated, as the $r$-value is -0.562 . This may be due to the obvious reason that as body fat increases, the PFI decreases and vice versa, which is corroborated by western studies that say that "for a given BMI, men and women who reported doing more physical activity had a lower body fat percentage; the greatest difference was observed between low and
moderate levels of physical activity" (Association between physical activity and body fat percentage, with adjustment for BMI: a large cross-sectional analysis of UK Biobank) by Kathryn et al. Our study result comparing the relationship between physical fitness index and body fat percentage was in accordance with various other studies, like the study done by Qinpei Zou, Chang Su, Wenwen Du, Yifei Ouyang, Huijun Wang, Zhihong Wang, Gangqiang Ding, and Bing Zhang (The association between physical activity and body fat percentage with adjustment for body mass index among middle-aged adults: China health and nutrition survey in 2015), which showed the inverse correlation between body fat percentage and physical fitness index.[6]

Analysis shows that the mean body fat percentage among the 91 male students is 23.4. Among the 119 female students, the mean body fat percentage is 20.9. Hence, in this study, the males had a higher mean body fat percentage of 23.4 when compared to the female's mean body fat percentage of 20.9. The result of our study is contrary to the common belief that female have a higher fat percentage than males. There are many reasons why women have more body fat than men. One is biological. Body fat content is $25 \%$ for women at normal size, compared to $15 \%$ for men. All other things being equal, such as age and exercise levels, women require fewer calories per pound of body weight daily than do men. Estrogen alone will cause increased fat deposition. Hence, our study result is contrary to various other studies, like the study done by Kalypso et al. "Sex differences in human adipose tissues - the biology of pear shape" which shows that body fat percentage is higher in females than males.

Fat-free mass, sometimes conflated with lean body mass, includes our body's water, organs, bone, and muscle content. In other words, it refers to all of our body components except fat. However, fat-free mass refers primarily to muscle mass,
especially when considering body composition and weight management. Most people are now trying to achieve a higher percentage of fat-free mass or as little fat as possible. Beyond just looking fit, it offers health benefits like better immunity, strength, agility, and metabolism. Therefore, fat-free body mass or lean body mass percentage plays a pivotal role in improving our health. In our study, the median fat-free mass was 47.18 (43.1651.64). The minimum fat-free mass was 34.3 and the maximum fat-free mass was 66.2. The study also showed that physical fitness index and fat-free mass are positively correlated ( $\mathrm{r}=0.172$ ). This may be due to the fact that in individuals with good physical fitness, the muscle mass (a type of fat free mass) was comparatively higher. Our study result comparing the relationship between physical fitness index and fat-free mass was in accordance with various other studies like the one done by Reshma Aziz Merchant, Santhosh Seetharaman, Lydia Au, Michael Wai Kit Wong, Beatrix Ling Ling Wong, John E Morley (Relationship of fat mass index and fat free mass index with body mass index and association with function, cognition and sarcopenia in pre-frail older adults) which showed the positive correlation between fat free mass and physical fitness index.

While it is obviously not true in all cases, women generally have a higher percentage of body fat than men. On average, women have 6 to 11 percent more body fat than men. Studies show oestrogen reduces a woman's ability to burn energy after eating, resulting in more fat being stored around the body. The likely reason is to prime women for childbearing, as many reviews suggest. Our analysis showed that the mean fat-free mass among the 91 male students was 52.7. Among the 119 female students, mean fat free mass is 43.7 . Hence, in this study, the males had a higher mean body fat-free mass of 52.7 when compared to the female's mean fat-free mass of 43.7. The
result of our study was in accordance with the study done by Hyeong Geun Park et al. (gender differences in relationship between fat-free mass index and fat mass index among Korean children using body composition chart), which showed that the value of FFM was higher in boys, but FM was not different. In subgroup analysis by grade, a significant gender by FFMI interaction ( $\mathrm{p}=0.015$ ) was found, indicating that the slope of the lines for FMI vs. FFMI was different between boys and girls.

The fat-free mass index describes the amount of muscle mass in relation to height and weight. Although the FFMI is less used, it is more precise than the BMI, and also provides information about somebody's condition and health. FFMI is defined in a way that allows for distinguishing between fat gain and muscle gain. If the mass of fat increases, the FFMI index goes down, and if the mass of muscle increases, the FFMI rises. It is this difference that allows FFMI to correctly estimate somebody's body and health condition. Among the students who participated in the study, the median fatfree mass index was 17.87 (17.05-18.77). The minimum fat-free mass index was 14.4 and the maximum fat-free mass index was 21.2. The study also showed that physical fitness index and fat-free mass index were negatively correlated, as the r -value was 0.255 . Our study result comparing the relationship between physical fitness index and Fat free mass index was in accordance with various other studies like the study done by Pontus Henriksson, Cristina Cadenas- Sanchez (Associations of fat mass and fat-free mass with physical fitness in 4-year-old children: results from the MINISTOP trial) which showed a positive correlation between fat free mass index and physical fitness index.[7]

Our study shows that the mean fat-free mass index among the 91 male students was 18.1. Among the 119 female students, the mean-fat free mass index was 17.7. Hence, in this study, the males had a higher mean body fat-free mass index of 18.1 when
compared to the female's mean fat free mass index of 17.7. This finding was statistically significant $(p=0.007)$. The result of our study is in accordance with other studies like "Age and gender-related fat mass index and fat-free mass index patterns among adolescents in Surulere LGA, Lagos" by SE Nwizu et al. which showed that overall percent body fat and FM were significantly higher in girls ( $18.9 \pm 7.5 \%$ Vs $9.5 \pm 4.5 \%$ : p $<0.001$ and $9.7 \pm 6.1 \mathrm{~kg}$ Vs $4.5 \pm 3.2 \mathrm{~kg}: \mathrm{p}<0.001$ respectively). FMI for girls ranged from 3.2 to $4.5 \mathrm{~kg} / \mathrm{m}^{2}$ peaking at 16 years. At all ages, girls had a higher mean FMI than boys. The mean FMI for males fell from 2.6 $\mathrm{kg} / \mathrm{m}^{2}$ at 10 years to a trough of $1.5 \mathrm{~kg} / \mathrm{m}^{2}$ at 16 years before a slight rise to $1.9 \mathrm{~kg} / \mathrm{m}^{2}$ at 18 years. FFM in boys increased consistently with age, overtaking that of girls at 12 years with the gap widening up to 18 years.[8] Measures of body fat were much lower in study subjects than reported from western countries even where lean mass was comparable.

## Conclusion

The majority (28.1\%) of the study population ( $\mathrm{n}=59$ ) had a poor PFI. Analysis shows that the majority ( $28.1 \%$ ) of the study population ( $\mathrm{n}=59$ ) had a poor PFI and 22 participants ( $10.5 \%$ ) had a good PFI. Physical fitness index and body fat percentage are negatively correlated. Physical fitness index and fat-free mass are positively correlated. The physical fitness index and fat-free mass index were negatively correlated. The males had a higher mean PFI of 74.4 when compared to the females' mean PFI of 66.0. The males had a higher mean body fat percentage of 23.4 when compared to the females' mean body fat percentage of 20.9. The males had a higher mean body fat free mass of 52.7 when compared to the females' mean fat free mass of 43.7. The males had a higher mean body fat free mass index of 18.1 when compared to the females' mean fat-free mass index of 17.7.

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