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BMI and Body Fat Percentage in Students - A Cross Sectional Study

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ABSTRACT

Background

The importance of fitness level for the well-being of children and adolescents has long been recognized. This study was conducted to evaluate the distribution and relationship between BMI and body fat percentage in students at Government Medical College, Thrissur.

Methods

This was a cross-sectional study. A total of 210 students attending classes in the Department of Physiology at the Government Medical College, Thrissur, from January 2020 to January 2021, were considered for the study after getting an informed consent. BMI and body fat percentage were recorded. Descriptive statistics were used in the study. Results have been expressed as percentages and proportions within appropriate confidence intervals.

Results

Males had a higher mean body fat free mass of 52.7 when compared to female's mean fat-free mass of 43.7.

Conclusion

The majority (74.2%) of the study population (n=156) had a normal BMI. 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 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 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.

Keywords: BMI, Body Fat Percentage.

INTRODUCTION

Since the 1980's, obesity has become a major health issue among children and adults. It is one of the concerns of developing countries like India. Body mass index (BMI), since it strongly correlates to body fat mass, can be used to assess whether a child is over-weight or obese.[1] The International Association for the Study of Obesity (IASO) and the International Obesity Task Force (IOTF) estimate that 200 million school children are either overweight or obese.

According to the WHO, under the age of 5 years, 41 million children were obese in 2016, and over 340 million children and adolescents aged 5-19 were overweight or obese in 2016 globally. According to a recent study, India has the second highest number of obese children, with 14.4 million children having excess weight.[2] WHO defines childhood over-weight as a body mass index.

At or above the 85th percentile and below the 95th percentile for children and teens of the same age and sex and childhood obesity as at or above the 95th percentile for children and teens of the same age and

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sex.[3] Childhood obesity can pave way for adult obesity, metabolic syndrome, cancer, polycystic ovarian syndrome, coronary heart disease, alcoholic fatty liver diseases, psychiatric disorders, sleep apnea, bone and joint diseases, poor physical health and respiratory problems.

Lower BMI (Body Mass Index) cut-offs of 23 and 25 kg/m2 have been suggested by the World Health Organization (WHO) and IOTF for Asian Indian adults for overweight and obesity, respectively, but these are not applicable for children and adolescents. Over the years, there has been a lack of consensus on the various cut-points or definitions used to classify obesity and overweight in children and adolescents. This makes it difficult to interpret and compare the global or national prevalence rates. For children and adolescents, overweight and obesity are usually defined using age- and gender-specific normograms of BMI.

Increased fat percentage and low levels of physical activity among students are hidden epidemics, as they are the major risk factors for chronic disease morbidity and mortality in later life. Yet, only a few studies are available in this regard.

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-

$n=4S^2/d^2$

Where

n is the size of the sample, S=standard deviation d=absolute precision

d= 1.2

S=8.7

Hence n= 4x8.7x8.7/1.2x1.2 = 210.25

So the sample size of the study is taken as 210

Study Procedure

BFP (Body Fat Percentage) was estimated using the Bioelectric Impedance method using the Omron Body Fat Analyzer.

Body mass index is calculated as BMI=weight (kg)/height (m^2).

Statistical Methods

Categorical and quantitative variables were expressed as frequency (percentage) and mean ± 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, $p<0.05$ was considered the threshold for statistical significance. Statistical analyses was performed using the statistical software package SPSS, version 20.0

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RESULTS

Demographic Profile of the Study Population

Of the 210 study subjects, the majority of them (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 (n=2) were between 21-22 years. The mean age group of the study sample was 19 ± 1.1 years. Out of the 210 study participants, 56.7% (n=119) were females, and the remaining 43.3% (n=91) were males**.**

Body Mass Index	Count	Percent
Normal	156	74.2
z	52	24.8
Obese	2	1.0
Total	210	100
Mean ± SD	23.1 ± 2.8	

Table 1: Distribution of Body Mass Index of the Study Population

Analysis shows that the majority (74.2%) of the study population (n=156) had a normal BMI. 52 participants (24.8%) of the study population were overweight. 2 participants (1%) were obese. The mean BMI of the study population was 23.1 ± 2.8.

	Mean ± SD	Median (IQR)	Minimum	Maximum
Body Fat Percentage	21.9 ± 6.2	20.6 (17.18 - 26.33)	11.1	40.8
	Mean ± SD	Median (IQR)	Minimum	Maximum
Fat Free Mass	47.6 ± 6.4	47.18 (43.16 - 51.64)	34.3	66.2
	Mean ± SD	Median (IQR)	Minimum	Maximum
Fat Free Mass Index	17.9 ± 1.2	17.87 (17.05 - 18.77)	14.4	21.2

Table 2. Distribution of Body Fat Percentage, Fat Free Mass, Fat Free Mass Index among Students

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± 6.2.

Among the students who participated in the study, the median fat-free 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. The mean fat-free mass was 47.6± 6.4

	Male			Female			P
	Mean	**SD**	**N**	**Mean**	**SD**	**N**	
Body Fat Percentage	23.4	6.4	91	20.9	5.8	119	0.003
	Male			**Female**			**P**
	Mean	**SD**	**N**	**Mean**	**SD**	**N**	
Fat Free Mass	52.7	5.1	91	43.7	4.1	119	<0.01
	Male			**Female**			**P**
	Mean	**SD**	**N**	**Mean**	**SD**	**N**	
Fat Free Mass Index	18.1	1.1	91	17.7	1.3	119	0.007

Table 3. Comparison of Body Fat Percentage, Fat Free Mass, Fat Free Mass Index among Students Based on Gender

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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 fat-free mass index was 21.2. The mean fat-free mass index was 17.9± 1.2.

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, 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 ($p=0.003$).

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 females' mean fat-free mass of 43.7. This finding was statistically significant ($p<0.01$).

Analysis shows that the mean fat-free mass index among the 91 male students was 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 females' mean fat-free mass index of 17.7. This finding was statistically significant ($p=0.007$**).**

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 exercise 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.

I.Sociodemographic Characteristics of the Study Population

a. Age

Our study population included 210 medical students between the age group of 17-22 years. Of the 210 study subjects, the majority of them (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 (n=2) were between 21-22 years. The presence of 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).

b. Sex

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 with 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.

II. Body Mass Index

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BMI is a value derived from the mass (weight) and height of a person. The BMI is defined as the body mass divided by the square of the body height, and is expressed in units of kg/m2. When used to predict an individual's health, rather than as a statistical measurement for groups, the BMI has limitations that can make it less useful than some of the alternatives, especially when applied to individuals with abdominal obesity, short stature, or unusually high muscle mass. BMIs under 20 and over 25 have been associated with higher all-cause mortality, with the risk increasing with distance from the 20–25 range. Our study shows that the majority (74.2%) of the study population (n=156) had a normal BMI. 52 participants (24.8%) of the study population were overweight. 2 participants (1%) were obese. The presence of a normal BMI in the majority of the study population is a good indication that the medical students are aware of the benefits of a healthy lifestyle. At the same time, overweight students were also high in this study which is a point of concern. Health personnel are important promoters and role models for maintaining a healthy lifestyle for the general population; however, studies on medical students and health personnel in many countries suggest that obesity is a problem among these population groups. The result of our study was in accordance with the study done by Reena Kumari Jha, Abuday Kumar Yadav, Sneha Shrestha, Pramit Ram Shrestha, Suyesh Shrestha, Mina Jha, and Ojashwi Nepal (Study of Body Mass Index among Medical Students of a Medical College in Nepal: A Descriptive Cross-sectional Study) which showed that thirty-nine students (14.66%) were overweight with a mean body mass index of 26.60±1.99 kg/m2. One hundred ninety-five (73.30%) students had a normal body mass index, and some 32 (12.3%) students were underweight.[5]

III. Body Fat Percentage

The BFP 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 weres negatively correlated as the r-value was -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]

IV. Body Fat Percentage among Students based on Gender

Analysis shows that the mean body fat percentage among the 91 male students was 23.4. Among the 119 female students, the mean body fat percentage was 20.9. Hence, in this study, 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 result of our study is contrary to the common belief that females 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 than males.

V. Fat-Free Mass

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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 (43.16-51.64). 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(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.

VI. Fat-Free Mass among Students based on Gender

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, the 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 females' 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 (p=0.015) was found, indicating that the slope of the lines for FMI vs. FFMI was different between boys and girls.

VII. Fat Free Mass Index

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 fat-free mass index was 17.87 (17.05-18.77). 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 was negatively correlated, as the r-value is -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 the positive correlation between fat-free mass index and physical fitness index.[7]

VIII. Fat-Free Mass Index among Students based on Gender

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 females' 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

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girls (18.9±7.5% vs. 9.5±4.5%: $p < 0.001$ and 9.7±6.1 kg vs. 4.5±3.2 kg: $p < 0.001$ respectively). FMI for girls ranged from 3.2 to 4.5 kg/m² peaking at 16 years. At all ages, girls had a higher mean FMI than boys. The mean FMI for males fell from 2.6 kg/m² at 10 years to a trough of 1.5 kg/m² at 16 years before a slight rise to 1.9 kg/ m² 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. The conclusion of the study is that adolescent females have higher body fat indices while males have higher lean mass indices. Indices of body fat in the current study are much lower than reported for western counterparts.

Limitations of the Study

- This study is not representative of the general population. So it would be difficult to generalize the findings of our study.
- We could only make observations regarding possible associations as this is not a case controlled study.
- Some of the factors that may have an impact on the result of this test are: the room temperature, noise level and humidity between tests, the subject's emotional state, the amount of sleep the subject had prior to testing, the subject's caffeine intake, the subject's prior knowledge/experience regarding the test, accuracy of measurements, inappropriate warm-up and talking about the subject during test.

CONCLUSION

The majority (74.2%) of the study population (n=156) had a normal BMI. 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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