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Research Article

Comparison of Body Fat Percentage and BMI in Pre-hypertensive and Hypertensive Female College Students of West Tripura

Puja Saha[1], Satyapriya Roy[2], Susmita Banik[1], Sonali Das[1] and Shilpi Saha[1]*

[1]Department of MLT, Bhavan's Tripura College of Science and Technology (BTCST), Anandanagar, West Tripura, India
[2]Department of Human Physiology, Government Degree College, Kamalpur, Dhalai Tripura, India

Abstract

Background: Obesity is a significant health risk linked to hypertension and heart-related disorders in adolescents, impacting their future well-being . Since, the present work is to determine the body constitute including percentage of body fat correlates with cholesterol level which associate with Body Mass Index.

Methods: This cross-sectional work was held in 120 college girls aged 19-23 years of Bhavan's Tripura College of Science and Technology, Anandanagar at West Tripura. Anthropometric measurements such as standing height, body weight, sub scapular and triceps skinfolds, waist &hip circumference were collected. These records were used to calculate Body Fat Percentage (%BF) and Fat Mass (FM). Waist and Hip ratio (WHR) and Body Mass Index (BMI). FM, %BF and biochemical studies such as serum cholesterol level were also used to measures the body fat composition.

Results: According to the present study, 53.33% of girls have a normal BMI, 8.83% are underweight, 31.67% are overweight, and 6.67% are obese. WHR results indicate that 54.17% of participants are classified as obese and 45.83% as non-obese. Out of 114 (95%) girls with normal cholesterol levels of 16 (13.33%) students are pre-hypertensive and 10 (8.33%) students are hypertensive. Out of 38 overweight and 8 obese students 13.34% are in pre or hypertensive. Based on WHR, 65 (54.17%) female students are obese; out of 65 obese students, 12 (10%) and 7 (5.83%) female students are pre-hypertensive and hypertensive, respectively and this value is statistically significant (p value < 0.05). Out of 55 (45.83%) no-obese students 8 (6.67%) girls are pre-hypertensive and 5 (6.67%) girls are hypertensive. According to BMI female students who are overweight or obese (5%) also have excessive blood cholesterol.

Conclusion: This study expressed clear evidence of correlation in BMI, serum cholesterol level and Hypertension. These results are important for epidemiological studies to identify the cardiovascular risk in obese adults and help to solve a health problem of present Youngers in their future life. This study serves as an early health warning for female college students.

More Information

***Address for correspondence:**
Dr. Shilpi Saha, Assistant Professor, Department of MLT, Bhavan's Tripura College of Science and Technology (BTCST), Anandanagar, West Tripura Pin: 799028, India,
Email: shilpisaha_07@yahoo.com

Dr. Shilpi Saha:
orcid.org/0000-0002-5629-9035

Dr. Satyapriya Roy
orcid.org/0000-0002-5277-2526

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Keywords: BMI; Percent body fat; Obesity; Cardio vascular disease; Hypertension; Tripura

Introduction

Obesity is an abnormal rise in the body weight because of extensive fat deposition. Obesity is a major health condition associated with cardiovascular disease (CVD) and causes of mortality & morbidity worldwide [1]. It mainly occurs because of inequity between energy expenditure and energy intake (energy expenditure<energy intake) [2]. Obesity is collaborated with many health complications such as vascular and metabolic dysfunction. It is a serious condition in developing children, teenagers, and young adults. An increase in the rate of morbidities is conduct with these various physiological effects, including CVD, cerebral infraction, heart disease, type 2 diabetes mellitus, high blood pressure, dyslipidaemia, sleep apnea, gastro oesophageal reflux disease, insulin resistance, osteoarthritis of the joint, cancer and carpal-tunnel syndrome [3-5].

Hypertension is a serious health problem which leading a risk factor for CVD. The causes of hypertension are related

with high hypertension & attributed to overweight, variation in dietary pattern, extending stress, diminished physical activity, gadgets usage etc. Elevated blood pressure are leads to hypertension which considerable to mortality and morbidity worldwide. This condition could increase the risk of micro and macro vascular complications such as neuropathy, retinopathy, nephropathy, coronary syndrome and stroke& also comprises the functional and structural integrity of microcirculation in brain, also encouraging micro vascular processing, dysfunction of nerves, disruption of blood-brain barrier, micro haemorrhage in brain, lacunar infraction and injury in white matter [6,7]. According to WHO (World Health Organization) records, globally adults 1.28 billion (aged 30 to 79 years) have increased BP, and about 46% adults are uncertain of their present situation [8,9]. Nearly 48.1% or 119.9 million adults have hypertension that is causes of high systolic or diastolic blood pressure [10]. However, estimation of blood pressure helps in hypertension analysis. BMI (Body mass index), WHR (waist-hip ratio) & percentage of body fat (%BF) are commonly used methods for the diagnosis of obesity with high cholesterol levels. The frequency of obesity is rising globally. Almost, 2 billion of people worldwide will have obesity where 13% of adults have obesity [11]. As body weight or body fat increases, BMI also increases.

However, the most popular method for measuring obesity is BMI but it is not the standard methods for diagnosing CVD and other metabolic diseases. So, the circumference of waist and hip measurement has been revealed to assist the measuring BMI that helps to improve the risk situation of showing CVD and metabolic syndrome. CVD is related with excess visceral adipose tissue and would be a sign of non-functional subcutaneous fat deposition leading to fat deposition in ectopic region such as fat increasing in the heart, pancreas, liver, skeletal muscle etc.) [12]. Especially, the component of total body fat deposition in visceral organ is called visceral obesity. CVD also associated by body composition phenotype [13,14]. Although, the body fat content also differs by age, sex, genetics, environmental conditions etc. [15,16]. Thus, the developing CVD and metabolic disease are diagnosed by the quantitative estimation of body fat which is vital for assessing the probable health risk [17]. Therefore, the cross-sectional study indicates the obesity associated with hypertension and CVD complications.

Aims & objectives

The main aims and objectives of the present work are as follows:

- It helps to evaluate unhealthy students which have overweight or obesity problems based on BMI, WH ratio and fat mass.
- This helps in estimation of hypertensive students based on laboratory parameters like blood pressure and level of cholesterol.
- The present study helps to evaluate future probability of cardio-vascular risks.

Materials and methods

Study plan, settings and sample quantity

The cross-sectional study was performed among the girls' students at Bhavan's Tripura College of Science and Technology (BTCST), Anandanagar, West Tripura from September to December, 2024. The 120 girl students aged 19-23 years willingly joined in this work and given their consent. The consent includes the information of the medical record such as sex, age, anthropometric measurement, blood pressure and collecting blood for biochemical analysis. Children suffering from any systemic disease or those who had undergone any major surgical operation were excluded from the study.

Anthropometric measurements

Anthropometric measurements were obtained using standard techniques and included height, weight , circumference of waist and hip (WC and HC), triceps skinfold thickness of triceps (TRSF) and subscapular (SBSF).

Students' weight and height were measured while wearing minimal clothing and standing barefoot. Height was assessed by a stadiometer with the head remained in the auriculo-orbital plane and collected data to the adjacent 0.1 cm. Body weight was assessed by using a digital weighing apparatus and recorded data to the nearby 0.5 kg. BMI (Body mass index) was assessed by dividing between body weight and squared height in meter i.e., BMI = Weight (kg)/ Height^2 (m^2).

Waist and hip circumference (WC& HC) were evaluated by using a non-stretchable tape meter while in a standing position. WC was assessed as the middle at a point halfway between the iliac and lower rib cage in the clinic plane somewhere about the body, while with stress-free abdomen and the hands as the resting position at both sides. The WC was recorded to the nearest 0.1 cm. Hip circumference (HC) was assessed as the largest at a point between hips and buttocks & also recorded to the adjacent 0.1 cm. By dividing WC by HC, the waist- hip ratio (WHR) was determined.

Skinfold thickness, including subscapular and triceps measurements, was determined using a skinfold caliper (Holtain) along a 10 g/mm^2 constant spring pressure at the right side around the body. Take three times data which were mean in a single position was obtained and mean the readings which result in a single standard value.

Body fat percentage (%BF) was calculated by using the summation of subscapular and triceps skinfold thickness to calculate the equation as following –

$$\%BF = 1.33(TRSF + SBSF) - 0.013(TRSF + SBSF)^2 - 2.5$$

Fat mass (FM) was calculated by body weight and %BF.

$$FM\ (kg) = Body\ Weight(kg) \times \%BF/100$$

Blood pressure measurement

Hypertension was diagnosed by measuring blood pressure. Take three times of BP which including diastolic blood pressure (DBP) and systolic blood pressure (SBP). This study was evaluated by mercury sphygmomanometer and a stethoscope. The subject was requested to sit in a room and tie the BP apparatus cuff around the upper arm. SBP was revealed by onset of Korotkoff sounds and DBP was revealed by disappearance of sounds. These sounds are measured by a stethoscope. After every 5 minutes, three times readings of blood pressure were taken.

Biochemical analysis

This includes cholesterol level measurement in blood. Cholesterol levels were measured by diagnostic kits with the help of a semi-auto analyzer (ERBA Chem 5) and BOD incubator. Cholesterol level was analyzed by an enzymatic method where cholesterol reagent, cholesterol standard, and serum sample were used. Cholesterol reagent helps to create a correct enzymatic reaction with cholesterol that helps to measure the correct cholesterol level in the blood sample. Create a series of cholesterol standard solutions with known concentrations and create a test sample mixture with 1 ml cholesterol reagent and 0.02 ml serum. Then incubate these solutions at 37 °c for 10 minutes to allow the enzymatic reaction to occur. After that a semi-auto analyzer used to measure the blood cholesterol level.

Statistical analysis

An Excel spreadsheet was amplified with described data such as name, age, sex, and collection of physical & biochemical data; and applied the described formulas for calculations. Mean and standard errors were quantitative variables that were calculated with each anthropometric variable following age and ethnicity. Different categorized variables were spread as frequencies and percentages. Therefore, the statistical analysis was carried out by use of statistical package SPSS 17. *p* value less than 0.05 was considered significant.

Results

A total of 120 female college students could be measured which come from three semesters. The standard values of BMI (kg/m^2) are subdivided into 3 groups including < 18.5 indicates under-weights, 18.5 to 24.9 considered as normal value, 25 to 29.9 specify overweight and > 30 indicates obesity. Waist to hip ratio is subdivided into two groups such as non-obese and obese (≥ 0.85 cm). Anthropometric variables are described in following (Table 1).

Cholesterol levels, as described in Table 2, are associated with hypertension. According to 7th report of JNC VII (Joint National Committee), grading of BP should be done on detection, assessment, prevention and treatment of hypertension. SBP and DBP of less than 120 mm Hg and less than 80 mm Hg respectively is considered as normal blood pressure. 120 to 139 mm Hg SBP and 80 to 89 mm Hg DBP is considered as pre-hypertension. 140 to 159 mm Hg SBP or 90 to 99 mm Hg DBP (stage 1 hypertension) and greater than 160 mm Hg of SBP or greater than 100 mm Hg of DBP (stage 2 hypertension) are specified to be high blood pressure. The present study shows that 53.33% has normal in BMI while 8.83% has underweight; 31.67% has overweight and 6.67% has obese person. According to WHR value, non-obese has 45.83% and 54.17% are obese. Normal cholesterol levels show in 95% of subjects and abnormal levels show in 5% of subjects.

Table 1: Anthropometric parameters in sample (*n* = 120)

Parameters	Mean ± SD
BMI (kg/m^2)	23.84 ± 4.16
WHR (cm)	0.87 ± 0.07
%BF	26.96 ± 4.05
FM (kg)	15.46 ± 4.64

BMI: Body Mass Index; WHR: Waist Hip Ratio; %BF: Percentage of Body Fat; FM: Fat Mass

Table 2: Characteristic of hypertension analysis (*n* = 120).

Variables	Total (*n* = 120)	Pre-hypertensive	*p* - value	Hypertensive	*p* - value
BMI					
Underweight (< 18.5 kg/m^2)	10 (8.33%)	2(1.67%)	0.015*	0	-
Normal (18.5-24.9 kg/m^2)	64 (53.33%)	4 (3.33%)	0.035*	4 (3.33%)	0.035*
Overweight (25-29.9 kg/m^2)	38 (31.67%)	8 (6.67%)	0.000*	8(6.67%)	0.000*
Obese (> 30 kg/m^2)	8 (6.67%)	6 (5%)	0.001*	0	-
WHR					
Non-obese	55 (45.83%)	8 (6.67%)	0.355	5 (4.17%)	0.465
Obese (≥ 0.85 cm)	65 (54.17%)	12 (10%)	0.000*	7 (5.83%)	0.000*
Cholesterol					
Normal (≤ 220 mg/dl)	114(95%)	16(13.33%)	0.001*	10 (8.33%)	0.043*
Elevated	6 (5%)	4 (3.33%)	0.000*	2 (1.67%)	0.000*

BMI: Body Mass Index; WHR: Waist-Hip Ratio; * *p* value < 0.05 is significant

Based on BMI out of 46 overweight and obese female students 22 numbers (47.8%) are in pre or hypertensive state and 65 female students (54.17%) are obese according to their WHR. The result showing high correlation at 95% confidence level ($p < 0.001$) between high BMI value with hypertension and obesity. According to BMI class in the overweight and obese group, some female students (5%) are also suffering from high blood cholesterol levels (Table 3).

The present study can be observed that adiposity parameters are classified into three forms like normo-tensive, pre-tensive, hypertensive which shows in following (Table 4). Multiple correlation value is also highly significant ($p < 0.05$) in the present study population (R=0.975; R^2=0.951) among BMI, fat%, hypertension, obesity and the blood cholesterol level.

Table 3: BMI classes with cholesterol characteristics (n = 120).

Cholesterol	Healthy	Under-weight	Over-weight	Obese	p - value
Normal	64 (53.33%)	10 (8.33%)	35 (29.17%)	5 (4.17%)	0.000*
Elevated	0	0	3 (2.5%)	3 (2.5%)	

* Significant at p value < 0.001

Table 4: Adiposity parameters in hypertensive classes (n = 120).

Adiposity parameters	Normo-tensive	Pre-tensive	Hyper-tensive	p - value
BMI (kg/m^2)	23.09 ± 3.21	25.85 ± 6.81	25.61 ± 3.82	0.017*
WHR (cm)	0.87 ± 0.06	0.89 ± 0.09	0.87 ± 0.05	0.002*
%BF	26.71 ± 4.15	25.50 ± 6.38	27.77 ± 3.33	0.015*
FM (kg)	14.48 ± 4.19	16.67 ± 6.86	19.10 ± 6.22	0.001*
Cholesterol (mg/dl)	148.13 ± 29.11	153.85 ± 41.72	179.93 ± 46.69	0.000*

* p value < 0.05 consider significant

Discussion

The present work findings demonstrated a correlation between elevated levels of many CVD risk variables and obesity and high body fat. For females, there was a positive correlation between the two adiposity indices and CVD risk variables. It was notable that most of the Indians are greatly affected by cardiovascular risks with the central obesity, modest overweight and physical inactivity [18]. According to WHO, Asians have different confederation between BMI, %BF and the health risk of CVD. With regard to SBP and DBP, statistically there are significant differences have found in between the groups of BMI i.e., normal, underweight, overweight and obese. These findings are reliable with earlier research that demonstrated obesity and overweight are stable markers linked to cardiovascular risk in the majority of populations [19-21].

Obesity is also evaluated through WHR, %BF, and body fat mass measurements. Visceral measured by %BF, fat mass etc. which helps to indicate obesity especially in female group. Body Fat percentage & fat mass are higher in female participants includes obesity or overweight subjects and healthy subjects [22,23]. The entire variation may characteristic to hereditary adaptations and manifestation to more subsist environmental stress and it has been responded by alteration of Fat Mass and %BF [24]. Such as some variations of body fat, visceral fat, fat mass may be associated with hormonal function, nutritional intake, and physical activity [25,26].

Obesity indicated by increased BMI which as predictor of increased cardiovascular risk and increased cardiac mortality [27-29]. A study reported that increased BMI are associated with SBP and DBP which result in increased blood sugar level that correlates with cholesterol level [30,31]. Such study also reported that increased WHR correlates with high BP [32]. A study also reported that %BF correlates with high BP which may be more affecting in detecting CVD, hypertension etc. [33]. Similarly fat mass, fat free mass affects fluctuations of BP levels. Therefore, this variation also indicates elevated blood pressure, which may contribute to hypertensive conditions. While high BMI correlates with high BP then that helps to reveal the obesity. Obesity also revealed by correlations of %BF, fat mass etc.

Mean BMI of our study was found within the normal range, although percentage of overweight or obesity is higher in college girls. Researchers have noted high average BMI in numerous Asian studies [34-36]. The findings that Indians have an average BMI that is overweight raises the possibility of a hereditary component interacting with a sedentary lifestyle and insufficient exercise. The results of our study, which correlated mean SBP, DBP, and cholesterol with BMI positively, are consistent with most other observations in Western populations [30,31] and numerous Asian groups [37-39]. A BMI of more than 23 kg/m2 is linked to cardiovascular risk and central obesity in the majority of Indians. It seems that maintaining a healthy weight is crucial for preventing hyperlipidaemia, and a lower body mass index is linked to weight loss.

Conclusion

Present study expressed clear evidence of positive correlation between BMI and body fat percentage. Dietary practices, significant lifestyle changes, and consistent exercise can help to prevent newly onset of hypertension, particularly persons with increased BMI and cholesterol levels. Therefore, to forecast cardiovascular risk factors, greater emphasis should be placed on measuring body composition First, this sample is representative of one college in West Tripura and may not reflect other regions and percent body fat in clinical practice. This could support early intervention or preventative steps to avert complications in future.

Limitations

There are few limitations to this study that need to be considered. First, this sample is representative of one college in West Tripura and may not reflect other regions . Secondly other tools of body fat composition like visceral fat rating, body water content is not included in methodology. This study was a cross-sectional design provides only a snapshot of current status. Understanding exercise motivation and how motivation can change among individuals over time would be better comprehended if a longitudinal study design was employed. This study did not take into account the different socioeconomic levels that might have impacted participant motivation to exercise.

Future aspect

Future studies should be carefully designed to address potential biases. Body composition tools like BIA, association of body composition with cause specific mortality will be included. In further studies sex specific comparison of body fat will be considered. This constraint also limits our capacity to estimate the true prevalence of obesity since large epidemiological and clinical investigations cannot be conducted with current approaches. It is evident that a lot more research still has to be done.

Ethics appropaval and consent to participate

The Ethical Committee of Bhavan's Tripura College of

Science and Technology, affiliated to Tripura University, Department Medical Laboratory Technology sanctioned ethical approval before data collection and the student's were also provided their written consent. This study was conducted in accordance with the ethical guidelines for human experiments, as laid down by the Helsinki Declaration of 2000 [40].

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Authors' contributions

First, third and fourth authors participated in the study design, data collection, statistical analysis and interpretation of data, manuscript drafting, and critical revision for important intellectual content. Second and fifth authors participated in data analysis and interpretation, drafting the manuscript, and its critical revision for important intellectual and administrative content. All of the authors have read and approved the version of the manuscript.

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