A CROSS-SECTIONAL STUDY ON CORRELATION OF BODY MASS INDEX WITH BLOOD PRESSURE INDICES AMONG YOUNG HEALTHY ADULTS IN A SEMI URBAN AREA OF ASSAM
Anupi Das¹, Jyotismita Deka²

ABSTRACT: BACKGROUND: Third world is greatly facing the epidemic of cardiovascular disorders, so preventive strategies are essential to combat this epidemic. The period of transition from childhood to adulthood is hazardous for adolescent health, as they often develop behavioral problems and improper lifestyle changes, which has its reflection in the form of various diseases in adult life. AIM: To study the correlation between body mass index (BMI) and blood pressure indices in young healthy adults. MATERIALS AND METHODS: A total of 195 healthy subjects of both the sexes participated in the study. The study was carried out in the Department of Physiology, Jorhat Medical College, Assam. The anthropometric parameters like height and weight were taken to evaluate the BMI and blood pressure was recorded by using a sphygmomanometer. In view of gender differences in autonomic regulation, data of male and female subjects were analyzed separately. Analysis of variance was used to compare differences between the three groups. Correlation between body mass index and blood pressure indices were statistically analyzed by using Karl Pearson’s Correlation Coefficient denoted by ‘r’. RESULT: Majority of subjects (especially females) belonged to overweight category. SP, DP and MAP are found to be low in underweight, intermediate in normal weight and high in overweight subjects. This difference is attributable to difference in sympathetic tone in the three different groups. Significant correlation was found to be present between body mass index and blood pressure indices. Gender differences were also observed in their correlation. CONCLUSION: The result showed that BMI have a profound influence on the blood pressure of an individual. The observed gender differences in correlation between BMI and blood pressure may be due to difference in cardiovascular autonomic control and energy metabolism.

INTRODUCTION: Third world is greatly facing the risk of cardiovascular disorders, the major cause of which is coronary heart disease associated with risk factors like obesity and hypertension. Adolescents and young adults forms the perspective human resource for the society. Various physiological changes besides physical growth and development takes place among boys and girls during their transition from adolescents to adults. In the present trend the tendency to become overweight among young adults has become more common.

The prevalence of obesity in India is 7-9%. The most recent data derived from National Urban Diabetes Community Survey showed that 30.8% adults are overweight.
ORIGINAL ARTICLE

Being overweight is associated with two to six fold increases in the risk of developing hypertension. An increase of 2-3mmHg in systolic and 1-3 mmHg in diastolic blood pressure has been shown for each 10 kg increase in western population. Blood pressure is regulated by activity in autonomic nervous system.\(^{(3)}\) Obesity associated hypertension is mainly due to excessive stimulation of sympathetic nervous system.\(^{(4)}\)

Body mass index (BMI) is considered as a useful, albeit crude population level measure of obesity and risks associated with it (WHO REPORT). It has shown to be a better index of body fatness compared to waist-hip ratio.\(^{(5)}\)

In the present study we tried to observe the relationship between BMI and blood pressure indices viz. Systolic pressure (SP), diastolic pressure (DP), mean arterial pressure (MAP), pulse pressure (PP), heart rate (HR) and rate pressure product (RPP) in young males and females.

**MATERIALS AND METHODS:** The study is a cross-sectional study done among 195 healthy young adults (18-22 years of age) including both male and female in the Dept. of Physiology, Jorhat Medical College, Assam.

**INCLUSION CRITERIA:** The healthy young subjects were selected randomly from the population in semi-urban area of Jorhat.

**EXCLUSION CRITERIA:** Detailed history was taken and general examination was performed to exclude those subjects who had history of intake of any drugs and history or clinical evidence of any medical illnesses. Ethical clearance was obtained from Institutional Ethical Committee.

After obtaining informed written consent, blood pressure was measured on left arm by auscultatory method using mercury sphygmomanometer. The subject was made comfortable and seated at least for five minutes in the chair before the measurement. Two readings were taken at an interval of 5 minutes and then the average of two readings was used for analysis. Height was measured without shoes in the standing position with the shoulders in relaxed position and arms hanging freely by using an anthropometer. Body Weight was measured after removal of shoes with minimal clothing by using Krup’s flat type of weighing machine. BMI was calculated as weight in kilograms divided by squared height in meter. According to WHO classification of BMI, the study population has been categorized into underweight (BMI<18.5 kg/m\(^2\)), normal weight (18.5≥BMI<24.9 kg/m\(^2\)), overweight (BMI≥25 kg/m\(^2\)).

Heart rate (HR) was recorded by counting the pulse rate by palpation of the radial artery. For Pulse pressure (PP), the difference between systolic blood pressure and diastolic blood pressure was recorded.

Mean arterial pressure (MAP) was calculated as Diastolic pressure +1/3 pulse pressure. Rate pressure product (RPP) was calculated as \(\text{SP} \times \text{HR} \times 10^{-2}\).\(^{(6,7)}\)

After obtaining the above data, they were analyzed by using the relevant statistical methods. Descriptive data were expressed as mean ± standard deviation. The difference between underweight, normal weight and overweight groups were tested by using ANOVA. The data were analyzed separately for comparison in both males and females subjects.
Correlation between Body Mass index (BMI) and blood pressure indices were assessed by calculating Karl Pearson’s Correlation Coefficient denoted by ‘r’. A two-tail ‘p’ value less than 0.05 (<0.05) is considered to be statistically significant.

RESULTS AND OBSERVATION: In the present study, 12.82% subjects (56 males, 44 females) belong to underweight category, 61.54% subjects (66.7% males, 33.3% females) belong to normal weight category and 25.64% subjects (46%males, 54% females) belong to overweight category. Thus a substantial proportion of study population is found to be overweight especially females.

All data are expressed as mean ± standard and results are given in Tables I–III. Subjects’ anthropometric characteristics, HR, SP, DP, MAP, PP, and RPP are given in Tables I and II. The correlation between BMI and various parameters is presented in the form of a correlation matrix in Table III. To observe the presence of gender differences (if any) in the correlation between BMI and BP indices, the data have been separately analyzed in males and females.

Males: In the three groups that is under weight, normal weight and overweight there is a significant difference between the groups in terms of BMI (P<0.0001). SP, DP and MAP is low in underweight subjects and high in overweight subjects (P<0.05). It was observed that HR, PP and RPP are similar in all the three groups (P>0.1 and also P>0.001 for each).

Females: There is a significant difference between the three groups in terms of BMI (P<0.001) in females also. There is a significant difference between the three groups in terms of SP, DP and MAP (P < 0.05). They are high in overweight and low in underweight subjects. PP and HR are found to be similar in both males and females in all the three groups.

Correlation: Correlation between BMI and BP indices i.e. SP, DP, MAP,PP, RPP and HR was assessed among 195 subjects by using Karl Pearson Correlation Coefficient denoted by ‘r’. A significant correlation between BMI and the BP indices, namely SP, DP, and MAP (P<0.05) is observed in underweight males. In underweight females modest correlation is observed between BMI and DP and PP (r=0.5), although not statistically significant. No significant correlations are observed between BMI and BP indices in over weight males subjects. Modest correlation is found to be present between BMI and DP, RPP (r=0.5) in overweight female subjects, but statistically not significant.
Table 1: Mean distribution of various characteristics among the male subjects

| Parameter | Under weight (n=11) | Normal Weight (n=40) | Over Weight (n=27) | P-value |
|-----------|---------------------|----------------------|-------------------|--------|
| Age (Years) | 19.02±0.6           | 19.31±0.43           | 19.3±0.112        | 0.09   |
| Height (m)  | 1.56±0.07           | 1.58±0.12            | 1.57±0.33         | 0.21   |
| Weight (kg) | 47.12±2.73          | 52.4±6.3             | 60.01±5.07        | <0.001 |
| BMI (kg/m²) | 16.41±1.71          | 21.4±1.34            | 26.2±2.106        | <0.001 |
| HR (beats/min) | 76.01±1.9          | 78.11±1.2            | 80.1±0.22         | 0.88   |
| SP (mmHg)   | 100.1±1.24          | 108.3±2.05           | 114.12±3.76       | 0.23   |
| DP (mmHg)   | 62.4±3.648          | 72±2.024             | 74±4.55           | 0.035  |
| PP (mmHg)   | 38±5.1              | 36.23±2.1            | 37.15±1.02        | 0.66   |
| MAP (mmHg)  | 75.12±8.5           | 86.01±3.02           | 90.12±2.8         | 0.04   |
| RPP (units) | 73.01±7.5           | 78.01±5.01           | 89.12±3.75        | 0.88   |

Table 2: Mean distribution of various characteristics among the female subjects

| Parameter | Under weight (n=11) | Normal Weight (n=40) | Over Weight (n=27) | P-value |
|-----------|---------------------|----------------------|-------------------|--------|
| Age (Years) | 19.02±0.6           | 19.31±0.43           | 19.3±0.112        | 0.09   |
| Height (m)  | 1.56±0.07           | 1.58±0.12            | 1.57±0.33         | 0.21   |
| Weight (kg) | 47.12±2.73          | 52.4±6.3             | 60.01±5.07        | <0.001 |
| BMI (kg/m²) | 16.41±1.71          | 21.4±1.34            | 26.2±2.106        | <0.001 |
| HR (beats/min) | 76.01±1.9          | 78.11±1.2            | 80.1±0.22         | 0.88   |
| SP (mmHg)   | 100.1±1.24          | 108.3±2.05           | 114.12±3.76       | 0.23   |
| DP (mmHg)   | 62.4±3.648          | 72±2.024             | 74±4.55           | 0.035  |
| PP (mmHg)   | 38±5.1              | 36.23±2.1            | 37.15±1.02        | 0.66   |
| MAP (mmHg)  | 75.12±8.5           | 86.01±3.02           | 90.12±2.8         | 0.04   |
| RPP (units) | 73.01±7.5           | 78.01±5.01           | 89.12±3.75        | 0.88   |

Table 3: Correlation between body mass index and various parameters in underweight (UW), normal weight (NW) and overweight (OW) subjects.

UW: BMI<18.5 kg/m², NW: 18.5≥BMI<24.9 kg/m², OW: BMI≥25 kg/m²
#Data are expressed as Pearson correlation coefficient (r)
*Correlation is significant (p<0.0001)

DISCUSSION: In the present study a substantial proportion of subjects were found to be overweight. Similar observations were also been made by Shamail Zafar et al.\(^{(8)}\) and W.P Jia et
al.\(^{(9)}\) in their studies. In the present era, the tendency of young adults to become overweight and obese is surprisingly increasing. This may be attributed to sedentary lifestyle, change in dietary habits and low physical fitness.\(^{(10)}\) The present study has highlighted that overweight and obesity are an emerging health problem. During the past two decades the prevalence of overweight and obesity among children and adolescents has significantly increased in both developed and developing countries.\(^{(11)}\)

On analyzing the relationship between body mass index and blood pressure indices in underweight, normal weight and overweight young adults, it is found that in both males and females systolic blood pressure and diastolic blood pressure is high in overweight subjects, intermediate in normal weight subjects and low in underweight subjects. This study correlated with the study of Ravi Sankar P. et al.\(^{(6)}\) and P Rajeswari et al.\(^{(7)}\) Low blood pressure in underweight individuals may be due to nutritional deficiencies,\(^{(12)}\) diet,\(^{(13)}\) hormonal imbalances,\(^{(14)}\) or they may be constitutionally thin or may be more active than their peers. Increase blood pressure in overweight individuals might be because of sympathetic overdrive. Human obesity is associated with marked sympathetic activation and the baroreflex impairment.\(^{(15)}\)

In the present study heart rate and pulse pressure were similar in the three groups in both males and females, which also correlated with the findings of Ravi Sankar P. et al.\(^{(6)}\) and P Rajeswari et al.\(^{(7)}\) who documented similar findings. It may be attributed to be due to insignificant difference in cardiac output, arterial compliance and stroke volume in all the three groups.

Significant correlation was found between BMI and the BP indices, namely SP, DP, and MAP in underweight males. In underweight females modest correlation is observed between BMI and DP and PP. No significant correlations are observed between BMI and BP indices in overweight males. Modest correlation is found to be present between BMI and DP, RPP in overweight females. The observed gender differences in correlation between BMI and BP indices indicate that it may due to difference in cardiovascular autonomic control and energy metabolism.\(^{(16)}\)

The observed differences in relationship of blood pressure indices with body mass index indicate that besides BMI, several other factors like differences in sympathetic tone,\(^{(16)}\) genetic factors,\(^{(17)}\) socioeconomic factors, cultural factors, physical activity, salt consumption, smoking and alcohol consumption may influence the blood pressure of an individual.

**CONCLUSION:** The systolic blood pressure and diastolic blood pressure is low in underweight, intermediate in normal weight and high in overweight subjects in healthy young adults indicate that adolescents and young adults are at increased risk of developing obesity and its related complication, hypertension in their later life. Obesity is associated with insulin resistance and hyperinsulinemia is associated with excessive sympathetic activity \(^{(4, 18, 19, and 20)}\). So as preventive measures, the young adults and adolescents should be engaged in regular and appropriate exercise in order to keep their weight and blood pressure within normal levels. Furthermore there is need for appropriate health education, emphasizing the importance of cardiovascular health at this level of education.
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**AUTHORS:**
1. Anupi Das
2. Jyotismita Deka

**PARTICULARS OF CONTRIBUTORS:**
1. Assistant Professor, Department of Physiology, Jorhat Medical College
2. Associate Professor, Department of Physiology, Silchar Medical College,

**NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:**
Dr. Anupi Das,
Assistant Professor,
Department of Physiology,
Jorhat Medical College,
Jorhat-785001.
E-mail: dranupidas@rediffmail.com

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