



A Study of Correlation of Body Mass Index and Waist Circumference with Blood Pressure

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ABSTRACT

Introduction: *Lifestyle and habits of people have its effect on body weight and it is seen that prevalence of obesity has been increasing greatly in the last few decades. It is seen that increase in weight gain have its negative effect on every organ system causing health hazards. A correlation is being shown between weight gain and blood pressure.*

Materials and Methods: *100 subjects from Assam Medical College are being examined to asses obesity by Body Mass Index and Waist Circumference and also their Blood Pressure are recorded.*

Results: *A positive correlation has been observed between BMI, WC with BP. Amongst BMI and WC , WC remains a better predictor of mean blood pressure.*

Conclusion: *Blood Pressure has got direct relationship with BMI and WC. Systolic, Diastolic and Mean BP increases proportionally with increasing BMI and WC.*

Keywords - *Obesity, Body Mass Index , Waist Circumference, Blood Pressure.*

1. INTRODUCTION

During recent years it is seen that due to modern lifestyle and changes in the habits of the people, the prevalence of overweight is increasing in developed and developing countries, both among adults and children. Increase in body weight leads to excessive cell growth of adipose tissue both in size and number, which in turn causes accumulation of body

fat within the abdominal region and around the flanks. The pathophysiological consequences of this type of weight gain involve major organ system resulting in health hazards. Increase in weight gain is seen to have its effect on the cardiovascular system also, and amongst the various risk factor on the cardiovascular system alteration of blood pressure seems to be one of them. A correlation has been observed between weight gain and blood pressure. This relation is seen to be associated with

increase peripheral resistance and cardiac output and also by some other factors, like increase sympathetic nervous system tone, increase salt sensitivity, insulin resistance and insulin mediated salt retention, thus modifying normal physiology. If we consider the normal physiology, maintenance of blood pressure within the physiological limit is important which is essential for supplying adequate amount of blood to the tissue which in turn supplies oxygen, hormones and various other nutrients to the tissues and remove carbon dioxide and other metabolic end product from the tissue. Reduced pressure may lead to fall of blood supply to the tissues which results in hypoxia, whereas raised BP indicates work of the heart and finally may end in heart failure, rupture of vessels or atherosclerosis complication etc.

Blood pressure is expressed in different terms . The maximum pressure exerted in the arteries during systole of heart is called systolic BP. The minimum pressure in the arteries during diastole of the heart is called diastolic BP. The average pressure that is maintained throughout the cardiac cycle is called the mean pressure, it is maintained 60% by the diastolic BP and 40% by the systolic BP.

Body Mass Index relates weight to height. It is the most widely used simple measure of body size, and is frequently used to estimate the prevalence of obesity within the population. Body Mass Index has been promulgated by the W.H.O. as the most useful epidemiological measure of obesity for assaying both over and under nutrition. Waist circumference is a convenient measure of abdominal adipose tissue and it correlates closely with BMI. WC has been found to be a better marker of abdominal fat content and the use of WC for the assessment of abdominal fat content has been recommended by the National Institute of Health Guidelines on the identification, evaluation and treatment of overweight and obesity.

AIM AND OBJECTIVE

Association between body built and related medical problems are important for Indians who are genetically susceptible to abdominal or central

obesity. Screening for BP level is important in the age group of 25 - 45 years so that they can be advised for periodic checkup, proper diet, proper physical exercise and salt prevention so that they can lead a healthy life. A very few studies have been done in recent years on association on BP with BMI and WC in this part of the country. And so with the following aim and objective the study is conducted. The study is conducted in the department of Physiology Assam Medical College, Dibrugarh.

1. To determine the correlation of BMI and Systolic, Diastolic and Mean Blood Pressure.
2. To determine the correlation of WC with Systolic, Diastolic, and Mean Blood Pressure.

METHOD AND MATERIAL

The study was based on a total of 100 subjects selected from staff and other employees of Assam Medical College and Hospital Dibrugarh. Those cases were selected who gave no history or symptoms referable to disease of any system, and clinical examination did not reveal any findings. Past history of illness was excluded. Age ranged from 25 - 45 years. All the cases were selected after recording the name, age, sex, occupation and address. In history taking emphasis was given on education, personal history, diet habits, past history and family history.

METHODS OF MEASUREMENT

For measuring the weight a standard weighing machine was used having scale from 0 to 150 kg. The subjects were asked to wear light clothes and remove their footwear. For height Anthropometer is used having a graduated vertical rod from 0 to 200 cm and horizontal one is from 1 to 25 cm. The subjects were kept erect posture with bare feet, heels closed together and arms hanging naturally at the side. Heels, buttocks, upper part of the back and the occipital were to touch the vertical rod. BMI was calculated as weight(kg) divided by height in square(m²). A low BMI as < 20kg/m²,desirable

range is from $20.1 - 25 \text{ kg/m}^2$, obesity is a BMI of $> 30\text{kg/m}^2$ and morbid obesity $> 40\text{kg/m}^2$.

For measuring waist circumference a standard measuring tape was used which have $0 - 150 \text{ cm}$. The subjects were asked to wear thin clothes. The measurements were made at the level of the umbilicus or the highest point of the iliac crest.

For measuring the blood pressure Sphygmomanometer was used and it was taken into account that the subjects were without worries and anxieties. The subjects were allowed to take rest for 5 min. The blood pressure was recorded in the sitting position and the instrument was kept at the level of the heart. Blood pressure was measured on the left arm using appropriate cuff size to ensure accurate measurement. Both systolic and diastolic BP was recorded. Three measurements were taken and averaged for analysis. A 5 min relaxation was maintained for all subjects. Systolic BP and diastolic BP was recorded to the nearest mm of mercury in the appearance (phase 1) and disappearance (phase v) of Korotkoff sound respectively. The Mean blood pressure was recorded using the standard formula.

Mean arterial pressure(mm Hg) = Diastolic BP + $\frac{1}{3}(\text{Systolic BP} - \text{Diastolic BP})$

STATISTICAL ANALYSIS

Statistical analysis was performed with one way analysis variance (ANOVA).

RESULTS

A total of 100 cases of age group $25 - 45$ years were taken up. The study was undertaken to evaluate the correlation of blood pressure with body mass index and waist circumference. Systolic, Diastolic and Mean blood pressure is found to increase with increase in body mass index and waist circumference. The increment of systolic, diastolic and mean blood pressure is significantly related to body mass index ($p <0.001$) and waist circumference ($p>0.05$). Amongst BMI and WC, WC remains a better predictor of mean blood pressure.

TABLE 1 : Systolic Blood Pressure According To Different Body Mass Index.

BMI kg/m^2	Number of Cases	Ranges mmHg	Mean mmHg	Median mmHg	Standard deviation	Standard error
<20	9	100-130	122.2 ²	120	9.72	3.24
20.1-25	43	110-150	121.7 ⁷	120	9.55	1.46
25.1-30	42	110-160	131.7 ⁶	120	10.88	1.68
>30	6	120-160	144	120	14.14	5.77

TABLE 2 : Diastolic Blood Pressure According To Different Body Mass Index

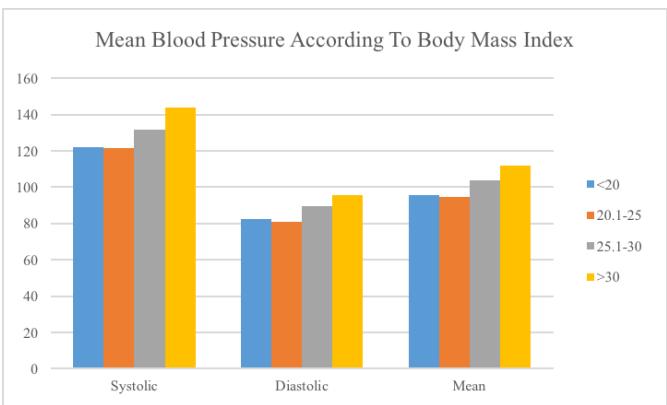
BMI kg/m^2	Number of Cases	Ranges mmHg	Mean mmHg	Median mmHg	Standard deviation	Standar d error
<20	9	70-90	82.22	80	8.33	2.78
20.1-25	43	70-100	81.07	80	7.61	1.16
25.1-30	42	70-110	89.48	90	8.42	1.30
>30	6	90-110	95.67	93	3.20	3.20

TABLE 3 : Mean Blood Pressure According To Different Body Mass Index

BMI kg/m^2	Numbe r of Cases	Ranges mmHg	Mean mmHg	Media n mmHg	Standar d deviatio n	Standar d error
<20	9	80.00- 103.33	95.56	96.67	7.45	2.48
20.1-25	43	83.33- 116.67	94.64	93.33	8.01	1.22
25.1-30	42	83.33- 126.67	103.5 ⁷	103.33	8.78	1.36
>30	6	100.00- 123.33	111.7 ⁷	111	8.77	3.58

TABLE 4 : Systolic Blood Pressure According To Different Waist Circumference.

WC in cm	Number of Cases	Ranges mmHg	Mean mmHg	Median mmHg	Standard deviation	Standard error
<102	85	100-150	124.66	120	9.82	1.07
>=102	15	120-160	142.53	140	12.86	3.32

**TABLE 5 :** Diastolic Blood Pressure According To Different Waist Circumference.

WC in cm	Number of Cases	Ranges mmHg	Mean mmHg	Median mmHg	Standard deviation	Standard error
<102	85	70-110	83.72	80	8.27	0.9
>=102	15	90-110	96.13	96	7.15	1.85

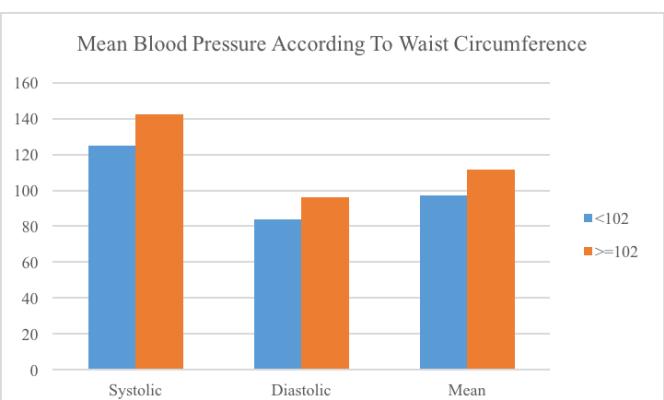
TABLE 6 : Mean Blood Pressure According To Different Waist Circumference.

WC in cm	Number of Cases	Ranges mmHg	Mean mmHg	Median mmHg	Standard deviation	Standard error
<102	85	80.00-122.00	97.36	96.97	8.39	0.91
>=102	15	100.00-126.67	111.6	112	8.22	2.12

DISCUSSION

In the present study we found a positive correlation of systolic blood pressure with BMI with slight variation in the second group of BMI 20.1 - 25(Desirable range) which shows decrease of mean systolic blood pressure with 121.77 mmHg. This may be due to the fact most of the subject in this group are 25 – 29 years old and all cases has WC < 102 cm. Our findings are found to be consistent with some workers who found a positive relation of BMI with systolic blood pressure. The relation of BMI with blood pressure can be explained, as reported by many observers that BMI increase when weight increase and weight gain is associated with increase peripheral resistance and cardiac output. The correlation coefficient of BMI with systolic BP is found to be 0.44 with $p < 0.001$ which statistically indicates high significance. For systolic BP, all the four groups of BMI has been compared with one another by One Way Analysis Variance. The variation among the mean of systolic BP of different group of BMI is found to be significantly greater than expected by chance. P value is < 0.0001 considered extremely significant.

In our present study the mean Diastolic BP and the Mean BP is seen to increase with increase in BMI with little variation in the BMI group 20.1 – 25(Desirable Range) which shows drop in diastolic BP with 80.07 mmHg and Mean pressure of 96.64 mmHg. This may be due to age factor as most of the subjects in this group are 25 -29 years old and also they have WC <102 cm . Our findings are not found to be compatible with the findings of Suh H and



Webber LS et all 1995 who found a negative relation of BMI with diastolic BP. The correlation coefficient with diastolic BP and Mean BP Is found to be 0.36 and 0.41 respectively with $p < 0.001$ which statistically indicates highly significant.

For diastolic and Mean BP all the 4 groups of BMI has been compared with one another by one way variance. The variation among the mean of Diastolic and Mean BP of different groups is found to be significantly greater than chance. The P value is < 0.0001 considered extremely significant. Relation of WC to systolic BP is observed by few, Alfonso et Al 2002, stated in their study, that WC is the anthropometric index that best correlates with BP, $p < 0.001$. WC remains the strongest predictor of BP. In our study, the mean of BP is seen to increase with increase in WC. The increasing trend of BP with increase in WC is associated with central adiposity which is related to factors like increase sympathetic nervous system tone, and other neuro-endocrine abnormalities along with increased peripheral resistance and cardiac output. The correlation coefficient for WC with systolic BP is found to be 0.57, with $p < 0.001$ considered highly significant.

Both the groups of WC is compared with one another by 't' test. After comparison the 'p' value is found to be 0.0001 considered extremely significant. In our present study, the mean of the diastolic BP and the mean BP is seen to increase with increasing WC. The reason for the increasing trend of diastolic and mean BP with increasing WC may be same as explained for systolic BP. The correlation coefficient for WC with diastolic and mean BP is found to be 0.56 and 0.59 respectively with $p < 0.001$ which is considered highly significant. Both the groups of WC is compared by 't' test. After comparison P is found to be < 0.0001 considered extremely significant.

CONCLUSION

From the above study it can be concluded that BP has got direct relationship with BMI and WC. Systolic, Diastolic and Mean BP increase

proportionally with the increasing BMI and WC. Amongst WC and BMI, WC is a better predictor of blood pressure. The present study is carried out with very less number of cases but in the future similar work may be carried out to find out more information regarding blood pressure and different factors affecting its rise and fall. Conclusion can be definitely ascertained by some future work taking a large number of cases to represent the population.

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