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A Study of Relationship of Waist Circumference and Waist-to-Hip Ratio with Blood Pressure Levels in Young Obese Adults

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Abstract:
Overweight and obesity are important determinants of health and lead to adverse metabolic changes including increase in blood pressure. Studies in urban Indian population showed strong relationship between different anthropometric parameters and blood pressure levels, but little is known about these relationships in North-eastern parts of India. Therefore, the present study was undertaken to study the relationship between different anthropometric indicators and BP levels in these North-Eastern parts of India. This cross sectional study was carried out in 250 subjects in the age group of 18 to 30 years residing in the premises of Assam Medical College & Hospital for duration of 1 year. The parameters, BMI, waist circumference (WC), hip circumference (HC), waist-to-hip ratio (WtHR) and BP were standardized according to Indian Health Ministry's guidelines for Prevention and Management of Obesity and Metabolic Syndrome and JNC-VII criteria. Statistical analysis was done using SPSS statistics version 17.0 with paired T test to analyze quantitative data and $P<0.05$ was used to indicate statistical significance. The results showed that the increment in BP is highly significantly related to age ($P<0.01$), weight ($P<0.01$), BMI ($P<0.01$), WC ($P<0.01$) and WtHR ($P<0.01$). So, it can be concluded that BP has got a direct relationship with age, weight, BMI, WC and WtHR.

Keywords: *waist circumference, BMI, blood pressure, waist-to-hip ratio, cardiovascular diseases*

1. Introduction

Overweight and obesity are important determinants of health and lead to adverse metabolic changes, including increase in blood pressure, unfavorable cholesterol levels, hypertriglyceridemia, increased resistance to insulin, low HDL and greater prevalence of metabolic syndrome. Being overweight is associated with 2 to 6 fold increase in the risk of developing hypertension. An increase of 2-3 mmHg in systolic and 1-3 mmHg in diastolic blood pressure has been shown for each 10 kg increase in weight in western population. Studies in urban Indian population also showed strong relationship between different anthropometric indicators and blood pressure levels[1] but little is known about these relationships in the North-Eastern part of India. Therefore, the present study was undertaken to examine the relationship between different anthropometric indicators and blood pressure levels in the North-Eastern region of India.

As we review the literature, the historical aspects of blood pressure dates back to 1733 when Stephen Hales, a biologist first made an attempt to measure blood pressure by introducing a long tube into the femoral artery of a mare and noted the pulsation of the rising column of blood in the tube[4,5]. Although several anthropometric indicators have been shown to be associated with cardiovascular risk factor, controversies still exist regarding the best anthropometric marker for assessing the relationship between body fat distribution and the risk of elevated blood pressure. Deshmukh et al in 2006 found a significant relationship between waist circumference and blood pressure[1]. Jaffer et al in 2007 found a significant relationship of BMI and waist to hip ratio with hypertension in young adult medical students[2]. Dalton et al in 2003 correlated waist circumference, waist-to-hip ratio and BMI with cardiovascular disease risk factors in Australian adults[3].

2. Methods

The study was carried out in a total of 250 subjects in the age group of 18 to 30 years, selected randomly from students, staff and other employees of the Assam Medical College & Hospital, Dibrugarh, Assam for a duration of 1 year. The cases were selected whose BMI is $\geq$23 kg/m^2 and who gave no history of symptoms referable to disease of any system and clinical examination did not reveal any abnormal findings. Cases having abnormalities in the respiratory system, central nervous system and alimentary system were

excluded. The instruments for measurement were standardized according to ICMR standardization. Blood pressure was recorded by the palpatory method followed by the auscultatory method in the supine position after taking 5 minutes of rest. The diaphragm of the stethoscope was placed first at the antecubital fossa in order to measure the brachial artery blood pressure. The pressure of the sphygmomanometer was raised to 10 mm above the point at which the pulse disappeared and released at a rate of 1 mm Hg per second. The systolic and diastolic blood pressures were recorded as per appearance and disappearance of Korotkoff sound respectively. Using the recently published Seventh Report of Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-VII) Criteria[25], hypertension was defined as systolic blood pressure (SBP) ≥140 mmHg and diastolic blood pressure (DBP) ≥90 mmHg.

For BMI measurement, first the subject was kept in an erect posture with bare feet, heels closed together and arms hanging naturally at the side. Heels, buttocks, upper part of the back and the occiput were to touch the vertical rod for height measurement. The external auditory meatus and the lower border of the orbit were kept in a plane parallel with the floor. A horizontal bar is firmly placed at right angle to the vertical rod touching the top most point of the vertex and height was measured from the graduation of the vertical rod. The height was measured the nearest 0.01cm. Similarly, weight was measured by keeping the subject in an erect posture with bare feet, heels closed together and arms hanging naturally at the sides. The weight was measured to the nearest 0.1 kg. BMI was calculated as body weight (in kg) divided by the square of the height (in metres). According to Indian Health Ministry's guidelines for Prevention and Management of Obesity and Metabolic Syndrome, obesity was defined as BMI of ≥23 kg/m^2 [26].

Waist circumference was measured at the level of halfway between the iliac crest and the costal margin in the mid axillary line after exhaling with the subject in standing position and both feet together. Two consecutive readings were made to the nearest 0.5 cm using non-stretchable fibre measuring tape on a horizontal plane without compression of the skin. The mean of the two values was used. Waist circumference cut offs were taken as >90cm for males and >80cm for females to define overweight[26]. Hip circumference was measured at the level of greater trochanters with the subject in standing position and both feet together using the same measuring tape. Waist to hip ratio (WtHR) was calculated by dividing the waist circumference by hip circumference. The cut off used for WtHR were >0.9 for males and >0.8 for females[26].

3. Results

For analysis, 250 subjects were divided according to their age, weight, height, BMI, WC, HC and WtHR. Statistical analysis was done using SPSS Statistics Version 17.0. Student T Test (Paired) was done to analyze the quantitative data and a P value of <0.05 was used to indicate statistical significance in all analyzes. Bivariate correlation was done to establish correlation and their significances. Stepwise linear regression techniques were used to assess the extent to which risk of hypertension depends on the obesity indices considered using the same independent variables.

Correlation Coefficient	Systolic BP	P Value	Diastolic BP	P Value
Age	0.497	0.01	0.560	0.01
Weight	0.358	0.01	0.261	0.01
Height	0.147	0.02	0.075	0.238
Body Mass Index	0.378	0.01	0.333	0.01
Waist Circumference	0.480	0.01	0.391	0.01
Waist-To-Hip Ratio	0.321	0.01	0.276	0.01

Table 1: Table showing correlation co-efficient of age, weight, height, body mass index (BMI), waist circumference (WC) and waist-hip-ratio (WtHR) with blood pressure (BP)

From table1, it is seen that for systolic blood pressure, the strongest correlation coefficient is of waist circumference (0.480 with P<0.01) followed by body mass index (0.378 with P<0.01) which is again followed by waist-to-hip ratio (0.321 with P<0.01). Similarly, for diastolic blood pressure the strongest correlation coefficient is of waist circumference (0.391 with P<0.01) followed by body mass index (0.333 with P<0.01) followed by waist-to-hip ratio (0.276 with P<0.01).

Obesity Index	Correlation Coefficient	R^2	P Value (<)
BMI	0.378	0.143	0.001
WC	0.480	0.231	0.001
WtHR	0.321	0.103	0.001

Table 2: Multiple Regression (R^2) Analysis of systolic blood pressure with body mass index, waist circumference and waist-to-hip ratio

Obesity Index	Correlation Coefficient	R^2	P Value (<)
BMI	0.333	0.111	0.001
WC	0.391	0.153	0.001
WtHR	0.276	0.076	0.001

Table 3: Multiple Regression (R^2) Analysis of diastolic blood pressure with body mass index (BMI), waist circumference (WC) and waist-to-hip ratio (WtHR)

As shown in table 2, the highest regression value (R^2) for systolic blood pressure is waist circumference (0.231 with P<0.001) followed by body mass index (0.143 with P<0.001) followed by waist-to-hip ratio (0.103 with P<0.001) which indicates that all three parameters have high significant correlation with an increase in systolic blood pressure but waist circumference has the highest significance among them. Similarly, in table 3, the highest regression value (R^2) for diastolic blood pressure is waist circumference (0.153 with P<0.001) followed by body mass index (0.111 with P<0.001) followed by waist-to-hip ratio (0.276 with P<0.001) which again shows the same result as that was found for systolic blood pressure.

4. Discussion

There is a rising trend of cardiovascular disease in young adults in Indian population as compared to Western counterpart. Several risk factors for cardiovascular disease have been identified of which obesity is the foremost. Obesity increases the risk of hypertension. Though the use of body mass index as a measure of generalized obesity in young adults is gaining acceptance rapidly, it is interesting to note that truncal obesity has a greater effect on cardiovascular disease incidence, independent of general obesity, thereby causing anthropometric parameters like waist circumference and waist-to-hip ratio to emerge as a better predictor for cardiovascular diseases.

In the present study, systolic and diastolic blood pressures were found to increase with increase in age, weight, height, body mass index, waist circumference and waist-to-hip ratio. The increment in systolic as well as diastolic blood pressures were highly significantly related to age (P<0.01), weight (P<0.01), body mass index (P<0.01), waist circumference (P<0.01) and waist-to-hip ratio (P<0.01). No increment in either systolic or diastolic blood pressure is observed according to height (P>0.05).

So from the above study it can be concluded that blood pressure has got a direct relationship with age, weight, body mass index, waist circumference and waist-to-hip ratio. Systolic and diastolic blood pressure increases proportionately with increasing age, weight, body mass index, waist circumference and waist-to-hip ratio. Among waist circumference and waist-to-hip ratio, waist circumference is a better predictor of blood pressure.

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