

Comparative Evaluation And Correlation Of Different Anthropometric Indices With Blood Pressure In Adult Population.

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Abstract: Background & Objectives: Best index of obesity that is predictive for hypertension is still a controversial subject because the predictive power of anthropometric indices varies from race to race; hence present study was carried out to assess correlation of the four mentioned anthropometric indicators with Blood pressure and to find out the best parameter as a predictor of Hypertension. **Method:** A cross sectional study was done in 600 subjects. Body mass index (BMI), Waist hip ratio (WHR), Waist stature ratio (WSR), Waist circumference (WC) and BP measurement was done. Mean, standard deviation, Students T test and Pearson Correlation analysis were used for analysis of results. **Results:** Mean values of all the four anthropometric indicators were significantly higher ($p < 0.01$) in Hypertensive than in normotensive population in both gender. Percentage of hypertensive detected by WSR was highest (71.63%) followed by WC (69.54%), BMI (68.4%), WHR (60%) in that order. A positive correlation was found between all the four anthropometric indicators with SBP and DBP. WSR had the highest correlation coefficient for both SBP and DBP followed by WC > BMI > WHR in that order. **Interpretation & Conclusion:** The majority of our examinees were found to be normal weight by BMI definition but the percentage of Hypertension was significantly higher among normal-weight examinees with $WSR \geq 0.5$. Thus, WSR may also be applied effectively to normal weight people facing higher risks of Hypertension, enabling early preventive health education.

Key words: Body mass index, blood pressure, hypertension, waist circumference, waist hip ratio, waist stature ratio

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Introduction: Obesity is a major health hazard all over the world; it is associated with hypertension, cardiovascular diseases, diabetes, raised cholesterol level, arthritis, anaesthesia risk, respiratory problem, breast cancer, menstrual abnormalities, ovarian dysfunction along with poor social image and rejection.¹The prevalence of obesity is increasing in both developed and developing countries.²In India, the prevalence of obesity among adults ranges from 10-50% depending on the definition used.³

Obesity has been defined by various anthropometric indices, like body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-stature ratio (WSR) etc. BMI is promulgated by the World Health Organization as the most useful epidemiological measure of obesity. It is nevertheless a crude index that does not take into account the distribution of body fat, resulting in variability in different individuals and populations.²WHR, WSR and WC are commonly used to predict the risk of obesity related morbidity and mortality as they account for regional abdominal obesity^{4,5,6}.

However, best index of obesity that is predictive for hypertension still remains as a controversial subject because predictive power of anthropometric indices is population dependent

and varies from race to race; For example in terms of body morphology, Asian Indian have lower BMI and for any given BMI, Asian Indian have higher central obesity and abdominal fat than do Europeans^{7,8,9}

In view of above consideration, to the best of our knowledge, the present study is an attempt considering the four mentioned anthropometric indices in the form of comparative evaluation, to study the relationship of obesity with blood pressure and to find out best anthropometric indicator associated with greater risk of hypertension.

Material and Method: STUDY DESIGN: After ethical clearance from Pt.J.N.M.Medical College, Raipur, a cross sectional study was carried out in district hospital, pandri, Raipur, Chhattisgarh, India from June 2010 to August 2011. 600 subjects (335 male and 265 female) aged 18 yrs and above, who visited district hospital for routine health check-up, were selected by random sampling method. Pregnant women & those who are unable to stand erect were excluded. Individual on antihypertensive medication and /or with known history of diabetes or renal disease were also excluded.

Informed consent was taken before BP and anthropometric measurement.

Anthropometric measurement: Body weight has been measured without shoes in light clothing (to the nearest 0.5 kg) with the subject standing motionless on the digital weighing scale in such a way that body weight should be distributed equally on each leg. Weighing machine was standardized every day with a weight of 50 kg. Height has been measured without shoes with the subject standing in an erect posture, shoulders in relaxed position and arms hanging freely. The head positioned so that the top of the external auditory meatus was in level with the inferior margin of the bony orbit (Frankfurt's plane) using tape meter. BMI has been calculated as weight (kg)/ height (meter)². Waist circumferences has been measured as per recommendation of WHO STEPS for surveillance (2008) protocol at the approximate midpoint between the lower margin of last palpable rib and the top of the iliac crest, using a stretch-resistant tape. Hip Circumference has been measured around the widest portion of the buttocks, with the tape parallel to the floor. For waist and hip circumference measurements, the subjects were instructed to stand with feet close together, arms at the side and body weight evenly distributed across the feet, and wear light clothing. They were instructed to be relaxed, and take a few deep breaths to minimize the inward pull of the abdominal contents and the measurement has been taken at the end of a normal expiration. Each measurement repeated twice; if the measurements were within 1 cm of one another, the average calculated. If the difference between the two measurements exceeded 1 cm, the two measurements be repeated.

Both measurements have been taken with a stretch-resistant tape that is wrapped snugly around the subject without compression to the skin. WHR was calculated as waist circumference divided by hip circumference. WSR was calculated as waist circumference divided by height.

BMI ≥ 23 and BMI ≥ 25 was taken as cut off to define overweight and obese respectively as per recommendation of WHO, the International Obesity Task Force and the International Association for the Study of Obesity for Asian and Pacific Island populations. Cut offs used for WC

were ≥ 90 cm in males and ≥ 80 cm in females, for WHR ≥ 0.9 in males and ≥ 0.85 in females and for WSR ≥ 0.5 for both sex. WC, WHR and WSR are indicator of abdominal obesity and their cut off value was taken as per recommendation given in the report of WHO expert consultation (Geneva 8-11 Dec, 2008) for Asian population.

Measurement of Blood Pressure: The auscultatory method of BP measurement with a properly calibrated and validated sphygmomanometer has been used. Subjects were made to be seated comfortably in a chair for at least 5 minutes with arm supported at heart level. The appropriate size cuff (bladder length 80% and width at least 40% of arm circumference) used to ensure accuracy.

The Systolic B.P. was defined as appearance of the first sound (Korotkoff phase 1) and Diastolic B.P. was defined as disappearance of the sound (Korotkoff phase 5). Two readings were taken at interval of 30 min and average of two readings was used to represent BP of the subject. If they differed by more than 5mm Hg, one more reading was obtained and then averaged. Before measuring the B.P. the subject were questioned about drinking tea or coffee, smoking, physical activity and a full bladder.

Hypertension was defined as SBP ≥ 140 mm Hg or DBP ≥ 90 mm Hg as per recommendation of Seventh Report of Joint National committee on Prevention, Detection, Evaluation and Treatment of High blood Pressure (JNC-VII). All the measurements were taken by trained medical professionals.

Statistical Analysis: Data were analysed by SPSS. Population characteristics, anthropometric indicator and SBP and DBP are shown as mean and standard deviation. Means were compared by using student's T-test. Association of anthropometric indices with SBP and DBP was compared by Pearson Correlation analysis.

Results: In present study Weight, height, WC, WSR, WHR and DBP were significantly higher in male subjects but no statistically significant difference was observed in BMI and SBP between male and female subjects. (Table-1). Mean values of all the four anthropometric indicators were significantly higher in Hypertensive than in normotensive population in both the gender (table-2). The Prevalence (%) of Hypertension

was more in obese category than non-obese category for all the four anthropometric indices. Percentage of hypertensive detected by WSR was highest followed by WC, BMI, WHR in that order (table-3).

There was a positive correlation of all four anthropometric indicators with SBP as well as DBP. WSR had the highest value of correlation coefficients for both SBP and DBP followed by WC, BMI and WHR in that order (table-4).

Table 1: Baseline characteristics of the study population

| Variables | Male (N=335) Mean±S.D. | Female (N=265) Mean±S.D. | Significance |
|--------------------------|---------------------------|-----------------------------|--------------|
| Age | 39.16±14.09 | 43.33±14.61 | p<.01 |
| Weight (Kg) | 59.86±12.15 | 51.26±9.46 | p<.01 |
| Height (cm) | 163.32±6.94 | 151.38±6.28 | p<.01 |
| BMI (kg/m ²) | 22.33±3.73 | 22.37±3.97 | p>.05 |
| Waist circumference | 83.24±9.83 | 81.06±10.13 | p<.05 |
| Waist-Stature Ratio | 0.50±0.05 | 0.53±0.06 | p<.01 |
| Hip circumference | 90.26±10.51 | 90.67±10.96 | p>.05 |
| Waist-Hip Ratio | 0.92±0.07 | 0.89±0.07 | p<.01 |
| SBP | 136.91±21.48 | 136.77±25.72 | p>.05 |
| DBP | 87.33±12.78 | 85.29±12.61 | p<.05 |
| No. of Hypertensives (%) | 192 (57.31%) | 144 (54.33%) | |

Table 2: Comparison of Anthropometric Indicators among Normotensive and Hypertensive Males and Females

| Anthropometric Indicator | | Normotensive (N=264) Mean±S.D. | Hypertensive (N=336) Mean±S.D. | Significance |
|--------------------------|---|-----------------------------------|-----------------------------------|--------------|
| BMI | M | 21.37±3.51 | 23.05±3.76 | p<.01 |
| | F | 21.56±3.58 | 23.07±4.15 | p<.01 |
| Waist circumference | M | 79.02±8.70 | 86.38±9.46 | p<.01 |
| | F | 78.12±9.29 | 83.52±10.19 | p<.01 |
| Waist Stature Ratio | M | 0.48±0.05 | 0.52±0.06 | p<.01 |
| | F | 0.51±0.05 | 0.55±0.07 | p<.01 |
| Waist-Hip Ratio | M | 0.90±0.08 | 0.93±0.05 | p<.01 |
| | F | 0.88±0.07 | 0.90±0.07 | p<.01 |

Table 3: Relationship of Anthropometric Indicators with Hypertension

| Anthropometric Indices | | No. of subjects | No. Of Hypertensive | Percent age |
|------------------------|------------------|-----------------|---------------------|-------------|
| BMI | Obese (≥ 25) | 133 | 91 | 68.4% |
| | Non Obese (< 25) | 467 | 245 | 52.4 % |
| Waist Hip Ratio | ≥ Cut off | 453 | 272 | 60 % |
| | < cut off | 147 | 64 | 43.5 % |
| WC | ≥ Cut off | 197 | 137 | 69.54% |
| | < cut off | 403 | 199 | 49.4% |
| Waist Stature Ratio | ≥ Cut off | 356 | 255 | 71.63% |
| | < cut off | 244 | 81 | 33.2% |

Table 4: Correlation of anthropometric indices with SBP and DBP (by Pearson correlation analysis)

| Anthropometric Indices | SBP | DBP |
|------------------------|---------|---------|
| BMI | 0.2385* | 0.2198* |
| WHR | 0.1944* | 0.2106* |
| WC | 0.3273* | 0.3329* |
| WSR | 0.3474* | 0.3380* |

*correlation is significant at the 0.01 level 2 – tailed)

Discussion: Importance of BMI, WC, WHR, and WSR has been recognized for estimating cardiovascular disease risk factors, particularly due to their positive association with hypertension. In our study mean values of all four anthropometric indicators were significantly higher in hypertensive than in normotensive population in both sexes. This finding was similar to several studies^{9, 10, 11, 12, 13}.

We also found a positive correlation between all the four anthropometric indicators with SBP and DBP which is similar to several studies^{14, 15, 16, 17}. WSR had the highest values of correlation coefficient for both SBP and DBP followed by WC > BMI > WHR in that order in our study. This finding is similar to study done by Hong – Yan – Wu et al¹⁴. Several studies have found that of all other prognostic indicators of central obesity, WSR seems a simpler, cheap and non-invasive indirect anthropometric index to screen for hypertension^{18, 19, 20, 21}.

Some studies reported significant positive correlation of BMI with systolic and diastolic blood pressure^{22,23}. However Webb GP stated that BMI was less reliable, because though BMI measures overall obesity with good relationship to fat content, it neglects body fat distribution which is assessed by WHR, WC or WSR. In our study also, WSR and WC was found to be superior to BMI for assessment of obesity (table-3); probable reason for these might be majority of the subjects in our study had abdominal / central obesity which is difficult to assess by BMI.

Significant positive correlation between WHR and systolic and diastolic blood pressure have also been reported earlier in various studies^{22,23,24,25,26}; However in our study percentage of Hypertensive detected by WHR was found to be less in comparison to the other three indicators. The most probable reason for this difference might be different body morphology and body composition in different ethnic groups; differences in cut off values between men and women and among various ethnic groups²⁷ and variations in measurement levels might be other possible reasons.

Some other studies have shown that WC was a better predictor of hypertension^{28,29,30}. In our study also percentage of Hypertensive detected by WC was more than that detected by WHR or BMI; However WSR was found to be superior over WC. Probable reason might be WSR which takes into account differences in height, have helped in more accurate tracking of fat distribution and in more comprehensive identification of individuals facing higher risks of Hypertension.

Dalton et al found that BMI, WC and WHR were equally related with hypertension²⁶. BMI, WC, WHR and WSR have all been found to be positively correlated with B.P. in various studies and different investigators preferred, different indicator for prediction of Hypertension depending on their study results. In our study WSR was shown to be best predictor of Hypertension followed by WC, BMI and WHR. The principal limitation of this study was the use of cross-sectional data to compare the ability of anthropometric indices to predict hypertension. Future studies using longitudinal data will provide stronger evidence on this evaluation. Hypertension is heterogeneous and

multifactorial, and besides anthropometric measurements, other factors such as hereditary and lifestyle-related factors must be considered. Given the aforementioned limitations, it is concluded that WSR, as compared to BMI, WC and WHR, may be a better indicator of Hypertension.

Conclusion: The majority of our examinees were of normal weight, as defined by BMI classification of WHO; but nevertheless faced a high prevalence of Hypertension. Moreover, the percentage of Hypertension was significantly higher among normal-weight examinees with $WSR \geq 0.5$. This observation confirms that not just the amount of fat, but also central fat distribution, results in increased health risks in both men and women. Thus, WSR may also be applied effectively to normal weight people (as per BMI classification) facing higher risks of Hypertension, enabling early preventive health education.

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