

## Original Research Article

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# Association between hypertension and anthropometric indices in adult men: a case control study

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## ABSTRACT

**Background:** Controversies over the value of BMI for the estimation of body fat have led to recommendations of the use of new methods to measure body fat. The objective of the study was to find the association between hypertension and anthropometric variables like BMI, Waist-Hip ratio, Ponderal index, Brocca index.

**Methods:** Newly diagnosed 150 hypertensive patients aged more than 30 years attending medicine OPD were selected as cases. Equal numbers of age matched controls were selected from relative or neighbourhood. Blood pressure of the subjects was recorded. BMI, WHR, Ponderal index, Brocca index were calculated. Association between two categorical variables was analyzed by using Chi -square test, odds ratio along with 95% confidence interval (CI). Student's T test was used as test of significance for difference between two means.  $P<0.05$  was considered to be statistically significant.

**Results:** Those having  $BMI \geq 25$  has 2.28 (1.31, 3.95) times risk of being hypertensive. Those having waist to hip ratio (WHR)  $\geq 0.9$  had 2.73 (1.68, 4.41) times higher chance of being hypertensive. Those having Ponderal Index  $\leq 40$  had 3.08 (1.75, 5.42) times higher risk of hypertension. Those with ideal body weight percent more than 100 by Brocca index had 2.98 (1.84, 4.83) times chance of getting hypertension.

**Conclusions:** Ponderal index (PI), Ideal body weight percent by Brocca index (BI) and waist hip ratio (WHR) were found to be strongly associated with hypertension with higher odds ratio than BMI.

**Keywords:** Hypertension, BMI, WHR, Ponderal index, Brocca index

## INTRODUCTION

Systemic hypertension is known as the “Silent Killer” because it is generally not detected unless specifically looked for. If not detected or left uncontrolled, high blood pressure increases the risk of various life threatening complications like heart disease, stroke, renal disease and blindness over a course of years.<sup>1</sup> Relationship between

obesity and hypertension is well established both in children and adults. Measuring anthropometric indices are cheap and easy to use techniques for the assessment of nutritional status of an individual. In order to measure and monitor levels of body fat, accurate methods of determining body composition are needed. Quantifying body fat is somewhat difficult in large scale studies. Because weight and height are standard measures of a

physical examination, body mass index (BMI) has been the most commonly used proxy for body fat, but it does not measure body fat distribution and in particular, abdominal fat mass. People with a large waist are many times more at risk of ill health, and poor quality of life. These increased risks also apply in people whose BMI is normal but who have a large waist. Hence, anthropometric indices that measure abdominal fat or central obesity such as waist hip ratio (WHR) are increasingly used in research and clinical settings.<sup>2-7</sup> Different cut off points or use of different anthropometric measurements to diagnose obesity are needed according to ethnic and racial variation among populations from different regions.<sup>8,9</sup> Controversies over the value of BMI for the estimation of body fat have led to recommendations of the use of new methods to measure body fat. With this background, present study was planned to study the association of BMI and the other easily measurable anthropometric indices like WHR, Ponderal index and Brocca index with hypertension among adult male.

## METHODS

Present case-control study was carried out amongst newly diagnosed hypertensive adult males aged above 30 years and age matched controls from June 2014 to October 2015 to study the association between hypertension and BMI, waist-hip ratio (WHR), Ponderal index and Brocca index.

### Sample size

Sample size was calculated by assuming

- Sample correlation coefficient- 0.4.<sup>10</sup>
- Population correlation coefficient- 0.6.
- Power of study - 90%,  $\alpha$  error- 5%
- Sample size= 148 cases and 148 controls.

However to round up, 150 cases and 150 controls were selected for the study. Approval from institutional ethics committee was sought. Newly diagnosed hypertensive patients aged more than 30 years attending medicine OPD were selected as cases. Age matched controls were selected from relative or neighbourhood. Written informed consent of the study subject was obtained after explaining the nature and purpose of the study. Detailed history was taken in predesigned proforma using interview technique.

### Inclusion criteria

Inclusion criteria were newly diagnosed hypertensive, adult males, aged more than 30 years,

### Exclusion criteria

Exclusion criteria were known case of diabetes, known case of chronic renal disease, known case of endocrine

dysfunction, known case of cardiovascular disease, smoker, alcohol consumer, other substance abuse

Blood pressure of the subjects was recorded using mercury sphygmomanometer by auscultatory method in supine position. Three readings were taken, two minutes apart and average of three readings was calculated. Hypertension was defined as systolic blood pressure more than or equal to 140 mmHg and/or diastolic blood pressure more than or equal to 90 mmHg.

Height of the subjects was measured using stadiometer. Body weight was measured using the electronic weighing machine. Waist circumference was measured by placing the measuring tape midway between top of hip bone and the bottom of ribs. Hip circumference was measured around the maximum circumference of the buttocks by the non-stretchable measuring tape.

BMI was calculated as weight in kilograms divided by the square of the height in metres ( $\text{kg}/\text{m}^2$ ). Waist – hip ratio (WHR) was calculated by dividing waist circumference by hip circumference.

Ponderal index was calculated as height in centimetres divided by cube root of body weight in kilograms. Ideal body weight by using Brocca index was calculated as height in centimetres minus 100. For statistical analysis, percentage of ideal body weight was considered. Percentage of ideal body weight was calculated as considering ideal body weight as 100%.

### Statistical analysis

Data were entered in Excel sheet and analyzed using Statistical software Epi Info 7. Percentage, mean, standard deviation, and range were used to summarize the descriptive characteristics. Association between two categorical variables was analyzed by using Chi -square test, odds ratio along with 95% confidence interval (CI). Student's t test was used as test of significance for difference between two means.  $P<0.05$  was considered to be statistically significant.

## RESULTS

**Table 1: Distribution of study subjects by age.**

Age (years)	Cases	Controls	Total
<b>36-45</b>	22	22	44
<b>46-55</b>	79	79	158
<b>56-65</b>	46	46	92
<b><math>\geq 66</math></b>	03	03	06
<b>Total</b>	150	150	300

Mean age $\pm$ SD (Range) years:  $52.51\pm 6.20$  (38-69).

Table 1 shows distribution of cases and controls by age. Age matched controls were selected. Majority of the cases i.e. 79 and controls i.e. 79 were in age group 46 to 55 years.

**Table 2: Association between BMI and hypertension.**

Nutritional status (BMI)	Cases	Controls	Total
<b>Normal weight (18.50-24.99)</b>	103	125	228
<b>Pre obese/overweight (25.00-29.99)</b>	27	23	50
<b>Obese (<math>\geq 30.00</math>)</b>	20	02	22
<b>Total</b>	150	150	300

Chi square=8.84, df=1, p=0.002(S), OR(CI)=2.28 (1.31, 3.95).

Association between overweight and obesity as per BMI and hypertension is depicted in Table 2. The proportion of overweight and obesity was higher among cases (31.33%) as compared to controls (16.67%); and this was statistically significant (p=0.002). Overweight and obese had 2.28 (1.31, 3.95) times risk of being hypertensive.

**Table 3: Association between WHR of cases and controls.**

Waist hip ratio	Cases	Controls	Total
<b>&lt;0.9 (normal)</b>	74	109	183
<b>&gt;0.9 (overweight)</b>	76	41	117
<b>Total</b>	150	150	300

Chi square=17.16, df=1, p<0.001(S), OR (CI =2.73 (1.68, 4.41).

Table 3 shows the association between WHR of cases and controls. The proportion of cases with waist to hip ratio more than 0.9 was significantly higher among cases as compared to controls. Thus, those having higher waist to hip ratio had 2.73 (95% CI= 1.68, 4.41) times higher chances of being hypertensive.

**Table 4: Ponderal index amongst study subjects.**

Ponderal index	Cases	Controls	Total
<b>&gt;40 (normal)</b>	98	128	226
<b><math>\leq 40</math> (obese)</b>	52	22	74
<b>Total</b>	150	150	300

Chi square=16.14, df =1, p≤0.001(S), OR(CI)=3.08 (1.75, 5.42).

Ponderal index amongst study subjects is seen in Table 4. Proportion of cases with obesity defined by using Ponderal index was higher amongst cases as compared to controls and this difference was found to be statistically significant. Those subjects having Ponderal index  $\leq 40$  had 3.08 times higher chance of hypertension as compared to those with Ponderal index  $>40$ .

**Table 5: Association between ideal body weight percentage of cases and controls as per Brocca index.**

Ideal body weight percentage	Cases	Controls	Total
<b><math>\geq 100</math> (normal)</b>	72	110	182
<b>&gt;100 (obese)</b>	78	40	118
<b>Total</b>	150	150	300

Chi square=20.17, df=1, p<0.001 (S), OR (CI)=2.98 (1.84, 4.83).

Association between ideal body weight percentage of cases and controls as per Brocca Index is seen in Table 5. Significant association was found between higher than ideal body weight percent and hypertension (p<0.001). Thus, those with ideal body weight percent more than 100 had 2.98 times chance of being hypertensive.

## DISCUSSION

Present case-control study was carried out amongst newly diagnosed hypertensive adult males aged above 30 years and age matched controls to study the association between hypertension and BMI, waist – hip ratio (WHR), Ponderal index and Brocca index. Majority of the cases i.e. 79 and controls i.e. 79 were in age group 46 to 55 years.

Significant association was found between overweight, obesity as per BMI and hypertension in the present study (p=0.002). Overweight and obese had 2.28 (1.31, 3.95) times risk of being hypertensive (Table 2). Similar findings are noted in various studies conducted in India and abroad. Cox et al<sup>11</sup> reported that the prevalence of elevated blood pressure was significantly (p<0.001) associated with increased BMI. Brown et al reported the association of BMI with high blood pressure was statistically significant.<sup>12</sup> Harris et al reported that elevated BMI was associated with increased odds for hypertension in African American and white men.<sup>13</sup> Mungreiphy et al reported that overweight/obese subjects were more likely to have hypertension than those with normal BMI (OR 2.42 for SBP and 3.76 for DBP).<sup>14</sup> Dua et al found that overweight/obese subjects were more likely to have hypertension than those with normal BMI (OR 2.65).<sup>15</sup> Kalani et al reported that elevated BMI was associated with increased odds for hypertension in Yazd - Iran adult male population (OR 2.86).<sup>16</sup>

In our study, the proportion of cases with waist to hip ratio (WHR) more than 0.9 was significantly higher among cases (51.67%) as compared to controls (27.34%) (p<0.001). Thus, those having higher waist to hip ratio had 2.73 (95% CI=1.68, 4.41) times higher chances of being hypertensive (Table 3). Similar findings are noted by different researchers in India and abroad. Kodali et al reported that hypertensives had significantly higher WHR as compared to controls.<sup>17</sup> Harris et al reported that elevated WHR was associated with increased odds of hypertension in African American and white men.<sup>13</sup> Reddy et al found that WHR was positively associated with blood pressure in males.<sup>18</sup> Kalani et al reported that those having higher waist to hip ratio (WHR) had 2.39 times higher chances of being hypertensive.<sup>16</sup>

In the present study, proportion of cases with obesity defined by using Ponderal index was higher amongst cases (34.67%) as compared to controls (14.67%). This difference was found to be statistically significant (p<0.001). Subjects having Ponderal index  $\leq 40$  had 3.08 (95% CI=1.75, 5.42) times higher chance of hypertension

as compared to those with Ponderal index >40 (Table 4). Findings similar to present study are noted by DiPietro et al.<sup>19</sup> They reported that Ponderal index was significantly associated with systolic and diastolic hypertension.

In the current study, significant association was found between higher than ideal body weight percent (by Brocca index) and hypertension ( $p<0.001$ ). Thus, those with ideal body weight percent more than 100 had 2.98 (1.84, 4.83) times higher chance of being hypertensive (Table 5).

The proportion of overweight and obesity as defined by Ponderal index and BMI were similar. BMI considers the square of the height while in Ponderal index cube root of the body weight is considered. Both the indices were significantly associated with hypertension but association between Ponderal index and hypertension was found to be highly significant with higher odds (3.08) as compared to BMI (2.28).

In the present study, by considering WHR and Ideal body weight percent by Brocca index more than half of the cases and about one fourth of controls were found to be overweight and obese. In a study by Rauscher et al they used Brocca index to study the relationship between hypertension and obesity.<sup>20</sup> Very high prevalence of hypertension (81%) and obesity by Ideal body weight percent by Brocca index (83.33%) was found. This could be due to small sample size of the study ( $n=48$ ).

In the present study, WHR (OR (CI)=2.73 (1.68, 4.41)) had higher odds for hypertension than BMI (OR (CI) = 2.28 (1.31, 3.95)). WHR was a better predictor of hypertension than BMI. WHR is a measure of central obesity. Abdominal fat (visceral fat) is now considered to be an important endocrine organ producing biologically active substances with local and systemic actions. Similar findings were noted by many researchers. Guagnano et al reported that WHR to be a better predictor of hypertension than BMI.<sup>21</sup> In the study by Guagnano et al males with WHR  $\geq 0.96$  and females with WHR  $\geq 0.86$  had significant association with hypertension, while BMI had no significant relationship to hypertension risk.<sup>22</sup> In the study by Dalton et al WHR had the strongest correlation with CVD risk factors.<sup>23</sup> Tambe et al found that diastolic blood pressure showed a better correlation with waist to hip ratio rather than with BMI.

Ponderal index, ideal body weight percent by Brocca index and WHR had highly significant association with hypertension ( $p<0.001$ ). BMI had significant association with hypertension ( $p=0.002$ ). All the other three Indices were found to be strongly associated with hypertension with higher odds ratio than BMI.

## CONCLUSION

Ponderal index (PI), Ideal body weight percent by Brocca index (BI) and WHR were found to be strongly

associated with hypertension with higher odds ratio than BMI. Other easily measurable anthropometric indices should also be taken into consideration to classify overweight and obesity in research and clinical settings.

## Limitations

Present study was conducted only in males. Hospital cases were selected; hence representativeness of the sample may be questionable to some extent.

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