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Original Article

Hypertension and its correlate with general and central adiposity: A study among urban population of Delhi

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ABSTRACT

Aim: Study aims to assess the association of various adiposity markers with blood pressure levels.
Study design: The present study was a cross-sectional study conducted in Delhi. A total of 568 (males- 250, females- 318) participants aged 20–55 years were enrolled for the study.
Result: Mean height (167.35 ± 7.59) and weight (73.76 ± 15.08) was found to be significantly higher in males. Mean values of minimum waist circumference (183.80 ± 12.24), maximum hip circumference (100.90 ± 12.811), body mass index (27.93 ± 5.76), and conicity index (1.25 ± 0.12) were found to be significantly higher in females. Correlation showed significant positive associations of body mass index ($p < 0.01$) and waist circumference ($p < 0.01$) with blood pressure in both males and females. Odds ratios showed strong association of hypertension (both SBP and DBP) with adiposity indices as measured by body mass index, waist circumference and conicity index.
Conclusion: Adiposity markers such as BMI, WC and CI could be effective predictors of hypertension.

1. Introduction

Hypertension is responsible for more than 9 million deaths annually and affects about 1 billion adults globally [1]. In 2015, hypertension was considered as a major contributor to global disability-adjusted life-years (DALYs), accounting for 9·2% of DALYs for men and 7·8% of DALYs for women [2]. It is estimated that the worldwide prevalence of hypertension could increase from 26.4% in 2000 to 29.2% in 2025 [3]. Increased or raised blood pressure is now considered to be major risk factor for CVD's and chronic kidney disease [4].

Chronic diseases including hypertension are now a major global burden in public health and increasing proportion of NCD's as cause of deaths has been reported in the latest Registrar General of India report also [5].There has been serial reports from the Census of India on proportionate increase in mortality from CVD's in India [6].

Indicator of abdominal obesity viz. body mass index (BMI), waist-to-hip ratio, and waist circumference are widely used clinical measure for assessing CVD risk factors [7].Abdominal obesity has been linked to increased risk for hypertension and diabetes [8]. Increased waist circumference has been found to be consistently associated with higher risk of hypertension and diabetes independent of BMI [9].

BMI has been widely used as clinical tools for assessing obesity. However, it doesn't consider the variation in body fat distribution as studies observed ethnic differences in BMI at similar level of body composition [10,11]. Literature has shown strong association of adiposity measure viz. waist circumference (WC) and waist-to-hip ratio (WHR) as better predictors of obesity-related morbidity and mortality risk disease than other anthropometric measurements [12,13]. Conicity index which accounts for WC, weight and height is considered as a useful indicator of abdominal adiposity and has observed good association with waist hip ratio (WHR) [14]. The present study aims to assess the association of various adiposity markers with blood pressure levels.

2. Materials and methods

2.1. Study population

This cross-sectional study was conducted in Delhi population. The sample consisted of a total of (568) of both gender of age group 20–55 years. Data was collected from May 2015 to December 2017. Before taking the detail information and measurements, the purpose of the study was explained to each subject and an informed consent was taken from them. Ethical clearance was taken from Department Ethical committee.

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2.2. Anthropometric measures

Anthropometric measurements such as stature, body weight, mid upper arm circumference, minimum waist circumference and maximum hip circumference were taken using standardized techniques. Body mass index (BMI), was calculated from the height and weight using the equation: BMI = weight (kg)/height^2 (m). The studied participants were classified on the basis of BMI following WHO International Standard and recommended cut-off points for Asians. Physiological measurements taken were systolic blood pressure and diastolic blood pressure. Blood pressure was measured by sphygmomanometer in millimetres of mercury. JNC VII, 2003 classification was followed for blood pressure. Waist circumference was obtained as the minimum circumference of the waist between the lower rib and iliac crest where minimum is found and were classified following WHO guidelines. WHR was calculated as WC divided by hip circumference. Participants were categorized on the basis of the World Health Organization's cut-offs. Conicity index (CI) was calculated using the equation as defined by Valdez as, Conicity index = Waist circumference (m)/ [0.109x$\sqrt{}${Body weight(kg)/ Height(m)}], where 0.109 is a constant. CI is based on the volume estimates of the human body constructed to range between the shapes of a cylinder and a double cone assuming a constant body density. CI was classified as $\geq$1.25 for males and $\geq$1.18 for females [14].

2.3. Statistical analysis

SPSS (Statistical Packages for Social Sciences) version 16.0 was used to carry out statistical analysis. Descriptive statistics of mean and standard deviation were used to examine the data. Independent *t*-test was used to compare mean values of continuous variables and chi-square test for categorical variables. Risk factors of the variables were determined by using multinomial logistic regression. Pearson correlation coefficient was used to determine the relationship between age at menarche with anthropometric and physiological variables.

The mean and standard deviation for anthropometric indices are given in Table 1. Mean height and weight was found to be significantly higher in males. Mean values of minimum waist circumference, maximum hip circumference, body mass index and conicity index were found to be significantly higher in females. Both the mean systolic and diastolic BP was found to higher in men. All the sex differences were found to be statistically significant at $p < 0.001$.

Correlation between body mass index, minimum waist circumference, waist hip ratio, and conicity index with blood pressure levels is shown in Table 2. There were significant ($p < 0.01$) positive correlations of BMI with both systolic and diastolic blood pressure in both males and females. In both males and females, there was also significant ($p < 0.01$) positive correlation of minimum waist circumference, waist hip ratio, and conicity index with both systolic and

Table 1
Anthropometric parameters of the participants stratified by gender.

Parameter	Male	Female	*t*-test
Weight (Kg)	73.76 ± 15.08	66.33 ± 13.17	6.343***
Height (cm)	167.35 ± 7.59	153.97 ± 5.72	23.944***
Minimum waist circumference	90.47 ± 12.97	183.80 ± 12.24	6.256***
Maximum Hip Circumference	96.89 ± 9.11	100.90 ± 12.811	4.178***
BMI	26.36 ± 4.91	27.93 ± 5.76	3.377**
CI	1.17 ± 0.09	1.25 ± 0.12	8.158***
SBP	131.26 ± 17.64	123.47 ± 17.29	5.285***
DBP	86.72 ± 12.44	80.67 ± 11.67	5.941***

***$p < 0.001$, **$p < 0.01$, BMI = Body mass index, CI = Conicity Index, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure.

Table 2
Correlation matrix between blood pressure and body mass index, minimum waist circumference, waist hip ratio, and coinicity index.

Variables	Male		Female	
	SBP	DBP	SBP	DBP
Body Mass Index	0.316**	0.760**	0.388**	0.447**
Minimum Waist Circumference	0.213**	0.760**	0.401**	0.394**
Waist Hip Ratio	0.098	0.303**	0.290**	0.233**
Conicity Index	0.040	0.184**	0.294**	0.208**

**$p < 0.01$.

Among males, 45.1% were found to have normal systolic blood pressure, 62.2% were pre-hypertensive and 33.3% were hypertensive. However, among females, it was found to be 54.9%, 37.8% and 66.7% respectively as shown in Fig. 1.

As assessed from diastolic blood pressure 32.2% of males and 67.8% of the females participants were found to have normal diastolic blood pressure. Percentage of diastolic pre-hypertensive males was 48.2% and that of females was 51.8% while diastolic hypertensive males and females was 58.1% and 41.9%, respectively.

Multinomial logistic regression was shown in Table 3. Odds of systolic blood pressure were found to be higher in females than males under overweight category of body mass index. For males, risk category of waist circumference had higher odds of being hypertensive (SBP) and was significantly associated (OR, 6.761; 95% CI, 2.573, 17.761). Odds of being hypertensive were found to be highest among those with risk category of waist hip ratio and conicity index in females. However, no significant association was observed.

Multinomial logistic regression was shown in Table 4. Odds of hypertension (DBP) were found to be higher in females than males and were significantly associated (OR, 2.570; 95% CI, 1.078, 6.125). Odds of being hypertensive (DBP) were found to be highest among those with risk category of waist hip ratio and waist circumference in males while no significant association was observed. Hypertension (DBP) showed the strongest association with conicity index in females as compared to males (OR, 1.946; 95% CI, 1.014, 3.733).

3. Discussion

The present study showed that males had significantly higher mean of weight and height as compared to females. Mean of minimum waist circumference and maximum hip circumference were significantly higher in females than males and is in line with findings observed by Gupta et.al. in Delhi [15]. Mean body mass index (BMI) found to be significantly higher in females than males. Study by Dua et.al. [16] observed a mean BMI of 27.7 in females and 25.8 in males, parallel with the present result. The present results coincide with reports from different parts of India, including the present one, that females have a higher BMI than males. Conicity index were found to be significantly higher in females and is consistent with the findings reported by Osei-Yeboah et. al. [17]. Both systolic and diastolic blood pressure was found to be significantly higher in males than females. Many studies have highlighted higher prevalence of hypertension in males than women in all ethnic groups. Other findings showed that men tend to have higher blood pressure than women [17].

Correlation showed significant positive associations between body mass index and blood pressure in both males and females. Kapoor et. al. [18] also found a significant correlation of BMI with blood pressure among Punjabi girls of Delhi. Many studies documented the adverse effect of abdominal adiposity on health regardless of BMI. Waist circumference had positive significant correlation with blood pressure both in males and females. Similar

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