Original Research Article

Blood pressure in adults and its association with selected anthropometric and biochemical parameters

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ABSTRACT

Background: Hypertension is one of the known cardiovascular risk factors. Several epidemiological studies have found an association between various anthropometric indicators and hypertension. The present study was conducted to investigate the relationship between different commonly and uncommonly used anthropometric parameters, various biochemical parameters and hypertension in adults.

Methods: A hospital based cross sectional study conducted among 300 adults aged 40 years and more, attending Medicine OPD of a tertiary care institution after obtaining their consent and permission from institutional ethical committee. Anthropometric measurements, blood pressure examination and relevant laboratory investigations were done.

Results: Hypertension was seen in both obese and non-obese study subjects. BMI, waist circumference, neck circumference, sagittal abdominal diameter and CRP was higher in hypertensive males than normotensives and it was statistically significant. BMI, waist circumference, hip circumference, neck circumference, sagittal abdominal diameter and CRP had a positive correlation with systolic and diastolic blood pressure and it was found to be statistically significant.

Conclusions: CRP, serum ferritin, sagittal abdominal diameter, hip circumference, waist circumference and neck circumference showed a positive correlation with both systolic and diastolic blood pressure, which means that WC and SAD can be used to get information about visceral obesity in an individual. This also suggests that decrease in intra-abdominal fat could decrease the blood pressure.

Keywords: Anthropometry, CRP, Hypertension, Serum ferritin, Serum bilirubin

INTRODUCTION

Hypertension is a global public health problem and a well-recognized risk factor for stroke, coronary heart disease and heart failure.[1] It is one of the leading modifiable risk factors for cardiovascular diseases. Globally, hypertension affects approximately one in four adults.[2] It is predicted that in 2025, the number of adults with hypertension will be around 1.56 billion.[3] Studies done in Indian subcontinent shows that hypertension occurs early in life and is more often associated with a cluster of other cardiovascular risk factors.[4,5] The prevalence of hypertension in India ranges between 20-40% in urban adults and 12-17% among rural adults.[6] Thus, reducing blood pressure can reduce the cardiovascular risk.

Hypertension is multifactorial, and obesity has been consistently shown to be associated with it. At least two thirds of the prevalence of hypertension can be attributed directly to obesity.[7] Obesity related impairments in cardiovascular function may present even at an early age

and this may progress silently for decades before any clinical manifestation sets in.

Anthropometry is one of the simplest and commonest techniques to diagnose obesity.

The common anthropometric measurements in adults are weight, height, hip circumference, waist circumference and thus the BMI and waist hip ratio. Sagittal abdominal diameter and abdominal circumference have also been used in certain studies to measure the fat deposits in the body.[8,9] Studies suggest that there might be some biochemical parameters like CRP and serum bilirubin levels which are also associated with hypertension.[10-12] In this context, the aim of this research paper was to study the relationship between the commonly and uncommonly employed anthropometric parameters with blood pressure and also to find if there is any relationship between an inflammatory marker like CRP, a potential antioxidant like bilirubin and serum ferritin with blood pressure among hypertensives and non-hypertensives of the local population.

METHODS

A cross sectional study was done among patients who visited medicine OPD of a teaching hospital in Karnataka between September 2016 and September 2018 after obtaining an informed consent from all participants. Institutional ethical Committee approval was obtained before the start of the study. A pilot study was done, and it was found that the proportion of hypertensive was 23%. Sample size was calculated using the formula $n=V/d^2$ where $V=P_1 (1-P_1) +P_2 (1-P_2)$.

The minimum sample size that was required for the study was found to be 142 which was rounded off to 150. Thus 150 hypertensives and 150 normotensives were selected for the study using systematic random sampling. All patients above the age of 40 attending the OPD during the study period were considered for the study based on their willingness and eligibility to participate. Subjects with spinal deformity, abdominal tumour, lump, significant ascites, pregnant females, pathological diseases (cancer, thyroid neck swelling, insufficient renal and chronic inflammatory pathologies) and in whom anthropometry measurements were not feasible were excluded from the study. Patients with conditions known to be associated with increased CRP levels like acute renal failure, bacterial infections, meningitis, smoking, trauma, etc. and patients with severe hepatocellular impairment were also excluded. Individuals with high liver enzyme levels (indicating liver injury or disease) were also excluded.

Definition of certain variables[13-17]

Measurement of blood pressure

The average of three blood pressure readings taken with five minutes interval on right arm using appropriate cuff size was considered for analysis. Systolic BP of >140mmHg and/or diastolic BP of >9mmHg and/or those on medication for BP were considered as hypertensives.

Measurement of weight

Weight was measured using SECA digital weighing scale and the weight was measured nearest to 0.1 kg.

Measurement of height

A stadiometer was used to measure the height with the subject made to stand erect on a flat surface without footwear and with both feet together.

Calculation of BMI

BMI was calculated as weight (Kg) divided by height in meters square. BMI of less than 18.5 was considered underweight, values between 18.5 and 24.99 was considered normal, between 25 and 29.99 was considered pre-obese and BMI more than or equal to 30 was considered obese.

Measurement of waist circumference

Waist circumference (WC) was measured midway between the lower rib margin and the iliac crest in standing position after normal expiration.

Measurement of hip circumference

The anatomical place used for assessment of HC was the height of the greater trochanter as recommended by the WHO.

Calculation of waist hip ratio

WHR was calculated by dividing waist circumference in cms by hip circumference in cms. Waist hip ratio of 0.81 and more in females and 0.88 and more in males was considered as having abdominal obesity.

Measurement of sagittal abdominal diameter

SAD or "Supine Abdominal Height" was measured after a normal expiration to nearest 0.1cm in supine position with straight legs on a firm examination table using a ruler and water level at the level of iliac crest (L4-5) without clothes. SAD cut-offs were taken as ≥22cm in men and ≥20cm in women.

Measurement of neck circumference

Neck circumference was measured to within 1mm by using a tape just below the laryngeal prominence after making the participants stand erect with their head in the Frankfort horizontal plane. Neck circumference of

≥37cms in male and ≥34cms in female was considered abnormal.

Relevant laboratory work-up was also done

- Serum CRP levels.
- Lipid profile: Serum total cholesterol, HDL, LDL and triglycerides.
- Fasting plasma glucose.
- Serum bilirubin.
- Serum ferritin.

The level of C-reactive protein was determined by latex-enhanced nephelometry method having sensitivity 0.5-320mg/L. Lipid profile by AGAPE-MISPA Nano Autoanalyser. (TC-cholesterol oxidase method, TG-glycerol 3-phosphate oxidase method, HDL-C by direct qualitative determination, LDL-C by calculation). Blood sugars were determined by Glucose oxidase method.

Estimation of serum ferritin was done by using automated Chemiluminescence Immunoassay system (CLIA). Bilirubin was determined by modified dimethyl sulfoxide DMSO method which is having the sensitivity 0.01-20mg/dL (AGAPPE MISPA Nano Autoanalyser).

The data was entered in Microsoft Office Excel 2007 and IBM SPSS version 20 was used for analysis.

RESULTS

Total of 300 subjects were studied, of whom 208 were males and 92 were females. 36.33% of them belonged to 40-49 years age group, followed by 25.6% in 50 - 59 years age group, 24.6% belonged to 60 - 69 years age group, 10.3 % belonged to 70 - 79 years age group, 2.3% belonged to 80 - 89 years age group and 0.6% above 90 years. The mean age of the study participants was 55.78±11.04 as seen in Table 1.

Table 1: Demographic, anthropometric and blood pressure characteristics of the study population.

Characteristic	Male Mean±SD	Female Mean±SD	Total Mean±SD	t value	p value
Age (years)	55.04±10.55	57.44±11.98	55.78±11.04	1.7415	0.0826
Height (cms)	165.76±7.75	154.53±6.51	162.32±9.02	12.1311	<0.001
Weight (kgs)	62.37±12.73	55.79±13.08	60.36±13.17	4.0935	<0.001
BMI (kg/m^2)	22.71±4.59	23.36±5.32	22.91±4.83	1.0760	0.2828
Waist circumference (cms)	83.74±12.31	83.04±13.11	83.52±12.54	0.4451	0.6566
Hip circumference (cms)	89.55±9.64	92.73±12.10	90.53±10.54	2.4297	0.0157
Neck circumference (NC)	35.72±3.74	34.32±3.56	35.29±3.73	3.0335	0.0026
Sagittal abdominal diameter (cms)	22.17±4.46	21.36±4.68	21.92±4.54	1.4286	0.1542
Systolic blood pressure (mm Hg)	131.55±20.80	137.10±23.07	133.26±21.63	2.0599	0.0403
Diastolic blood pressure (mm Hg)	82.55±12.87	84.76±12.10	83.23±12.66	1.3964	0.1636

Table 2: Prevalence of overweight/obesity among males with different anthropometric indicators.

Anthropometric indicators	Males Hypertensives (%)	Normotensives (%)	Chi square	P value
BMI				
<18.5	10	23		
18.5 - 24.99	48	78	15.7	<0.001
25-29.99	19	16		
≥30	12	2		
Waist circumference				
<85cms	38	78	10.8	0.001
≥85cms	51	41		
Waist hip ratio				
<0.88	17	31	1.39	0.239
≥0.88	72	88		
Neck circumference				
<37cms	40	84	13.9	<0.001
≥37cms	49	35		
Sagittal abdominal diameter				
<22cms	32	82	22.3	<0.001
≥22cms	57	37		

Table 3: Prevalence OF overweight/obesity among females with different anthropometric indicators.

Anthropometric indicators	Females		Chi square	P value
	Hypertensives (%)	Normotensives (%)		
BMI				
<18.5	9	4		
18.5 - 24.99	34	18	1.33	0.721
25 - 29.99	10	7		
≥30	8	2		
Waist circumference				
<85cms	40	17	1.00	0.316
≥85cms	21	14		
Waist hip ratio				
<0.88	23	16	1.63	0.202
≥0.88	38	15		
Neck circumference				
<37cms	42	24	0.744	0.388
≥37cms	19	7		
Sagittal abdominal diameter				
<22cms	37	19	0.348	0.953
≥22cms	24	12		

Table 4: Cardiovascular risk factors stratified according to gender and hypertensive status.

Risk factors	Males			Females		
	Normotensives Mean±SD	Hypertensives Mean±SD	P value	Normotensives Mean±SD	Hypertensives Mean±SD	P value
BMI	21.71±3.50	24.06±5.48	0.0002	23.36±5.13	23.51±5.52	0.9035
WC	80.49±10.55	88.08±13.19	<0.0001	82.16±13.64	83.77±13.12	0.5968
WHR	0.92±0.06	0.95±0.07	0.0011	0.89±0.08	0.89±0.06	1.000
NC	34.6±3.34	37.21±3.74	<0.0001	34.42±3.82	34.39±3.49	0.9709
SAD	20.98±3.31	23.76±5.08	<0.0001	21.1±3.66	21.55±5.17	0.6793
CRP	1.75±1.49	2.72±1.91	<0.0001	1.52±1.05	2.79±1.75	0.0006
Serum bilirubin	1.17±0.60	0.88±0.46	0.0002	0.84±0.32	0.97±1.13	0.5526
Serum ferritin	84.95±9.85	98.71±12.04	<0.0001	53.8±12.45	55.75±13.64	0.5218

Among the 300 study participants who were studied, 150 were hypertensives and the rest were normotensives. The mean systolic and diastolic blood pressures were 133.26±21.63 and 83.23±12.66 as seen in Table 1.

According to the BMI, 15.3% of them were underweight, 17.3% were in the overweight category and 8% were obese. 59.3% of them were normal when BMI was taken into consideration as seen in Table 2. The mean BMI of the study participants were 22.91±4.83 as seen in Table 1.

Total of 53.3% of the male population and 27.3% of the female population had a higher waist hip ratio as seen in Table 3. The mean waist hip ratio was 0.92±0.07 as seen in Table 1.

With regards to the neck circumference, 29.6% of the males had a neck circumference ≥37cms and 17.66% of the females had a neck circumference ≥34cms as seen in Table 2 and 3. The mean neck circumference was 35.29±3.73 as seen in Table 1. 31.33% of the males had

sagittal abdominal diameter ≥22cms and 18.66% of females had SAD ≥20cms (Table 2 and 3).

Hypertension was not just restricted to the overweight and obese individuals in the present study, but also was seen in study subjects who had a normal BMI, waist circumference, waist-hip ratio, neck circumference and sagittal abdominal diameter (Table 2 and 3).

The mean BMI, waist circumference, neck circumference, sagittal abdominal diameter, CRP and serum ferritin was higher in hypertensive males than normotensives and it was statistically significant. The serum bilirubin was higher in hypertensives than normotensives and this was also statistically significant. But only CRP values were significantly higher when hypertensive females were compared with the normotensive females (Table 4).

Karl Pearson correlation was used to analyse the degree of relationship between the chosen cardiovascular risk

factors with systolic and diastolic blood pressures. Among those risk factors which were considered in this study BMI, waist circumference, hip circumference, neck circumference, sagittal abdominal diameter, serum triglycerides and CRP levels had a positive correlation with systolic and diastolic blood pressures and it was found to be statistically significant. HDL and serum bilirubin had a negative correlation, but this was not statistically significant as seen in Table 5.

DISCUSSION

One of the major risk factors for cardiovascular and cerebrovascular diseases is hypertension. BMI, waist circumference and waist hip ratio have been well established as risk factors for cardiovascular diseases by various studies.[18-20] In addition to the above-mentioned variables, sagittal abdominal diameter and neck circumference have also been studied as risk factors in the present study. Only few studies in India have used these as risk factors of cardiovascular diseases in rural population.

Waist circumference and sagittal abdominal diameter have also been considered as indicators of coronary risk since it correlated well with abdominal fat as seen in other studies.[21,22] Studies show that waist circumference is related to abdominal obesity and sagittal abdominal diameter to visceral fat.[19,23,24] Systemic free fatty acid concentrations are primarily determined by upper body subcutaneous fat.[24] Subcutaneous fat in the upper body is determined by neck circumference. There have also been studies which showed that neck circumference may be an independent correlate of metabolic risk factors beyond BMI and waist circumference. Thus, neck circumference is an indicator of upper body obesity and also correlates positively with changes in blood pressure.[25]

Studies have also correlated CRP levels with hypertension.[26,27] Serum bilirubin has also been considered as a major contributor to antioxidant capacity in blood plasma and is an independent cardiovascular risk factor. High serum bilirubin may decrease the risk of hypertension by inactivating and inhibiting the synthesis of reactive oxygen species in vascular cells.[28]

It is seen from Table 1 that the mean values of most of the anthropometric parameters were almost the same in males and females and thus comparable. The t test also statistically proved that there was no statistically significant difference between the two. From Table 2 and 3, it is seen that the proportion of study subjects with BMI, WC, NC and SAD above the normal range were more in hypertensive males than in normotensive males. This indicates that they might be risk factors in male population and these findings are similar to other studies.[29] But in female population these differences were not seen probably because of a smaller sample size.

From Table 4, it is evident that the mean values of all anthropometric indicators were significantly higher in hypertensive males than normotensives. This finding is similar to several studies thus indicating that the anthropometric indicators used in this study are indeed risk factors for hypertension and thus cardiovascular disease.[30-32] But in the female population, only the CRP values were significantly different between hypertensives and normotensives. Further studies involving female population are needed before actually a conclusion is reached on this.

It is seen from Table 5 that a positive correlation between certain indicators like BMI, waist circumference, hip circumference, neck circumference, sagittal abdominal diameter, triglycerides, ferritin and CRP levels with systolic and diastolic blood pressure were found which was similar to several studies.[33-35] Thus indicating that these indicators are related to hypertension.

CONCLUSION

CRP, serum triglycerides, SAD, HC, WC and NC showed a positive correlation with both systolic and diastolic blood pressure. This suggests that WC and SAD can be used to get information about visceral obesity in an individual and Neck circumference can be used to measure upper body obesity. This also suggests that decrease in intra-abdominal fat could decrease the blood pressure. Serum bilirubin levels were also found to have a relationship with the hypertensive status. Further studies in a large sample have to be done before certainly establishing this relationship.

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