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Study of Association of Haematological Parameters & Anthropometric Indicators with Blood Pressure

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Abstract: *Hypertension is a major health problem worldwide. It can lead to cardiovascular disease and also leads to functional disturbances including hematological parameters. The abnormalities of haematological parameters may enhance an end organ damage.*
Hypertension is one of the factors associated with stroke, congestive heart failure, or kidney failure. Over-weight and obesity are the two most key determinants of health that leads to adverse metabolic changes including increase in blood pressure. The cellular components of blood contribute to the viscosity and volume of blood, thus playing a vital role in regulating blood pressure.
Objectives: *To compare the hematological parameters and anthropometric indicators in hypertensive and normotensive males.*
Material and Methods: *This was a hospital based case control study which included 60 normal healthy male subjects and 60 hypertensive male subjects. Blood pressure was measured by mercury sphygmomanometer. Hematological indices were estimated using an autoanlayser. The data collected were entered and analyzed using software Statistical Package for the Social Science 16.0 (SPSS 16.0).*
Results and Discussion: *The mean levels of hemoglobin and hematocrit were significantly lower in the hypertensive group compared to the normotensives in our study. The anthropometric measurement waist hip ratio, showed a statistically significant positive correlation with systolic blood pressure. Multiple regression analysis showed waist hip ratio, hemoglobin and hematocrit were significant predictors of systolic blood pressure.*
Conclusion: *The present study concludes that Waist hip ratio, a simple and inexpensive anthropometric measurement can be used as a significant predictor of systolic blood pressure. Also monitoring of hematological indices like hemoglobin and hematocrit is essential in the prevention of development of cardiovascular complications in hypertension.*
Key Words: *Hypertension, Anthropometric indicators, Hematological indices, BMI, WHR*

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I. Introduction

Hypertension is a major health problem worldwide. It can lead to cardiovascular disease and also leads to functional disturbances including hematological parameters. The abnormalities of haematological parameters may enhance an end organ damage. Therefore, the aim of this study was to compare the haematological parameters and anthropometric indicators in hypertensive and normotensive males.

Hypertension (HTN) is also called high blood pressure. It is a condition in which systemic arterial pressure is elevated above the threshold value [1]. It is expressed by systolic (maximum) and diastolic (minimum) arterial pressures. Systolic pressure is occurring during contraction of the left ventricle of the heart while diastolic pressure is occurring before the next contraction. Normally at rest the systolic pressure is within 100–140 mm mercury (mmHg) and diastolic pressure is within 60–90 mmHg [2, 3]. Based on the seventh Joint National Committee (7 JNC) report in 2008, normal HTN was defined as systolic blood pressure (SBP) < 120 mmHg and diastolic blood pressure (DBP) < 80 mmHg, pre-HTN with SBP of 120-139 mmHg or DBP 80–89 mmHg, stage I HTN with SBP of 140–159 mmHg or DBP 90–99 mmHg and stage II HTN with SBP ≥ 160 mmHg or DBP ≥ 100 mmHg [1, 4].

HTN can be categorized in to two; primary and secondary hypertensions. Primary HTN, which consists of about 95% cases, can occur without any obvious underlying causes while secondary HTN is developed due to secondary to diseases such as kidney disease, endocrine disorders and narrowing of the aorta or kidney arteries.

HTN is a major health problem worldwide that affects 20–30% of the adult population

HTN may lead to severe end-organ damage, coronary heart disease and stroke which constitute the leading cause of mortality [11, 12]. It is strongly associated with functional and structural abnormalities to organs that involve in hematopoiesis and blood viscosity is increased in most hypertensive patient's . Although, the details of this association is unclear, development of HTN is accompanied by reduction in deformability, and an increase in size, number and aggregability of red blood cells. These abnormalities of the red cells may worsen the microcirculation and enhance an end-organ damage.

On the other hand, HTN has an impact on hematological parameter such as hematocrit (HCT), hemoglobin (Hgb), red blood cell (RBC) count, white blood cell (WBC) count and platelet (PLT) count. Impaired hematological parameters may strongly indicate hypertensive end-organ damage, specifically kidney failure . Specifically increased Hgb level may cause left ventricular hypertrophy while low Hgb levels causes anemia and heart failure.

Generally, there are contradictory results regarding hematological parameters of hypertensive patients in different countries. Moreover, there is lack of information regarding to hematological parameters in hypertensive patients in Ethiopia. Therefore, this study was aimed at assessing hematological parameters in hypertensive patients in comparison with apparently healthy individuals and correlating hematological parameters with blood pressure indices (systolic blood pressure, diastolic blood pressure and mean arterial pressure).

Hypertension is defined as blood pressure more than 140/90 mm Hg as per US Seventh Joint National Committee on Detection, Evaluation and Treatment of Hypertension (JNC VII).1 The prevalence of hypertension in India is 23.10 % among men and 26.60% among women.2 Prevalence of hypertension in South India was found to be 20% according to the CURES 2007 study.3

Overweight and obesity are the two most important key determinants of health that leads to adverse metabolic changes including increase in blood pressure. Obesity and weight gain are independent risk factors for hypertension. Also 60-70% of hypertension in adults may be directly attributable to adiposity.4

Body mass index or BMI is propagated by the WHO as the most beneficial epidemiological measure of obesity. Waist hip ratio (WHR) and waist circumference (WC) are frequently used to forecast the danger of obesity linked morbid-ity and mortality as they account for regional abdominal adiposity. Visceral fat is a more significant determinant of blood pressure elevation than is peripheral body fat.5In longitudinal studies, a direct association exists between change in weight and change in blood pressure over time.4

Though hypertension and obesity are closely linked but there is no universal anthropometric marker due to distinct population features. Studies in urban population showed a strong relationship between different anthropometric indicators and blood pressure levels but very little is known about these relationships in rural Indian population.6, 7, 8

The cellular components of blood contribute to the viscosity and volume of blood, thus playing a vital role in regulating blood pressure. It has been newly realized that many haematological parameters varies with hypertension in comparison with normotensives. This gives a vision into the connection between blood cell defects and blood pressure. There are number of disputes in different studies with respect to variability of hematological parameters in hypertensive and normotensive subjects.9,

The pathophysiology of hypertension is multifactorial which is affected by sympathetic over activity contributing to alterations in hematological parameters like hematocrit, viscosity and hypercoagulability of blood. These factors change the kinetics of blood flow acting as contributory risk factor for coronary artery diseases, stroke and thromboembolism.12Thus the hematological parameters gives an insight to prognosis of disease also. So the present study was therefore undertaken to compare the hematological parameters and anthropometric indicators in hypertensive and normotensive males.

The present study was carried out with the following objective:
To compare the hematological parameters and anthropometric indices in normotensive and hypertensive males.

II. Material And Methods

This study was conducted between October 2018 and July 2019 in Patna Medical College and Hospital,Patna.The study was approved by the ethical committee of the institute.

STUDY DESIGN
Hospital based case control study.
Sample size: 120 subjects. We included
60 normal healthy male subjects of 35-55years of age.
60 hypertensive male subjects of 35-55 years of age.

DATA COLLECTION

A representative sample of local population comprising of 120 subjects aged 35-55 years were selected from

1. Hypertensive patients attending medicine OPD in PMCH PATNA
2. Normotensives were attendants of patients.

INCLUSION CRITERIA

1. Hypertensive subjects having blood pressure >140/90 mmHg.
2. Normotensive subjects having blood pressure

≤120/80mmHg

EXCLUSION CRITERIA

Subjects with any systemic illness, subjects on drug medications (steroids, α methyl dopa) for past three months Subjects who fulfilled the inclusion and exclusion criteria were included in the study. After explaining the nature of the study, informed consent was obtained from the study subjects.

III. Methodology

1. Measuring Blood pressure:

Blood pressure was measured by a mercury sphygmomanometer .

The classification of blood pressure is as follows4

Normal BP: <120/80 mmHg

Pre Hypertension: 120-139/ 80-89 mmHg

Stage I Hypertension: 140-159 / 90-99 mmHg

Stage II Hypertension: > 160/100 mmHg.

2. Hematological parameters:

MCV (Mean Corpuscular Volume) is calculated directly from the RBC histogram.MCH (Mean Corpuscular Hemoglobin) is calculated from the Hb value and the RBC count. MCHC (Mean Corpuscular Hemoglobin Concentration) is calculated according to the Hb and HCTvalues.The hematocrit is measured as a functionof the numeric integration of the MCV.14

3. Body weight:

Body weight was measured while the subject minimally clothed and without shoes, standing steady on a weighing scale and it was recorded.

4. Height:

Height was measured while the subject was standing barefoot in erect position with a wallmounted stadiometer.15

5. Body mass index:

BMI was measured by weight in kilograms divided by square of height in meters (kg/m2).

(BMI in the range of 18.50 to 24.99 kg/m2 is considered to be normal.15

6. Waist circumference:

Waist circumference was measured in centimeters over light clothing at a point mid-way between the lower rib and iliac crest.

7. Hip circumference:

Hip Circumference was measured in centimeters over light clothing at the widest girth of the hip. For waist and hip circumference two consecutive readings were made at each site on a horizontal plane without compression of the skin. The mean was taken as the final reading. 15

8. Waist Hip Ratio: It was calculated by dividing waist circumference by hip circumference.

STATISTICAL STUDIES

The data collected were entered and analyzed using software Statistical Package for the Social Science 16.0 (SPSS 16.0). All parameters were presented as mean ± standard deviation (mean ± SD). Comparison of parameters between hypertensive subjects and normal healthy controls was done with student 't' test. Correlation analysis was done with Pearson's correlation method. A linear regression analysis was per-formed to evaluate the independent predictors of hypertension. A p value of less than 0.05 was considered statistically significant.

IV. Results

(Table 1) presents the demographic characteristics and the anthropometric indices of the study participants. A significant difference however existed between the cases and controls with respect to systolic blood pressure and diastolic blood pressure ($p<0.001$).The mean values of blood indices are presented in (Table 2). Within the hypertensive and normotensive groups, the mean levels of hemoglobin and hematocrit were significantly higher in controls compared to hypertensive patients.

Correlation analysis showed a statistically significant positive correlation between WHR and systolic blood pressure (Table 3). Hemoglobin and hematocrit showed a negative correlation with systolic blood pressure among the cases. Systolic blood pressure was also found to be positively correlated with the duration of hypertension among the cases (Table 3).

Pearson's correlation analysis showed a statistically significant positive correlation between age and duration of hypertension. Hemoglobin and hematocrit showed a negative correlation with duration of hypertension among the cases (Table 4).

Correlation analysis of Waist hip ratio with other anthropometric indicators like body mass index and waist cir-cumference are shown in (Table 5). Waist hip ratio showed a statistically significant positive correlation with the body mass index and waist circumference among the hypertensive subjects. The association was found to be stronger with waist circumference ($r = 0.778$) than the body mass index($r=0.699$).

A linear regression analysis was performed to evaluate the in-dependent predictors of systolic blood pressure. Regression analysis with systolic blood pressure as a dependent variable showed a linear relationship with WHR, hemoglobin and hematocrit levels among the cases (Table 6).

Further regression analysis with duration of hypertension as a dependent variable showed a linear relationship with hemoglobin and hematocrit levels among the cases (Table 7).

Table 1: Comparison of baseline characteristics and anthropometric indicators in hypertensive patients and controls

Parameters	CASES(n=60)	CONTROLS(n=60)	P value
Age (years)	45.81±6.09	45.10±5.64	0.82
Height(m)	1.47±0.08	1.48±0.07	0.56
Weight(kg)	63.31±8.41	62.81±8.66	0.74
Body mass index(kg/m2)	28.9±3.61	28.4±3.77	0.44
Hip circumference(cm)	104.08±7.88	102.90±7.44	0.41
Waist circumference(cm)	90.86±10.88	90.88±10.45	0.99
Waist Hip Ratio	0.88±0.07	0.87±0.06	0.53
Systolic blood pressure(mmHg)	153.50±6.50	115.17±4.15	<0.001*
Diastolic blood pressure(mmHg)	91.4±12.72	70.36±7.06	<0.001*

Data are presented as Mean ±SD.*P value ≤0.05 is statistically significant. Independent student t test was performed to analyse the data.

Table 2: Comparison of hematological indices (mean ± standard deviation) in hypertensive patients and controls

Parameters	CASES(n=60)	CONTROLS(n=60)	P value
RBC count x103(cells/mm3)	4.74±0.43	4.63±0.54	0.85
Hb(g/dl)	12.07±1.87	14.14±1.57	<0.001*
Hct(%)	35.75±5.21	41.15±4.22	<0.001*
MCV(fl)	86.41±7.18	87.58±5.25	0.31
MCH(pg)	29.62±2.99	30.15±2.47	0.29

MCHC(g/dl)	33.98±1.02	34.68±2.78		0.07
WBC count x103(cells/mm3)	7.17±1.92	7.49±1.84		0.36
PLT count x103(cells/mm3)	277.63±70.63	273.28±85.02	0.76	

Data are presented as Mean ±SD.*P value ≤0.05 is statistically significant. Independent student t test was performed to analyse the data.RBC=Red blood cell; Hb=Hemoglobin; Hct=Hematocrit; MCV=Mean corpuscular volume; MCH=Mean corpuscular hemoglobin; MCHC=Mean corpuscular hemoglobin concentration; WBC=white blood cell; PLT= platelet.

Table 3: Correlation of selected variables with systolic blood pressure among the cases

Parameters (cases, n=60)	Systolic blood pressure	
	R vaiue	P value
Body mass index	0.126	0.33
Waist circumference	0.196	0.13
Waist hip ratio	0.337	0.01*
Hemoglobin	-0 .271	0.03*
Hematocrit	-0.293	0.02*
Duration of hypertension	0.260	0.04*

Pearson correlation analysis was performed to analyze the data. * p<0.05 is considered statistically significant.

Table 4: Correlation of selected variables with duration of hypertension among the cases

Parameters (cases, n=60)	Duration of Hypertension	
	R value	P value
Age	0.273	0.03*
Hemoglobin	-0 .571	<0.001*
Hematocrit	-0.523	<0.001*

Pearson correlation analysis was performed to analyze the data. * p<0.05 is considered statistically significant.

Table 5: Correlation of Waist hip ratio (WHR) with other anthropometric indicators among the cases

Parameters (cases, n=60)	Waist Hip Ratio	
	R value	P value
Body mass index	0.699	<0.001*
Waist circumference	0.788	<0.001*

Table 6: Multiple linear regression model of Systolic blood pressure as a dependent variable

Independent variables	Nonstandardized coefficients	Standardized coefficients	P value
B value	β		
Hemoglobin	0.941 -0.271		0.03*
Hematocrit	-0.365	-0.293	0.02*
WHR	0.343 0.337		<0.001*

* p<0.05 is considered statistically significant.WHR=Waist hip ratio

Table 7: Multiple linear regression model of Duration of hypertension as a dependent variable

Independent variables	Nonstandardized coefficients	Standardized coefficients P value
B value β		
Hemoglobin	-0.625	-0.574 <0.001*
Hematocrit	-0.203	-0.520 <0.001*

* p<0.05 is considered statistically significant.

V. Discussion

Our study showed significant differences in the mean levels of hematocrit and hemoglobin concentration between hypertensive and the normotensive subjects. The mean levels of hemoglobin and HCT were significantly lower in the hypertensive group compared to the normotensives in our study. Although a number of studies have shown significant differences in the levels of hemoglobin, RBC, MCV, HCT and MCH between hypertensive and normotensive individuals, there are also a few studies that has not shown any significant difference between the two groups.

There is a causal relationship between vascular function and different hematological disorders . Most hypertensive patient's exhibit increased blood viscosity compared with healthy controls [14]. There is a decreased RBC deformability which could cause an increased microvascular flow resistance, which may result in haemolysis and organ damage [11]. This haemolysis induces release of Hgb in to the plasma which scavenges nitric oxide and causes endothelial dysfunction . There is also functional alterations and abnormalities of platelets in hypertension which is associated with increased risk of clot formation. Activated and large platelets are produced as a result of endothelial dysfunction. These large and activated platelets produce vasoconstrictors. This enhances narrowing of blood vessels; there by high blood pressure and thrombotic disease .

The relationship between WBC and hypertension may be explained by an increased concentration of stem cell factor (SCF) in serum . During HTN, there is a vascular endothelial dysfunction . Thus, to repair this dysfunction SCF/c-kit increases. The SCF has an important role in differentiation and proliferation of haematopoietic cells. This pathway might increase WBC via its participation in the differentiation and proliferation of haematopoietic cells. Additionally, white blood cells are inflammatory marker and tends to increase during HTN which is supported by Kim D-J et al. But in contradiction to this study, a study conducted in São Paulo, Brazil showed lower mean value of WBC count in hypertensive individuals when compared to apparently healthy normotensive subjects. But there was no significant association. This difference may be due to differences in the study subjects. The study subjects included in this study were HTN confirmed but the study subjects in São Paulo, Brazil were without a previous diagnosis of high blood pressure.

According to Richard D. Gordon, sympathetic activity is responsible for an increase in renal afferent arteriolar constriction which in turn causes an increase in renin secretion and eventually, a rise in aldosterone secretion. Renin, via the effect of angiotensin on aldosterone, is a key factor for sodium and water retention in the body. The subsequent increase in blood volume thereby causes haemodilution and may be responsible for decreased hemoglobin and hematocrit level in hypertensives.17

The other probable mechanism responsible for decrease in hemoglobin levels in hypertension may be reduced production of erythropoietin and resistance of the bone marrow to erythropoietin stimulation.Hypertension if not treated promptly leads to cardiac and renal failure.21Congestive cardiac failure may also cause a low hemoglobin level due to hemodilution in later stages. Ultimately, the fall in hemo- globin concentration due to hypertension leads to an increase in cardiac output and heart failure.

According to Julius S sympathetic stimulation in hypertensives is associated with elevation of plasma renin levels. In-creased renin circulation leads to sodium and water retention in the body, which leads to hemodilution and may be the cause for low hemoglobin concentration in hypertensives.

The anthropometric measurement waist hip ratio, showed a statistically significant positive correlation with systolic blood pressure in hypertensive individuals. (Table 3) This finding is in accordance with the study by Hartz et al, 24 in which it was revealed that Waist hip ratio is a strong independent indicator of hypertension, particularly in men aged 40-59 years. However, in our study BMI and waist circumference did not independently correlate with blood pres-sure. Multiple regression analysis showed that variables like WHR, Hb, Hct were significant predictors of systolic blood pressure.

Visceral fat, measured as WHR, showed a positive corre-lation with Waist circumference, body mass index (Table 5).Various mechanisms may explain the association between visceral obesity and arterial blood pressure. The greater quantity of visceral fat may favor an increase in sympathetic activity mediated by the associated insulin resistance, besides potentializing the activity of the renin-angiotensin-aldosterone system due to the increased angiotensinogen secretion by visceral adipocytes, when compared to the subcutaneous fat.The

visceral fat accumulation could also exert a mechanical effect, inducing renal compression and promoting arterial blood pressure exacerbation.

In our study the best association was found between Waist hip ratio and Waist circumference. This correlation's magnitude is similar to the one that was found by Beauloye et al.88 But in a study by Freedman et al indicate that arterial blood pressure changes in a certain population do not necessarily correlate to obesity changes. These evidences suggest that anthropometric's influence on hypertension is quite complex and needs to be better investigated. Also the results suggest that visceral fat as measured by waist hip ratio exerts greater influence in systolic blood pressure levels.

VI. Conclusion

The present study concludes that Waist hip ratio, a simple and inexpensive anthropometric measurement can be used as a significant predictor of systolic blood pressure. It may be useful as an assessment tool in screening programs to assess the risk of hypertension. In addition, we also conclude that monitoring of hematological indices like hemoglobin and hematocrit is essential in the prevention of development of cardiovascular complication

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