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Assessing the Effects of Hypertension on Body Composition and Biochemical Markers

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ABSTRACT

Background: Hypertension is a widespread health concern globally, contributing significantly to morbidity and mortality. In India, it affects a considerable portion of the population, with lifestyle factors contributing to its rise. This study aims to analyze the relationship between various biochemical parameters and gender-specific differences in hypertensive individuals compared to a control group.

Methods: A case-control observational study was conducted with 240 participants aged 30-60 years, consisting of 120 hypertensive patients and 120 controls, recruited from the outpatient department of Index Medical College, Hospital and Research centre, Indore. Anthropometric measurements, blood pressure readings, and biochemical analyses were performed. Statistical analyses were conducted using Student's t-test and Pearson's correlation.

Results: Significant differences were observed in anthropometric parameters, with hypertensive subjects exhibiting increased height, weight, BMI, and waist-to-hip ratio (WHR) ($p<0.001$). Biochemically, hypertensive individuals had elevated fasting blood sugar, HbA1c, triglycerides, low-density lipoprotein (LDL), and uric acid, along with decreased high-density lipoprotein (HDL) levels ($p<0.001$). Gender-wise analysis revealed higher uric acid levels in females and lower HDL compared to males. Positive correlations were established between systolic/diastolic blood pressure and BMI, creatinine, and uric acid levels.

Conclusion: The study highlights significant alterations in anthropometric and biochemical parameters in hypertensive subjects compared to controls. Elevated BMI, uric acid, and creatinine levels were associated with hypertension, emphasizing the need for targeted interventions. The findings support the importance of regular monitoring of cardiovascular and renal health in hypertensive patients, considering gender-specific differences in risk profiles.

Key-words: Hypertension, BMI, HDL, Creatinine, Uric acid, Waist-to-hip ratio (WHR)

INTRODUCTION

Hypertension, often referred to as elevated level of blood pressure (BP), is a condition characterized by consistently elevated pressure in the blood vessels.[1]

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Hypertension possess a significant global public health challenge because of its widespread occurrence. In India, hypertension affects 24%–30% of the population in urban areas and 12%–14% in rural regions.[2] The NFHS-5 (National Family Health Survey 2019-2021) reports that 21% of women over the age of 15 have hypertension, compared to 24% of men in the same age group.[3]

Additionally, the World Health Organization (WHO) states that one in six adults is affected by obesity, while one in three adults suffers from hypertension.[4] A high-salt diet, the development of diabetes, and a body mass

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index (BMI) above 30 kg/m² are some of the major risk factors identified for the onset of hypertension in young and middle-aged Indian adults. Additionally, WHR, socioeconomic status, central obesity, elevated cholesterol levels, physical inactivity, poor dietary habits, lack of exercise, low educational attainment, inadequate health awareness, and a history of vascular disease have all been recognized as contributing factors in research. [5]
Hypertension is often referred to as a "silent killer" and a heterogeneous group of diseases because its complications can impact multiple target organs, including the heart, brain, kidneys, eyes, and peripheral blood vessels.[6] Hypertension is responsible for about 54% of strokes and 47% of cases of ischemic heart disease worldwide.[7]
This study aimed to examine the relationship between biochemical parameters and gender differences in hypertensive individuals compared to healthy controls from the central Indian population.

MATERIALS AND METHODS

This case-control study included hypertensive subjects recruited from the outpatient department (OPD) of the Medicine Department at Index Medical College, Hospital, and Research Centre, Indore. The study was approved by the institute's ethics committee, and written informed consent was obtained from all subjects.

Subjects- The study group included a total of 240 participants, consisting of 120 hypertension patients (case subjects) and 120 healthy individuals (control subjects), all aged between 30 and 60 years. The hypertension group was further categorized by gender, with 69 males and 51 females, while the control group included 73 males and 47 females.

Criteria for study

Exclusion criteria- Age <30 years and >60 years, Renal failure, patients with nephropathy, Diabetes mellitus, Cardiac patients, pregnant women, and antihypertensive medication were excluded from the study.

Inclusion criteria- Age of case (hypertensive) subject between 30 to 60 years.

Anthropometric parameters- All subjects underwent clinical history assessment and physical examination. Measurements of height and weight were taken, and body mass index (BMI) was calculated using the formula: weight (kg) divided by height squared (m²). Waist circumference (WC) and hip circumference (HC) were measured using a tape measure, and the waist-to-hip ratio (WHR) was determined by dividing WC by HC.

Blood pressure measurement- Blood pressure (BP) was measured three times while the participants were seated, with measurements taken from the right arm using a standard aneroid sphygmomanometer (as mercury-based BP devices are no longer used in healthcare settings). The protocol for BP measurement was standardized, and the average of the last two readings was used for analysis. Hypertension was defined as a systolic blood pressure (SBP) of 140 mmHg or higher, and/or a diastolic blood pressure (DBP) of 90 mmHg or higher.[8]

Biochemical Parameters- A 5 mL blood sample was collected from each participant after an overnight fast of 12 hours, using EDTA, fluoride, and plain vials for the analysis of biochemical parameters. The tests conducted included fasting and postprandial blood sugar (FBS and PPBS) levels, HbA1c, fasting lipid profile (FLP), kidney function tests (KFT), and uric acid. All measurements were performed using the Erba Mannheim kits with the XL system, and the Erba EM 360 fully automated analyzer.

Statistical Analysis- The data were presented as the mean±standard deviation for continuous variables and as frequency counts for categorical variables. Independent Student's t-tests and Pearson's correlation were used to compare quantitative variables. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were conducted using Prism software.

RESULTS

In anthropometric analysis, we observed that height, weight, BMI, and WHR were significantly increased in hypertensive subjects as compared to control ($p<0.001$) (Table 1). SBP and DBP were significantly higher in hypertensive subjects relative to control ($p<0.001$).

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Table 1: Anthropometric Parameters of Hypertensive and Control subjects

Biochemical parameters		Control (n=120)	Case (n=120)
Gender	Male	73	69
	Female	47	51
Height (cm)		156.66±7.75	154.38±8.95*
Weight (Kg)		59.20±6.42	78.08±10.67***
BMI (Kg/m^2)		24.15±2.44	32.69±3.88***
WHR		0.94±0.07	1.02±0.01***
SBP (mmHg)		124.92±8.91	157.75±16.17***
DBP (mmHg)		82.66±8.49	109.86±16.05***

**=p< 0.05, **=p< 0.01, ***=p<0.001*

Biochemical analysis was performed in hypertensive and control subjects. In the biochemical analysis, blood sugar profiles were normal in both hypertensive and normal subjects but we observed that FBS, PPBS and HbA1c were significantly high in hypertensive subjects as compared to control subjects with p-value<0.001 (Table 2).

In the FLP cholesterol, triglyceride (TG), low-density lipid (LDL), and very low-density lipid (VLDL) were elevated in the hypertensive subject compared to control and showed statically significance (TG; p<0.01, LDL; p<0.001 and VLDL; p<0.001). On the other side high-density lipid (HDL) was significantly (p<0.001) lower in hypertensive subjects (Table 2).

Table 2: Biochemical analysis of Hypertensive and Control subjects

Biochemical parameters	Control (n=120)	Case (n=120)
FBS (mg/dl)	79.03±11.49	90.21±8.25***
PPBS (mg/dl)	103.97±9.25	123.57±14.19***
HbA1c (%)	4.99±0.28	5.23±0.59***
Cholesterol (mg/dl)	175.61±16.43	281.76±28.78***
TG (mg/dl)	136.02±15.13	312.29±43.13**
HDL (mg/dl)	44.39±5.72	29.39±5.56***
LDL (mg/dl)	72.05±12.53	125.61±10.82***
VLDL (mg/dl)	27.20 ±3.02	62.45±8.62***
Urea (mg/dl)	25.23±4.27	38.20±5.27***
Creatinine (mg/dl)	0.69±0.17	0.89±0.12***
Uric Acid (mg/dl)	4.21±0.71	6.15±1.36***

**=p< 0.05, **=p< 0.01, ***=p<0.001*

In the Kidney profile, we observed that circulatory levels of urea and creatinine were increased in hypertensive subjects as compared to control with p<0.001. Furthermore, Uric Acid was significantly (p<0.001) increased in hypertensive subjects (Table 2).

We categorized hypertensive subjects in two groups male (n=69) and female (n=51). In the gender-wise distribution of anthropometric parameters, we found that WHR is slightly decreased in female hypertensive subjects as compared to male hypertensive subjects with a p-value of 0.04. On the other hand, gender-wise distribution of biochemical parameters, we found circulatory level of uric acid is significantly (p=0.02) elevated but HDL was significantly decreased in female hypertensive subjects as compared to male hypertensive subjects (Table 3).

Table 3: Gender-wise distribution of parameters in Hypertensive subjects

Parameters	Male (n=69)	Female (n=51)
Height (cm)	154.50±8.90	154.22±9.10
Weight (Kg)	78.28±10.89	77.81±10.47
BMI (Kg/m^2)	32.82±3.85	32.51±3.95
WHR	1.021±0.01	1.016±0.01*
SBP (mmHg)	159.23±17.15	157.11±15.79
DBP (mmHg)	110.53±16.53	108.96±15.49
FBS (mg/dl)	89.47±8.35	91.21±8.08
PPBS (mg/dl)	124.39±13.13	122.45±15.57
HbA1c (%)	5.22±0.61	5.23±0.56
Cholesterol (mg/dl)	284.94±28.91	277.47±28.33

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TG (mg/dl)	316.02±44.25	307.23±41.45
HDL (mg/dl)	30.52±5.97	27.86±4.57**
LDL (mg/dl)	124.05±12.00	127±10.67
VLDL (mg/dl)	63.20±8.85	61.44±8.29
Urea (mg/dl)	38.05±5.45	38.41±5.07
Creatinine (mg/dl)	0.88±0.15	0.90±0.15
Uric Acid (mg/dl)	5.94±1.35	6.44±1.33*

**=p<0.05, **=p< 0.01, ***=p<0.001*

We performed a correlation of systolic and diastolic pressure with BMI, creatinine and uric acid in hypertensive subjects. We observed BMI (r=0.3437; p =0.001), creatinine (r=0.7672; p=<0.001) and uric acid (r=0.5155; p=<0.01) significantly positive correlated with SBP. On the other side, we also observed a significantly positive correlation of DBP with BMI (r=0.3371; p=0.001), creatinine (r=0.7128; p=<0.001) and uric acid (r=0.4442; p=<0.001) in the hypertensive subject (Table 4).

Table 4: Pearson's Correlation of Systolic and Diastolic blood pressure with the following parameters of the Hypertensive subjects

Parameters	**SBP (mmHg)**	**DBP (mmHg)**
	Pearson (r)	**Pearson (r)**
BMI (Kg/m^2)	0.3437**	0.3371***
Creatinine (mg/dl)	0.7672***	0.7128***
Uric Acid (mg/dl)	0.5155***	0.4442***

**=p< 0.05, **=p< 0.01, ***=p<0.001*

DISCUSSION

In this present study, we discussed the anthropometric and biochemical parameters. In the anthropometric study, anthropometric parameters were increased in hypertensive subjects, both genders and associated with hypertension and their risk factors. An experimental study by Battaglia *et al.* [9] reported that BMI and WC were identified as predictors of both SBP and DBP. On the other side, we also found a positive correlation between BMI with hypertension. Shihab *et al.* [10] study and Linderman *et al*. [11] supported our result and found that for every unit increase in BMI, there was a corresponding increase in both SBP and DBP. The authors emphasized that obesity is a significant risk factor for the development of hypertension, suggesting that weight management can be an effective intervention for controlling blood pressure. National Health and Nutrition Examination Survey (NHANES) and Shrestha *et al*. [12] all studies reported that women with hypertension tend to have greater central adiposity than their male counterparts but, in our study, female subjects were lower than males, so we found that male subject had slightly higher WHR than females in hypertensive subjects.

The moderate correlations between BMI and blood pressure are well-documented. In our study, we observed that BMI was significantly positively correlated with hypertension. A meta-analysis by Yusni *et al*. [13] indicated that higher BMI is consistently associated with hypertension. Increased body fat, particularly visceral fat, contributes to insulin resistance and subsequent increases in blood pressure.

In the biochemical study, we observed that the hypertensive subjects were at increased risk of developing biochemical alterations over time, including changes in blood sugar profile, lipid profile and kidney profile. Haile *et al.* [14] the study found the same alteration in their experiment.

Our findings suggest that subjects with hypertension are more likely to have elevated glucose levels, indicating a potential link between hypertension and dysglycemia. This aligns with existing research that has explored the relationship between hypertension and glucose metabolism. Experimental studies by Ahn *et al*. [15] and Kuwabara *et al*. [16] reported that hyperglycemia is an independent risk factor for the development of hypertension and its complications.

The significantly altered lipid profiles in hypertensive subjects reflect a concerning association between hypertension and dyslipidemia, both of which are major risk factors for cardiovascular disease. Research by He *et al*. [17] and Kim [18] show that individuals with hypertension frequently exhibit dyslipidemia characterized by elevated triglycerides, reduced HDL, and increased LDL cholesterol levels. These lipid abnormalities are often linked to metabolic syndrome, which is prevalent among hypertensive patients. We were further gender-wise categorized hypertension subjects and observed that HDL levels were significantly

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downregulated in females and some previous studies supported our findings such as Cho *et al.* [19] reported that hypertensive subjects with lower HDL levels were significantly associated with a higher prevalence of cardiovascular events in female's hypertensive subjects. Some studies just opposite our observation such as Akhtar *et al.* [20] reported that females had a significantly higher mean HDL level compared to males. This study emphasizes the importance of monitoring lipid profiles in hypertensive patients.

Our results highlight significant changes in kidney function markers among hypertensive subjects, suggesting that hypertension may negatively impact kidney function. We observed elevated levels of serum urea and creatinine. The same observation was reported by Dash *et al.* [21] and Panday *et al.* [22], hypertension is a leading cause of chronic kidney disease (CKD) and elevated levels of urea and creatinine in hypertensive subjects and indicates that sustained high BP can lead to kidney damage and impaired filtration capacity.

We found a positive correlation between creatinine levels and BP. Elevated creatinine is a marker of impaired kidney function, which can lead to hypertension. Akpotaire *et al.* [23] found that even mild increases in creatinine levels were associated with a higher risk of developing hypertension, suggesting a direct link between renal impairment and BP regulation.

In our study, we observed elevated uric acid levels in hypertensive subjects' same observation Singh *et al.* [24] reported that hyperuricemia not only correlates with hypertension but also independently predicts cardiovascular morbidity and mortality. The higher uric acid levels in hypertensive subjects could exacerbate renal dysfunction and increase the risk of adverse cardiovascular events. Geraci *et al.* [25] and Cicero *et al.* [26] also supported the study; they also reported elevated levels of serum uric acid in hypertensive subjects.

Singh *et al.* [24] observed higher uric acid levels in males, whereas our study found elevated uric acid levels in female hypertensive subjects. This could be attributed to hormonal changes in women, particularly the decline in estrogen, which affects the renal clearance of uric acid. These hormonal factors may contribute to increased cardiovascular risk, especially in postmenopausal women. In the correlation study, we found uric acid was positively correlated with SBP and DBP. Ansari *et al.* [27] supported our correlation and showed that hyperuricemia is associated with high SBP and DBP and may play a key role in the pathogenesis of hypertension. Increased uric acid can lead to endothelial dysfunction and increased vascular resistance, supporting hypertension.

CONCLUSIONS

This study demonstrates that hypertensive subjects exhibit significant increases in anthropometric measurements, biochemical markers (including blood glucose and lipid profiles), and renal function indicators compared to controls. Notably, elevated BMI correlates with increased BP and both uric acid and creatinine are significantly higher in hypertensive individuals, suggesting a complex interplay between hypertension and metabolic dysfunction. Gender differences were observed, particularly in HDL levels and creatinine concentrations, highlighting the need for tailored approaches to managing hypertension and its associated risks. These findings underscore the importance of regular monitoring and intervention to mitigate cardiovascular and renal complications in hypertensive patients.

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