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Original Research Article

A Study of Biochemical Changes Associated with Hypertension at Tertiary Care Hospital

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Abstract:

Objectives: The present study was to evaluate the anthropometric evaluation, biochemical changes (lipid profile and renal profile) associated with hypertension in male and female population at tertiary care centre.

Methods: The study group included a total of 200 participants, consisting of 100 hypertension patients (case subjects) and 100 healthy individuals (control subjects), all aged between 30 and 60 years. A compete assessment were performed to all subjects. Anthropometric examinations, blood pressure measurement, biochemical parameters (fasting and postprandial blood sugar (FBS and PPBS) levels, HbA1c, fasting lipid profile (FLP), kidney function tests (KFT), and uric acid) were evaluated to all subjects.

Results: BMI, and WHR were significantly increased in hypertensive subjects as compared to control ($p<0.001$). SBP and DBP were significantly higher in hypertensive subjects relative to control ($p<0.001$). Cholesterol, triglyceride (TG), low-density lipid (LDL), and very low-density lipid (VLDL) were significantly elevated in the hypertensive subject compared to control and showed statically significance (TG; $p<0.01$, LDL; $p<0.001$ and VLDL; $p<0.001$). In the gender-wise comparison of hypertensive cases, we found that WHR is slightly decreased in female hypertensive subjects as compared to male hypertensive subjects with a p-value of 0.03. Circulatory level of uric acid is significantly ($p<0.05$) elevated but HDL was significantly decreased in female hypertensive subjects as compared to male hypertensive subjects.

Conclusions: Hypertension is greatly seen in male population as compared to females. And hypertensive subjects have significantly increased anthropometric measurements, biochemical profile (including blood glucose and lipid profiles), and renal profile (uric acid and creatinine) as compared to controls (normal healthy subjects). Hence, we should organise free health check-up programme in communities for the patient education, frequent biochemical parameter monitoring, and dietary and life style changes for the preventions of hypertension.

Keywords: Hypertension, Biochemical Profile, Gender.

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Introduction

Hypertension is a chronic elevation of blood pressure that, in the long-term, causes end-organ damage and results in increased morbidity and mortality [1].

The age-adjusted prevalence rate of hypertension is around 20-30% in Asian countries. Between the years 2000 to 2025, there will be a 65.4% increase in prevalence of hypertension in Asia compared with a 51.2% increase in the rest of the world. This change is even more severe in females, with a 81.6% increase in Asia compared to a 54.4% increase in the rest of the world [2]. The etiology of hypertension reflects a number of factors – genetic predisposition, environmental influences, iatrogenic causes and unknown components [3].

Non-steroidal anti-inflammatory drugs acquired by the patient over- the-counter are numerically the most important because they are particularly likely to interfere with the efficacy of antihypertensive drug treatment. Other drugs (e.g. corticosteroids such as prednisolone, combined oral contraceptive pill) are known to predispose to hypertension [3].

Blood pressure is the product of cardiac output and systemic vascular resistance. It follows that patients with arterial hypertension may have an increase in cardiac output, an increase in systemic vascular resistance, or both. In the younger age group, the cardiac output is often elevated, while in older patients increased systemic vascular resistance and increased stiffness of the vasculature play a dominant role [1].

Vascular tone may be elevated because of increased a-adrenoceptor stimulation or increased release of peptides such as angiotensin or endothelins. The final pathway is an increase in cytosolic calcium in vascular smooth muscle causing vasoconstriction. Several growth factors, including angiotensin and endothelins, cause an increase in vascular smooth muscle mass termed vascular remodeling [1].

Both an increase in systemic vascular resistance and an increase in vascular stiffness augment the load imposed on the left ventricle; this induces left ventricular hypertrophy and left ventricular diastolic dysfunction [1]. Objective of our study was to evaluate the anthropometric evaluation; biochemical changes associated with hypertension in male and female population at tertiary care centre.

Material & Methods

The present study was conducted in the Department of Biochemistry, with the collaboration of the Department of Medicine, Shri Krishna Medical College & Hospital, Muzaffarpur, Bihar during a period from January 2025 to June 2025.

This case-control study included hypertensive subjects recruited from the outpatient department (OPD) of the Medicine, Sri Krishna Medical College and Hospital, Muzaffarpur.

Subjects: The study group included a total of 200 participants, consisting of 100 hypertension patients (case subjects) and 100 healthy individuals (control subjects), all aged between 30 and 60 years. The hypertension group was further categorized by gender, with 56 males and 44 females, while the control group included 58 males and 42 females.

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 (m^2). 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 automated analyzer.

Statistical Analysis: Data was analysed by using latest version of SPSS software. Mean±Standard deviations were observed. Independent t-test was applied. P-value was taken less than or equal to 0.05 ($p \leq 0.05$) for significant differences.

Results

In the present study, we were enrolled a total of 200 subjects. Out of them, it was categorised into two groups case and control. Case group had 100 hypertensive patients and control group had 100 normal subjects.

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

Table 1: Anthropometric Parameters of Hypertensive and Control subjects Biochemical parameters.

Parameters		Control (n=100)	Case (n=100)	P-Value
Gender	**Male**	**58**	**56**	
	Female	**42**	**44**	
Height (cm)		157.54±8.43	155.12±7.68	<0.05
Weight (Kg)		57.56±7.75	80.24±11.65	<0.001
BMI (Kg/m2)		23.89±2.78	33.24±2.68	<0.001
WHR		0.96±0.09	1.01±0.07	<0.001
SBP (mmHg)		122.86±9.45	158.63±18.24	<0.001
DBP (mmHg)		80.74±7.86	110.22±17.12	<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.

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 hand, high-density lipid (HDL) was significantly (p<0.001) lower in hypertensive subjects.

Table 2: Biochemical analysis of Hypertensive and Control subjects Biochemical parameters.

Parameters	Control (n=100)	Case (n=100)	P-value
FBS (mg/dl)	78.67±10.86	91.54±7.88	<0.001
PPBS (mg/dl)	101.65±8.76	124.26±10.24	<0.001
HbA1c (%)	3.86±0.42	6.12±0.42	<0.001
Cholesterol (mg/dl)	174.24±17.76	283.64±30.73	<0.001
TG (mg/dl)	137.12±17.27	310.64±44.65	<0.01
HDL (mg/dl)	45.42±4.86	28.64±5.42	<0.001
LDL (mg/dl)	74.12±10.48	126.32±11.56	<0.001
VLDL (mg/dl)	28.12 ±2.43	64.26±6.86	<0.001
Urea (mg/dl)	24.76±3.78	39.12±6.38	<0.001
Creatinine (mg/dl)	0.67±0.42	0.92±0.32	<0.001
Uric Acid (mg/dl)	3.86±0.48	7.24±2.24	<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.

We categorized hypertensive subjects in two groups male (n=56) and female (n=44). 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 0.03. On the other hand, gender-wise distribution of biochemical parameters, we found circulatory level of uric acid is significantly (p<0.05) elevated but HDL was significantly decreased in female hypertensive subjects as compared to male hypertensive subjects.

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

Parameters	Male (n=56)	Female (n=44)	P-value
Height (cm)	155.65±9.01	155.64±9.86	
Weight (Kg)	79.65±11.24	76.76±9.48	>0.05
BMI (Kg/m2)	32.65±4.54	32.68±4.28	>0.05
WHR	1.245±0.05	1.034±0.76	<0.05
SBP (mmHg)	158.54±16.42	157.87±14.63	>0.05
DBP (mmHg)	109.65±15.42	107.85±14.12	>0.05
FBS (mg/dl)	88.64±7.94	90.81±7.42	>0.05
PPBS (mg/dl)	125.72±12.62	123.82±16.42	>0.05
HbA1c (%)	5.74±0.78	5.84±0.64	>0.05
Cholesterol (mg/dl)	285.65±29.32	278.52±29.42	>0.05
TG (mg/dl)	317.32±45.74	308.62±42.64	>0.05
HDL (mg/dl)	31.35±4.72	26.75±5.43**	<0.01
LDL (mg/dl)	123.67±11.24	126±9.88	>0.05
VLDL (mg/dl)	64.73±7.68	62.34±7.65	>0.05
Urea (mg/dl)	37.12±4.24	37.12±4.24	>0.05
Creatinine (mg/dl)	0.79±0.14	0.87±0.13	>0.05
Uric Acid (mg/dl)	4.87±1.56	5.76±1.76*	<0.05

Discussions

In order to manage hypertension, biochemical profiling is essential since it can be used to detect metabolic changes that raise the risk of cardiovascular disease. Research indicates that people with hypertension frequently have dyslipidaemia, which is defined by higher triglyceride and lower HDL cholesterol levels. More than half of patients with hypertension exhibit numerous lipid abnormalities at the time of presentation [4,5]. Additionally, compared to normotensive controls, hypertensive people

frequently have higher fasting blood glucose levels, suggesting serious abnormalities in glucose metabolism [5,6]. In order to direct individualized therapies and enhance clinical outcomes, these metabolic anomalies highlight the importance of early identification and thorough biochemical evaluations.

In this present 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. [7] 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. [8] study and Linderman et al. [9] 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. [10] 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.

In our study, we observed that BMI was significantly positively correlated with hypertension. A meta-analysis by Yusni et al. [11] 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. [12] 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. [13] and Kuwabara et al. [14] 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. [15] and Kim [16] 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 downregulated in females and some previous studies supported our findings such as Cho et al. [17] 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. [18] 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 other authors, 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 [19,20].

Plasma lipid profile, that is changed in hypertensive patients appears to be a significant factor in the development of premature atherosclerosis and includes an increase in TC, LDL-C and decrease in HDL-C and phospholipids [21]. Abnormalcies in lipid profile predate the occurrence of stage I hypertension from prehypertension, so it is wise to advocate lipid profile as screening of asymptomatic prehypertensive patients. Moreover, dyslipidemia is not rare in hypertensive; therefore, hypertensive patients require measurement of BP and lipid profile at regular intervals all through their primary health care to stop further provocation and risks of coronary artery diseases (CAD) and stroke.

The significance of routine biochemical profile of hypertension is highlighted by this present study. Increased levels of biochemical profile, including cholesterol, triglycerides, and glucose, are known risk factors for cardiovascular disorders. Finding these indicators and their relationships lays the groundwork for individualized treatment plans that try to lessen the long-term effects of hypertension and enhance patient outcomes.

Conclusions

The present study concluded that the hypertension is greatly seen in male population as compared to females. And hypertensive subjects have

significantly increased anthropometric measurements, biochemical profile (including blood glucose and lipid profiles), and renal profile (uric acid and creatinine) as compared to controls (normal healthy subjects). Hence, we should organise free health check-up programme in communities for the patient education, frequent biochemical parameter monitoring, and dietary and life style changes for the preventions of hypertension.

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