Original Research Article

Haematological Profiles and Acute Phase reactants of Hypertensive Individuals in Port Harcourt.

Comment [MS1]: Title need revision. The term "Hypertensive individual" seems unethical.

Author may consider, " **Haematological Profiles and Acute Phase Reactants among Individuals with Hypertension in Port Harcourt.**

ABSTRACT

Background: Hypertension or high blood pressure affects numerous individuals worldwide and is associated with cardiovascular issues. Recent studies have examined the connection between haematological parameters and hypertension.

Aim: This study was aimed at assessing the haematological profiles and acute phase reactants of hypertensive individuals in Port Harcourt, Nigeria.

Method: A case control study was conducted among 160 hypertensives and 100 age-matched normotensives in Port Harcourt. Ten milliliters (10mls) of venous blood was collected aseptically by venipuncture technique from the subjects into vacutainer tubes. Three milliliters (3mls) was dispensed into EDTA tubes for full blood count using haematologicalautoanalyser, Sysmex Kx-21N and ESR using Westergren method while 4mls was dispensed into sodium citrate tubes for the determination of fibrinogen levels and 3mls into plain tubes; this was spun and the separated serum was used for the determination of CRP and albumin levels. The serum CRP and plasma fibrinogen were determined by Sandwich ELISA method while serum albumin was determined using Bromocresol green (BCG) binding method.

Result: The hypertensives had significantly higher WBC ($p \leq 0.001$), LYM ($p=0.044$), NEU ($p=0.009$) and RDW-SD ($p=0.004$) compared to normotensives. The hypertensives had statistically higher SBP (mm/Hg) ($p \leq 0.001$), DBP (mm/Hg) ($p \leq 0.001$) and BMI (kg/m^2) ($p<0.001$) compared to the normotensives. The hypertensives also had statistically higher CRP (mg/L) ($p \leq 0.001$) and fibrinogen (mg/dL) ($p=<0.001$) compared to the normotensives. However, the ALB (g/dl) ($p \leq 0.001$) was statistically lower among hypertensives compared to the normotensives.

Conclusion: This study has shown that some haematological parameters may possibly indicate heightened immune system activity and chronic inflammation associated with hypertension.

Keywords: Haematological profiles, Acute phase reactants, Hypertension, Port Harcourt.

Comment [MS2]: Please don't use the term "Hypertensive individuals". It seems unethical

1. INTRODUCTION

Comment [MS3]: Introduction need reframing.. please keep only the relevant content and also in a smooth flow. Reduce the number of paragraphs….please merge small paragraph and improv ethe writing quality.

Hypertension, a prevalent condition characterized by high blood pressure, poses a significant health concern globally, contributing to cardiovascular diseases [1]. Blood pressure is measured using two values: systolic pressure and diastolic pressure. The systolic pressure represents the maximum pressure in the arterial system when the left ventricle is contracted, while the diastolic pressure

represents the minimum pressure when the left ventricle is relaxed before the next contraction. Hypertension, often referred to as the "silent killer" because it typically does not exhibit noticeable symptoms until significant damage has already occurred in the cardiovascular system [2,3]. Increase in blood pressure can lead to the development of bulges and weak spots in blood vessels, which can eventually

rupture and collapse. If left uncontrolled, hypertension can result in serious complications including heart attacks, kidney failure, strokes and even death [4]. It is influenced by various factors such as genetics, lifestyle, and the environment. In Nigeria, including Port Harcourt, hypertension has emerged as a major public health issue. Nigeria, as the most populous

country in Africa, is undergoing an epidemiological transition, where non-communicable diseases like hypertension are replacing infectious diseases. Studies indicate an increasing prevalence of hypertension in Nigeria, affecting around 25% to 40% of the adult population [5]. Urbanization, sedentary lifestyles, unhealthy diets and stress contribute to the escalating burden of hypertension in the country.

Haematological parameters are essential for diagnosing and monitoring various diseases, including hypertension. Several studies have explored the link between hypertension and haematological parameters such as complete blood count (CBC), red blood cell indices, white blood cell count, platelet count, and others. The cellular components present in the blood play a crucial role in regulating blood pressure by influencing its viscosity, volume and ability to clot [6]. Hypertension can cause changes in the blood as well as the cellular parameters, which in turn disrupt the functioning of various body systems. These changes include an increase in white blood cell count, a decrease in the deformability of red blood cells and an increase in the activation of platelets [7–9]. Such alterations can have a detrimental impact on the microcirculation and contribute to damage in various organs [10].

Erythrocyte sedimentation rate (ESR) is a remarkable indicator of systemic inflammation and heart failure [11]. The erythrocyte sedimentation rate is a common hematology test that may indicate and monitor an increase in inflammatory activity within the body caused by one or more conditions such as autoimmune disease, infections or tumors. The ESR is not specific for any one disease but is used in combination with other tests to determine the presence of increased inflammatory activity. However, hypertension can contribute to other health issues that may cause inflammation, leading to an elevated ESR [11]. Medications used to treat hypertension can also affect ESR.

Comment [MS4]: Please use the abbreviation if it has been mentioned earlier in the text.

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Inflammation is a protective response to injury or infection. It is a complex process that involves inflammatory cells first identifying the affected tissue, leukocyte recruitment into tissue, elimination of the offending agent and repair of the site of injury. Inflammation requires interactions between cell surfaces, extracellular matrix and proinflammatory mediators [12]. Excessive inflammation can have detrimental effects and contribute to the progression of chronic and/or prolonged diseases such as cardiovascular diseases, atherosclerosis, rheumatoid arthritis and systemic lupus erythematosus [13].

The acute phase protein, C-reactive protein (CRP) is involved in innate immune responses and has roles that include activating the complement system and enhancing phagocytosis [14]. C-reactive protein (CRP) can stimulate monocytes to release proinflammatory cytokines such as interleukin-6 (IL-6), interleukin-1 beta (IL-1), and tumour necrosis factor alpha (TNF-) [15] and also endothelial cells to express intracellular adhesion molecule (ICAM)-1 and vascular cell adhesion molecule (VCAM)-1 [16], effects which will further promote inflammation. CRP is considered the inflammatory marker with the strongest association with hypertension. It has been demonstrated in numerous clinical trials that hypertensive patients commonly have increased plasma CRP levels [17]. Prehypertensive patients generally have higher plasma CRP levels than normotensives and higher baseline CRP levels are reportedly associated with a higher risk of developing overt hypertension [18], consistent with the concept that systemic low-grade inflammation may precede hypertension.

Thrombosis is one of the most complicated courses of patients with hypertension and could be developed to many of organ damages. Circulatory homoeostasis depends on the equilibrium between vasoconstricting and vasodilating forces regulating blood pressure, as well as the equilibrium between procoagulant and fibrinolytic factors regulating blood rheology [18]. Arterial disease is the major underlying factor leading to most clinically

relevant cardiovascular events and these events are usually due to formation of a thrombus at the site of an atherosclerotic plaque; research has concentrated on the state of the coagulation pathways. Fibrinogen is both a coagulation factor and an acute-phase reactant that has been identified as a major independent risk factor for coronary artery [19]. Previous studies have associated fibrinogen levels, D-dimer and other coagulation factors with hypertension and other heart disease. A high fibrinogen level has been identified as a major independent risk factor for cardiovascular disease and measurement of fibrinogen level may be beneficial to avoid the complication of hypertension [20-22].

Serum albumin which is a negative acute phase reactant is found in the blood plasma helps in the regulation of osmotic pressure between the tissues and blood vessels [23]. Decrease in serum albumin levels indicates inflammation, liver disease and malnutrition which has been linked with elevated cardiovascular disease mortality and morbidity [24]. Meanwhile, higher serum albumin levels are associated with cardiovascular risk factors which include cholesterol levels and blood pressure [25,26].

The present study was aimed at assessing the haematological profiles and acute phase reactants of hypertensive individuals in Port Harcourt, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Design

A case-control study was employed to assess the haematological parameters of hypertensive individuals in Port Harcourt, Nigeria.

2.2 Study Area

This study was carried out in Port Harcourt, Rivers State, Nigeria. Port Harcourt is the capital of Rivers state which has about 23 local government areas and lies along the Bonny River, in the Niger Delta region of Nigeria located between Latitude 4º53'N and Latitude 4º23'N, and Longitude 6º54'E and Longitude 6º18'E [27]. Port Harcourt is a metropolis that is considered the commercial center of the Nigeria oil Industry with a 2021 United Nations estimated population of 3,171,076 [28]. After Lagos, Kano, Ibadan and Benin, Port Harcourt is the fifth most populous city in Nigeria.

2.3 Study Population

A total of 260 individuals comprising 160 hypertensives on anti-hypertensive medications and 100 age-matched normotensives who gave informed and written consents were recruited from Port-Harcourt and used for this study. A well-structured questionnaire was used to obtain relevant information (such as the age and sex) about each subject.

2.4 Inclusion Criteria

Hypertensives who has been attending the hypertension clinic at the same tertiary health care facility for a minimum of 2 years, female participants who were not pregnant and were not using hormone therapy or hormonal contraception.

2.5 Exclusion Criteria

Individuals currently suffering from a previous history of diabetes, stroke or haematologic conditions that could affect the investigated parameters, below the age of 30 and those who were above the age of 89 in order to narrow down the age group under investigation and ensure consistency in the study population. Also, participants not residing in Port Harcourt.

2.6 Sample Size

Sample size was determined using G-power 3.1.9.2 at power of 0.95. This gave a sample size of 76. However, this study used sample size of 160 hypertensive subjects and 100 control subjects.

2.7 Sample collection and Processing

Comment [MS6]: Please clearly mention the relevance of the study

Comment [MS7]: Physical activity level of the participants should be taken into account as that can also affect study variables

Comment [MS8]: This much detail about the study area is not as such required as per study objective

Comment [MS9]: Matching should also be done as per gender as the hematological factors and inflammatory markers are affected by the gender.

Comment [MS10]: Please provide this questionnaire in appendix

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Ten milliliters (10mls) of venous blood was collected aseptically by venipuncture technique from the subjects into vacutainer tubes. Four milliliters (4mls) was dispensed into EDTA tubes for the analysis of ESR while three millilitres (3mls) was dispensed into sodium citrate tubes for the determination of fibrinogen levels and three millilitres (3mls) into plain tubes; this was spun and the serum separated was used for the determination of CRP and albumin levels.

2.8 Method:

Estimation of full blood count was analysed using Sysmex Kx-21N Haematology Analyzer as described by Cheesbrough [29].

2.8.1 Principle:

This device conducts hematology analyses through several methods, including hydro-dynamically focused impedance measurement, flow cytometry employing a semiconductor laser, and the sodium lauryl sulphate hemoglobin (SLS-HGB) method. Specifically, it counts and sizes red blood cells (RBC) and platelets (PLT) using hydrodynamic impedance counting. Simultaneously, it calculates the hematocrit (HCT) through the RBC pulse height detection method. The device also employs cytometry to examine the physiological and chemical characteristics of cells and other biological particles, with flow cytometry being the method used to analyze these entities as they pass through extremely small flow cells.

2.8.2 Procedure for using Sysmex Kx-21N Haematology Analyzer

The samples in EDTA bottles were numbered appropriately and placed in a mixer. The mixer was plugged to an electric socket, which allows the blood to properly mix together. The Sysmex equipment was then cleaned and quality control checked. Each sample number was inputted into the equipment, followed by opening of the cap of each sample to be run. The tube of the equipment's probe was set and 'Start Switch' put on. Each of the samples was held firmly beneath the probe which was inserted into the sample until it aspirated the sample, which was indicated by a 'beep' sound. After this, the sample was removed from the probe, and with within 60 seconds, the result was obtained in a printed format.

2.9 Method:

Estimation of erythrocyte sedimentation rate (ESR) using Westergren method as described by Cheesbrough [29]

2.9.1 Principle:

This is based on the fact that blood is essentially a suspension of formed elements such as red blood cells and white blood cell capsules in plasma and as such red blood cells will settle out of suspension in blood plasma measured under standard conditions.

2.9.2 Procedure for using Westerngren Method

400µL of trisodium citrate solution was pipetted into a westergren bucket, 1600µL of mixed blood was also transferred into the same bucket and then mixed gently. By the application of a clean westergren tube, the blood is drawn to the zero mark. It was then allowed to stand vertically in the westergren stand for 1 hour.

2.10 Method:

Estimation of CRP using Latex particle enhanced immunoturbidimetric assay as described by Dupuy *et al.* [30]

2.10.1 Principle:

Serum C-reactive protein (CRP) causes agglutination of the latex particles coated with anti-human C-reactive protein. The agglutination of the latex particles is proportional to the CRP concentration and can be measured by turbidometry.

2.10.2 Procedure for using ELISA for C-reactive protein estimation

Reagent volumes were prepared by mixing 1 mL of Reagent 2 and 4 mL of Reagent 1. Reagent 2 vial was gently mixed before pipetting. The working reagent after preparation of was brought to room temperature. Two test tubes were labelled "Test" and "Standard". 7µL of the sample was transferred into the test tube labelled "Test", 7µL of the CRP standard was transferred into the test tube labelled "Standard". 1mL of the working reagent was transferred into both tubes and mixed properly and allowed to stand for 10 minutes. After 10 minutes the absorbance was measured at 540nm.

2.11 Method: Estimation of plasma fibrinogen using Latex Particle-enhanced Immunoturbidometric ELISA as described by Pletsch-Borba *et al.* [31].

2.11.1 Principle:

Plasma fibrinogen induces the clustering of latex particles that have been covered with anti-human fibrinogen. The degree of particle is proportional to the concentration of fibrinogen and can be quantified using turbidometry.

2.11.2 Procedure for using ELISA for plasma Fibrinogen estimation

Reagent volumes were prepared by mixing 1 mL of Reagent 2 with 4 mL of Reagent 1. After preparation of the working reagent, it was brought to room temperature. Two test tubes were labeled "Test" and "Standard". About 7 µL of the sample was transferred into the test tube labeled "Test", about 7 µL of the fibrinogen standard was transferred into the test tube labeled "Standard". Then, about 1 mL of the working reagent was transferred into both test tubes; they were mixed properly and allowed to stand for 10 minutes, after which the absorbance was measured at 540nm.

2.12 Method: Estimation of serum albumin Bromocresol Green by Garcia *et al.* [32] was employed.

2.12.1 Principle: Bromocresol Green functions as an indicator that appears yellow within the pH range of 3.5 to 4.3. When exposed to acidic conditions, serum selectively associates with bromocresol green, causing a transition in the indicator's color from yellow-green to blue-green. The intensity of this color change is directly related to the concentration of albumin in the sample. The absorbance is read at 640nm.

2.12.3 Procedure: The following was pipetted into the appropriately labeled test tubes

List 1 : Study protocol

	Test	Standard	Blank	QC
BCG Reagent	1mL	1mL	1mL	1mL
Plasma	10µL	-	-	-
Standard	-	10µL	-	-
QC	-	-	-	10µL

Calculation: Albumin conc. in g/L = $\frac{\text{Reading of test x conc. of std. in g/L.}}{\text{Reading of std.}}$

2.13 Determination of Height and Weight as described by Ezuizo*et al.* [33] was employed

Participants' height and weight were measured using a standard scale (seca model). Height was measured in meter (m) and weight in kilogram (kg).

2.14 Determination of Body Mass Index (BMI) as described by WHO [34] was employed

Individuals in the study were sorted into various weight categories using the Body Mass Index (BMI). BMI is determined by dividing a person's weight in kilograms by the square of their height in meters. Based on their BMI values, study participants were then classified into categories such as underweight, normal weight, overweight and obese.

2.15 Determination of Blood Pressure as described by Williams *et al.* [35] was employed

Blood pressure measurements were taken manually using a standard mercury sphygmomanometer with a cuff size suitable for each participant. Before taking the measurements, individuals were provided with a 30-minute rest period in a comfortable chair. While seated with their left arm resting on a table at heart level, both the diastolic blood pressure (DBP) and systolic blood pressure (SBP) from the left upper arm were recorded. Multiple readings were acquired until two consecutive measurements closely matched. SBP was determined based on the initial phase of the Korotkoff sound, while DBP was determined from the fifth phase. To categorize hypertension, the ESC/ESH document criteria were used, with Grade 1 hypertension defined as 140-159 mmHg for SBP and 90-99 mmHg for DBP, Grade 2 as 160-179 mmHg for SBP and 100-109 mmHg for DBP, and Grade 3 as SBP ≥180 mmHg and DBP ≥110 mmHg [35].

2.16 Data Analysis

Data derived from this study were processed and examined using SPSS version 23, a statistical software package. The findings were then displayed in tables. To make comparisons between values, both independent t-tests and one-way ANOVA were utilized. Statistical significance was established when the p-value was less than 0.05, with a confidence level of 95%.

Comment [MS13]: Normality of the data should be checked before processing the data for any analysis.

Comment [MS14]: Please specify where one-way ANOVA has been used

3.0 RESULTS

Comment [MS15]: Comparison among various stages of hypertension may be done

3.1 Demographic Characteristics, Body Mass Index and Blood Pressures of Hypertensives and Control Subjects

A total of 260 samples consisting of 167 females and 93 males were recruited for this study. 94 females and 66 males were hypertensive while 73 females and 27 males were apparently healthy controls. The age range for hypertensives were 47-67 years, Height (m) 1.19-2.07, Weight (kg) 77.6-85.8, BMI (kg/m^2) 24.85-35.25, SBP(mm/Hg) 132.28-163.32 and DBP (mm/Hg) 92.07-108.03 and for the controls were 49-56 years, Height (m) 0.74-2.54, Weight (kg) 64.53-75.23, BMI (kg/m^2) 21.13-30.03, SBP(mm/Hg) 113.4-125.66 and DBP (mm/Hg) 74.07-86.33respectively as shown in Table 1.

Comment [MS16]: Mean±SD should be mentioned for demographic characteristics. Comparison between the groups on the basis of demographic should also be performed.

3.2 Comparison of Blood Pressures and Body Mass Index (BMI) of Hypertensives and Control Subjects

The comparison of the mean and standard deviation value for hypertensives were SBP (mm/Hg) (119.53±6.13), DBP (mm/Hg) (80.20±6.13) and BMI (kg/m^2) (30.05±5.20) for control subjects were SBP (mm/Hg) (119.53±6.13), DBP (mm/Hg) (80.20±6.13) and BMI (kg/m^2) (25.58±4.45) as shown in table 2. However, the hypertensives had statistically higher

SBP (mm/Hg) ($p \leq 0.001$), DBP (mm/Hg) ($p \leq 0.001$) and BMI (kg/m^2) ($p \leq 0.001$) compared to the control subjects as shown in Table 2.

Comment [MS17]: Table 1 and 2 can be merged

3.3 Comparison of Haematological Parameters of Hypertensives and Control Subjects

The comparison of the mean and standard deviation values for hypertensives were WBC ($\times 10^9$/L) (8.10±5.27), LYM ($\times 10^9$/L) (2.61±1.50), NEUT ($\times 10^9$/L) (4.63±0.32), RBC ($\times 10^{12}$/L) (4.24±1.69), HGB (g/dl) (12.43±8.19), HCT (%) (34.41±7.31), MCV (fL) (81.48±9.46), MCH (pg) (28.18±5.67), MCHC (g/dl) (34.04±1.97), RDW-SD (fL) (46.07±10.53), RDW-CV (%) (14.73±5.82), PLT (x 10^9/L) (231.21±105.25), MPV (fL) (9.87±1.18), PDW (fL) (13.34±2.62), plateletcrit (%) (0.23±0.09) and ESR (mm/hr) (47.84±3.09) for control subjects were WBC ($\times 10^9$/L) (6.13±2.52), LYM ($\times 10^9$/L) (2.28±0.82), NEUT ($\times 10^9$/L) (3.45±2.96), RBC ($\times 10^{12}$/L) (4.24±1.01), HGB (g/dl) (12.69±7.82), HCT (%) (33.87±5.80), MCV (fL) (81.50±6.70), MCH (pg) (30.87±2.74), MCHC (g/dl) (35.03±5.45), RDW-SD (fL) (42.57±7.52), RDW-CV (%) (15.00±6.24), PLT (x 10^9/L) (239.30±119.02), MPV (fL) (10.15±1.15), PDW (fL) (13.97±2.71), plateletcrit (%) (0.22±0.15) and ESR (mm/hr) (25.27±1.88) respectively as shown in Table 3.

The hypertensives had statistically higher WBC ($\times 10^3/\mu L$) ($p \leq 0.001$), LYM ($\times 10^9$/L) ($p=0.044$), NEU ($\times 10^9/\mu L$) ($p=0.009$), RDW-SD (fL) ($p=0.004$) and ESR (mm/hr) ($p \leq 0.001$) compared to the control. However, the RBC (x 10^{12}/L) ($p=0.976$), HGB (g/dl) ($p=0.796$), HCT (%) ($p=0.538$), MCV (fL) ($p=0.983$), MCH ($p=0.227$), MCHC ($p=0.084$), RDW-CV ($p=0.072$), PLT ($\times 10^9$/L) (0.568), MPV (fL) ($p=0.067$), PDW (fL) ($p=0.066$) and plateletcrit (%) ($p=0.121$) were not statistically significant when compared.

3.4 Comparison of Acute Phase Reactants of Hypertensives and Control Subjects

The comparison of the mean and standard deviation values for hypertensives were ALB (g/dl) (41.86±10.00), CRP(mg/L) (4.54±3.35) and fibrinogen (mg/dL) (294.36±88.10) for control subjects were ALB (g/dl) (36.04±13.39), CRP (mg/L) (10.99±7.25) and fibrinogen (mg/dL) (393.47±107.41) respectively as shown in Table 4.

Comment [MS18]: Don't use subject for participants

The hypertensives had statistically higher CRP (mg/L) ($p \leq 0.001$) and fibrinogen (mg/dL) ($p=<0.001$) compared to the control subjects. However, the ALB (g/dl) ($p \leq 0.001$) was statistically lower among hypertensives compared to the control subjects.

Table 1: Demographic Characteristics, Blood Pressures and Body Mass Index of Hypertensives and Control Subjects

	Hypertensive	Control
Female	94	73
Male	66	27
Age (years)	47-67	49-56
Height (m)	1.19-2.07	0.74-2.54
Weight (kg)	77.6-85.8	64.53-75.23
SBP	132.28-163.32	113.4-125.66
DBP	92.07-108.03	74.07-86.33

BMI (kg/m$^{2)}$	24.85-35.25	21.13-30.03

Abbreviations: SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; BMI: Body Mass Index.

Table 2: Comparison of Blood Pressures and Body Mass Index (BMI) of Hypertensives and Control Subjects

	Hypertensive Mean±SD (n = 160)	**Control Mean±SD (n = 100)**	**P –value**	**t – value**	**Remark**
SBP (mm/Hg)	147.80±15.52	119.53±6.13	<0.001	17.317	S
DBP (mm/Hg)	100.05±7.98	80.20±6.13	<0.001	21.180	S
BMI (kg/m^2)	30.05±5.20	25.58±4.45	<0.001	7.034	S

Abbreviations: SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; BMI: Body Mass Index

Table 3: Comparison of Haematological Parameters of Hypertensives and Control Subjects

	HYP (n = 160) Mean±SD	**Control (n = 100) Mean±SD**	**P –value**	**t – value**	**Remark**
WBC (x10^3/µL)	8.10±5.27	6.13±2.52	<0.001	4.040	S
LYM (x10^3/µL)	2.61±1.50	2.28±0.82	0.044	2.026	S
NEUT (x10^3/µL)	4.63±0.32	3.45±2.96	0.009	2.629	S
RBC (x10^6/µL)	4.24±1.69	4.24±1.01	0.976	0.031	NS
HGB (g/dl)	12.43±8.19	12.69±7.82	0.796	0.259	NS
HCT (%)	34.41±7.31	33.87±5.80	0.538	0.617	NS
MCV (fL)	81.48±9.46	81.50±6.70	0.983	0.021	NS
MCH (fL)	28.18±5.67	30.87±2.74	0.227	1.212	NS
MCHC (g/dl)	34.04±1.97	35.03±5.45	0.084	1.74	NS
RDW-SD (fL)	46.07±10.53	42.57±7.52	0.004	2.887	S
RDW-CV (%)	14.73±5.82	15.00±6.24	0.720	0.358	NS
PLT (x10^3/µL)	231.21±105.25	239.30±119.02	0.568	0.572	NS
MPV (fL)	9.87±1.18	10.15±1.15	0.067	1.838	NS
PDW (fL)	13.34±2.62	13.97±2.71	0.066	1.847	NS
PLATELETCRIT(%)	0.23±0.09	0.22±0.15	0.121	12.233	NS
ESR (mm/hr)	47.84±3.09	25.27±1.88	<0.001	5.350	S

Abbreviations: WBC: White Blood Cell; LYM: Lymphocytes; NEU: Neutrophils, RBC: Red Blood Cell; HGB: Hemoglobin; HCT: Hematocrit; MCV: Mean Corpuscle Volume, MCH: Mean Corpuscle Hemoglobin; MCHC: Mean Corpuscle Hemoglobin Concentration, RDW-SD: Red Cell Distribution Width -Standard Deviation, RDW-CV: Red Cell Distribution Width – Coefficient of Variation; PLT: Platelet count, MPV: Mean Platelet Volume; PDW: Platelet Distribution Width; ESR: Erythrocyte Sedimentation Rate.

Table 4: Comparison of Acute Phase Reactants of Hypertensives and Control Subjects

	Hypertensive Mean±SD (n = 160)	**Control Mean±SD (n = 100)**	**P –value**	**t – value**	**Remark**
ALB (g/dl)	36.04±13.39	41.86±10.00	<0.001	3.728	S
CRP (mg/L)	10.99±7.25	4.54±3.35	<0.001	9.730	S
FIBRINOGEN (mg/dL)	393.47±107.41	294.36±88.10	<0.001	7.720	S

Abbreviations: ALB: Albumin; CRP: C-Reactive Protein

4. DISCUSSION

Hypertensionor high blood pressure affects numerous individuals universally and it is associated with cardiovascular issues, meanwhile inflammation is the response of the body's immune system to harmful stimuli, including toxic compounds, irradiation, pathogens or damaged cells. Acute phase reactants can aid in detecting inflammation in the body as a result of metabolic abnormalities and other factors including cardiovascular diseases.

Findings from this study revealed significantly increased systolic blood pressure ($p \leq 0.001$) among hypertensives as compared to control subjects. This may be due to increased peripheral resistance caused by narrowed and stiffened arteries which makes it challenging for the heart to pump blood effectively during systole, an increased cardiac output leading to a greater volume of blood being forced into the arteries during each contraction and endothelial dysfunction which can impair vasodilation. This finding is consistent with the findings of Yeldu*et al.* [18].

This study revealed significantly higher diastolic blood pressure ($p \leq 0.001$) among hypertensives as compared to control subjects. This may result from increased resistance to blood flow in peripheral arteries, making it difficult for arteries to relax and expand during diastole, arterial stiffness, endothelial dysfunction and increased blood volume which could require the arteries to accommodate more blood during diastole. This finding is in line with the findings of Yeldu*et al.* [18].

Findings from this study revealed significantly increased body mass index (p=<0.001) among hypertensives compared to control subjects which could be caused by chronic inflammation and obesity. This reflects an increase in body fat, which has been identified as an independent risk factor for hypertension. However, the exact mechanisms connecting visceral fat and hypertension are not fully understood. Inflammatory processes could play a significant role in the development of hypertension. Fat cells are sensitive to fat breakdown and can produce inflammatory cytokines in substantial quantities, contributing to elevated blood pressure. Findings from this study is in consonance with the study of Chen *et al.* [36]; Yeldu*et al.* [18].

Findings from this study revealed elevated total white blood cell count ($p \leq 0.001$) among hypertensives when compared to control subjects. This may be due to the fact that hypertension is frequently associated with persistent, mild inflammation in the body that disrupts the endothelial function. This is similar to the findings of Fantin *et al.* [37]; Enawgaw*et al.* [38]; Imtiaz and Nadera [39]; Furuncuoğlu*et al.* [40].

Significantly higher absolute lymphocyte levels (p=0.044) in hypertensives compared to control subjects as revealed in this study. This could be triggered by inflammation and this inflammatory response can affect the immune cell counts, leading to a rise in the production and circulation of lymphocytes, which are integral to immune defense mechanisms. This is in line with the study of Nunez *et al.* [41].This finding is not in consonance with the study reported by Eziuzo*et al.* [33] which stated that there was no significant difference in the absolute lymphocyte countamong hypertensive subjects compared to non-hypertensive controls. This could be attributed to the smaller sample size and age range of the subjects used.

Significantly increased absolute neutrophil count (p=0.009) among hypertensives compared to control subjects was observed in this study. This may be attributed to the fact that

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Comment [MS21]: Please explain a bit about the yeldu et al study

neutrophils could contribute to the immune response during sterile inflammation, which occurs in the absence of infection. This finding is consistent with the study of Eziuzo*et al.* [33].

Significantly higher random distribution width standard deviation (RDW-SD) levels (p=0.004) in hypertensives compared to control subjects as revealed in this study may be due to inflammation which could contribute to heightened immune system activity, possibly resulting in greater variability in measurement. This finding is not consistent with the study of Sileshi *et al.* [42] who reported that there was no significant difference in random distribution width standard deviation of hypertensives compared to normotensives. This could be attributed to the geographical location and study design used.

Comment [MS22]: Use abbreviation RDW-SD

Comment [MS23]: Please elaborate this and quote reference

Findings in this study revealed significantly increased levels of erythrocyte sedimentation rate (ESR) ($p \leq 0.001$) among hypertensives compared to normotensives which may be caused by chronic inflammation as a result of a heightened inflammatory response which could play a significant role in the pathophysiology leading to the onset of hypertension.This is not in agreement with the findings of Ighoroje and Dapper [43] who reported that there was no significant difference in erythrocyte sedimentation rate between the hypertensive and normotensive subjects. This is attributed to the study population and sample size used in this study.

Significantly reduced levels of serum albumin ($p \leq 0.001$) among hypertensives in comparison with normotensives was observed in this study which could be attributed to the fact that albumin has anti-inflammatory characteristics and this can trigger the body's reaction to inflammation and vascular damage. This finding is similar to the findings of Haile *et al.* [44].

The significantly elevated levels of c-reactive protein (CRP) ($p \leq 0.001$) in hypertensives compared to control subjects was observed in this study as a result of persistent inflammatory state and obesity which involves the release of pro-inflammatory cytokines from adipose tissue (fat cells). This finding is consistent with the study of Hage [17].

Significantly elevated plasma fibrinogen levels ($p \leq 0.001$) in hypertensive subjects compared to normotensive subjects was observed in this study. This phenomenon is likely due to various factors related to the complex pathophysiology of hypertension caused by chronic inflammation, which can stimulate the liver to produce more fibrinogen. This finding in this study is supported the findings of Pasquale *et al.* [45]; Ahmed *et al.* [46]; Eldour*et al.* [47]; Osman *et al.* [21].

5. CONCLUSION

Findings from this study revealed that higher body mass index and some haematological parameters indicate heightened immune system activity and chronic inflammation associated with hypertension. Acute phase reactants like fibrinogen, CRP and albumin, which indicate inflammation are often elevated or decreased in hypertensives, providing insights into their inflammatory burden and vascular health. Additionally, erythrocyte sedimentation rate, a non-specific measure of inflammation, can be used to assess the inflammatory state of hypertensive patients. By evaluating these markers, health-care professionals can better manage hypertension and improve patient outcomes.

6. RECOMMENDATION

Sequel to this study, it can be recommended that

1. Individuals should maintain a healthy lifestyle.
2. Individuals should go for regular medical checkup.

Comment [MS24]: This point cannot be recommendation for the study as this has not been evaluated in the present study.

3. The body mass index, systolic and diastolic blood pressure should be monitored regularly.

ETHICAL APPROVAL

Ethical approval for this study was obtained from the Research Ethics Committee of the Ministry of Health, State Secretariat Complex with a clearance from Rivers State Hospital Management Board, Port-Harcourt, Rivers State, Nigeria.

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Comment [MS25]: Please have an uniform style for referencing.

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