Original Article

Comparative Assessment of Some White Blood Cell and Platelet Parameters among Normotensive and Hypertensive Subjects in Port Harcourt, Nigeria

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Abstract

Background: Reports comparing the values of white blood cells (WBCs) and platelet parameters among normotensive, newly diagnosed hypertensive, and known hypertensive participants in Nigeria are relatively scarce. This study sought to compare these hematologic parameters of normotensive and hypertensive participants in the Southeastern Nigeria. **Materials and Methods:** Fifty participants each of normotensive, newly diagnosed hypertensive, and known hypertensive and age- and sex-matched individuals were recruited into the study. Using an automated hematology analyzer, the following hematological parameters were determined in all participants: total WBC; neutrophil, lymphocyte and platelet counts; percentage value of neutrophil and lymphocytes; mean platelet volume (MPV); platelet distribution width; and total lymphocyte count. **Results:** Significantly higher total WBCs and (absolute) neutrophil counts and lower percentage lymphocyte were observed among known hypertensive male participants, whereas percentage neutrophil was significantly higher among known hypertensive female participants. Platelet count and MPV were significantly higher in hypertensive male participants compared to their normotensive counterparts. MPV was found to be significantly lower in hypertensive female participants compared to normotensive females. **Conclusion:** The present study reports significantly higher leukocytes, platelet counts, and MPV among hypertensive males and lower MPV among hypertensive females. Regular assessment of hematological parameters may perhaps be useful indicators of the prognosis of hypertension among the study population.

Keywords: Hypertension, platelets, white blood cells

Introduction

Hypertension a chronic medical condition in which there is sustained elevation of arterial blood pressure up to or above 140/90 mmHg is a leading cause of cardiovascular morbidity worldwide and has gained the global public health importance.[1-4] It disproportionately contributes to the burden of heart disease, stroke, kidney failure, and premature mortality and disability, especially in low- and middle-income countries with weak health systems.[3] By 2000, the total number of adults with high blood pressure was estimated to be approximately 972 million or 26.4% of the world's adult population.[5] It is further projected that by 2025, nearly 75% of the world's hypertensive population will likely reside in developing countries.[5] Clearly, with approximately one-quarter of the world's population being possibly affected, hypertension an avoidable and manageable medical condition will remain an important public health challenge.[5,6]

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The World Health Organization reports that the prevalence of hypertension is the highest in the African region at 46% of adults aged 25 years and above, whereas the lowest prevalence at 35% is found in the Americans.[3] There is rising evidence to indicate that the overall pattern of diseases in sub-Saharan Africa is dynamic; with noncommunicable diseases to blame for 22% of the entire deaths within the region, and cardiovascular diseases alone accounting for 9.2% of the aggregate mortality in 2000.[7] In most countries in sub-Saharan Africa, hypertension and its complications are reported to be significant contributors to morbidity and mortality.[8,9] In Nigeria,

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for example, hypertension has been reported to be the Number 1 risk factor for stroke, cardiomyopathy, ischemic heart disease, and renal complications.[8] With an increasing adult population and a rising prevalence of hypertension, Nigeria will clearly encounter economic and health challenges if this trend is not controlled.[8] Recently, the reported prevalence of hypertension in Nigeria ranges between 8% and 46.4% depending on the study target population, type of measurement, and cutoff values.[8] For instance, in Port Harcourt, southeastern Nigeria, Akpa *et al.* in 2008 surveyed 921 adult Nigerian participants and reported a prevalence of 40.82%.[2] However, more recent studies have reported a crude prevalence of 18.3% in a rural community in the Niger Delta region near Port Harcourt, Nigeria.[9] Ordinioha in 2013 reported a prevalence of 21.3% among academics in a tertiary educational institution in Port Harcourt and concluding that the lower prevalence compared to the general population is perhaps due to the better health-seeking behavior and lifestyle pattern of the population under investigation.[10]

Several studies have reported a positive association between hypertension and elevated white blood cell (WBC) counts among the number of population types.[11-15] These reports suggest that inflammation could possibly play a key role in the development of cardiovascular disease.[16] For instance, a hypertensive leukocytosis has been described among Indians and Caucasians; initial leukocyte counts have been found to be related to the development of hypertension with increased risk in persons in the highest as compared to the lowest quartile of WBC count.[17,18] Tatsukawa *et al.* reported that significant association exists between increased neutrophil count and the incidence of hypertension among Japanese women and concludes that neutrophils are the major WBC component contributing to the increased incidence.[11] A similar pattern has been described by Gillum and Mussolino in 1994 in the NHANES I Epidemiologic Follow-up Study in the US.[14] Inflammation may also contribute to increasing microvascular capillary resistance, initiation of platelet aggregation, and increased catecholamine levels.[18-20] Chronic or low-grade inflammation has been shown to be a potential risk factor for hypertension.[14,18,20] Platelets secrete and express a large number of substances that are crucial mediators of coagulation, thrombosis, atherosclerosis, and inflammation.[21,22] The demonstrated ability of platelet drugs to reduce cardiovascular events has reinforced the major role of platelets in the atherothrombotic process.[23] Platelets from hypertensive patients show increased sensitivity to agonists and have high intracellular free Ca^{2+} concentration.[24] These reports clearly implicate platelets in the possible pathogenesis of inflammation, atherogenesis, and possibly hypertension. Evidence of platelet activation has also been described in Turkish hypertensives; significantly elevated values of mean platelet volume (MPV) reported in both prehypertensives and hypertensives.[25]

Considering the reported high prevalence of hypertension in our environment[2,9,10] and reports that hematological parameters are indicative of the possible risk factors of hypertension;[11,12,16,26] studies assessing simple hematological parameters among hypertensive participants, in our environment, are relatively scarce. Previous reports from our center did not include recently diagnosed hypertensive participants.[27] The present study, therefore, attempts a comparative assessment of some WBC and platelet parameters among normotensive, newly diagnosed (anti-hypertensive drug naïve) hypertensive, and known hypertensive participants in Port Harcourt, southeastern Nigeria. The study also attempts to confirm possible sex variations of these parameters among our participants as previously reported from our center.[28] This could provide insight into the possible role these parameters play in the prognosis of hypertension in our environment.

Materials and Methods

Ethical approval was obtained from our Institutional Research Ethics Committee and the Research Ethics Committee, Health Management Board, Rivers State, Nigeria. Participation was entirely based on voluntary. Informed consent was sought and obtained from each participant before recruitment. The study was conducted in accordance with the Helsinki Declaration of 1975 as amended in 2000.

Subjects

A total of 150 participants that included 50 each of normotensives, newly diagnosed and known hypertensives aged 31–54 years were recruited into the study. Normotensive participants were apparently healthy staff and the postgraduate students of the University of Port Harcourt, Nigeria with appropriate blood pressure for age. All newly diagnosed hypertensive participants were, at the time of inclusion into the study, anti-hypertensive drug naïve being seen at the general out-patient clinic of a tertiary health care facility in Port Harcourt, Nigeria. The known hypertensive participants who have been attending the hypertension clinic of the same tertiary healthcare facility for a minimum of 4 years were included in the study. All the participants in the study groups were sex matched. No participant had any prior history of diabetes or hematologic diseases likely to influence any of the parameters under investigation. All female participants were in the nonpregnant state; none was on any form of hormone therapy or hormonal contraception.

Determination of height, weight, and body mass index

Height and weight of participants were measured in meters (m) and kilogram (kg), respectively, without shoes and wearing light clothing using a standard scale (seca model). The body mass index was calculated by dividing body weight in kilogram by square of the height in meter (kg/m^2).

Determination of blood pressure

In all participants, diastolic blood pressure (DBP) and systolic blood pressure (SBP) were measured manually using a standard mercury sphygmomanometer with an appropriate cuff size. On arrival, participants were allowed to rest for 30 min in a comfortable chair before the measurement of blood pressure. During measurement, readings were taken

until two similar consecutive measurements were obtained. All blood pressure measurements were determined from the left upper arm by the same observer with the subject seated comfortably and the left arm resting on a table at the level of the heart. The first phase of the Korotkoff sound was regarded as SBP, whereas the fifth phase was regarded as the DBP. The mean arterial pressure was calculated using the formula: MAP = DBP + ⅓ pulse pressure.

Determination of white blood cell and platelet parameters

A volume of 5 ml of venous blood sample was aseptically obtained from an antecubital vein with minimum stasis and transferred immediately into ethylenediaminetetraacetic acid specimen bottles and gently mixed. All blood samples were collected between 9:00 a.m. and 12:00 noon and analyzed within 2 h of collection at room temperature (27.0°C ± 0.5°C) using a Sysmex KX-21N Hematology Automated Blood Analyzer (Sysmex Corporation Kobe, Japan; KX-21, 2010). The following parameters were determined: total WBC; neutrophil, lymphocyte, and platelet counts; percentages of neutrophils and lymphocytes. MPV and platelet distribution width (PDW) were also determined. Total lymphocyte count (TLC) was obtained by multiplying total WBC count by the value of percentage lymphocyte count.[29]

Statistics

Results obtained is presented as mean ± standard error of the means [Tables 1-4]. Statistical significance was determined, as appropriate, using the Student's *t*-test. A value of $p < 0.05$ was considered statistically significant.

Results

The values for age and the various anthropometric parameters: weight, height, body mass index, and blood pressure indices: systolic, diastolic, and mean arterial pressure are presented in Tables 1 and 2 for male and female participants, respectively. Similarly, values of the different WBC and platelet parameters are presented in Tables 3 and 4 for male and female participants, respectively.

Table 1 shows that no significant difference existed in age, weight, height, and body mass index between the three groups of male participants. Expectedly, all the blood pressure indices were found to be significantly higher in both newly diagnosed hypertensive and known hypertensive male participants as compared to normotensive male controls ($p < 0.05$). Table 2 also shows that no significant differences existed in both age and height between the three groups of female participants; however, both newly diagnosed and known hypertensive female participants were found to have significantly higher values of weight and body mass index compared to normotensive female controls. Furthermore, consistent with the male pattern, values of all blood pressure indices were found to be significantly higher in both newly diagnosed hypertensive and known hypertensive females as compared to the female normotensives ($p < 0.05$).

Table 3 shows that the values of total WBC count, percentage neutrophil and neutrophil counts were significantly higher, whereas the values of percentage lymphocyte were significantly lower in known hypertensive male participants

Table 1: Age, anthropometric parameters and blood pressure indices of male participants

Parameters	Normotensive male participants ($n=25$)	Newly diagnosed hypertensive male participants ($n=25$)	Known hypertensive male participants ($n=25$)
Age (years)	35.12±2.23	52.2±2.34	57.72±2.49
Weight (kg)	72.40±2.36	77.68±3.61	74.28±2.51
Height (m)	1.71±0.01	1.69±0.08	1.68±0.01
BMI (kg/m^2)	24.64±0.73	26.92±0.98	25.88±0.82
SBP (mmHg)	117.28±2.18	149.96±2.16*	148.00±2.31*
DBP (mmHg)	75.76±1.20	90.56±2.02*	93.60±1.79*
MAP (mmHg)	89.52±1.31	110.32±1.77*	111.76±1.51*

All values are mean±SEM; *Significant differences compared to normotensive participants at $p<0.05$. BMI – Body mass index; SBP – Systolic blood pressure; DBP – Diastolic blood pressure; MAP – Mean arterial pressure; SEM – Standard error of the mean

Table 2: Age, anthropometric parameters, and blood pressure indices of female participants

Parameters	Normotensive female participants ($n=25$)	Newly diagnosed hypertensive female participants ($n=25$)	Known hypertensive female participants ($n=25$)
Age (years)	33.44±1.79	58.12±2.03	60.76±2.80
Weight (kg)	73.04±2.22	80.20±2.42*	81.92±3.22*
Height (m)	1.89±1.21	1.68±0.07	1.63±0.02
BMI (kg/m^2)	25.68±0.59	28.40±0.85*	30.96±1.41*
SBP (mmHg)	121.36±1.99	162.08±4.59*	160.60±5.46*
DBP (mmHg)	74.80±1.49	95.76±2.37*	95.80±2.58*
MAP (mmHg)	90.24±1.23	117.84±2.79*	116.04±3.15*

All values are mean±SEM; *Significant differences compared to normotensive participants at $p<0.05$. BMI – Body mass index; SBP – Systolic blood pressure; DBP – Diastolic blood pressure; MAP – Mean arterial pressure; SEM – Standard error of the mean

Table 3: White blood cell and platelet parameters of male participants

Parameters	Normotensive male participants ($n=25$)	Newly diagnosed hypertensive male participants ($n=25$)	Known hypertensive male participants ($n=25$)
Total WBC count ($\times10^9$/L)	5.84±0.52	5.73±0.29	7.42±0.63*
Percentage neutrophil (%)	49.60±3.10	42.09±2.41	59.90±3.41*
Percentage lymphocyte (%)	39.58±2.48	45.14±2.20	31.99±3.00*
Neutrophil count ($\times10^9$/L)	3.06±0.38	2.35±0.22	4.68±0.59*
Lymphocyte count ($\times10^9$/L)	2.22±0.21	2.55±0.17	2.19±0.25
TLC ($\times10^9$/L/%)	222.50±20.75	254.80±16.87	219.40±25.19
Platelet count ($\times10^9$/L)	192.00±4.09	199.28±8.79	234.00±15.50*
MPV (fL)	9.43±0.20	10.49±0.27*	9.05±0.17
PDW (fL)	16.16±0.72	16.15±0.07	15.90±0.15

All values are mean±SEM; *Significant differences compared to normotensive participants at $p<0.05$. WBC – White blood cell; TLC – Total lymphocyte count; MPV – Mean platelet volume; PDW – Platelet distribution width; SEM – Standard error of the mean

Table 4: White blood cell and platelet parameters of female participants

Parameters	Normotensive female participants ($n=25$)	Newly diagnosed hypertensive female participants ($n=25$)	Known hypertensive female participants ($n=25$)
Total WBC count ($\times10^9$/L)	5.67±0.29	5.96±0.33	5.98±0.37
Percentage neutrophil (%)	46.72±2.78	51.28±3.15	56.73±2.83*
Percentage lymphocyte (%)	42.00±2.53	39.47±3.06	35.52±2.73
Neutrophil count ($\times10^9$/L)	2.70±0.23	3.21±0.38	3.55±0.36
Lymphocyte count ($\times10^9$/L)	2.33±0.15	2.23±0.16	1.99±0.14
TLC ($\times10^9$/L/%)	232.40±15.21	222.40±15.75	198.30±14.26
Platelet count ($\times10^9$/L)	214.84±11.08	243.88±11.22	231.56±12.74
MPV (fL)	10.25±0.27	8.91±0.23*	9.40±0.23*
PDW (fL)	16.00±0.09	15.14±0.33*	15.59±0.23

All values are mean±SEM; *Significant differences compared to normotensive participants at $p<0.05$. WBC – White blood cell; TLC – Total lymphocyte count; MPV – Mean platelet volume; PDW – Platelet distribution width; SEM – Standard error of the mean

as compared to normotensive male participants ($P < 0.05$). There were no statistically significant differences in the values of these particular parameters between newly diagnosed hypertensive male participants and normotensive male participant ($P > 0.05$). Furthermore, no significant differences were observed in the values of both (absolute) lymphocytes count and TLC between the three groups of male participants ($P > 0.05$). Known hypertensive male participants were found to have significantly higher values of platelet count compared to the normotensive male participants ($P < 0.05$). The values of MPV of newly diagnosed hypertensive male participants were significantly higher than the values obtained for normotensive male participants. There were no statistically significant differences in the values of platelet count of newly diagnosed hypertensive male participants and the MPV of known hypertensive male participants compared to the normotensive male control participants ($P > 0.05$). No statistically significant differences were observed in the values of PDW between the three groups of male participants involved with the present study ($P > 0.05$).

Table 4 shows that aside from the significantly higher percentage of neutrophil values among known hypertensive female participants as compared to the normotensive female participants ($P < 0.05$); no significant differences were observed in the total WBC count, percentage lymphocytes, neutrophil count, lymphocytes count, TLC, and platelet count among the three groups of female participants ($P > 0.05$). Furthermore, the values of MPV of both newly diagnosed hypertensive female participants and known hypertensive female participants were significantly lower than the values for normotensive female participants ($P < 0.05$). In addition, values of PDW were found to be significantly lower among newly diagnosed hypertensive female participants as compared to the normotensive female participants ($P < 0.05$); however, differences in PDW between known hypertensive female participants and normotensive female participants were not statistically significant ($P > 0.05$).

Discussion

The present study describes, for the first-time, differences in body mass index and some WBC and platelet indices among newly diagnosed (anti-hypertensive drug naïve) hypertensive and known hypertensive participants as compared to normotensive controls. Previous reports from our environment have been relatively scarce and have focused essentially on the epidemiology and the prevalence of hypertension[2,9,10] and obesity[30] and on hemorheological changes in hypertensives.[27,28] The present study also describes sex variations in the values of some of the indices investigated among our participants, concurring with earlier reports from our center.[28]

Amongst our participants, only normotensive males were found to have body mass index within normal weight ranges. Newly diagnosed hypertensive males, known hypertensive males, normotensive females and newly diagnosed hypertensive females were all found to have body mass index above 25 (preobese), while known hypertensive females had body mass index above 30 (obese class I): Although, the interpretation of body mass index gradings in relation to risk may differ for different populations, these changes may be associated with increased risk of comorbidities amongst our participants.[31] No significant differences were observed in the values of weight, height, and body mass index between the three groups of male participants; therefore, the significantly higher values of body weight among both newly diagnosed hypertensive female and known hypertensive female participants compared to normotensive female participants could possibly account for the corresponding significant differences in body mass index between the different female groups. Our results contrasts with a recent report supporting an independent effect of change in body mass index on changes in both systolic and DBP in both sexes; increase in body mass index is associated with increased risk of hypertension.[32] Expectedly, in both sexes, values of all blood pressure indices were found to be significantly higher among both newly diagnosed hypertensive and known hypertensive participants as compared to normotensive control participants. This differences in the blood pressure indices fairly parallel the pattern of changes in body weight and body mass index, especially among female participants. Our findings thus partly confirm the previous suggestions in Caucasians that overweight and obesity are associated with elevated blood pressure.[32,33] Noteworthy are the observed sex variations in the pattern of these differences among participants involved in the present study. Apparently, these variations suggest that changes in body weight and body mass index that likely predispose to hypertension are more easily manifest among our female population. The exact underlying pathophysiological mechanisms between change in body weight and body mass index and changes in systolic and DBP are at present unclear;[32] however, sympathetic activation, involvement of insulin and leptin, activation of the renin–angiotensin system, and physical compression of the kidney have all been proposed as contributory.[34,35] The findings would require further investigations, especially to determine the precise pathophysiological mechanisms among our participants.

Expectedly, we describe significantly higher total WBC count, percentage neutrophil and (absolute) neutrophil counts and significantly lower percentage lymphocyte counts in known hypertensive male participants as compared to normotensive male participants; a fairly similar pattern for each of these parameters is described also for female participants; although, only percentage neutrophil was found to be significantly elevated among known hypertensive female participants. These findings are consistent with most previous reports in this regard. For instance, higher values of WBCs have been described in hypertensives as compared to normotensives participants in Saudi Arabia.[36] In the United States, higher WBC counts have also been associated with increased incidence of hypertension in male participants;[14] with leukocytes reported to be of fairly predictive value in hypertension.[18] Among the Japanese, WBC count is an important risk factor for hypertension; the increased risk of hypertension associated with WBC count being more pronounced in nonsmokers.[13] Furthermore, a number of studies within the normotensive blood pressure range suggest a clear association of WBC counts with SBP;[15] with increases in SBP associating with elevated WBC counts.[16] Sex variations described in the present study are consistent with the report of Tatsukawa *et al.* in 2008 that elevated WBC counts predicted the increased incidence of hypertension, especially among females and neutrophils being the major WBC component contributing to the increased risk.[11] Note worthily, neutrophils are the only leucocyte parameter that showed significantly higher values among known hypertensive female participants who also had higher body mass indices compared to normotensive female participants. The clinical import of our findings among our female participants is at present uncertain, considering reports that (although) leukocyte counts are related to the development of hypertension; this relationship is largely independent of parental history of hypertension, alcohol and tobacco consumption, body fat distribution, and body mass index.[18]

Unexpectedly, we report nonsignificant differences in the values of both (absolute) lymphocyte count and TLCs among all hypertensive and normotensive groups in both male and female participants; this finding is at variance with the previous reports that significant increases in inflammatory markers such as TLC and neutrophil counts in hypertensive Indian patients suggest that hypertension is perhaps an inflammatory disease.[17] Indeed, an elevated neutrophil-lymphocyte ratio significantly correlates with an increased risk of the development of hypertension and may be useful in elucidating the mechanisms underlying the development of hypertension among Chinese participants.[37] Apparently, our result suggests that both (absolute) lymphocyte count and TLCs do not affect to a significant extent changes in either systolic or DBP among our participants.

The results of the present study suggest also that sex variations exist in some platelet parameters among our participants. For instance, higher platelet counts and MPV were observed among known and newly diagnosed hypertensive male participants. Significantly lower MPV and PDW were observed in newly diagnosed hypertensive female participants and significantly lower MPV was also observed among known hypertensive female participants compared to normotensive females. Our results are consistent with the report from Saudi Arabia that platelet counts were significantly higher in hypertensives as compared to normotensives, with a higher mean concentration of platelets among females compared to males within the same group.[36] Expectedly, the higher MPV seen among newly diagnosed hypertensive male participants is consistent with

a recent report among Turkish hypertensives whose MPV is elevated in untreated prehypertensive and hypertensive patients due to a characteristic platelet activation seen in hypertension.[25] Reasons for the unexpectedly significantly lower indices of platelet activation among our hypertensive female participants compared to normotensive controls are not immediately clear. The possible clinical import of our findings is also presently unclear; however, possible reduction in cardiovascular morbidity among our female hypertensive population is implied; platelet aggregation plays an important role in acute myocardial infarction and larger platelets are casually related to acute myocardial infarction.[38] Indeed, the MPV is a potentially useful biomarker in patients with cardiovascular disease.[39] This finding would also require further investigations.

Conclusion

The present study reports significantly higher values of body weight and body mass index among both newly diagnosed and known hypertensive female participants compared to their normotensive counterparts with known hypertensive female participants tending to obesity. Our results confirm suggestions that significant variations occur in the values of some WBC and platelet parameters between normotensive and hypertensive participants; with a possible sex bias in these variations. Regular assessment of hematological parameters may perhaps be useful indicators of the prognosis of hypertension among our population. Our results could be of value in the management of hypertensives since previous reports in this regard in Nigeria have been relatively scarce.

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Conflicts of interest

There are no conflicts of interest.

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