The Journal of Medical Research

Research Article

JMR 2021; 7(5):136-141
September- October
ISSN:2395-7565

www.medicinearticle.com
Received:11-08-2021
Accepted:01-09-2021

Some Selected Haematological Parameters of Patients with Pre-eclampsia and Eclampsia in Sokoto, Nigeria

Abubakar U. Musa[1]*, Aisha I. Mamman[2], Abubakar A. Panti[3], AbdulWahab Alhassan[4], Anas F. Rabi'u[3]

[1] Department of Haematology and Blood Transfusion, Usmanu Danfodiyo University Teaching Hospital Sokoto, Nigeria

[2] Department of Haematology and Blood Transfusion, Ahmadu Bello University Teaching Hospital Zaria, Nigeria

[3] Department of Obstetrics and Gynaecology, Usmanu Danfodiyo University Teaching Hospital Sokoto, Nigeria

[4] Department of Human Physiology, Faculty of Basic Medical Sciences, College of Medical Sciences, Ahmadu Bello University Zaria, Nigeria

Abstract

Background: In Sokoto Nigeria, pre-eclampsia and eclampsia complicate 6% and 4.29% of pregnancies respectively. The occurrences of these diseases pose additional challenges to the haematopoietic system in pregnancy with resultant changes in haematological parameters. Documented changes include worsening of the dilutional anaemia of pregnancy, exaggerated neutrophilic leucocytosis and varying patterns of platelet count. However, the pattern of these changes have been shown to be influenced by nutritional status, presence of co-morbidities such as diabetes, renal diseases, haemoglobinopathies and infections as well as race and genetics. **Aims and Objectives:** This study aimed to determine haematocrit, white blood cell and platelet counts of patients with pre-eclampsia and eclampsia and compare same with normotensive pregnancy. **Study Design:** Cross-sectional comparative. **Settings:** Ninety-three pregnant women from two tertiary hospitals in Sokoto Northwest Nigeria were consecutively enrolled and grouped into three groups (pre-eclampsia, eclampsia and normotensive pregnancy) of 31 each. **Materials and Methods:** Structured proforma was used for clinical data capturing while automated full blood count using Nortek 3-part haematology analyser was conducted on venous blood. Leishmann stained peripheral blood smears were examined to validate the haemogram findings. **Statistics:** Data analysis was performed using SPSS version 21.0. Data distribution was ascertained using Shapiro-Wilk and summarized as means ± standard deviations. Comparison of means was performed using Anova or Independent samples *t*-test as appropriate. Results were presented in tables and statistical significance was set at $p<0.05$. **Results:** There were statistical significant differences in mean haematocrit (32.67±4.30 vs.29.74±6.08 vs.32.24±3.02; $p=0.031$), white blood cell count (8.02±2.11 vs. 15.92±7.11 vs. 4.61±2.78; $p=0.001$) and platelet count (212.19±59.01 vs. 203.10±64.86 vs. 266.23±65.29; $p=0.001$) of pre-eclamptics, eclamptics and normotensive pregnant women respectively. The highest mean MCV, MCH and RDW were recorded for eclampsia (89.35±5.80, 29.00±2.76 and.17.70±21.23) when compared with pre-eclampsia (87.95±10.68, 28.33±2.76 and.13.61±1.07) and normotensive pregnancy (81.29±4.66, 28.27±3.80 and.14.23±6.67) respectively. The following mean MPV, PDW, PCT and P-LCR were recorded for the pre-eclamptics (9.89±0.94, 20.47±25.54, 0.21±0.05 and 30.77±8.94), eclamptics (9.46±0.81, 15.52±1.02, 0.19±0.53 and 27.82±7.66) and normotensive pregnancy (9.36±0.64, 16.02±2.35, 0.25±0.06 and 19.23±5.93) respectively. Patients with severe pre-eclampsia had lower mean haematocrit (32.44±3.80 vs.33.23±5.56; $p=0.649$) and platelet count (187.00±45.62 vs. 273.78±39.76; $p=0.001$) but higher white blood cell count (8.06±2.11 vs.7.922.25; $p=0.869$) when compared to those with mild pre-eclampsia respectively. Similarly, the severe pre-eclamptics had higher mean MCV (88.01±10.51 vs.87.79±11.73; $p=0.959$), MCH (28.46±2.83 vs.28.01±2.71; $p=0.692$), MCHC (32.53±3.07 vs.32.11±2.88; $p=0.727$) and RDW (13.72±1.04 vs.13.34±1.15; $p=0.380$) when compared with mild pre-eclamptics respectively. Furthermore, higher mean MPV(10.07±0.97 vs.9.43±0.75; $p=0.087$) and P-LCR (31.92±9.37 vs.27.98±7.54; $p=0.273$) but lower mean PDW (15.89±0.87 vs.31.64±47.39; $p=0.348$) and PCT (0.19±0.05 vs.0.26±0.04; $p=0.001$) were recorded in severe pre-eclampsia when compared with mild pre-eclampsia respectively. **Conclusions:** We observed higher mean haematocrit values for pre-eclampsia when compared with eclampsia and normotensive pregnancies. We also observed normocytic-normochromic red cell picture, neutrophilic leucocytosis and consumptive thrombocytopaenia in patients with pre-eclampsia and eclampsia; reflecting challenges posed by these diseases on the haematopoietic system during pregnancy. Furthermore and in keeping with disease progression, some of these haematological changes were noted to be more pronounced in severe pre-eclampsia when compared with mild pre-eclampsia.

Keywords: Haematocrit, White blood cell count, Platelet count, Pre-eclampsia, Eclampsia.

***Corresponding author:**
Dr. Abubakar U. Musa
Department of Haematology and Blood Transfusion, Usmanu Danfodiyo University Teaching Hospital Sokoto, Nigeria
Email:
abubakarumar38@yahoo.com

INTRODUCTION

Pregnancy induces maternal physiologic alterations that affect the haematopoietic system with resultant changes in haematological variables [1-4]. Physiologic changes in pregnancy include increase in maternal blood volume greater than the accompanying increase in red cell mass leading to a fall in haematocrit and a dilutional anaemia [5, 6].

Due to the selective immune tolerance, immunosuppression and immunomodulation induced by the fetus there is an attendant increased inflammatory response which has been reported to underlie the observed neutrophilic leucocytosis of pregnancy [1-3, 5, 6]. Additional explanation for the neutrophilia include impaired neutrophilic apoptosis and stress induced redistribution of leucocytes between the marginating and circulating pools [5, 6]. Thrombocytopaenia has been severally reported in pregnancy arising from a dilutional effect and increased consumption of platelets at the uteroplacental bed; but normal or increased platelet counts have also been observed [4, 5, 6]. It is pertinent to note that the pattern of haematologic changes in pregnancy could be influenced by nutritional status, presence of co-morbidities such as hypertensive disorders of pregnancy particularly pre-eclampsia and eclampsia, diabetes, renal diseases, haemoglobinopathy and infection as well as race and genetics [4-6].

In Sokoto Nigeria, 17% of pregnancies are complicated by hypertensive diseases of pregnancy with pre-eclampsia and eclampsia affecting 6% and 4.29% of pregnancies respectively [7, 8]. Pre-eclampsia is the occurrence of hypertension and proteinuria beyond 20 weeks of gestation while eclampsia is the occurrence of convulsions and or unexplained coma in association with pre-eclampsia [9, 10, 11, 12]. These disorders result from defective placentation with the abnormal placentae elaborating substances that mediate widespread arterial vasoconstriction, generalized inflammation, endothelial injury, activation of intravascular coagulation and deposition of microvascular thrombi in multiple organs [11, 12]. These effects manifest as hypertension, proteinuria, acute renal failure, pulmonary oedema, hepatic dysfunction, headache and seizures or convulsions [9, 11, 12].

Pre-eclampsia and eclampsia have been associated with worsening of the dilutional anaemia of pregnancy but higher haematocrit values have also been documented with pre-eclampsia due to the observed minimal or no expansion of maternal plasma volume and widespread vasospasm associated with it [13-16]. Exaggerated neutrophilic leucocytosis has been reported in pre-eclampsia and eclampsia and was attributed to the heightened stress-induced re-distribution of leucocytes between the marginal and circulating pools [15, 17-20]. With respect to platelet count, pre-eclampsia and eclampsia are reported to be associated with increased platelet activation and peripheral destruction leading to thrombocytopaenia and active turnover of platelet production [19, 21-25].

Thus, this study aimed to determine the haematocrit, white blood cell and platelet counts of patients with pre-eclampsia and eclampsia and compare these haematologic parameters with those of normotensive pregnancy.

METHODOLOGY

Study design, Study area and Study population:

This was a cross-sectional comparative study which involved consecutive recruitment of 93 pregnant women receiving care between Oct 2019 and Sept 2020 at the Departments of Obstetrics and Gynaecology Usmanu Danfodiyo University Teaching Hospital and Specialist Hospital Sokoto, Nigeria. The study participants were matched for gestational age and grouped into three groups of 31 each namely; pre-eclampsia, eclampsia and normotensive pregnancies.

Inclusion criteria:

Pregnant women with eclampsia. Pregnant women with pre-eclampsia. Pregnant women with normotensive pregnancies.

Exclusion criteria:

Previous history or family history of non-pregnancy related seizure disorders, haemostatic disorders or haemoglobinopathies. Presence of gestational trophoblastic diseases, pre-existing diabetes mellitus, systemic hypertension and renal disorders. Recent usage of drugs that could affect blood counts such as antibiotics, anticoagulants and steroids.

Definition of clinical variables:

i. Normotensive pregnancy: A positive plasma or urine pregnancy test corroborated by presence of intrauterine fetus via obstetric USS at gestational age of ≥20 weeks and a blood pressure of < 140/90 mmHg
ii. Pre-eclampsia: Pregnancy at gestational age of ≥20 weeks with blood pressure ≥140/90 mmHg on ≥2 occasions at least 6 hours apart with proteinuria of ≥1+ on 2 random urine samples 6 hours apart [9-12].
iii. Mild pre-eclampsia: Pre-eclampsia with systolic blood pressure of 140-159mmHg and diastolic blood pressure of 90-109mmHg [9].
iv. Severe pre-eclampsia: Pre-eclampsia with severe hypertension (systolic blood pressure ≥160 mmHg and or diastolic blood pressure of ≥110mmHg) [9].
v. Eclampsia: Occurrence of convulsions and/or unexplained coma during pregnancy or postpartum in patients with features of pre-eclampsia [9-12].

Laboratory tests

Three millilitres of free flowing venous blood were collected from each study participant with 2.5mls dispensed into tri-potassium ethylene di-amine tetra-acetic acid (K_3-EDTA) anticoagulated container for full blood count analysis and kept at room temperature until processing within 4 hours of collection. Full blood count was conducted via automation using Nortek 3-part differential haematology analyser using the impedance principle for blood cells count. A peripheral blood smear stained with Leishmann stain was examined to validate the findings of the haemogram.

Ethical Considerations

Approval to conduct this study was obtained from the Health and Ethics Research committees of the study centres while written informed consent was obtained from study participants.

STATISTICAL ANALYSIS

Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 21.0 (IBM Corp, Armonk, NY, USA). Shapiro-Wilk test was used to determine normality of data distribution. Quantitative data were summarized as means ± standard deviations and compared using Anova or Independent samples *t*-test as appropriate. Level of significance was set at $p < 0.05$.

RESULTS

Nine-three (93) pregnant women were recruited for this study and were categorized into three groups of 31 each namely; pre-eclampsia, eclampsia and normotensive pregnancy groups. The Mean±SD of ages were 30.52±6.73, 20.61±3.92 and 27.32±4.99 years for the pre-eclampsia, eclampsia and normotensive pregnant women respectively; p <0.001. There was no statistically significant difference in gestational age across the three study groups with 36.98±4.36, 37.14±1.79 and 37.73±1.23 weeks for pre-eclampsia, eclampsia and normotensive pregnancies respectively; p=0.140. For the eclampsia group, the prevalence of antepartum, intrapartum and post partum eclampsia were 11 (35.5%), 20 (64.5%) and 0(0%) respectively; while 9 (29.0%) and 22 (71.0%) of women with pre-eclampsia had mild and severe forms of pre-eclampsia respectively.

The haematologic parameters and the results of their comparison across study groups are captured in Table 1. The eclampsia group had significantly lower Mean±SD haematocrit value when compared with the pre-eclampsia group; 29.74±6.08 vs. 32.67±4.30 respectively, p=0.044. Though the pre-eclampsia group had higher mean

haematocrit value when compared with the normotensive group (32.67±4.30 vs. 32.24±3.02 respectively) this however didn't attain statistical significance; *p*=1.000. White blood cell counts were significantly different across all the three study groups with the eclampsia group recording highest values followed by the pre-eclampsia and then the normotensive group with Mean±SD values of 15.92±7.11, 8.02±2.11 and 4.61±2.78 respectively, *p*=0.001. The platelet counts were significantly lower with the eclampsia group who had a Mean±SD value of 203.10±64.86 when compared with the 212.19±59.01 and 266.23±65.29 recorded for the pre-eclampsia and normotensive groups respectively, p = 0.001. Similarly, the pre-eclampsia group had significantly lower platelet count when compared with the normotensive group. The red cell indices, white blood cell differential counts and platelet indices of study participants are as outlined in Table 1.

Table 1: Haematologic Parameters And Their Comparison Among Study Participants

Parameter	Participants			Anova		Post hoc test (*p* value)	
	Pre-eclampsia (P) n=31 Mean±SD	Eclampsia (E) n=31 Mean±SD	Normotensive (N) n=31 Mean±SD	F-test	P-value		
HCT (%)	32.67±4.30	29.74±6.08	32.24±3.02	3.625	0.031	P vs. E P vs. N E vs. N	0.044 1.000 0.108
MCV (fL)	87.95±10.68	89.35±5.80	81.29±4.66	10.178	0.000	P vs. E P vs. N E vs. N	0.796 0.008 0.000
MCH (pg)	28.33±2.76	29.00±2.76	28.27±3.80	0.525	0.593	-	-
MCHC (g/dl)	32.41±2.98	32.40±1.63	34.70±3.62	6.660	0.002	P vs. E P vs. N E vs. N	1.000 0.023 0.007
RDW-CV (%)	13.61±1.07	17.70±21.23	14.23±6.67	0.911	0.406	-	-
WBC count ($X\ 10^9$/l)	8.02±2.11	15.92±7.11	4.61±2.78	49.801	0.000	P vs. E P vs. N E vs. N	0.000 0.000 0.000
Differential GRA count (%)	66.49±9.77	72.93±12.14	73.44±6.67	4.861	0.010	P vs. E P vs. N E vs. N	0.063 0.005 0.978
Differential LYM count (%)	25.20±8.34	20.51±9.34	21.55±5.88	2.941	0.058		
Differential MON count (%)	8.31±4.90	7.55±6.35	4.83±2.63	4.385	0.015	P vs. E P vs. N E vs. N	1.000 0.018 0.092
Platelet count ($X\ 10^9$/l)	212.19±59.01	203.10±64.86	266.23±65.29	9.063	0.000	P vs. E P vs. N E vs. N	1.000 0.003 0.000
MPV (fL)	9.89±0.94	9.46±0.81	9.36±0.64	3.722	0.028	P vs. E P vs. N E vs. N	0.118 0.036 1.000
PDW (fL)	20.47±25.54	15.52±1.02	16.02±2.35	1.047	0.355	-	-
PCT (%)	0.21±0.05	0.19±0.53	0.25±0.06	8.420	0.000	P vs. E P vs. N E vs. N	0.787 0.016 0.000
P-LCR (%)	30.77±8.94	27.82±7.66	19.23±5.93	19.234	0.000	P vs. E P vs. N E vs. N	0.348 0.000 0.000

HCT= haematocrit; WBC= white blood cell; PLT= platelet; MCV=mean corpuscular volume; MCH=mean corpuscular haemoglobin; MCHC=mean corpuscular haemoglobin concentration; RDW: red cell distribution width; GRAN=granulocyte; LYM=lymphocyte; MON=monocyte; MPV=mean platelet volume; PDW=platelet distribution width; PCT=plateletcrit; P-LCR=platelet-large cell ratio

Reference Values: HCT 29.74-37.12%; WBC count 5.47-9.65 x 10^9 /l; PLT count 182.18-314.4 x 10^9 /l; MCV 75.36-86.14fL; MCH 22.59-28.35pg; MCHC 29.27-33.69g/dl; RDW-CV 10.92-15.54%; MPV 7.2-11.7 fL; PDW 10-18%; PCT 0.22-0.24%; P-LCR 15-35% (Musa *et al.,* 2016; Pogorzelska *et al.,* 2020)

Table 2: Haematologic Parameters And Their Comparison Among Participants with Mild and Severe Pre-eclampsia

Parameter	Participants		T-test	P- value
	Mild Pre-eclampsia n=9 Mean±SD	Severe Pre-eclampsia n=22 Mean±SD		
HCT (%)	33.23±5.56	32.44±3.80	0.460	0.649
MCV (fl)	87.79±11.73	88.01±10.51	-0.051	0.959
MCH (pg)	28.01±2.71	28.46±2.83	-0.040	0.692
MCHC (g/dl)	32.11±2.88	32.53±3.07	-0.352	0.727
RDW-CV (%)	13.34±1.15	13.72±1.04	-0.891	0.380

WBC count (X 10^9/l)	7.92±2.25	8.06±2.11	-0.167	0.869
Differential GRA count (%)	66.10±10.61	66.65±9.67	-0.133	0.896
Differential LYM count (%)	27.00±10.42	24.46±7.49	0.764	0.451
Differential MON count (%)	6.89±2.85	8.90±5.47	-1.037	0.308
Platelet count (X 10^9/l)	273.78±39.76	187.00±45.62	5.278	0.000
MPV (fL)	9.43±.0.75	10.07±0.97	-1.771	0.087
PDW (fL)	31.64±47.39	15.89±0.87	0.997	0.348
PCT (%)	0.26±0.04	0.19±0.05	4.037	0.000
P-LCR (%)	27.98±7.54	31.92±9.37	-1.118	0.273

HCT= haematocrit; WBC= white blood cell; PLT= platelet; MCV=mean corpuscular volume; MCH=mean corpuscular haemoglobin; MCHC=mean corpuscular haemoglobin concentration; RDW: red cell distribution width; GRAN=granulocyte; LYM=lymphocyte; MON=monocyte; MPV=mean platelet volume; PDW=platelet distribution width; PCT=plateletcrit; P-LCR=platelet-large cell ratio

Reference Values: HCT 29.74-37.12%; WBC count 5.47-9.65 x 10^9 /l; PLT count 182.18-314.4 x 10^9 /l; MCV 75.36-86.14fL; MCH 22.59-28.35pg; MCHC 29.27-33.69g/dl; RDW-CV 10.92-15.54%; MPV 7.2-11.7 fL; PDW 10-18%; PCT 0.22-0.24%; P-LCR 15-35% (Musa *et al.,* 2016; Pogorzelska *et al.,* 2020)

Table 2 depicts results for comparison of haematologic parameters between mild pre-eclampsia and severe pre-eclampsia. Significantly lower Mean±SD of platelet count was recorded for severe pre-eclampsia when compared with the mild pre-eclampsia (187.00±45.62 vs. 273.78±39.76 respectively; p =0.001). Similarly lower Mean±SD for haematocrit and white blood cell counts were observed with severe pre-eclampsia when compared to mild pre-eclampsia, though both observations didn't attain statistical significance 32.44±3.80 and 8.06±2.11 vs. 33.23±5.56 and 7.92±2.25 respectively; p<0.05.

DISCUSSION

As a response to the physiological stimuli provided by the foetus, pregnancy induces anatomical, physiological and biochemical changes that affect most organ systems of the body [1-6]. With regards to haematological parameters, documented changes include the dilutional anaemia of pregnancy, peripheral neutrophilic leucocytosis and varying patterns of platelet counts [4-6]. However, it is pertinent to note that the rate and magnitude of haematologic changes in pregnancy could be influenced by nutritional status, presence of co-morbidities such as hypertensive disorders of pregnancy particularly pre-eclampsia and eclampsia, diabetes, renal diseases, haemoglobinopathy, infection, race and genetics [4-6].

This study found women with eclampsia having the lowest haematocrit level when compared to both women with pre-eclampsia and normotensive pregnancy. A fall in haematocrit level and a consequent physiological dilutional anaemia has been documented in pregnancy; resulting from expansion of maternal blood volume much more than the accompanying increase in red blood cell mass and may be further worsened by the development of eclampsia as reflected in this study [5]. In agreement with our finding, Sibai *et al*., had earlier recorded significantly lower haematocrit level with the eclamptics when compared with the severe pre-eclamptics [13]. Similar to the finding, several other workers found higher haematocrit level with pre-eclampsia compared to normotensive pregnancy; a finding attributable to the minimal or no expansion of maternal plasma volume and widespread vasospasm observed in pre-eclampsia [14-16]. This increase in haematocrit was also found by some workers to be of predictive value in the early diagnosis of pre-eclampsia [14]. In contrast to this study, Ceyhan and colleagues didn't find any difference between women with pre-eclampsia and normotensive pregnant women with respect to haematocrit concentration [17].

Analysis of the red cell indices (MCV, MCH and MCHC) for all the three study groups in this study revealed a predominantly normocytic-normochromic red cell picture; though the eclamptics had significantly higher mean MCV and lower mean MCHC values when compared to both pre-eclamptic and normotensive pregnant groups. With regards to both MCH and RDW, higher mean values were encountered among the eclamptics when compared with the pre-eclamptics and normotensive pregnant groups; though this didnt attain statistical significance. Red cell macrocytosis in pregnancy has severally been documented in the literature and may be due to haematinic deficiency during pregnancy. Furthermore, and in contrasts to our observation, Avcioglu and colleagues from Turkey had reported significantly lower MCV, higher MCHC and higher RDW for the pre-eclamptics when compared with normotensive pregnant women respectively [26]. Probably in reflection of disease progression, severe pre-eclamptics recorded lower mean haematocrit but higher mean red cell indices (MCV, MCH, MCHC and RDW) when compared with mild pre-eclampsia; though none of these attained statistical significance; a finding similar to that of Asheeha *et al*., and Gogoi *et al*., in respect of haematocrit and RDW [19, 24].

Leucocytosis in normal pregnancy is documented by numerous workers and has been attributed to impaired neutrophilic apoptosis in pregnancy and increased inflammatory response as a consequence of selective immune tolerance, immunosuppression and immunomodulation induced by the fetus [5, 6]. Our finding of normal white blood cell count with normotensive pregnancy may be a reflection of the modifying effects of genetics and other environmental factors on haematological variables [4].

However, the occurrence of pre-eclampsia and eclampsia add up to the stress-induced redistribution of white blood cells between the marginal and circulating pools. This is reflected in our finding of significantly higher mean white blood cell count of neutrophilic predominance among the eclamptics when compared to the pre-eclamptic and normotensive pregnant women. In the same vein, both the pre-eclamptic and eclamptic women had higher mean differential monocytic and lymphocytic counts when compared with the normotensive pregnancies. Similar to the finding of some workers, women with pre-eclampsia in this study had higher white blood cell count when compared to the normotensive pregnant though this didn't attain statistical significance [17, 19, 26]. In contrast, significantly higher white blood cell count has been documented with pre-eclampsia compared to normotensive pregnancies by some workers [15, 20]. We also recorded higher mean white blood cell count of neutrophilic predominance, though not statistically significant, among severe pre-eclamptics when compared with mild pre-eclamptics; a finding similar to that of others [19].

There are varying findings in respect of platelet count in pregnancy with most studies reporting a decrease in platelet count during the last trimester of pregnancy; a finding attributed to dilutional effect and increased consumption of platelets within the utero-placental bed [5, 6]. Platelet count has been shown to further drop with the additional haemostatic challenge posed by pre-eclampsia and eclampsia (Osmanagaoglu *et al*., 2005; Annam *et al*., 2011; Khan *et al*., 2018) [20-

[23]. Though the mean platelet counts recorded for all the study groups in this study were within the normal reference range for the third trimester of pregnancy, the eclamptics however had the lowest mean platelet count while the pre-eclamptics had lower mean values when compared with the normotensive pregnancy. Our findings are similar to numerous other studies that found pre-eclamptics with significantly lower platelet count when compared with normotensive pregnancy [19, 24, 25]. In contrast to our finding, Ceyhan and Thalor didn't find significant difference in platelet counts of women with pre-eclampsia/eclampsia and normotensive pregnant women [17, 27]. As pre-eclampsia worsens, platelet count has been demonstrated to drop further; reflecting disease severity and this corroborate our finding of severe pre-eclampsia having significantly lower platelet count when compared to those with the milder form of the disease [17, 20, 21].

The effect of pre-eclampsia and eclampsia on platelet indices is that of increased platelet activation, increased peripheral destruction and active turn over of platelet production in the bone marrow [18]. This manifests as elevated mean levels of platelet indices alongside thrombocytopaenia. In line with this, we recorded higher mean MPV, PDW and P-LCR but lower PCT with pre-eclampsia and eclampsia when compared with mormotensive pregnancy. Both the separate works of Alkholy *et al*., and Thalor *et al*., found significantly higher mean values of MPV, and PDW with the pre-eclamptics when compared with normotensive pregnancy [25, 27]. In contrast, Alsheeha *et al*., didn't find difference between pre-eclamptics and normotensive pregnancy with regards to MPV and PDW [19].

With regards to severity of pre-eclampsia, similar to our findings, some studies have found no significant difference in MPV and PDW between the severe and mild form of pre-eclampsia [19], while others found these platelet indices to be significantly higher with the severe pre-eclampsia [25]. Among all the platelet indices analysed, our study found only PCT (an index which measures total platelet mass as a percentage of volume occupied in the blood) to be significantly lower with severe pre-eclampsia when compared with mild pre-eclampsia; a finding which supports further drop in platelet count as pre-eclampsia worsens.

CONCLUSION

During pregnancy, the occurrence of pre-eclampsia and eclampsia pose additional challenges to the haematopoietic system with resultant changes in haematological parameters. This study observed higher mean haematocrit values for pre-eclampsia when compared with eclampsia and normotensive pregnancies. We also observed normocytic-normochromic red cell picture, neutrophilic leucocytosis and consumptive thrombocytopaenia with both pre-eclampsia and eclampsia. Furthermore, some of these haematological changes were noted to be more pronounced with severe pre-eclampsia probably reflecting disease progression.

Conflict of Interest

We declare that we have no conflict of interest

Author's Contribution

All authors substantially contributed to components of this study which included but not limited to; conceptualization and design, data acquisition or analysis and interpretation, article drafting or critical revision as well as final draft approval.

Acknowledgements

We wish to acknowledge Dr. Sani Awwalu of the Department of Haematology and Blood Transfusion, Ahmadu Bello University Teaching Hospital Zaria, Nigeria for his assistance during data analysis of this study.

REFERENCES

1. Hoffbrand AV, Moss PAH. Pregnancy and Neonatal Haematology. In: Essential Haematology 6th edition. Willey-Blackwell Publishing Ltd USA, 2011; 414-416.
2. Mims MP, Prchal JT. Haematology during pregnancy. In: Lichtman MA, Kipps TJ, Kanshansky K, Beutler E, Seligsohn U, Prchal JT, editors. Williams Haematology. 17th ed. USA: McGraw Hill Inc.; 2006. p. 101-10.
3. Ramsay M. Normal hematological changes during pregnancy and puerperium. In: Pavord S, Hunt B, editors. The Obstetric Hematology Manual. UK: Cambridge University Press; 2010. p. 3-12.
4. Musa AU, Ndakotsu MA, Panti AA, Shehu CE, Kaoje AU. Haematological Variables of Healthy Pregnant Women in Sokoto, North-western Nigeria. Sub-Saharan African Journal of Medicine, 2016; 3:194-198
5. Kaur S, Khan S, Nigam A. Hematological profile and pregnancy: A review. Int J Adv Med 2014; 1:68-70.
6. Azab AE, Albasha MO, Jbireal JM, Hemady SY. Haematological Changes during Pregnancy: Insight into Anaemia, Leukocytosis and Thrombocytopaenia. East African Scholars Journal of Medical Sciences. 2020; 3(5):185-192.
7. Singh S, Ekele BA, Shehu CE, Nwobodo EI. Hypertensive Disorders in Pregnancy among Pregnant Women in a Nigerian Teaching Hospital. Niger Med J. 2014; 55(5):384-388
8. Ekele BA, Bello SO, Adamu AN. Clusters of Eclampsia in a Nigerian Teaching Hospital. Int J Gynaecol Obstet. 2007; 96(1):62-66.
9. World Health Organization (WHO). Recommendations for prevention and treatment of pre-eclampsia and eclampsia. World Health Organization, Geneva, Switzerland, 2011; 1-6.
10. American College of Obstetricians and Gynaecologists. Hypertension in pregnancy. In: ACOG Technical Bulletin. 1996 No: 219. ACOG, Washington DC, USA.
11. Sibai BM. Diagnosis, Prevention and Management of Eclampsia. Obstet Gynecol. 2005; 105:402-410.
12. Rodie VA. Pre-eclampsia and Eclampsia: Pathophysiology and Treatment Options. Rev Bras Hipertens. 2006; 13(2):88-95.
13. Sibai BM, Abdella TN, Hill GA, Anderson GD. Hematologic Findings in Mothers and Infants of Patients with Severe Pre-Eclampsia/Eclampsia, Clinical and Experimental Hypertension. Part B: Hypertension in Pregnancy. 1984; 3(1)13-21.
14. Galboni F, Heydarpour S, Taghidazadeh Z, Kazennezhad A. Predictive value of Plasma Haematocrit Level In Early Diagnosis of Pre-eclampsia. Eastern Mediterranean Health Journal. 2011; 17(10):744-748
15. Jhajharia N, Verma N. Haematological Changes in Pregnancy Induced Hypertension in Their Third Trimester at Jhalawar Medical College, Jhalawar India. International Journal of Reproduction, Contraception, Obstetrics and Gynaecology. 2019; 8(9):3497-3501
16. Basak SK, Begum K, Rashid M, Yasmin N, Begum H. Haematocrit Values in Pre-eclampsia. Bagladesh Journal of Obstetrics and Gynaecology. 2015; 30(2):80-85.
17. Ceyhan T, Beyen C, Baser I, Kaptan K, Gungor S, Ifran A. The effect of Preeclampsia on Complete Blood Count, Platelet Count and Mean Platelet Volume. Ann Hematol 2006; 85:320-322.
18. Pogorzelska K, Kretowska A, Krawczuk-Rybak M, Sawicka-Zukowska M. Characteristics of platelet indices and their prognostic significance in selected medical conditions-a systematic review. Advances in medical Sciences. 2020; 65:310-315.
19. Alsheeha MA, Alaboudi RS, Algasham MA, Iqbal J, Adam I. Platelet count and platelet indices in women with preeclampsia. Vascular health and Risk Management. 2016; 12:477-480.
20. Sitotaw C, Asrie F, Melku M. Evaluation of platelet and white cell parameters among pregnant women with Preeclampsia in Gondar Northwest Ethiopia: A comparative cross-sectional study. Pregnancy Hypertension. 2018; 13:242-247.
21. Osmanagaoglu, M. A., Topcuoglu, K., Ozeren, M., Bozkaya, H. (2005). Coagulation Inhibitors in Pre-eclamptic Pregnant Women. Arch Gynaecology & Obstetrics 271: 227-230
22. Annam V, Srinivasa K, Yatnatti SK, Suresh DR. Evaluation of platelet indices and platelet counts and their significance in preeclampsia and eclampsia. Int J Biol Med Res. 2011; 2(1):425-428.
23. Khan MN, Hameed A, Hassan A, Khan JK, Ashraf S. Comparison of platelet count, platelet indices and coagulation profile in preeclampsia and normal pregnancy. PJMHS. 2018; 12(4):1723-1726.
24. Gogoi P, Sinha P, Gupta B, Firmal P, Rajaram S. Neutrophil-to-lymphocyte ratio and platelet indices in pre-eclampsia. Int J Gynecol Obstet. 2019; 144:16-20.

25. Alkholy EA, Farag EA, Behery MA, Ibrahim MM. The significance of platelet count, mean platelet volume and platelet distribution width in preeclampsia. AAMJ. 2013; 11(1):200-214.
26. Avcioglu SN, Sezer SD, Altinkaya SO, Kucuk M, Omurlu IK, Yuksei H. Erythrocyt indices in patients with preeclampsia. Meandros Medical and Dental Journal. 2015; 16:35-42.
27. Thalor N, Singh K, Pujani M, Chauhan V, Agarwal C, Ahuja R. A correlation between platelet indices and preeclampsia. Hematol Transfus Cell Ther. 2019; 41(2):129-133.