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Hematological Profile of Pregnant Women in Port Harcourt, Nigeria

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ABSTRACT

Background: Pregnant women experience many changes, physiological or pathological, which are often reflected in their hematological indices. We hypothesized that there would be no significant variations in the mean FBC of pregnant and non-pregnant women, as well as no significant variations in the mean FBC of pregnant women during all trimesters. The study examines the differences in the hematological profiles of pregnant and non-pregnant women in Port Harcourt, in the Niger Delta region of Nigeria.

Methods: The subjects were systematically sampled, comprising of 90 pregnant and 90 non-pregnant women, with ages ranging 16 to 45 years. Five milliliters of whole blood was collected from each subject at ambient temperature using standard venipuncture techniques and three milliliters were dispensed in an ethylenediamine tetraacetic acid (EDTA) bottle to determine the hematological parameters such as total white blood count (TWBC), red blood cell count (RBC), platelet count (PLT), hemoglobin, hematocrit, mean cell volume (MCV), mean cell hemoglobin (MCH), and mean cell hemoglobin concentration (MCHC). The t-test was used to compare the mean of the parameters among the pregnant and non-pregnant women. An analysis of variance was used to compare the means for the parameters within the three trimesters of pregnancy. The Tukey's Post Hoc test was used to identify the trimester pairs that had a significant mean difference. The hematological parameters were analyzed using the Abacus 380 hematological analyzer. The data obtained were coded and analyzed using the SPSS version 20; data were considered significant at $p \leq 0.05$.

Results: Comparison of pregnant women with controls showed that TWBC, monocytes, neutrophils, MCV, and MCH were significantly increased during pregnancy ($p<0.05$); while RBC count, hemoglobin, hematocrit and MCHC were significantly decreased ($p<0.01$). The following hematological parameters showed significant mean variation within the 3 trimesters: MCH ($F=3.59$, $p=0.03$) and MCHC ($F=16.85$, $p<0.01$). MCHC showed a significant difference between the first versus second trimesters ($p \leq 0.01$) and the 1st vs. 3rd trimesters ($p \leq 0.01$) thus, null hypotheses were rejected.

Conclusion and Implications for Translation: The lower hematocrit and hemoglobin levels of pregnant women from Port Harcourt, Nigeria, when compared with the non-pregnant controls, implied that there is a need for more emphasis on the importance of prenatal vitamin supplementation during the antenatal period, perhaps leveraging prenatal counseling sessions. Proper supplementation may avert anemia in pregnancy, and consequently, the poor birth outcomes.

Keywords: Hematological Profile • Pregnant Women • Nigeria • Pregnancy

1. Background and Introduction

Pregnancy is usually associated with many changes in a woman, which can be physiologic or pathologic.[1] These changes are often reflected in the maternal hematological profile. Hematological indices reflect the individual's state of health, and that of a pregnant woman has been proven to affect both the pregnancy and its outcome.[2] During the first trimester, the performance of a maternal assessment through the review of the patient's medical history and characteristics, along with biochemical tests, can help in determining the risk for pregnancy-related complications such as macrosomia, intrauterine growth restriction (IUGR), fetal abnormalities, miscarriage, stillbirth, pre-eclampsia (PE), gestational diabetes mellitus (GDM) and preterm delivery.[3]

Hematological changes occur during pregnancy to ensure the efficient oxygen supply to the fetus. The pregnancy outcome may vary in response to the magnitude of the hematological change.[4] The main hematological changes that occur include physiologic anemia, neutrophilia, mild thrombocytopenia, elevation of procoagulant factors and diminished fibrinolysis.[5] The blood volume increases by more than 50% than that of the pre-pregnancy state, and starts from the 6th week of pregnancy.[6] This is attributed to a reduction of the atrial natriuretic peptide and an increased renin activity, which arise from the systemic vasodilation and an increased vascular capacitance that are induced by pregnancy.[7] There is a more pronounced elevation of blood volume in iron-deficient women, and in those who have had multiple pregnancies.[8] Hemoglobin concentration, hematocrit and red blood cell counts remain unchanged until the 16th week of gestation, which then start to decline.[4] Physiologic or dilutional anemia is a result of an increased ratio of plasma volume to red blood cells.[9] There is a slight increase in mean corpuscular volume (MCV), following an increase in erythropoiesis.[8]

White blood cell increase occurs early, and is sustained as such throughout gestation, due to physiological stress.[4,8] In differential count, the main leukocyte that is elevated is the neutrophil, most likely due to inefficient neutrophilic apoptosis, and while having an increased oxidative metabolism. Meanwhile, eosinophils and basophils are not significantly altered.[8] There is a decreased lymphocyte count in the first and second trimesters, but increases during the third semester. There is monocytosis, usually during the first trimester, but it declines as the pregnancy progresses.[8] Gestational leukocytosis arises from elevated inflammatory activities, which can be elicited by selective immune tolerance, immunomodulation and immunosuppression of the fetus.[10] There is a reduction in the circulating platelets during pregnancy, especially in the last trimester,[8] with elevated aggregation during the last 8 weeks of gestation.[4] Gestational thrombocytopenia, though usually mild and asymptomatic,[9] has a multifactorial etiology. This can be as a result of a platelet lifespan reduction in the uteroplacental circulation along with an increase in the consumption of platelets,[4] and an increase in platelet activation and dilution.[8]

In Nigeria, prior studies have assessed the hematological changes that occur during pregnancy among women in Port Harcourt (South),[11,12] Lagos (West),[13] and Sokoto (North).[14] In Port Harcourt, platelet count was recorded not to significantly vary during the three trimesters[11]; however, the hematocrit count had a significant mean variation within the three groups.[12] The researchers in Lagos reported that the Packed Cell Volume (PCV) and White Blood Cell (WBC) counts both had statistically significant associations with increasing gestational age.[13] The pregnant women in Sokoto were found to have no significant change in their hematocrits, WBC counts, and platelet indices.[14]

Some of these prior studies were not performed using a homogeneous number of subjects per trimester. This may have had a significant effect in the results obtained given that some hematological parameters can either increase or decrease during a given trimester. Also, none of the prior studies were carried out using the same method employed in the present study; also, the research is dated from a few years back.

As such, the present study was designed and implemented to evaluate Port Harcourt women's hematological indices during pregnancy at regular intervals.

This measurement is an important part of prenatal care, aids in assessing the pregnant woman's state of health, and potentially predicts the pregnancy outcome.

1.1. Objectives of the Study

The objectives of this study were to: ascertain and compare the mean Full Blood Count (FBC) of pregnant and non-pregnant women, and assess their mean variations at different stages/trimesters of pregnancy.

1.2. Hypothesis

We hypothesized that there would be no significant differences in the mean FBC of pregnant and non-pregnant women in Port Harcourt, and that there would be no significant differences in the mean FBC of pregnant women at the different trimesters.

2. Methods

This was an observational cross-sectional study. The study was carried out at the Military Hospital, Port-Harcourt, the capital of Rivers State, Nigeria. The participants of this research were pregnant and non-pregnant women who obtained medical services at the Military Hospital, Port Harcourt.

This study was performed using systematic sampling. Thirty (30) pregnant women per trimester were sampled, yielding a total number of 90 pregnant subjects. In turn, a total of 90 non-pregnant women were sampled; these subjects were women of apparent health who visited the health facility for other services such as family planning and immunization.

Inclusion and exclusion criteria: The subjects who participated in this study were between the ages of 16-45 years old, apparently healthy, had no chronic illness, and were registered at the Military Hospital. On the other hand, sick women who had either acute or chronic ailments, those not within the stated age range, those on certain medications, and subjects who were not registered in the facility were excluded from this study. Also, women who were menstruating were excluded from the control group.

Sample Size Determination: G-power version 3.0.10 was used to calculate the sample size; with parameters such as error of probability at 0.05, power (1-β error) set at 0.95 (95%), and with an effect size of 0.15. This yielded a sample size of 90 pregnant and 90 non-pregnant women (total of 180 subjects).

2.1. Study Variables

A total of five milliliters of whole blood were collected from each subject at ambient temperature using standard venipuncture technique. Three milliliters were dispensed in an ethylenediamine tetraacetic acid (EDTA) bottle and were used for the FBC assay. Using the Abacus 380 hematology analyzer (Diatron Group), the parameters that were determined were Total White Blood Count (TWBC), lymphocytes, monocytes, neutrophils, Red Blood Cell (RBC) count, hemoglobin, hematocrits, Mean Cell Volume (MCV), Mean Cell Hemoglobin (MCH), Mean Cell Hemoglobin Concentration (MCHC), and platelet (PLT) count.

The study drew upon core methodological principles. The *impedence method or coulter method* counts and sizes the cells by detecting and measuring changes in the electrical impedence when a particle in a conductive liquid passes through a small aperture. As each cell passes through the aperture, there is a constant direct current (DC) flowing between the external and internal electrodes, which causes some change in the impedance of the conductive blood cell suspension. These changes are recorded as increases in the voltage between the electrodes. The number of pulses is proportional to the number of particles. The intensity of each pulse is proportional to the volume of that particle. The volume distribution of the cells is displayed on diagrams: WBC, RBC, and PLT histograms.

The principle of hemoglobin measurement: The lysed sample dilution can be measured by a photometric method. The reagent lyses the red blood cells, which release hemoglobin. The chemical process forms stable hemoglobin, which is measured by a photometer on the chamber.

Hemoglobin Measurement Procedure

25 µl of anticoagulated (K_3 – EDTA) whole blood sample were aspirated into the sampling needle and mixed with 4 ml of diluent (Diatron Dill-Diff) and stored in the WBC chamber (MIX dilution). 25 µl of the MIX dilution were aspirated into the needle. Lysing reagent (Diatro Lyse-Diff) was added to the mix dilution held

in the chamber for WBC differential analysis. Four ml of diluent were added to the second dilution in the RBC chamber (using the 25 µl of mix dilution stored in the needle). This portion was analysed for RBC count, PLT count and their parameters. Parallel to this, the lysed dilution in the WBC chamber was measured. Hemoglobin concentration was also measured in the process. The unit was then washed using a cleaning solution and prepared for the next analysis.

2.2. Statistical Analysis

The data generated were coded, entered and analyzed using Statistical Package for Social Science (SPSS) version 20. The descriptive data were presented as means ± Standard Deviation (SD). Comparison of the Full Blood Count (TWBC, lymphocytes, monocytes, neutrophils, RBC count, Hemoglobin, PCV, MCV, MCH, MCHC, Platelet count), among pregnant and non-pregnant women was done using the t-test. The difference in mean FBC at various trimesters was determined by One-way Analysis of Variance (ANOVA). The Tukey Post Hoc test was used to identify the trimesters that had significant mean difference. Confidence Interval was set at 95% and data were considered significant at $p \leq 0.05$.

2.3. Data Collection and Socio-demographic Characteristics

Information such as age, religion, highest level of education, ethnicity, occupation and blood transfusion history, was obtained from all participants in this study. Only the pregnant women provided their gestational age, parity, history of pregnancy loss, means of previous pregnancy loss and blood pressure.

2.4. Ethical Approval

Ethical approval was obtained from the Ethics Committee of Military Hospital, Port Harcourt. Informed consent of each participant was sought for verbally.

3. Results

3.1. Socio-demographic Characteristics

The participants were predominantly within the age range of 18-30 years, Christians, had tertiary education, were from the Igbo tribe, and had not been previously transfused. Table 1 presents the breakdown of the socio-demographic characteristics that are common to both the test and control groups.

Table 1: Socio-demographic characteristics of subjects

Socio-demographic variables	Non-pregnant women (n=90)	Pregnant women (n=90)
	Frequency (%)	Frequency (%)
Age (years)		
18-30	49 (54.4)	45 (50.0)
31-40	40 (44.4)	41 (45.6)
>40	1 (1.1)	4 (4.4)
Mean age±SD (years)	30.76±5.6	30.73±6.0
Education		
Primary	4 (4.4)	3 (3.3)
Secondary	9 (10.0)	17 (18.9)
Tertiary	77 (85.6)	70 (77.8)
Non-formal	0 (0.0)	0 (0.0)
Ethnicity		
Igbo	46 (51.1)	43 (47.8)
Esan	1 (1.1)	3 (3.3)
Etche	1 (1.1)	4 (4.4)
Efik	2 (2.2)	1 (1.1)
Hausa	0 (0.0)	2 (2.2)
Yoruba	4 (4.4)	4 (4.4)
Ijaw	8 (8.9)	8 (8.9)
Ikwerre	3 (3.3)	3 (3.3)
Ogoni	7 (7.8)	8 (8.9)
Ibibio	8 (8.9)	7 (7.8)
Engeni	6 (6.7)	3 (3.3)
Idoma	4 (4.4)	4 (4.4)
Occupation		
Health worker	12 (13.3)	9 (10.0)
Unemployed	8 (8.9)	11 (12.2)
Legal practitioner	6 (6.7)	5 (5.5)
Farmer	5 (5.6)	4 (4.4)
Teaching/lecturing	11 (12.2)	11 (12.7)
Armed force	1 (1.1)	1 (1.1)
Student	13 (14.4)	10 (11.1)
Trader	9 (10.0)	15 (16.7)
Civil servant	14 (15.6)	15 (16.7)
Public servant	11 (12.2)	9 (10.0)
Transfusion history		
Yes	4 (4.4)	8 (8.9)
No	86 (95.6)	82 (91.1)

Table 2: Socio-demographic characteristics of subjects (only pregnant women)

Variables	Pregnant women (n=90)
	Frequency (%)
Gestational age (trimester)	
First trimester	30 (33.3)
Second trimester	30 (33.3)
Third trimester	30 (33.3)
Parity	
Primigravida	28 (31.1)
One	30 (33.4)
Two	22 (24.4)
Three	10 (11.1)
Pregnancy loss	
Yes	30 (33.3)
No	60 (66.7)
Means of pregnancy loss (N=30)	
Elective abortion	9 (30.0)
Miscarriage	15 (50.0)
Stillbirth	6 (20.0)
Blood pressure (mm/Hg)	
Mean systolic blood pressure ± SD	106.8 ± 14.5
Mean diastolic blood pressure ± SD	67.6 ± 11.7
Blood pressure status	
Normal	48 (53.3)
Pre-hypertension	21 (23.3)
Hypertension	5 (5.6)
Hypotension	16 (17.8)

The pregnant women were evenly distributed among the three trimesters. The majority of them had one child, no previous pregnancy loss, and were normotensive. Characteristics that are particular to only the test group are presented in Table 2.

3.2. Hematological Parameters of Subjects

The mean of all the measured hematological parameters were significantly different ($p<0.01$); except for the lymphocytes and platelet counts ($p=0.27$ and $p=0.10$, respectively). The TWBC, monocytes, neutrophils, MCV and MCH were higher; while the RBC count, hemoglobin, hematocrit and MCHC were lower among the pregnant subjects compared to non-pregnant (Table 3).

3.3. Hematological Changes at Different Trimesters of Pregnancy

MCH ($F=3.59$, $p= 0.03$) and MCHC ($F=16.85$, $p<0.01$) were the hematological parameters whose mean significantly varied in the three trimesters (Table 4).

3.4. Multiple Comparisons of Hematological Parameters among the Trimesters

The post hoc test showed no significant mean difference in TWBC, lymphocytes, monocytes, neutrophils, RBC, hemoglobin, hematocrits, MCV and platelets. MCH comparison between the 1st and 3rd trimesters was very close to significance ($p=0.06$). MCHC showed significant difference between the 1st vs. 2nd trimesters ($p=<0.01$), and 1st vs. 3rd trimesters ($p=<0.01$) (Table 5).

4. Discussion

The findings from this study are consistent with those from earlier research. This includes increased TWBC,[15,16,17,18,19,20] increased neutrophils,[15,18,19,20,21] decreased RBC count,[15,16,21] decreased hemoglobin,[15,16,17,18,19,20,21] decreased PCV,[15,16,17,18,20,21] increased MCV,[15] increased MCH,[15] and reduced MCHC.[16] Although the mean platelet count was lower in pregnancy, this was not a significant finding in this research.

The decreased PCV and hemoglobin seen among pregnant women in this study may be attributed to dilutional or physiologic anemia caused by a relative increase in the ratio of plasma volume to RBCs.[9] Also, the physiological stress of pregnancy increases the TWBC,[4] especially the neutrophils.[8] Gestational leukocytosis arises from elevated inflammatory activities, which can be elicited by selective immune tolerance, immunomodulation and immunosuppression of fetus.[10]

Some findings in the comparison of parameters among pregnant and non-pregnant women differ from those of some reviewed articles. The monocyte count in this study was significantly higher among pregnant subjects, unlike in some other research that reported lower values among pregnant women.[15,19,21] A possible explanation for

Table 3: Comparison of the hematological parameters among the subjects

Parameter	Non-pregnant (n=90)	Pregnant (n=90)	t	p-value
	Mean±SD	Mean±SD		
TWBC (10^9/l)	5.25±1.38	9.19±3.38	−10.25	<0.01*
Lymphocytes (10^9/l)	2.42±1.03	2.26±0.90	1.11	0.27
Monocytes (10^9/l)	0.43±0.19	0.94±0.66	−7.04	<0.01*
Neutrophils (10^9/l)	2.88±1.14	6.49 3.45	−9.43	<0.01*
RBC count (10^{12}/l)	4.63±0.58	3.93±0.68	7.37	<0.01*
Hemoglobin (g/l)	130.78±11.12	113.94±12.14	9.71	<0.01*
Hematocrit	0.39±0.03	0.34±0.03	11.49	<0.01*
MCV (fl)	85.57±5.42	88.38±5.04	−3.60	<0.01*
MCH (fmol)	1.81±0.14	1.87±0.14	−2.77	0.01*
MCHC (g/l)	347.10±21.86	321.30±27.80	6.92	<0.01*
Platelet count (10^9/l)	237.46±84.90	215.94±89.27	1.66	0.10

SD–Standard Deviation, TWBC– Total White Cell Count, RBC–Red Blood Cell, MCV–Mean Cell Volume, MCH–Mean Cell Hemoglobin, MCHC–Mean Cell Hemoglobin Concentration, *-Significant

Table 4: Analysis of variance (ANOVA) showing hematological changes at different trimesters of pregnancy

Parameters	Gestational age			F	p-value
	1st trimester (n=30)	2nd trimester (n=30)	3rd trimester (n=30)		
	Mean±SD	Mean±SD	Mean±SD		
TWBC (10^9/l)	9.21±2.86	9.36±3.02	9.01±4.20)	0.08	0.93
Lymphocytes (10^9/l)	2.58±0.80	2.15±0.80	2.07±1.03	2.91	0.06
Monocytes (10^9/l)	0.94±0.48	1.02±0.80	0.86±0.67	0.47	0.63
Neutrophils (10^9/l)	7.48±2.56	6.39±3.81	5.60±3.70	2.31	0.11
RBC count (10^{12}/l)	4.01±0.54	3.95±0.79	3.85±0.71	0.38	0.68
Hemoglobin (g/l)	115.78±9.60	112.75±12.44	113.28±24.13	0.53	0.59
PCV (%)	34.55±2.12	33.79±2.24	34.21±3.31	0.63	0.53
MCV (fl)	89.83±4.74	88.07±4.73	87.23±5.43	2.13	0.13
MCH (f/mol)	1.90±0.10	1.89±24.71	1.82±0.14	3.59	0.03*
MCHC (g/l)	300.65±25.44	331.93±24.71	331.33±21.27	16.85	<0.01*
Platelet count (10^9/l)	231.10±85.31	215.37±82.66	201.37±99.18	0.83	0.44

SD–Standard Deviation, TWBC–Total White Cell Count, RBC–Red Blood Cell, MCV–Mean Cell Volume, MCH – Mean Cell Hemoglobin, MCHC–Mean Cell Hemoglobin Concentration, *-Significant

this inconsistency may be that one study only sampled pregnant women in the third trimester,[15] and that monocyte count is known to decrease with pregnancy progression.[8] Similarly, another study had an unequal number of subjects per trimester, with the highest in third trimester; this might negatively skew the mean to be lower.[19] The third study did not state selection criteria and number of subjects per trimester, although their sample size was quite smaller than that of this study (40 vs. 90), thus, the possible source of this irregularity was not determined.[21] The first research hypothesis of no difference between the mean FBC among pregnant and non-pregnant women is hereby rejected due to the statistically significant difference that was recorded for most parameters.

Table 5: Post hoc test showing multiple comparisons of hematological parameters

Dependent variable	Trimester (I)	Trimester (J)	Mean difference (I-J)	p-value
TWBC (10^9/l)	1st trimester	2nd trimester	−0.14	0.99
		3rd trimester	0.20	0.97
	2nd trimester	1st trimester	0.14	0.99
		3rd trimester	0.34	0.93
	3rd trimester	1st trimester	−0.20	0.97
		2nd trimester	−0.34	0.93
Lymphocytes (10^9/l)	1st trimester	2nd trimester	0.43	0.17
		3rd trimester	0.51	0.09
	2nd trimester	1st trimester	−0.43	0.17
		3rd trimester	0.08	0.94
	3rd trimester	1st trimester	−0.51	0.09
		2nd trimester	−0.08	0.94
Monocytes (10^9/l)	1st trimester	2nd trimester	−0.08	0.90
		3rd trimester	0.09	0.88
	2nd trimester	1st trimester	0.08	0.90
		3rd trimester	0.17	0.63
	3rd trimester	1st trimester	−0.09	0.88
		2nd trimester	−0.17	0.63
Neutrophils (10^9/l)	1st trimester	2nd trimester	1.09	0.47
		3rd trimester	1.88	0.11
	2nd trimester	1st trimester	−1.09	0.47
		3rd trimester	0.79	0.67
	3rd trimester	1st trimester	−1.88	0.11
		2nd trimester	−0.79	0.67
RBC (10^{12}/l)	1st trimester	2nd trimester	0.06	0.94
		3rd trimester	0.15	0.69
	2nd trimester	1st trimester	−0.06	0.94
		3rd trimester	0.09	0.87
	3rd trimester	1st trimester	−0.15	0.69
		2nd trimester	−0.09	0.87
Hemoglobin (g/l)	1st trimester	2nd trimester	3.03	0.63
		3rd trimester	2.50	0.73
	2nd trimester	1st trimester	−3.03	0.63
		3rd trimester	−0.53	0.99
	3rd trimester	1st trimester	−2.50	0.73
		2nd trimester	0.53	0.99
Hematocrit	1st trimester	2nd trimester	0.008	0.54
		3rd trimester	0.003	0.88
	2nd trimester	1st trimester	−0.008	0.54
		3rd trimester	−0.004	0.83

(Contd...)

Table 5: Post hoc test showing multiple comparisons of hematological parameters *(Continued)*

Dependent variable	Trimester (I)	Trimester (J)	Mean difference (I-J)	p-value
	3rd trimester	1st trimester	−0.003	0.88
		2nd trimester	0.004	0.83
MCV (fl)	1st trimester	2nd trimester	1.77	0.39
		3rd trimester	2.60	0.14
	2nd trimester	1st trimester	−1.77	0.39
		3rd trimester	0.83	0.81
	3rd trimester	1st trimester	−2.60	0.14
		2nd trimester	−0.83	0.81
MCH (fmol)	1st trimester	2nd trimester	0.01	0.96
		3rd trimester	0.08	0.06
	2nd trimester	1st trimester	−0.01	0.96
		3rd trimester	0.08	0.10
	3rd trimester	1st trimester	−0.09	0.06
		2nd trimester	−0.08	0.10
MCHC (g/l)	1st trimester	2nd trimester	−31.29	<0.01*
		3rd trimester	−30.69	<0.01*
	2nd trimester	1st trimester	31.29	<0.01*
		3rd trimester	0.60	1.00
	3rd trimester	1st trimester	30.69	<0.01*
		2nd trimester	−0.60	1.00
Platelets (10^9/l)	1st trimester	2nd trimester	15.73	0.79
		3rd trimester	29.73	0.44
	2nd trimester	1st trimester	−15.73	0.79
		3rd trimester	14.00	0.83
	3rd trimester	1st trimester	−29.73	0.44
		2nd trimester	−14.00	0.83

SD–Standard Deviation, TWBC–Total White Cell Count, RBC–Red Blood Cell, MCV–Mean Cell Volume, MCH–Mean Cell Hemoglobin, MCHC–Mean Cell Hemoglobin Concentration, *-Significant

The analysis of variance used to assess the mean FBC among the three trimesters only revealed that with increasing gestational age, there was a significant difference in MCH and MCHC. The second hypothesis of this study was thereby rejected, as it stated that there was no significant difference in the mean FBC at different trimesters. It is recommended that new studies among pregnant women should be prospective longitudinal, unlike the present study which was cross-sectional.

5. Conclusion and Implications for Translation

For the pregnant women of Port Harcourt, Nigeria, the findings of this study showed a significant increase of TWBC, neutrophils, MCV and MCH; while RBC count, hemoglobin, PCV and MCHC decreased. There was no significant difference for lymphocytes, and platelet counts. The hematological parameters that showed a significant variation within the trimesters were MCH and MCHC. For the multiple comparisons among the trimesters, MCHC showed a significant difference between the 1st vs. 2nd trimesters, and the 1st vs. 3rd trimesters.

The lower hematocrit and hemoglobin levels in pregnant women when compared with the non-pregnant controls, implied that there is a need for more emphasis on the importance of prenatal vitamins during the antenatal care period. This could

be addressed during prenatal counseling sessions. This will avert anemia in pregnancy, and consequently, avert poor birth outcomes.

Compliance with Ethical Standards

Conflicts of Interest: *The authors declare no competing interest.* ***Financial Disclosure:*** *Nothing to declare.* ***Funding/Support:*** *There was no funding for this study.* ***Ethics Approval:*** *Ethical approval was obtained from the Ethics Committee of the Military Hospital, Port Harcourt. Informed consent of each participant was sought for verbally.* ***Acknowledgments:*** *We acknowledge the compliance of the medical staff at Military Hospital, Port Harcourt and the subjects that willingly participated.* ***Disclaimer:*** *This publication was supported by the Global Health and Education Projects, Inc. (GHEP) under the Emerging Scholar's Grant Program (ESGP). The information, contents and conclusions are those of the authors and should not be construed as the official position or policy of, nor should any endorsements be inferred by ESGP or GHEP.*

Key Messages

- The study showed that during pregnancy there is a significant increase in the total white blood count (TWBC), neutrophils, mean cell volume (MCV), and mean cell hemoglobin (MCH); while there is a decrease in red blood cell (RBC) count, hemoglobin, packed cell volume (PCV) and mean cell hemoglobin concentration (MCHC); and no difference in lymphocytes and platelets (PLT) counts.
- Women who are pregnant have lower hematocrit and hemoglobin levels than non-pregnant women.
- The decrease in the hematological parameters of pregnant women could be addressed through prenatal counseling and vitamins supplementation.

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