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The Impact of Body Mass Index on Haematological Parameters of Pregnant Women at Booking in Ilorin, Nigeria

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ABSTRACT: **Background**: Pregnancy is associated with physiological changes that affect almost all of the systems in the body, including weight gain; these changes accommodate the demands of the feto-placental unit. Therefore, hematological parameters in pregnancy may not be comparable with those of non-pregnant women. **Methodology**: A total of 500 pregnant women were consecutively recruited at booking, and 465 met the inclusion criteria. Their blood samples were analyzed for some blood indices, which were compared with their body mass indices and sociodemographic characteristics. **Results**: The mean levels of Mean Corpuscular Volume(MCV) and Mean Corpuscular Hemoglobin Concentration(MCHC) were 82.2 fl ± 8.4 and 34.0 g/dl ± 1.9, respectively, which were within the normal reference values but close to the lower limits. The hemoglobin concentration was low (10.5 g/dl), whereas the erythrocyte sedimentation rate was high (34.1 mm/hr). Hematological parameters were compared by trimesters. MCV and Mean Corpuscular Hemoglobin (MCH) increased across the trimesters, with P values of 0.0007 and 0.011, respectively (P< 0.05). PCV was also inversely proportional to the gestational age (P0.026). There was no statistically significant difference when BMI and hematological parameters were compared (P>0.05), although RBC and PCV values increased as the maternal weight increased, suggesting a probable positive correlation between the red cell count and concentration and body mass index in pregnancy. **Conclusion:** This study confirmed the hemodilutional effect of pregnancy and suggests a relationship between BMI, RBC and PCV in pregnancy. Body weight may increase the red cell parameters in pregnancy.

Keywords: body mass index, hematological parameters, maternal weight, pregnancy.

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1.1 INTRODUCTION

Laboratory parameters in pregnancy are different from those of non-pregnant women because of the physiological changes that occur during pregnancy. [1] These changes include an increase in the plasma volume by 30-45%, [2] which results in a general hemodilution known as the physiological anemia of pregnancy. The progressive physiological changes that occur are essential to support and protect the developing fetus and prepare the mother for parturition. [3] In view of these changes, the reference values of laboratory parameters differ from those of non-pregnant women. These parameters are valuable in diagnosing abnormalities in pregnancy and predicting abnormalities before symptomatology develops; they are also important in the monitoring of disease and response to therapy under specific clinical conditions.

Hematological parameters are affected by many factors, such as age, sex, diet, recent nutritional status, and consumption of medications or illicit drugs [4]. Environmental factors and ethnic and tribal peculiarities have also been implicated [5]. Unfortunately, most reference values are based on Caucasian populations, which may not be applicable to all populations, especially African populations, in which there are genetic adaptations to some prevalent infections, such as malaria. Additionally, the pregnant state has its own set of characteristics. There is a need to determine applicable references in view of the previously mentioned factors. Although some studies are available on this subject in Nigeria, many were carried out at non-specific times in pregnancy and did not depend on the type of care received.

Hematological parameters are useful in risk assessment in pregnant women, and the booking visit provides an opportunity for assessing these parameters. It is also a starting point for interventions in pregnancy. This study is aimed at determining the acceptable limits of blood indices in healthy pregnant women when they present for antenatal care and determining the impact of body mass index on the blood indices. This study also compared the pattern/trend of these indices across trimesters with other studies.

1.2 MATERIALS AND METHODS

The study was conducted at the antenatal clinic of the University of Ilorin Teaching Hospital, Ilorin, Nigeria, between March and June 2006. The hospital attends to the population of the Ilorin metropolis, surrounding towns and communities. It also serves as a referral center for health facilities in the middle belt and parts of south-western Nigeria. Ilorin is located in the north-central geopolitical zone of Nigeria, an area of stable malaria transmission year round.

All consecutive healthy pregnant women who presented for booking at the antenatal clinic of the hospital and consented to the study were recruited during the study period. The socio-demographic data, history of fever, and treatment of any febrile illness within the last fourteen days were collected. Pregnant women with fever at

presentation, those being treated for febrile illness, and those with underlying medical conditions, such as hypertension and sickle cell anemia, were excluded from the study. The height, weight and vital signs of the participants were measured, and complete medical and obstetric examinations were also performed. The body mass index (BMI) was calculated as the following:

$$\frac{\text{Weight (kg)}}{\text{Height (m}^2\text{)}}$$

BMI classification was performed as follows: < 18 kg m^{-2} = underweight; normal weight= 18- 24.9 kg m^{-2}; overweight=25-29.9 kg m^{-2}; and obese $\geq$30 kg m^{-2}.

In total, 5 ml of blood was collected from each participant into an EDTA bottle by venipuncture using an aseptic technique. The mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), white blood cell count (WBC), absolute RBC count, platelet count, hemoglobin level and packed cell volume (PCV) were determined using a Sysmex KX 21 automated cell counter.

The data were entered into a Microsoft excel data sheet. Statistical analyses were performed using Epi–info statistical software, version 2005. Associations between variables were tested using the chi-square test for discrete variables and the Student t-test for continuous variables. Analysis of variance tests were used to compare the means of hematological parameters. The level of statistical significance was designated as P less than or equal to 0.05 ($p \leq 0.05$).

1.3 RESULTS

A total of 465 pregnant women who satisfied the inclusion criteria at booking were included. The sociodemographic characteristics of these women are shown in Table 1. Primiparous women accounted for 60% of the studied population, and 59.6% were in the second trimester. The mean maternal weight and body mass index in the first, second and third trimesters were 60.7 kg, 66.9 kg and 72.5 kg, respectively, and 23.1 kgm^{-2}, 25.2 kg/m^2 and 26.8 kg/m^2, respectively. The mean height of all women studied was 1.63 m ± 0.01 (range 1.5- 1.8 m).

TABLE 1: SOCIODEMOGRAPHIC CHARACTERISTICS OF THE PREGNANT WOMEN AT BOOKING.

Variables	Freq (%) N=465
Age	
≤ 19	18 (3.9)
20 – 24	58 (12.5)
25 – 29	213 (45.8)
30 – 34	118 (25.4)
35 – 39	45 (9.7)
≥ 40	13 (2.8)
Parity	
Nulliparous	8 (1.7)
Para 1	279 (60)
Para 2	98 (21.1)
≥ Para 3	80 (17.2)
Level of Education	
None	11 (2.4)
Primary	36 (7.7)
Secondary	105 (22.6)
Tertiary	313 (67.3)
Marital Status	
Single	15 (3.2)
Married	450 (96.8)
Gestational Age	
First trimester	52 (11.2)
Second trimester	277 (59.6)
Third trimester	136 (29.2)

Variables	Freq (%) N=465

The mean values of the hematological parameters are shown in Table 2, and these values are compared with gestational age and BMI in Tables 3 and 4.

Table 2:Ranges and Means of Hematological Parameters

Parameters	Range	Mean	SD
MCV	26 – 101	82.21fl	±8.40
MCHC	22- 39	33.97 g/l	±1.90
MCH	20 - 38	28. 65pg	± 2.81
WBC	1.8 – 17	$6x10^9$/l 76 $x10^9$/l	± 2.20
Platelets	4.8 – 386.0	181.05 $x10^9$/l	± 70.74
Hb	3.3 - 20	10.53 g/l	± 1.79.
ESR	13 – 65	34.11 mm/hr	± 11.46
RBC	21 – 37	4.17	± 2.63
PCV	19 – 57	31.16%	± 3.75

Table 3: Comparisons of the Mean Values of Parameters with Gestational Age

Parameters	Means (SD)	F Statistics	P-Value
MCV			
1st Trimester	78.63 (9.85)		
2nd Trimester	83.21 (6.51)	7.32	0.0007
3rd Trimester	81.53 (10.58)		
MCHC			
1st Trimester	33.73 (2.15)		
2nd Trimester	34.04 (1.83)	0.67	0.5127
3rd Trimester	33.91 (1.95)		
MCH			
1st Trimester	27.58 (3.76)		
2nd Trimester	28.85 (2.61)	4.55	0.011
3rd Trimester	28.65 (2.69)		
WBC			
1st Trimester	6.24 (1.93)		
2nd Trimester	6.75 (2.15)	2.21	0.1111
3rd Trimester	6.99 (2.38)		
PLATELETS			
1st Trimester	196.08 (63.55)		
2nd Trimester	182.82 (71.62)	2.46	0.0862
3rd Trimester	171.70 (70.76)		

Hb	10.83 (1.25)		
1st Trimester	10.41 (1.90)	1.78	0.1703
2nd Trimester	10.67 (1.72)		
3rd Trimester			
ESR	30.88 (10.73)		
1st Trimester	34.74 (11.44)	2.50	0.0831
2nd Trimester	34.06 (11.65)		
3rd Trimester			
RBC	4.02 (0.53)		
1st Trimester	4.24 (3.20)	0.18	0.8373
2nd Trimester	4.17 (1.54)		
3rd Trimester			
PCV	32.04 (3.14)		
1st Trimester	30.86 (3.99)	3.78	0.0236
2nd Trimester	31.66 (3.37)		
3rd Trimester			

Table 4: Comparisons of the Mean Values of Parameters with BMI

Parameters	**Means (SD)**	**F Statistics**	**P-Value**
MCV			
Underweight	85.27 (6.96)		
Normal	82.18 (8.80)		
Overweight	81.55 (8.48)	1.42	0.2358
Obese	83.39 (5.46)		
MCHC			
Underweight	34.64 (1.63)		
Normal	34.11 (1.89)		
Overweight	33.77 (2.19)	1.44	0.2290
Obese	34.18 (1.49)		
MCH			
Underweight	29.45 (2.91)		
Normal	28.67 (3.03)		
Overweight	28.57 (2.60)	0.38	0.7685
Obese	28.75 (2.28)		

WBC			
Underweight	7.82 (1.63)		
Normal	6.61 (2.15)		
Overweight	6.96 (2.17)	1.66	0.1749
Obese	6.77 (2.47)		
PLATELETS			
Underweight	181.36 (71.86)		
Normal	187.13 (70.57)		
Overweight	173.31 (71.32)	2.04	0.1071
Obese	168.92 (63.80)		
Hb			
Underweight	10.15 (1.11)		
Normal	10.43 (1.81)		
Overweight	10.63 (1.67)	0.89	0.4481
Obese	10.72 (2.07)		
ESR			
Underweight	37.64 (11.68)		
Normal	33.60 (11.71)		
Overweight	35.70 (10.53)	1.38	0.2493
Obese	34.24 (12.33)		
RBC			
Underweight	3.52 (0.43)		
Normal	3.96 (1.22)		
Overweight	4.59 (4.18)	2.15	0.0925
Obese	4.22 (1.63)		
PCV			
Underweight	29.55 (3.05)		
Normal	30.98 (4.03)		
Overweight	31.32 (3.31)	2.54	0.0554
Obese	32.07 (3.64)		

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1.4 DISCUSSION

During pregnancy, the levels of different hematological parameters generally decrease because of hemodilution and increased needs. [2] Accordingly, hematological parameters, such as hemoglobin concentration and hematocrit, were decreased in our

study group. These results are in agreement with studies performed in various races and tribes within and outside Nigeria .[5,6,7,8] The small differences between this study and reference values in other studies may be related to genetic variations due to race, climate or other environmental factors. The MCV values in this study were lowest in the first trimester, increased to their highest in the second trimester and declined in the third trimester, and these differences were statistically significant. This pattern is in agreement with findings in Jamaican primigravid women seen at the first antenatal visit in the West Indies. [9] However, they were slightly lower than the reference values reported by Abassi-Ghanavati et al in the USA; the values were based on the review of several studies on the laboratory results of normal pregnant women. [10] Generally, MCV has been reported to increase in pregnancy, meaning that the red cell volume increases in pregnancy, and the increase appears to be significant in the second trimester. This result most likely suggests a compensatory increase in the volume because of the hemodilution anemia that occurs in pregnancy. This "physiological anemia" of pregnancy is demonstrable by the low hematocrit and hemoglobin levels in pregnant women compared with non-pregnant adults. The similar pattern observed with MCH in this study and by others most likely corroborates the explanation for the MCV increase in pregnancy.

Therefore, it appears that the low levels of hematocrit and hemoglobin in pregnancy are compensated for by the increased individual cell volume and hemoglobin concentration in red cells such that hemodilution anemia may not affect the mother if there is no other pathology. Also, in this study, PCV was highest in the first trimester, declined in the second trimester and increased in the third trimester. RBC values were constant throughout pregnancy. These findings were within the expected physiological norms and are comparable with global findings. There was a steady decrease in the platelet count throughout pregnancy. This result is similar to results from a Jamaican study [9], but the mean platelet values in the three trimesters were lower than values obtained by Abassi-Ghanavati et al and Akingbola et al in Ibadan, Nigeria.[10,11] However, the ESR increased in the second trimester but decreased minimally in the third trimester. The increase in ESR is in keeping with findings from other studies. The plasma volume increases throughout pregnancy until approximately the thirty-second week, after which it plateaus.[6] This plateau could account for the fairly constant values in the second and third trimesters.

The mean values of WBC obtained in this study were comparable to findings by other authors across Nigeria.[5,8,11] The increase in WBC observed in pregnancy, specifically the steady increase as pregnancy advances, is further supported by this study. Although the values appear lower than results obtained in the USA and Jamaica, [9, 10] this difference may most likely be due to racial differences.

This study has shown that values of hematological parameters may vary considerably in pregnancy, although they may be comparable. We suggest that standards for references should be based on local studies, even in the same geographical locations.
A unique aspect of this study is the comparison between hematological parameters and the body mass index of the pregnant women at booking. Generally, the comparisons did not yield statistical significance, but some observations are worth mentioning. The MCH and hemoglobin concentration were not influenced by maternal weight, but MCH and MCV were highest among the underweight. Our finding contradicts the significantly high levels of MCHC and MCV found in overweight Thai women and men, most likely because the Thai study involved both sexes, and pregnancy was not a common factor.[12] The RBC and PCV values increased as the maternal weight increased, suggesting a probable positive correlation between the red cell count and concentration in pregnancy. A Japanese study showed a significant increase in hematocrit levels in both pregnant and non-pregnant obese women and suggested that the high frequency of pre-eclampsia among pregnant women with obesity was due to increased hematocrit and blood viscosity, which were factors predisposing women to pre-eclampsia. [13] Further research may lead to pre-conception therapy for the prevention of pre-eclampsia. The reason for the constant values of hemoglobin and MCHC regardless of maternal weight needs further clarification. However, a definite pattern could not be demonstrated with respect to MCV and platelet counts. Therefore, it is possible that maternal weight does not influence hemoglobin during pregnancy but possibly contributes to the red cell mass and concentration in pregnancy. The WBC count appeared constant in the various weight groups; however, it was highest in the underweight group, although this difference was not statistically significant. Similarly, the leucocyte count has been shown to be higher in underweight pregnant women in Serbia,[14] and it was significantly associated with anemia. Well-balanced nutrition is required for the regular functioning of the entire body, and this is reflected by the weight.

1.5 Conclusion

The mean values of the hematological parameters of apparently healthy pregnant women at booking in Ilorin are comparable with those of other women in other parts of the country and showed minimal differences from women outside the country, most likely because of race, environment and geographical variations. The parameters are not significantly influenced by weight. It is still important to assess these parameters in pregnancy regardless of the apparent physical wellness, as some women may have abnormally low values that may adversely affect maternal and fetal outcome. Therefore, it is recommended that a review of blood parameters be performed at booking for all pregnant women, regardless of their weight and socioeconomic status.

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