Hematological profile in pregnancy and its effect on birth outcomes; a longitudinal study of the Komfo Anokye Teaching Hospital, Kumasi

Olivia Nyarko-Mensah[1,2], Kweku Bedu- Addo[1], Alex T. Odoi[3], Prince Adoba[4], Richard K.D Ephraim[5]

[1]Department of Physiology, School of Medical Sciences, Kwame Nkrumah University of Science and Technology

[2]Kumasi Nursing and Midwifery Training College, Kumasi

[3]Department of Obstetrics and Gynaecology, School of Medical Sciences, Kwame Nkrumah University of Science and Technology

[4]Department of Molecular Medicine, School of Medical Sciences, Kwame Nkrumah University of Science and Technology

[5]Department of Medical Laboratory Sciences, School of Allied Health Sciences, University of Cape Coast

RKDE: rephraim@ucc.edu.gh

KBA: kwekuba@yahoo.com

ATO: dratodoi@yahoo.com

PA: adobaprince@yahoo.com

ONM: maameesi20@yahoo.ca

Abstract

Background: Pregnancy causes remarkable and dramatic changes in hematological variables which have an impact on pregnancy and its outcome.

Objective: This descriptive longitudinal study examined maternal hematological parameters during pregnancy and its effect on pregnancy outcomes.

Methods: Three hundred and fifty (350) pregnant women with singleton pregnancies who delivered at the Obstetrics and Gynecology Unit of the Komfo Anokye Teaching Hospital (KATH) were randomly selected into the study. Blood sample was collected from each

participant for the estimation of full blood count (FBC) and a well-structured questionnaire was used to collect socio-demographic data and obstetric history of participants.

Results: Haemoglobin levels steadily decreased from first to the third trimester, with a rise during parturition and neonatal periods. Anemia was most prevalent in the third trimester of pregnancy (47.1%). WBC increased from the first trimester till the puerperium,platelet (PLT) count was similar in the three trimesters, with a significant decrease at parturition and puerperium. Except for the mean corpuscular volume (MCV), all the other hematological indices did not show a significant correlation with Apgar score < 7 at the 5th minute in our study ($P > 0.05$). No correlation was found between maternal hematological indices at parturition and neonatal birth weight ($P > 0.05$). Maternal white blood cell (WBC) count showed a positive significant relationship ($\beta = 0.095$, $P = 0.012$) with the neonatal WBC count.

Conclusion: Pregnant women have altered hematological indices during pregnancy, parturition and puerperium. Parturient hematological indices did not have any significant association with Apgar score < 7 at the 5th minute and birth weight.

Keywords: Hematological indices, parturient, Apgar score, birth weight, birth outcome

Introduction

Maternal and child health is an important public health problem that influences the development of the family and the community. Pregnancy is characterized by many physiological changes, which may appear to be pathological in the non-pregnant state [1]. It is capable of causing remarkable and dramatic changes in hematological variables [2].

Anaemia is a widely identified hematological abnormality. Although recent study in the prevalence of iron deficiency anemia in pregnancy worldwide suggests a decline in the

industrialized regions, more than half of pregnant women are still anemic, with about 80% of them found in the middle and low income countries such as Ghana [3, 4].

Factors such as the inadequate intake and absorption of iron coupled with the loss of blood during pregnancy might also be some of the precipitating causes of anemia during pregnancy, research has shown that it is related to adverse pregnancy outcomes such as maternal mortality, premature deliveries and low birth weight [5, 6]. A number of studies have also suggested that a fall in maternal hemoglobin is associated with a significant rise in perinatal mortality rate [7, 8]. Few studies have assessed the effect of hematological indices on pregnancy outcomes in Africa. Even among these published works, most examined the hematological parameters only during the three trimesters of pregnancy. There is therefore a need to monitor the hematological profile during pregnancy, at parturition and in the puerperal stage and its effects on neonates. This study is aimed to examine maternal hematological parameters during pregnancy, parturition and neonatal period and to determine its effect on pregnancy outcomes at the Komfo Anokye Teaching Hospital in the Ashanti region of Ghana.

Methods

Study Design/ Study Setting

This is a descriptive longitudinal study conducted at the Komfo Anokye Teaching Hospital (KATH) in Kumasi, Ghana. It is the second largest hospital in the country and the only tertiary health institution in the Ashanti Region. KATH (Gee) as known by the public is one

of the autonomous and self-funded referral centers within the northern sector of Ghana consisting of the Ashanti, Brong Ahafo, Northern, Upper East and Upper West Regions.

Study Population

A total of 350 pregnant women with singleton pregnancies who delivered at the labour ward of Obstetric and Gynaecological unit were randomly enrolled into the study. Pregnant women or parturients who did not agree to the terms of the study and therefore did not consent to be part of the study were excluded. Mothers with multiple pregnancies and pregnant women who were psychologically unstable were also excluded from the study.

Ethical Considerations:

Approval for the study was sought from the KATH Research and Development unit and the Committee on Human Research Publication and Ethics (CHRPE), SMS, KNUST.

Consent:

Informed written consent was obtained from the participants after adequate counseling on the objectives and benefits of the study. The study was conducted based on WHO Guidelines for good clinical practice (WHO, 1995).

Questionnaire administration and data collection

A well-structured pre-tested questionnaire was used to obtain demographic, obstetric and other relevant clinical data from consented participants. Demographic data on age, marital status, educational status, occupation, religion and ethnicity was recorded. We also obtained obstetric data like the number of antenatal visits, history of previous pregnancy, parity and gravidity, gestational age, history of premature delivery. Other relevant clinical data like the

presence or absence of haemoglobinopathies or enzymopathies, history of anemia, history of iron supplementation, history of blood transfusion were also obtained from participants.

Blood Sampling:

Mother: Five (5) mls of venous blood was collected into a labeled ethylenediaminetetra acetic acid (EDTA) tube.

Baby (Neonate): Three (3) mls cord blood was aspirated from the umbilical vein and transferred into a labeled ethylenediaminetetra acetic acid (EDTA) tube.

Hematological Analysis

The full blood count was estimated by an automated hematology analyzer (Mindray BC-3000 plus system, China). Standardization, calibration of the instrument, and processing of the samples were done according to the manufacturer's instructions.

Determination of Apgar score and Body Mass Index

The Apgar scores, the length and weight of the newborn were evaluated immediately after birth in the delivery room at the labour ward. The Apgar scores were determined at 1st minute and the 5th minute after birth. The BMI (Body Mass Index) of the baby was calculated after the fifth minute of birth.

Data Analysis

Data was entered into Microsoft Excel and analyzed with SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). The results were expressed as mean ± SD and ANOVA was used to compare means. Correlation and linear regression analyses were used to find relationship between variables. A P value of ≤ 0.05 was considered statistically significant.

Results

Table 1 shows the obstetric history of the study participants. Majority of the participants 300/350 (85.7%) attended the antenatal clinic 1–5 times before delivery. Most 252/300 (72%) of them were multigravida, while about 199/300 (57%) have one living child.

Hemoglobin levels steadily decreased from first trimester to third trimester, and was followed by a rise during parturition and puerperal stage. HCT and MCV were similar during the first, second and third trimesters, but increased at parturition and the puerperal stage. The trends of RBC, MCH and MCHC were comparable at first to third trimesters, but there was a decrease at parturition followed by a rise in the puerperal stage except for the RBC which continued to decrease. Furthermore, PLT and PCT were similar in all the trimesters of pregnancy but there was a dramatic decrease at parturition and a sharp increase in PCT at neonatal stage. On the other hand, WBC increased steadily from the first to third trimesters, with a significant increase during parturition and neonatal stages as shown in Figure 1.

MCV showed a significant negative correlation with Apgar score < 7 after the 5^{th} minute. The other full blood count indices did not show a significant correlation with Apgar score < 7 after the 5^{th} minute as shown in Table 2.

The prevalence of anemia at the various trimesters of pregnancy is presented in Figure 2. Anemia was most prevalent in the third trimester of pregnancy followed by the second trimester and puerperal period. The least prevalence was observed in the first trimester.

Table 3 compares the hematological indices at different gestational periods. A significant difference ($P < 0.05$) was found between all the hematological indices at parturition and the various trimesters, except for the MCV in the first trimester.

Neonatal full blood count indices did not show significant correlation with Apgar score after 5 minutes ($P > 0.05$) as shown in Table 4.

Low birth weight did not show significant correlation with hematological indices at parturition (P> 0.05) as shown in Table 5

Table 6 presents the relationship between neonatal hematological indices and the parturient indices. MCV (β =0.119, *P* = 0.018), MCHC (β = 0.132, P ≤ 0.001) and WBC (β = 0.095, *P* = 0.012) showed positive significant relationships between mothers in labour and the neonatal indices at birth

Discussion

Pregnancy is one of the physiological conditions capable of causing remarkable and dramatic changes in hematological variables. The hematological indices also have an impact on pregnancy and its outcome [2]. This study examined maternal hematological parameters throughout pregnancy and its effect on pregnancy outcomes among parturients. Hemoglobin levels steadily decreased from the first to third trimester of pregnancy followed by a rise during parturition and puerperal stage. Anemia was most prevalent in the third trimester of pregnancy. This is consistent with previous studies and has been attributed to an increased demand for iron as pregnancy progresses or hemodilution in the third trimester of pregnancy [9, 10]. WBC increased from the first trimester to the puerperal stage. This agrees with previous work by Luppi [11], who asserted that WBC count rising in early pregnancy will remain elevated through pregnancy. Akinbami *et al*., [12] also observed an increased WBC count from the first to third trimester in a study conducted in Lagos, Nigeria. The increase might be due to a rise in neutrophils count as a response to stress due to redistribution of the WBCs between the marginal and circulating pools [12]. Similarly, the white blood cells are responsible for body defense during pregnancy and the continuous rise may be because of the

body building the immunity of the fetus [13]. This hypothesis is further supported by our finding of a significant positive correlation between maternal and neonatal WBC counts.

The PLT count was similar in the first, second and third trimesters, but showed a significant decrease at parturition and puerperal stage. This is in consonance with the finding of no significant differences in the three trimesters by Amah-Tariah *et al*., [14] in a study conducted in Port Harcourt, Nigeria. This has been associated with gestational thrombocytopenia which is due to hemodilution and increased platelet activation and accelerated clearance. The condition requires no specific treatment and corrects itself spontaneously after delivery [15].

The Apgar score describes the condition of the newborn infant immediately after birth [16] . A low Apgar score at 5 minutes in term infants correlates poorly with future neurologic outcomes [17]. Except for MCV which had a significant negative correlation, all the other hematological indices did not show a significant correlation with Apgar score < 7 after the 5th minute in our study. This is in line with the finding of no significant correlation of maternal hemoglobin, hematocrit and RBC count with Apgar score at the 5th minute by Papadopol *et al*., [18]. Neonatal full blood count indices also did not show significant correlation with Apgar score after 5 minutes.

Maternal hemoglobin levels has been significantly associated with the physical growth of neonates [19, 20]. On the contrary, no correlation was found between the maternal hemoglobin level at parturition and neonatal birth weight in this study. A Nigerian study by Olatunbosun *et al*., [21] also showed no significant relationship between maternal parameters and birth weight of the newborn. In another longitudinal study by Al Mudallal *et al*., [22], there was no significant difference between maternal hemoglobin and Apgar scores and birth weight. The differences in the various observations could be attributed to differences in geographical locations, race, socio-economic status and cultural practices.

Maternal hemoglobin, RBC count, hematocrit and MCH were not associated with that of the neonates. This is consistent with the findings of Dalal and Shah [20] in which maternal hemoglobin level had no effect on neonatal hemoglobin and mean corpuscular hemoglobin (MCH) at birth.

To the best of our knowledge, this is the first study to examine hematological changes throughout the trimesters of pregnancy and puerperium. However, our inability to assess the cause of hematological changes among the parturient served as a limitation.

Conclusion

Alteration in hematological indices occurs throughout pregnancy and up to the puerperal period. Parturient and neonatal hematological indices did not have any significant association with Apgar score <7 at the 5th minute and birth weight.

Competing Interests

The authors declare that there are no competing interests.

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Author contributions

ONM, KBA and ATO conceived of the study and participated in its design and coordination. ONM, and ATO were involved in the recruitment of participants, data collection and analysis. RKDE, PA, and ONM drafted the manuscript. All authors read and approved the final manuscript.

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Results

Table 1: Obstetric characteristics of the study participants

Variable	Frequency (n=350)	Percentage (%)
Number of ANC visits		
1-5 times	300	85.7
6-10 times	44	12.6
11-15 times	6	1.7
First pregnancy		
No	252	72
Yes	98	28
Number of previous pregnancies		
None	98	28
One	199	56.9
Two	43	12.3
Three	8	2.3
Four	2	0.6
ANC-antenatal clinic		

A B

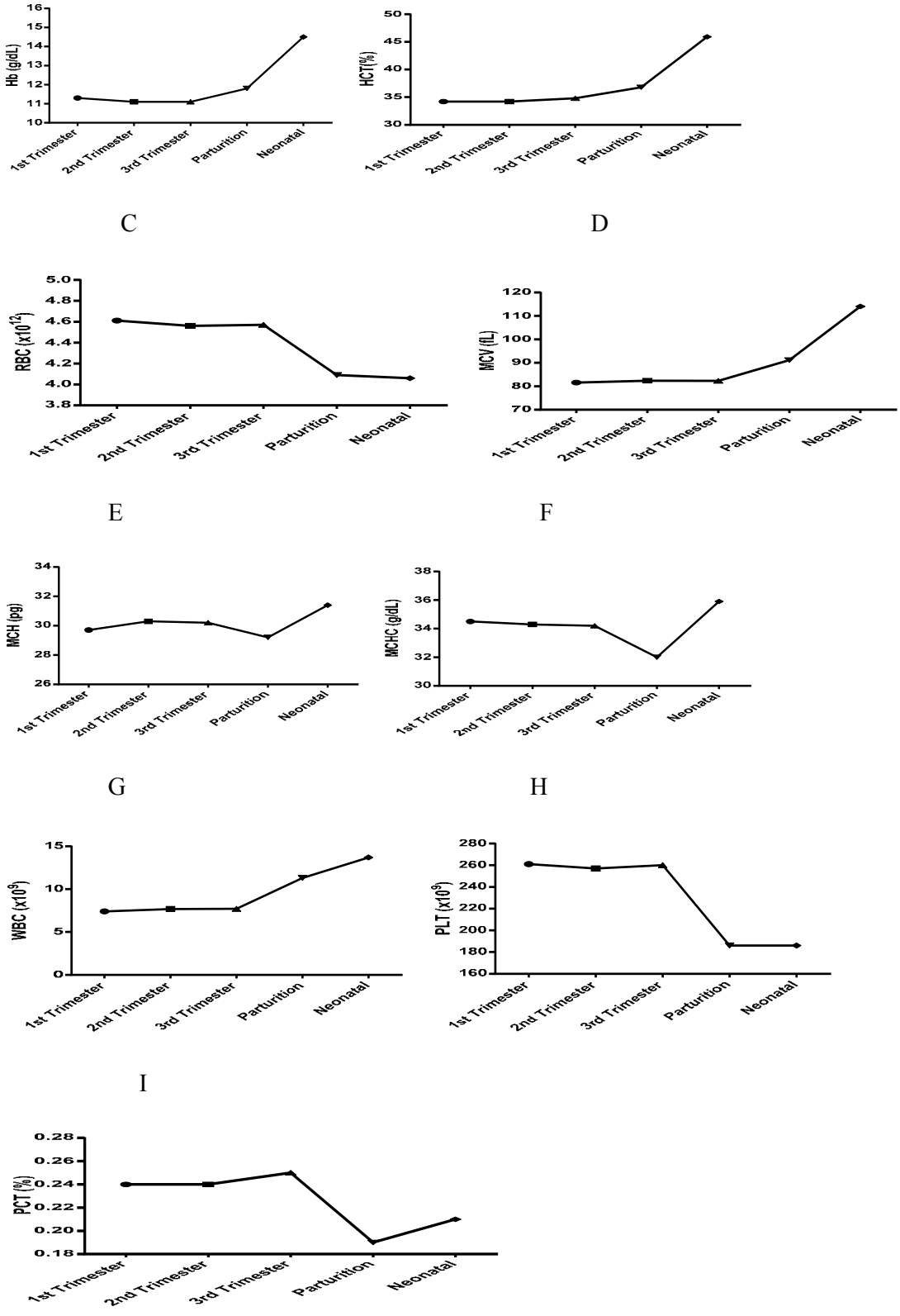

Figure 1: A-I; Haematological indices of the participants from first trimester to preperium.

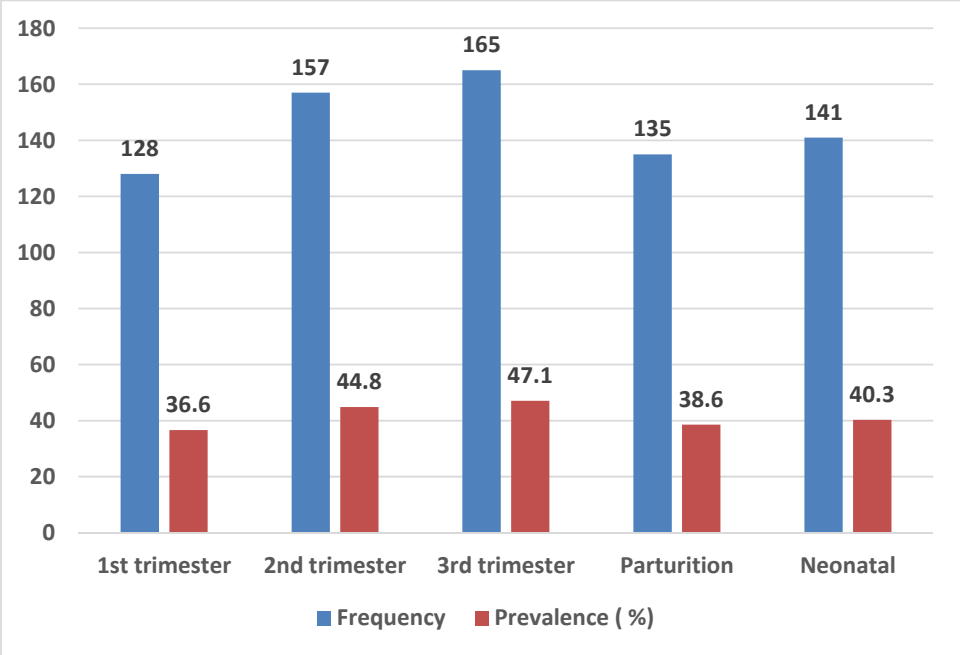

Figure 2: Prevalence of anemia at the various stages of pregnancy

Table 2. Pearson Correlation between hematological parameter of parturition and Apgar score

Hematological parameter at Parturition	Apgar score_< 7 after 5th_minutes	
	R	**p-value**
Hb (g/dL)	0.087	0.675
RBC ($10^{\wedge 12}$/L)	0.367	0.070
HCT (%)	0.038	0.854
MCV(fL)	-0.557	**0.003**
MCH (pg)	-0.316	0.124
PCT (%)	0.196	0.367
MCHC (g/dL)	0.033	0.875
WBC (10^9)	0.154	0.461
PLT (10^9/L)	0.114	0.605

Table 3: Comparative differences between hematological indices for the trimesters and parturition

	1st & Part.*		2nd & Part*		3nd & Part*	
Index	**Diff. (se)**	**p-value**	**Diff. (se)**	**p-value**	**Diff. (se)**	**p-value**
HGBg/dl	-0.44 (0.14)	0.002	-0.62 (0.15)	<0.001	-0.66 (0.14)	<0.001
RBC (x 10^{12})	0.52 (0.07)	<0.001	0.46 (0.07)	<0.001	0.48 (0.07)	<0.001
HCT (%)	-2.6 (0.50)	<0.001	-2.5 (0.54)	<0.001	-2.01 (0.54)	<0.001
MCV (fL)	-9.60 (0.80)	<0.001	-8.0(0.76)	<0.001	-8.92 (0.77)	<0.001
MCH (pg)	0.51 (0.26)	0.054	1.07 (0.27)	<0.001	1.03 (0.27)	<0.001
PCT (%)	5.44 (0.53)	<0.001	5.79 (0.60)	<0.001	6.04 (0.60)	<0.001
MCHC (g/dl)	2.53 (0.22)	<0.001	2.35 (0.21)	<0.001	2.24 (0.23)	<0.001
WBC (x 10^9)	-3.85 (0.25)	<0.001	-3.58(0.30)	<0.001	-3.55 (0.27)	<0.001
PLT (x 10^9)	75.4 (5.09)	<0.001	70.6 (5.01)	<0.001	74.4 (4.80)	<0.001

Table 4: Pearson Correlation between hematological parameter of neonates and Apgar score

Hematological parameter of Neonate	Apgar score_< 7 after 5th_minutes	p-value
	R	
Hb (g/dL)	0.088	0.6734
RBC(10^{12}/L)	0.257	0.2133
HCT (%)	0.106	0.6137
MCV(fL)	-0.284	0.1683
MCH (pg)	-0.368	0.0697
PCT (%)	-0.016	0.9426
MCHC (g/dL)	-0.142	0.4954
WBC (x10^{9})	0.103	0.6288
PLT (x10^{9}/L)	-0.009	0.9657

Table 5. Pearson Correlation between hematological parameter at parturition and low birth weight

Hematological parameter at Parturition	Low birth weight (<2.5kg)	p-value
	R	
Hb (g/dL)	-0.132	0.359
RBC(10^{12}/L)	0.090	0.532
HCT (%)	-0.146	0.312
MCV(fL)	-0.043	0.767
MCH (pg)	0.007	0.963
PCT (%)	0.065	0.653
MCHC (g/dL)	0.054	0.712
WBC (10^{9})	0.014	0.921
PLT (10^{9}/L)	0.190	0.187

Table 6: Relationship between neonatal hematological indices and parturient indices

Index	B	p-value
Hb (g/dL)	-0.009(0.05)	0.846
RBC (10^{12}/L)	0.054(0.06)	0.405
HCT (%)	-0.009(0.04)	0.840
MCV(fL)	0.119(0.05)*	0.018*
MCH (pg)	0.111(0.08)	0.154
MCHC (g/dL)	0.132(0.04) *	<0.001*
WBC(10^{9})	0.095(0.04) *	0.012*
PLT (10^{9}/L)	0.048 (0.04)	0.213
PCT (%)	0.038(0.04)	0.346