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Research Article

Maternal Hematology in Focus: Evaluating Red Cell Indices During Pregnancy in Shendi Town, Sudan

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Abstract

Background: Pregnancy is the period from conception to birth. There may be some adjustments during these times. Red blood cell mass increases by 15 - 20% when erythropoietin production increases. The net effect of Hb concentration is a drop of 1 - 2 g/dl since the increase in plasma volume is more than the increase in red cell mass. This condition is known as pregnancy-related physiological anemia. According to the World Health Organization's (WHO) guidance, anemia of pregnancy is defined as a Hb value of less than 110 g/l. 41.8% of pregnant women globally suffer from anemia. Asia and Africa are the two regions most affected. Approximately 56% of pregnant women in Africa suffer from anemia.

Objective: The goal of this case-control study, which was place in Shendi town between January and April of 2025, was to ascertain the red blood cell characteristics of expectant mothers.

Materials and Methods: 50 milliliters of venous blood in total. In this study, 25 samples from healthy non-pregnant women served as the control group, while samples were taken from pregnant women as the test group. The blood samples were examined using a hematological analyzer.

Results: The test group's mean Hb level, RBC count, PCV, MCV, MCH, MCHC, and RDW-CV were 10.38 g/dl, 3.69×106/µI, 29.72%, 81.70 fl, 28.40 pg, 34.88 g/dl, and 15.39 percent, according to statistical analysis using SPSS, while the control groups were 12.19 g/dl, 5.30×106/µI, 36.16%, 91.20 fl, 30.40 pg, 33.44 g/dl, and 15.69%, respectively.

Conclusion: Throughout pregnancy, hematological parameters change, with low levels of hemoglobin and red cell mass varying considerably across trimesters. Estimating hemoglobin is a crucial metric for assessing well-being. It is advised to take enough supplements to counteract the negative signs of bad health. It is possible to conclude that pregnant women's haematological parameters alter significantly throughout their pregnancy. Therefore, during pregnancy, it is crucial to monitor and control these factors. To determine the prevalence and underlying causes of anemia in expectant mothers, more research should be done.

Keywords: *Pregnancy; Anemia; RBC Parameters; Hemoglobin; Shendi*

Introduction

After the egg is fertilized by sperm and implants in the uterus, pregnancy is the time between conception and delivery. It grows into an embryo, placenta, and then a fetus [1]. The signs and symptoms of pregnancy differ from woman to woman, but the most typical ones include missing periods, worsening, increased weight, and frequent urination [1]. Pregnancy is measured in 40 weeks, or trimesters, starting on the first day of the last menstrual cycle. One week to twelve weeks, or roughly three months, is the first trimester of pregnancy. Thirteen to twenty-seven weeks is the second trimester. The 28 weeks leading up to delivery constitute the third trimester of pregnancy [1]. The placenta serves as the active interface between the circulation of blood in the mother and the fetus during pregnancy, regulating significant physiological changes and accounting for fetal development and nutrient supply [1]. Various changes may occur during pregnancy, including the demands of the growing fetus and placenta, as well as the increasing volume of maternal blood and red cell mass. In order to meet the needs of the developing fetus and placenta, women experience a number of hematological changes during pregnancy, including notable alterations in blood volume. Progesterone and estrogen directly affect the kidney, causing renin to be released and an average 40 - 45% rise in plasma volume. This activation of the aldosterone renin-angiotensin mechanism occurs. This causes an increase in body water and salt retention in the kidneys. This rise occurs more fast in the latter part of the second trimester [2-4]. Red blood cell mass increases by 15 - 20% when erythropoietin production increases. The net effect of Hb concentration is a drop of 1 - 2 g/dl since the increase in plasma volume is more than the increase in red cell mass. This condition is known as pregnancy-related physiological anemia [4,5]. The red blood cell indices change little in pregnancy. There is a small increase in MCV. Increase production of RBCS to meet the demand of pregnancy, which reasonably explains why there is an increase (MCV) due to a higher proportion of young (RBCS), which are larger [6]. Anemia of pregnancy is the most common hematologic problem during pregnancy, occurring when the Hb concentration is less than 110 g/l as per the World Health Organization's (WHO) recommendation [7-9]. Although anemia is physiological, it has an impact on the course of pregnancy. The WHO 2008 study estimates that 62.7% of pregnant Ethiopian women will be affected by this hematological condition, making it a serious public health concern. Anemia in pregnant mothers is prevalent worldwide at 41.8%, with Asia and Africa being the two regions most affected, with approximately 56% of pregnant women in Africa experiencing anemia [10,11]. Significant functional consequences of anemia include increased maternal, fetal, and neonatal mortality; poor pregnancy outcomes include low birth weight and preterm birth; children's impaired cognitive development, limited learning capacity, and worse academic performance; and adults' reduced productivity [12]. Anemia is associated with 20.3% of maternal deaths in Sudan [13].

Materials and Methods

Study design

This is a case-control study conducted among pregnant women at the Shendi locality. This study was conducted in Shendi locality, River Nile State-Sudan. Shendi is a town in northern Sudan on the east bank of the Nile, 150 km northeast of Khartoum.

Study population

This study included 75 women in total. The test group consisted of 50 pregnant women in various trimesters and ages, while the control group consisted of 25 healthy non pregnant women.

Inclusion criteria

Pregnant women were included in the study.

Exclusion criteria

Pregnant women with have Previous history of hypertension and proteinuria, History of systemic illnesses like diabetes mellitus, renal disease, liver diseases, Eclampsia, and Women with a history of recent blood transfusion were also excluded.

Method

A 5 ml syringe, a blood sample of 3 ml was collected from the antecubital vein of each client after a sterile swab was used to clean the site. The sample was then put into an EDTA bottle. A dry swab was used to apply pressure to the vein after collection, and the bottle was labeled. After each day's collection, the samples were transported to the laboratory, often within 2 hours. The samples were analyzed in the laboratory on the day of collection.

Quality control

Quality control was performed at each step and during each procedure during this study to ensure reliable performance and correct reporting of results.

Data collection tools

Women who were pregnant were selected and data collected using-self-administered questionnaire, which was specifically designed to obtain information that would help in the study.

Ethical consideration

The study was approved by the Department of Hematology in the College of Medical Laboratory Sciences at Shendi University. The study matched the ethical review committee board. Sample collection was done after agreement with the participants. The aims and benefits of this study were explained with the assurance of confidentiality. All protocols in this study were done according to the Declaration of Helsinki (1964).

Data analysis

Data are calculated and analyzed using the Social Science Software Program version 21.0 statistical package. Mean values are obtained, and the frequencies and percentages of other variables are calculated and displayed in numerical and tabular form. The p-value is used to assess the significance of the results.

Results

Parameter		Mean	P value
HB	Test	10.38	0.000
	Control	12.19	
RBCs	Test	3.69	0.225
	Control	5.30	
PCV	Test	29.72	0.000
	Control	36.16	
MCV	Test	81.70	0.000
	Control	91.20	
MCH	Test	28.40	0.039
	Control	30.40	
MCHC	Test	34.88	0.000
	Control	33.44	
RDW-CV	Test	15.39	0.569
	Control	15.69	

***Table 1**: The mean of the RBC parameter in the test and control groups.*

Parameter	Age	Mean	Std. deviation	P value
HB	17-27	10.79	1.07	0.515
	28-37	10.56	1.43	
RBCs	17-27	3.72	0.32	0.477
	28-37	3.80	0.44	
PCV	17-27	30.81	2.92	0.562
	28-37	30.26	3.78	
MCV	17-27	83.27	4.52	0.339
	28-37	81.20	10.04	
MCH	17-27	29.20	1.77	0.191
	28-37	28.06	4.04	
MCHC	17-27	34.94	0.75	0.283
	28-37	47.69	61.11	
RDW-CV	17-27	14.61	1.63	0.165
	28-37	15.48	2.65	

Table 2: *The mean, Std. deviation and p-value of RBC parameters in pregnant women according to age.*

Parameter	No	Mean	Std. deviation	P value
HB	1-4	10.92	1.08	0.002
	5-8	9.46	1.36	
RBCs	1-4	3.79	0.37	0.145
	5-8	3.58	0.41	
PCV	1-4	31.12	2.95	0.005
	5-8	27.63	3.81	
MCV	1-4	82.85	6.30	0.262
	5-8	79.55	12.54	
MCH	1-4	29.05	2.50	0.042
	5-8	26.68	4.82	
MCHC	1-4	34.99	0.73	0.021
	5-8	71.33	103.72	
RDW-CV	1-4	14.96	2.53	0.701
	5-8	15.29	2.14	

Table 3: *The mean, Std. deviation and P value of RBC parameters in pregnant women according to the number of deliveries.*

Parameter	No	Mean	Std. deviation	P value
HB	Yes	10.50	1.04	0.791
	No	10.70	1.26	
RBCs	Yes	3.87	0.40	0.599
	No	3.75	0.38	

PCV	Yes	30.00	2.65	0.76
	No	30.60	3.38	
MCV	Yes	79.33	6.19	0.486
	No	82.51	7.66	
MCH	Yes	28.77	2.70	0.957
	No	28.67	3.10	
MCHC	Yes	34.67	0.35	0.794
	No	41.20	42.75	
RDW-CV	Yes	14.13	0.57	0.477
	No	15.07	2.24	

Table 4: *The mean, Std. deviation and P value of RBC parameters in pregnant women according to the history of abortion.*

Parameter	Trimester	Mean	Std. deviation	P value
Hb	First	11.01	1.08	0.412
	Second	10.43	1.29	
	Third	10.85	1.23	
RBCs	First	3.83	0.31	0.369
	Second	3.67	0.43	
	Third	3.82	0.34	
PCV	First	31.29	2.69	0.470
	Second	29.91	3.48	
	Third	31.00	3.36	
MCV	First	82.26	4.77	0.974
	Second	82.07	3.21	
	Third	82.60	3.28	
MCH	First	28.94	1.100	0.962
	Second	28.57	3.21	
	Third	28.69	3.28	
MCHC	First	35.23	0.62	0.511
	Second	34.86	0.70	
	Third	48.89	63.96	
RDW-CV	First	14.83	2.12	0.555
	Second	15.39	2.58	
	Third	14.68	1.74	

Table 5: *The mean, Std. deviation and P value of RBC parameters in pregnant women according to the trimesters.*

Discussion

Pregnancy results in a variety of physiological and hematological changes due to the fetus's continuous development; these changes return to normal after puerperium, but these adjustments are necessary to meet the mother's metabolic needs and ensure that the fetus receives adequate oxygen. The degree to which the hematological profile changes during pregnancy may vary, so monitoring hematological parameters during pregnancy is essential to improve the outcome. Anemia in particular can negatively impact pregnancy outcomes and contribute significantly to maternal mortality and morbidity in the majority of underdeveloped nations [14]. As a result, a lot of work goes into tracking and reacting to hematological parameters [14,15]. According to the current study's findings, pregnant women had significantly lower levels of MCV, Hb, Hct, MCH, MCHC, RBCs, and Hct than non-pregnant women. The Hb levels in our study decreased gradually from the first to the third trimester. Akinbami., *et al.* [16] showed similar results, observing a progressive decrease in Hb concentration from the first to the third trimester. These findings corroborate those of a similar study done in Ibadan, south-western Nigeria, by Akingbola., *et al*. [17] in 2006, which revealed the same pattern. An increased need for iron as pregnancy goes on could be the cause of the progressive drop in Hb concentration from the first to the third trimester [16]. To fulfill the demands of fetal growth and the expansion of maternal hemoglobin mass, more iron is needed. Renin is released from the kidneys as a result of the placenta's increased production of progesterone and estrogen during pregnancy [16]. Atrial natriuretic peptide levels tend to slightly decrease, and plasma renin activity tends to rise during pregnancy. This implies that rather than actual blood volume expansion, which would result in the opposite hormonal profile (i.e. low plasma renin and elevated atrial natriuretic peptide levels), the increase in plasma volume during pregnancy is due to an underfilled vascular system caused by systemic vasodilatation and an increase in vascular capacitance [18,19]. The total blood volume rises by approximately 1.5 liters throughout pregnancy, primarily to meet the needs of the growing vascular bed and to make up for blood loss during birth [20]. Pregnancy-related physiological anemia is caused by a decrease in maternal hemoglobin because the rise in plasma volume is comparatively larger than the rise in red cell mass [16]. The reduction in hemoglobin is typically by 1 - 2 g/dL by the late second trimester. After that, it stabilizes in the third trimester when maternal plasma volume decreases as a result of elevated atrial natriuretic peptide levels [21]. In comparison to women who were not pregnant, the current study found a highly significant drop in hematocrit levels in the first, second, and third trimesters. In a similar vein, Wulsa., *et al*. [22] found that, in comparison to controls, pregnant women's hematocrit values decreased statistically significantly in the first, second, and third trimesters ($p < 0.01$). A significant increase in plasma volume that occurs during a typical pregnancy may be the cause of this drop in hematocrit readings. This dilution of numerous circulating substances and cells can lead to physiological anemia [23-25]. In another study with Akinbami., *et al*. this study found very little fluctuation in MCV, MCH, MCHC, and RDW-CV between trimesters. MCH stayed comparatively constant during all trimesters, according to [16]. MCHC decreased in the third trimester after remaining steady in the first and second. Iron deficiency anemia could be the cause of these results [16]. In contrast, Azab., *et al.* [26] reported that values of MCH were highly significantly decreased in the second and third trimester, and MCHC were significantly decreased in the first trimester compared to non-pregnant women. Additionally, a research by Edugbe A. E., *et al*. [27] found that the MCV rose from the first to the second trimester and then slightly declined in the third trimester. A greater percentage of young, bigger RBCs may be the cause of the elevated MCV, which could be explained by enhanced RBC production to satisfy the demands of pregnancy [28]. Although these differences were not statistically significant, they may be a reflection of iron depletion. This is possibly due to late registration for antepartum care, irregular antepartum visits, especially when the women are feeling very well, non-compliance with routine antepartum hematinic [29-31]. This is at variance with Akinbami., *et al*'s study that showed a decline in MCV, and a relatively stable MCH and MCHC through the three trimesters [32]. Other similar studies showed varying patterns combining these red cell indices with the progress of pregnancy.

Conclusion

Throughout pregnancy, hematological parameters change, with low levels of hemoglobin and red cell mass varying considerably across trimesters. Estimating hemoglobin is a crucial metric for assessing well-being. It is advised to take enough supplements to counteract the negative signs of bad health. It is possible to conclude that pregnant women's hematological parameters alter significantly

throughout their pregnancy. Therefore, during pregnancy, it is crucial to monitor and control these factors. To determine the prevalence and underlying causes of anemia in expectant mothers, more research should be done.

Recommendations

1. Regular investigations should be conducted on mothers who are pregnant mothers.
2. Women who are pregnant should take vitamins consistently throughout their pregnancy.
3. More research on red blood cell parameters during pregnancy is necessary.
4. Raising pregnant women's understanding of how to manage their health and safeguard themselves against complications.

Limitations

While this is the first research from Shendi City, Sudan, focusing on the Evaluation of Red Blood Cell Parameters in Pregnant Women, it is still a single-center study with a limited sample size.

Consent

The patient's written consent has been collected.

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Conflict of Interest

The authors have declared that no competing interests exist.

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