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Research Article

Assessment of Haematological Changes at Different Trimester in Pregnant Women at Secondary Health Facilities in Southwestern, Nigeria

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Abstract

This study assessed and contrasted the haematological parameters of healthy non-pregnant women who were attending a secondary health facility in Ogun State, Southwestern Nigeria, with those of pregnant women at various trimesters. Due to a lack of knowledge regarding suitable haematological cut-off levels during pregnancy, the study was carried out. 300 (79.2%) healthy pregnant women and 85 (20.8%) seemingly healthy non-pregnant women served as controls out of the 385 participants who were enlisted. Prenatal attendance patterns were used to stratify the pregnant individuals into the first (n=60), second (n=105), and third (n=135) trimesters. The participants ranged in age from 19 to 48. The Sysmex XP-300 automated haematology analyser was used to analyse four millilitres of venous blood that had been collected into EDTA tubes. Using SPSS version 14.0, the data were analysed with significance set at $p < 0.05$ and reported as mean $\pm$ standard deviation. The findings demonstrated a significant difference ($p < 0.01$) in all evaluated haematological parameters between pregnant and non-pregnant women, as well as a significant correlation (p=0.024) between age groups and study status. MCV, MCH, and MCHC increased across all trimesters, while haemoglobin, haematocrit, and red blood cell count significantly decreased. Eosinophil and basophil numbers did not change, although lymphocyte counts marginally decreased and monocyte counts slightly increased. These results highlight the significance of ongoing monitoring and proper clinical care during gestation by pointing to significant haematological changes during pregnancy.

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1. Introduction

Pregnancy is the period during which a fetus develops inside a woman's uterus after fertilization with unique physiological condition characterized by a series of systemic changes, especially within the haematological system, which are essential for maintaining maternal health and supporting fetal development [1]. The knowledge is necessary because there is limited knowledge of haematological changes at the trimester stages in Ogun State, southwestern, Nigeria [2]. However, many of these haematological variations can mimic disease states, leading to diagnostic dilemmas, misinterpretations, and sometimes unnecessary clinical interventions [3].

In clinical practice, most reference ranges for haematological indices are derived from non-pregnant populations or from studies that do not account for gestational age-specific fluctuations [3]. As a result, normal physiological adaptations such as haemodilution-induced anaemia, leukocytosis, and increased erythrocyte sedimentation rate (ESR) may be wrongly interpreted as pathological [1, 4, 5]. This is particularly concerning during the first to third trimesters when these haematological shifts are most dynamic and when critical decisions regarding maternal care and nutritional supplementation are made [5].

In low- and middle-income countries like Nigeria, the problem is further exacerbated by the lack of locally derived trimester-specific reference values, limited antenatal follow-up in early pregnancy, and high prevalence of nutritional deficiencies [3, 6]. These gaps hinder the early detection of true haematological disorders, such as iron-deficiency anaemia, folate or B12 deficiency, and infections—all of which can adversely affect pregnancy outcomes if left unrecognized or untreated [5, 7].

Hence, there is a compelling need to systematically track and evaluate haematological changes at the trimester stages of pregnancy among apparently healthy women [8]. Such a study would fill an important knowledge gap, improve diagnostic accuracy, guide clinical management, and potentially influence policy regarding maternal health monitoring [3]. This research seeks to address this critical gap by providing trimester-specific insights into haematological trends, with the ultimate aim of improving maternal care and optimizing outcomes for botdh mother and child.

2. Materials and Methods

2.1. Study Design

The study was a cross-sectional study of apparently healthy pregnant women (subjects) and non-pregnant women (control) in Secondary Health Facilities, Ogun State, Southwestern Nigeria.

2.2. Study Area

The research was carried out at the Secondary Health Facilities in Remo Metropolis of Ogun State, Southwestern, Nigeria. Remoland is situated in southwestern part of Nigeria with a population of 619,520 as at 2006 census. Remoland comprises of three local governments; Remo North, Ikenne and Sagamu. The national language is Yoruba with time zone UTC+1(WAT).

2.3. Selection of Subjects

The subjects for the study were recruited consecutively after the informed consent was obtained from the participant. Questionnaire was administered to collect socio-demographic and other bio-data such as health status, age, occupation, level of education, area of resident, number of children and tribe from the consenting participant.

2.4. Eligibility Criteria

Inclusion Criteria: Consenting, confirmed pregnancy with gestational age classified into first, second, and third trimester, attendance at antenatal clinic during the study period and apparently healthy female residents in Ogun State.

Exclusion Criteria: Non-consenting, known haematological disorders, chronic medical conditions, acute and recent infections, use of medication, recent blood transfusion, apparently non pregnant women with bleeding disorders.

2.5. Sample Size Estimation

The sample size for this study can be calculated based on the probable proportional alterations in the complete blood count value, using the Cochran formula.

$$n = Z^2 \times \frac{P(1-P)}{d^2},$$

where;
n= required sample size
d= desired level of significance (0.05)
Z= confidence level (1.96)
p= population proportion assumed to be 0.5(50%)

$$n = \frac{(1.96)^2 \times 0.5(1-0.5)}{0.05^2}$$

$$n = \frac{3.84 \times 0.5(0.5)}{0.0025} = n = 384.6$$

Therefore, 385 sample size was considered for this study.

2.6. Sample Collection

Laboratory Procedure
A total of 4 ml of venous blood was taken from each study participant from anti-cubital vein, with minimal stasis and placed into Ethylene Diamine Tetra Acetic Acid (EDTA) Vacutainer tubes (Becton-Dickinson, Franklin Lakes, New Jersey, USA) as anticoagulant for hematological analysis. Venous blood specimens were mixed thoroughly by gently inverting about eight times and the bottle was appropriately labeled accordingly. The samples were processed within 2-4 hours of collection; using Sysmex XP 300 automated haematology system.

Haematological Parameters
The haematological parameters analysed include haemoglobin concentration (Hb), packed cell volume (PCV), total white cell count (WBC), differential white cell count, platelet count; using Sysmex XP 300 automated haematology analyser.

Principle: The measuring principle of Sysmex are based on impedance and spectrophometry principles. As sample are analysed, the system software may produce three types of intelligent information messages. The information is designed to guide and aid the user in the practice of complete haematology.

The category of information are

- Normal Results
- Low and High abnormal results (messages of abnormal patients or out-of- range control results with notation)
- Out of alert results (an indicator and double triangle used if the value is out of alert limits) [4]

Procedure

1. The following steps were used when analyzing the red cell parameters.
2. The reagent needed were checked for the number of samples to be processed.
3. The power switch was on at the left side of the unit. Self check, auto rinse and background check was automatically performed and the Ready (ready for analysis) appeared.
4. Quality control blood materials (low, normal and high) were performed so as to verify that the instrument was performing within the specified ranges.
5. If the result of the quality control falls within acceptable ranges, input the blood samples.
6. Every sample was identified and the sample introduced into the system for analysis.

2.7. Statistical Analysis

The data obtained were analysed using Statistical Package for Social Sciences Version 16.0. The means were compared using Students T-test and $p < 0.05$ was the level of significance.

3. Results

Table 1: Demographics Characteristics of pregnant women and control subjects

Demographic Profile	Frequency
Pregnant Women	85 (20.8%)
Non-Pregnant Women	300 (79.2%)
Age Group (years)	19-48 years

Table 2: Comparison of Haematological parameters Subjects and Controls.

Parameters	Pregnant women Mean ± SD	Non- Pregnant women Mean ± SD	T. test	P. value
HB (g/dl)	10.57 ± 1.22	12.17 ± 0.63	-11.373	0.000*
RBC ($x10^6$/uL)	3.80 ± 0.53	4.50 ± 0.31	-11.127	0.000*
MCH (Pg)	27.86 ± 2.06	27.11 ± 1.96	2.934	0.004*
MCHC (g/dL)	34.62 ± 0.69	33.76 ± 1.07	8.680	0.000*
MCV (fL)	81.02 ± 5.64	80.32 ± 5.25	1.001	0.317
HCT (%)	32.20 ± 10.58	36.09 ± 1.16	-3.275	0.000*
PLT (10^3ul)	238.67 ± 67.51	226.46 ± 60.31	1.470	0.383
WBC (10^9/L)	8.32 ± 2.09	7.51 ± 2.84	2.829	0.005*
NEU (%)	64.80 ± 6.18	64.70 ± 12.96	0.102	0.919
LYM (%)	27.45 ± 6.20	28.85 ± 13.46	-1.347	0.179
MON (%)	4.30 ± 0.97	3.93 ± 1.15	2.966	0.003*
EOS (%)	2.43 ± 0.78	2.20 ± 0.59	2.434	0.015*
BAS (%)	0.39 ± 0.25	0.31 ± 0.25	2.366	0.018*

Table 3: Comparison of Haematological profile of Subjects and Controls by trimesters

Parameters	Non-pregnant (Control) Mean ± SD	Pregnant 1st trimester Mean ± SD	Pregnant 2st trimester Mean ± SD	Pregnant 3st trimester Mean ± SD	F. ratio	P value
HB (g/dl)	12.17 ± 0.63	11.04 ± 1.33	10.90 ± 1.38	10.60 ± 1.17	1.779	0.171
RBC (x10^6/uL)	4.50 ± 0.31	3.83 ± 0.52	3.78 ± 0.55	3.82 ± 0.59	3.438	0.033*
MCH (Pg)	27.11 ± 1.96	27.40 ± 2.03	27.84 ± 2.07	28.10 ± 2.02	2.974	0.053
MCHC (g/dL)	33.76 ± 1.07	34.55 ± 0.82	34.55 ± 0.82	34.42± 0.82	0.640	0.528
MCV (fL)	79.94 ± 5.37	79.94 ± 5.37	80.87 ± 5.72	81.47± 5.83	3.082	0.047*
HCT (%)	36.09 ± 1.16	33.82 ± 10.83	32.82 ± 9.21	31.41 ± 7.09	1.568	0.210
PLT (10^3ul)	226.46 ± 60.31	247.17 ± 67.16	236.63 ± 69.94	223.49 ± 62.95	2.953	0.054
RDW (%)	13.63 ± 1.38	14.58 ± 1.32	14.44 ± 1.37	14.64 ± 2.07	0.243	0.785
WBC (10^9/L)	7.51 ± 2.84	8.23 ± 2.23	8.19 ± 2.39	8.57 ± 2.25	0.749	0.474
NEU (%)	64.70 ± 12.96	65.39 ± 7.58	65.64 ± 6.85	66.04 ± 8.21	0.175	0.840
LYM (%)	28.85 ± 13.46	26.93 ± 7.46	26.91 ± 6.73	26.75 ± 8.18	0.016	0.984
MON (%)	3.93 ± 1.15	4.24 ± 0.93	4.22 ± 1.02	4.35 ± 1.11	0.489	0.613
EOS (%) Bd	2.20 ± 0.59	2.35 ± 0.75	2.38 ± 0.79	2.32 ± 0.74	0.157	0.855
BAS (%)	0.31 ± 0.25	0.42 ± 0.24	0.39 ± 0.23	0.34 ± 0.25	2.596	0.076

Significant difference compared to non-pregnant women (controls) group ($P < 0.05$)

4. Discussion

According to World Health organization, one woman dies every minute from a pregnancy related problem. The major reasons of deaths are due to antepartum and postpartum haemorrhage, unsafe abortion, eclampsia, obstructed labour and infection [9].

Many haematological changes occur during pregnancy due to constant maturity of fetus. Haematological parameters of pregnant women provide vital information on physiological change associated with pregnancy progress, outcome and maternal-fetal complication [3]. With series of studies on pregnant women and its haematological profile, trimester-specific haematological parameters in Ogun State, Southwestern Nigeria remain unclear.

The aim of this study is to determine the trimesters-specific mean values of haematological indices in pregnancy. We found progressive decline in haemoglobin concentration and haematocrit from the first to the third trimesters - Hb(g/dl):11.04=1.33,10.90=1.38,10.6=1.17) and HCT (%): 33.82=1083, 32.82=9.21,31.41=7.09). These findings were in line with [4]. The fall of these parameters is due to an increased demand for iron as pregnancy progresses. More iron is required to meet the expansion of the maternal haemoglobin mass and the needs of the fetal growth. The additional progesterone and the estrogen that are secreted by the placenta caused the release of renin from kidneys. Renin stimulates the aldosterone-renin-angiotensin mechanism, leading to sodium retention and increased plasma volume. The increase of plasma volume is relatively greater than the increase in the red cell mass which results in a fall in maternal haemoglobin, hence the physiological anemia that occurs in pregnancy is called physiological haemodilution.

It is of interest to document that the MCH and MCV increase in most trimester stages but only the MCV was statistically significant. This is consistent with the previous study by [10] but contrary to the findings of [11] which observed lower values of red cell indices. During pregnancy the red cell indices increases in most cases mainly to supply the demands of the new vascular bed and to compensate for the blood loss occurring at delivery.

From our report, white blood cell count shows a significant increase from the first to third trimesters Table 3. The increased observed in WBC count is consistent with the findings of [8]. Physiologic stress-induced pregnancy has been implicated as possible mechanism for pregnancy associated leukocytosis [12]. Besides, fetal immunity development pathways which include selective immune tolerance and modulation have also been possible explanation. Primarily, there was slight increase of neutrophils and decrease in lymphocytes from first trimester to third trimester. This may represent a response to stress due to redistribution of the WBCs but pain, nausea, vomiting and anxiety have been reported to cause leukocytosis in the absence of infection. There was a mild decrease of lymphocytes at all the trimester stages. Monocytes were elevated from first to third trimesters. It was observed that eosinophils and basophils have no change in this report. Our findings concur with the scientific explanation by [13].

From this study, it was observed that platelet count values were not alter during pregnancy in all the trimester stages. Our finding is similar with other studies [3, 9]. Although in most cases, thrombocytopenia is the second most common haematological abnormality during pregnancy and is usually benign. The finding of predominantly mild thrombocytopenia may be attributed to gestational thrombocytopenia (GT), which bis of a mild type and accounts for the majority of thrombocytopaenias during pregnancy. Also, it could be due to platelet aggregation especially during 8 weeks of gestation. it has been reported that that significant fall in platelet count can occur from 32 weeks on gestation onwards due to haemodilution and increased platelet-activation and consumption.

From our findings, age has no influence in the reduction values where in most occasions the HB, HCT and RBC parameters reduced in all age groups. The mean age of pregnant women in this study was 26.23 ± 4.02 SD (ranged 19-48). Azab et al [13] reported that the mean age of pregnant women in Deina, Libya was 30 years ± 5.8 SD (ranged from 18- 45 years) while [8] reported that the mean age of pregnant women in Lagos, Nigeria was 30.52 ± 4.6 SD (ranged from 20 - 46 years old). But the mean age of pregnant women in Northwestern Ethiopia was 26.13 ± 4.55 years SD.

However, from this study, it was observed that the age group (29-38) had the highest frequency of 126 - 41.3%. It shows that the decline phase of fertility in Ogun State begins in the late 40s (39 years). This is consistent with the previous report computed by [5, 7, 14] which shows that the estrogen level is still normal till age of 38 years but there is extreme decline phase of estrogen level at the age group (39-48), due to hormonal imbalance. Estrogen is the hormone responsible for the development and regulation of female reproductive system

5. Conclusion

This study provide more baseline data for basic haematological parameters in healthy pregnant women in Ogun State, southwestern, Nigeria. The findings of the study suggest the need for supplementation and prenatal vitamins for all pregnant women. Additionally, routine complete blood counts should be done at least in every trimester during antenatal care period. This will aid in monitoring and management of pregnant women during antenatal visits and fetal medical care.

Limitation of Study

Recruiting equal number of participants in first, second and third semester was difficult. This imbalance can affect comparison of haematological parameters in trimesters. Similarly, because different women are sampled at each trimester rather than the same women throughout the pregnancy, inter-individual variability may influence trimester comparisons.

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Article Information

Disclaimer (Artificial Intelligence): The author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.), and text-to-image generators have been used during writing or editing of manuscripts.

Competing Interests: Authors have declared that no competing interests exist.

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