

**Comparative Analysis of Haematological Profile in Women After Caesarean and Spontaneous Vaginal Delivery**

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**Abstract**

Postpartum haemorrhage and related haematological disturbances are major contributors to maternal morbidity and mortality. Mode of delivery may influence early postpartum haematological recovery. This study compared the haematological profiles of women who underwent caesarean section (CS) and spontaneous vaginal delivery (SVD) to evaluate the impact of delivery type on complete blood count parameters. A cross-sectional study was conducted among 50 postpartum women at Uniosun Teaching Hospital, Nigeria. Venous blood samples were collected within 24 hours of delivery and analysed using a haematology analyzer. Haemoglobin concentration, red cell indices, white blood cell count, and platelet parameters were assessed. Data were analysed using SPSS version 22.0, with statistical significance set at  $p < 0.05$ . Women in the SVD group had significantly lower mean haemoglobin ( $8.02 \pm 1.33$ g/dL) than those in the CS group ( $10.58 \pm 2.52$ g/dL;  $p = 0.002$ ). Red cell indices (MCV, MCH, MCHC) were also significantly lower in the SVD group. While total white blood cell count showed no significant difference. The SVD group had higher neutrophil and lower lymphocyte percentages ( $p < 0.05$ ), indicating a stronger acute inflammatory response. No significant differences were observed in platelet parameters between the groups. Mode of delivery significantly influences early postpartum haematological recovery, particularly red and white cell parameters. Future studies should explore long-term haematological trends and the effect of maternal comorbidities on recovery trajectories.

**Keywords:** Postpartum haemorrhage, Caesarean section, Spontaneous vaginal delivery, Anaemia

**Introduction**

Postpartum haemorrhage (PPH) remains a leading contributor to maternal morbidity and mortality worldwide, especially in low- and middle-income countries. Defined as blood loss of more than 500 mL after vaginal delivery or more than 1,000 mL after caesarean section, PPH can lead to severe anaemia, haemodynamic instability, and even death if not promptly managed (Bláha & Bartoová, 2022). Despite advances in obstetric care, the unpredictable nature continues to pose significant clinical challenges. Many women who develop severe PPH present with no clear predisposing factors, underlining the importance of routine monitoring and vigilance during and after childbirth (Ngwenya, 2016; Chandraran & Krishna, 2017). Early identification and effective response strategies such as the use of the shock index and standardized care protocols have been associated with improved maternal outcomes (Andrikopoulou & Dalton, 2019). Nonetheless, the haematological aftermath of childbirth especially in blood loss, warrants close investigation to better understand maternal recovery and the risks involved.

Childbirth, whether through spontaneous vaginal delivery (SVD) or caesarean section (CS), triggers a series of physiological changes. These changes reflect the body's response to delivery-associated blood loss, tissue trauma, and physiological stress, and mark the beginning

of postpartum recovery (Dekel *et al.*, 2019). The complete blood count (CBC) is a critical diagnostic tool that provides insight into these changes by measuring red blood cells (RBCs), white blood cells (WBCs), and platelet parameters. Monitoring haematological parameters during the postpartum period is essential for detecting anaemia, infections, inflammatory responses, or other complications that may arise during recovery (Das Mahapatra, 2024). The trajectory of haematological recovery can vary widely depending on delivery mode, maternal health status, and other individualized factors (Ragsdale *et al.*, 2021).

Among the FBC components, haemoglobin and haematocrit are central markers of maternal blood loss and red cell status. Haematocrit, which often declines immediately following delivery due to acute blood loss, typically begins to rebound within the first few weeks postpartum. In a large prospective cohort, Ragsdale *et al.* (2021) reported that average haematocrit increased from approximately 31% at discharge to nearly 39% by the third postpartum week, representing a mean increase of 7.9 percentage points. This recovery was more robust among women who did not experience complications, while women with chronic conditions like hypertension or diabetes exhibited delayed or less pronounced haematologic recovery. Such findings reinforce the value of tracking red cell parameters in the days and weeks after delivery to evaluate recovery and guide clinical interventions.

The haemoglobin concentration, too, follows a predictable pattern, with the most rapid decline occurring within the first 6 to 12 hours postpartum and stabilization typically achieved by 24 to 48 hours. According to Yefet *et al.* (2020), a decrease of 2 g/dL or more in haemoglobin concentration is consistent with PPH and should prompt further evaluation. Women who experience mild or moderate blood loss may exhibit subclinical anaemia, which, if undetected, can affect physical recovery, breastfeeding ability, and overall well-being during the postpartum period (Miller *et al.*, 2019).

While red cell parameters are often the primary focus of postpartum haematologic assessments, other parameters such as white blood cells and platelets also play vital roles. White blood cells, particularly neutrophils and lymphocytes, are involved in inflammation and immune response, and their levels may fluctuate depending on the mode of delivery (Arbib *et al.*, 2016). Platelets, which contribute to haemostasis and tissue repair, may also show variations in concentration and function during postpartum recovery (Simioni & Campello, 2013). These components, although less frequently examined in postpartum literature, provide meaningful insight into the physiological distinctions between surgical and natural deliveries.

Given these considerations, this study aims to compare the haematological profiles of women who underwent caesarean section versus those who delivered via spontaneous vaginal delivery. By focusing on complete blood count parameters, including haemoglobin, haematocrit, red cell indices, white blood cell counts, and platelet values, this research seeks to enhance understanding of how the mode of delivery influences postpartum haematologic recovery and maternal health outcomes.

## Materials and Methods

### Ethical Considerations

Ethical approval for this study was obtained from the Research and Ethics Committee of UNIOSUN Teaching Hospital, Osogbo, Osun State, Nigeria, with the clearance number UTH/REC/2023/05/763. Prior to enrolment, all participants were thoroughly informed about the purpose, procedures, potential risks, and benefits of the study. Written informed consent was obtained from each participant.

### Study Location

The study was conducted at UNIOSUN Teaching Hospital, located in Osogbo, the capital city of Osun State, Southwestern Nigeria. Geographically, Osogbo is situated between latitudes 7°40'N and 7°59'N, and longitudes 4°22'E and 4°39'E. It is bounded to the south by Ede, to the north by Ikirun, to the west by Ilobu, and to the east by Ilesa. The metropolitan city covers a land area of approximately 143 square

kilometers and lies 500 meters above sea level. As of 2024, Osogbo has an estimated population of nearly 800,000 people (Oyeleye & Bigon, 2025).

### **Study Design and Population**

This was a hospital-based comparative cross-sectional study involving 50 postpartum women who delivered at UNIOSUN Teaching Hospital. The study population consisted of two groups: women who underwent caesarean section and those who had spontaneous vaginal delivery.

### **Inclusion and Exclusion Criteria**

Postpartum women aged 20-50 years who had delivered via caesarean section or spontaneous vaginal delivery at UNIOSUN Teaching Hospital and provided written informed consent were included in the study.

### **Data and Sample Collection**

Sociodemographic and clinical data were collected using a semi-structured questionnaire. 3 ml venous blood sample was aseptically collected from each participant within 24 hours postpartum. The samples were drawn aseptically into labelled ethylenediaminetetraacetic acid (EDTA) vacutainers and labelled appropriately.

### **Laboratory Analysis**

Haematological parameters, including haemoglobin concentration, haematocrit, total white blood cell count, platelet count, red cell indices and platelet indices were analyzed using a calibrated 5-part Mindray Haematology Analyzer (Mindray Medical International Limited, Shenzhen, Guangdong, China). Quality control measures were observed throughout the analysis

to ensure the accuracy and reliability of results.

### **Statistical Analysis**

Data were entered into and analyzed using the Statistical Package for Social Sciences (SPSS) version 22.0. Descriptive statistics such as means, standard deviations, frequencies, and percentages were used to summarize the data. Comparative analysis between the CS and SVD groups was performed using the independent samples t-test. A p-value less than 0.05 was considered statistically significant.

### **Results**

The mean age of the study participants was  $32.42 \pm 5.91$  years. Half of the participants were aged 31–40 years, 21 (42%) were between 21–30 years, and 4 (8%) were above 40 years. Regarding gestational age at delivery, 21 women (42%) delivered between 39–40 weeks, 16 (32%) between 37–38 weeks, 9 (18%) before 37 weeks, and 4 (8%) after 40 weeks. Most of the participants (68%) had haemoglobin genotype AA, while 14 (28%) were AS and 2 (4%) were AC. Blood group distribution showed a predominance of group O (35 participants, 70%), followed by group B (22%) and group A (8%); all participants were Rh positive (Table 1).

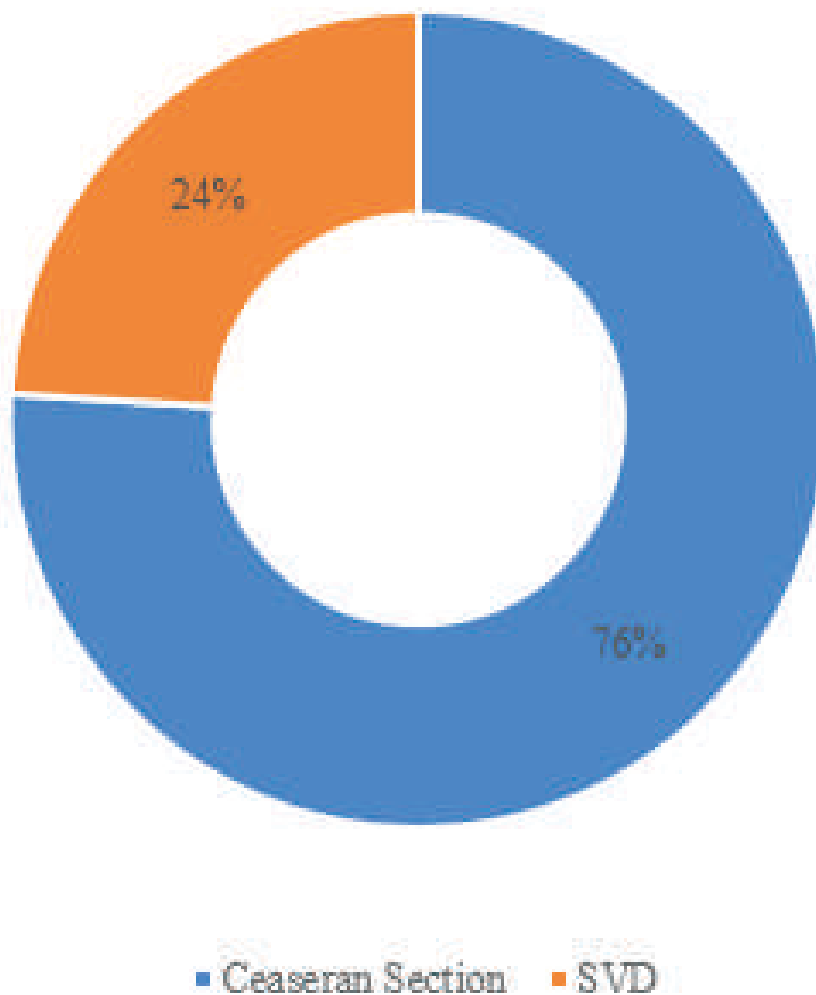
Of the 50 women enrolled, 22 (44%) were hypertensive and 2 (4%) had diabetes mellitus. None of the participants reported physical abnormalities or alcohol intake (Table 2). As shown in Figure 1, caesarean section accounted for most of the deliveries (76%), while spontaneous vaginal delivery occurred in 24% of cases.

**Table 1: Socio demographic data of study participants**

Variable	Frequency (n=50)	Percentage (%)
<b>Age group</b>		
21-30 years	21	42.0
31-40 years	25	50.0
Above 40 years	4	8.0
Mean ± SD	32.42±5.91	
<b>Gestational age</b>		
<37weeks	9	18.0
37-38weeks	16	32.0
39-40 weeks	21	42.0
Above 40 weeks	4	8.0
<b>Haemoglobin Genotype</b>		
AA	34	68.0
AC	2	4.0
AS	14	28.0
<b>Blood group</b>		
A Rh Positive	4	8.0
B Rh Positive	11	22.0
O Rh Positive	35	70.0

**Table 2: Medical history of study participants**

Variable	Frequency (n=50)	Percentage (%)
<b>Hypertension</b>		
Yes	22	44.0
No	28	56.0
<b>Diabetes</b>		
Yes	2	4.0
No	48	96.0
<b>Alcohol</b>		
Yes	0	0
No	50	100.0
<b>Physical Abnormality</b>		
Yes	0	0
No	50	100.0



**Figure 1: Showing distribution of participants by mode of delivery**

Table 3 presents a comparative analysis of haematological parameters between women who delivered via caesarean section and those who had spontaneous vaginal delivery. Significant differences were observed in several red cell parameters between the two groups. Women who delivered through SVD had a significantly lower mean haemoglobin concentration ( $8.02 \pm 1.33 \text{g/dL}$ ) compared to those who underwent CS ( $10.58 \pm 2.52 \text{g/dL}$ ;  $p < 0.05$ ). Similarly, red cell indices including mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) were significantly lower in the SVD group. The mean MCV was  $76.87 \pm 11.39 \text{fL}$  for SVD compared to  $85.78 \pm 7.15 \text{fL}$  for CS ( $p = 0.002$ ). Mean MCH was

$21.50 \pm 4.38 \text{pg}$  in the SVD group versus  $28.67 \pm 2.33 \text{pg}$  in the CS group ( $p < 0.01$ ), and mean MCHC was  $27.83 \pm 2.98 \text{g/dL}$  for SVD and  $33.53 \pm 3.13 \text{g/dL}$  for CS ( $p = 0.001$ ).

Although the total white blood cell count did not differ significantly between the two groups ( $p > 0.05$ ), differential counts revealed significant variations. The mean lymphocyte percentage was lower in the SVD group ( $15.67 \pm 6.41\%$ ) compared to the CS group ( $21.54 \pm 8.67\%$ ), while the neutrophil percentage was higher in the SVD group ( $77.17 \pm 7.42\%$ ) than in the CS group ( $68.25 \pm 11.33\%$ ), both  $p < 0.05$ . Platelet-related parameters showed no statistically significant differences between the groups ( $p > 0.05$ ).

**Table 3: Comparison of haematological parameters**

Parameters	CS (n=38) Mean± SD	SVD (n=12) Mean± SD	t-test	p-value
TWBC X10 <sup>9</sup> /L	9.21±3.65	9.50±2.66	0.258	0.798
RBC X10 <sup>12</sup> /L	3.62±0.84	3.78±0.63	0.596	0.554
Hb g/dL	10.58±2.52	8.02±1.33	3.358	0.002*
HCT %	31.69±7.53	28.43±1.72	1.478	0.146
MCV fL	85.78±7.15	76.87±11.39	3.238	0.002*
MCH pg	28.67±2.33	21.50±4.38	7.376	0.001*
MCHC g/dl	33.53±3.13	27.83±2.98	5.375	0.001*
PLT X10 <sup>9</sup> /L	180.03±72.54	198.17±58.09	0.788	0.434
LYM %	21.54±8.67	15.67±6.41	2.162	0.036*
MXD%	9.56±1.16	7.17±1.17	1.101	0.276
NEUT %	68.25±11.33	77.17±7.42	2.549	0.014*
LYM X10 <sup>9</sup>	1.87±0.94	1.33±0.28	1.936	0.059
MXD X10 <sup>9</sup>	0.83±0.42	0.65±0.11	0.864	0.392
NEUT X10 <sup>9</sup>	6.44±3.26	7.53±2.81	1.049	0.300
RDW_SD fL	48.35±5.89	44.33±6.68	1.994	0.052
RDW_CV %	14.71±1.19	15.17±1.12	1.178	0.245
PDW fL	15.59±4.28	18.17±4.88	1.759	0.085
MPV fL	11.02±1.40	11.83±1.64	1.679	0.100
P_LCR %	32.30±10.46	37.83±9.88	1.617	0.112

\* p-value<0.05

**Discussion**

This study examined and compared haematological profiles of postpartum women who underwent caesarean section and spontaneous vaginal delivery at UNIOSUN Teaching Hospital, Nigeria. The findings demonstrate significant differences in haemoglobin, red cell indices and white cell parameters between the two groups.

Consistent with existing literature, haemoglobin concentration was significantly lower in the SVD group compared to those who delivered via CS. This aligns with reports by Yefet *et al.* (2020). The lower mean haemoglobin observed among SVD participants suggests that vaginal deliveries, though generally perceived as less invasive, may involve more unmeasured or underestimated bleeding compared to CS, where blood loss is

more accurately monitored in a surgical setting. This could also reflect differences in intrapartum management practices, uterine tone monitoring, or perineal trauma during vaginal births (Rubio-Álvarez *et al.*, 2017).

Similarly, significant differences in red cell indices MCV, MCH and MCHC were observed. Women who delivered vaginally had notably lower values for all three indices, indicating a trend toward microcytic, hypochromic anaemia, which may reflect pre-existing subclinical iron deficiency unmasked by delivery-related blood loss, which disagrees with the findings of Webster & Loughney (2010). This is however consistent with findings from a study in sub-Saharan Africa where maternal anaemia remains prevalent due to nutritional deficiencies, parasitic infections, and limited access to

antenatal care (Ouédraogo *et al.*, 2012). The relatively higher red cell parameters observed among CS participants may also be attributed to use of intravenous fluids and closer monitoring, as part of perioperative obstetric protocols.

Haematocrit levels, though lower in the SVD group, did not reach statistical significance. This may be due to the narrow range of values observed or the sample size. Nonetheless, the trend toward lower haematocrit corroborates the pattern seen in haemoglobin levels, reinforcing the notion of greater relative blood loss among the SVD group, or less efficient intravascular volume compensation in the early postpartum phase (Ragsdale *et al.*, 2021).

The total white blood cell count did not differ significantly between the groups. This mirrors findings from other studies where total leukocyte counts, although elevated postpartum, did not serve as a discriminatory marker between delivery types (Simioni & Campello, 2013; Roussel *et al.*, 2015). Instead, the differential white cell counts seemed more responsive to the physiological changes associated with labour and delivery. The neutrophil percentage was significantly higher in the SVD group, while lymphocyte percentage was lower, suggesting an enhanced acute inflammatory or stress response following vaginal delivery. Neutrophilia is a well-documented postpartum finding, often related to delivery stress, pain, and tissue trauma (Arbib *et al.*, 2016). However, the higher neutrophil levels in the SVD group may also indicate subclinical perineal or uterine inflammation, or a more pronounced immunologic shift associated with spontaneous delivery. The higher lymphocyte proportion observed among women who underwent caesarean section may indicate a milder systemic inflammatory response or a more rapid initiation of postpartum immunological recovery. These findings suggest that the mode of delivery affects both blood loss and immune response, with potential implications for postpartum infection risk, wound healing, and recovery.

No statistically significant differences were found in platelet count or platelet indices (PDW, MPV, P-LCR) between CS and SVD groups. Platelets are crucial in postpartum haemostasis,

and their counts may initially fall due to consumption during delivery but typically normalize within a few days (McLintock, 2020). The similarity in platelet profiles suggests that thrombopoietic responses are not heavily influenced by the mode of delivery, at least in the early postpartum window, echoing observations by Pafumi *et al.* (2013).

It is also worth to note that hypertension was present in nearly half of the study population, which may have influenced haematologic outcomes. Hypertensive disorders are associated with endothelial dysfunction, altered intravascular volume, and abnormal placental perfusion, all of which can impact postpartum recovery (Hauspurg *et al.*, 2019). Although this study did not stratify results based on comorbid conditions, future analyses may benefit from adjusting for such variables.

### Conclusion

This study demonstrates that mode of delivery significantly influences early postpartum haematological profiles. Women who had spontaneous vaginal deliveries showed lower haemoglobin levels and red cell indices, suggesting higher risk of postpartum anaemia, while differences in white cell differentials reflected varying inflammatory and recovery responses. Future research should explore longitudinal haematological changes beyond the immediate postpartum period and assess the influence of comorbidities, such as hypertension, to better understand recovery trajectories and optimize postnatal care.

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