



## Original Research Article

# RETROSPECTIVE EVALUATION OF MATERNAL ANEMIA AND CESAREAN DELIVERY OUTCOMES AT A TERTIARY CARE CENTER

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## ABSTRACT

**Background:** Maternal anemia is one of the most common medical disorders complicating pregnancy, particularly in developing countries, and is associated with increased maternal morbidity and adverse perinatal outcomes. Women with anemia undergoing cesarean delivery are at increased risk of perioperative complications, including postpartum hemorrhage, blood transfusion, and hemodynamic instability.

**Materials and Methods:** This retrospective observational study included 213 anemic pregnant women who underwent cesarean delivery during the study period. Demographic characteristics, obstetric profile, antenatal registration, iron and folic acid supplementation, perioperative blood transfusion, blood component therapy, invasive monitoring, anesthetic management, and maternal outcomes were collected from medical records and analyzed descriptively.

**Results:** Among the 213 patients, 154 (72.3%) were aged 25–35 years, 167 (78.4%) were primigravida, and 189 (88.7%) were registered antenatal cases. Regular iron and folic acid supplementation was documented in 201 (94.4%) patients. The mean perioperative blood transfusion requirement was  $3 \pm 1$  units. Blood component therapy (FFP and RDP) was required in 188 (88.3%) patients, while 49 (23.0%) underwent central venous catheter insertion and 28 (13.1%) required inotropic support. Severe postpartum hemorrhage occurred in 8 (3.8%) patients, and 3 (1.4%) required elective postoperative mechanical ventilation. No anesthesia-related complications or maternal deaths were observed. The hemoglobin concentration ranged from 3.9 g/dL to 9.8 g/dL.

**Conclusion:** Maternal anemia is associated with increased perioperative transfusion requirements and intensive perioperative management during cesarean delivery.

**Keywords:** Maternal anemia, Pregnancy, Cesarean section, Pregnancy outcome, Retrospective studies.

## INTRODUCTION

Anemia in pregnancy remains one of the most prevalent nutritional disorders worldwide and continues to be a major public health concern, particularly in low- and middle-income countries. The World Health Organization (WHO) defines anemia during pregnancy as a hemoglobin concentration of less than 11 g/dL and estimates that nearly 40% of pregnant women globally are affected, with iron deficiency accounting for the

majority of cases. Maternal anemia is associated with reduced oxygen-carrying capacity, impaired maternal well-being, and increased susceptibility to adverse obstetric outcomes.<sup>[1]</sup>

Maternal anemia has been consistently linked with an increased risk of maternal morbidity, including postpartum hemorrhage, blood transfusion, puerperal infections, prolonged hospital stay, and maternal mortality. Furthermore, fetal and neonatal complications such as preterm birth, low birth weight, intrauterine growth restriction, low Apgar

scores, and increased neonatal intensive care unit (NICU) admissions have also been reported. These adverse outcomes underscore the importance of early diagnosis and effective management of anemia during pregnancy.<sup>[2]</sup>

Cesarean delivery is one of the most commonly performed obstetric surgical procedures worldwide. Although it is generally considered safe, women with pre-existing anemia are particularly vulnerable to perioperative complications because of the physiological blood loss associated with surgery. Even moderate intraoperative hemorrhage may precipitate severe postoperative anemia, increasing the need for blood transfusion, delaying recovery, and contributing to maternal morbidity. Therefore, optimization of maternal hemoglobin before cesarean delivery has become an important component of obstetric care.<sup>[3]</sup>

Several observational studies have demonstrated a significant association between maternal anemia and cesarean delivery. A recent systematic review and meta-analysis involving over 336,000 pregnant women reported that anemic women had significantly higher odds of undergoing cesarean delivery compared with non-anemic women. Similarly, case-control studies have identified maternal anemia as an independent predictor of cesarean section after adjusting for other obstetric risk factors. These findings suggest that anemia may not only be a consequence of pregnancy but may also influence the mode of delivery and perioperative outcomes.<sup>[4]</sup>

Despite growing evidence regarding the impact of maternal anemia, there remains limited data from tertiary care centers evaluating the relationship between antenatal anemia and maternal outcomes following cesarean delivery, particularly in resource-constrained settings where the burden of anemia is disproportionately high. Understanding the clinical profile and perioperative outcomes of anemic women undergoing cesarean section is essential for improving antenatal screening, optimizing preoperative management, and reducing preventable maternal and neonatal complications.<sup>[5]</sup>

India bears one of the highest burdens of maternal anemia globally despite longstanding national nutrition and anemia control programs. According to the National Family Health Survey-5 (NFHS-5, 2019–2021), approximately 52.2% of pregnant women aged 15–49 years are anemic, highlighting the persistent public health challenge posed by maternal anemia. Iron deficiency remains the predominant cause, although deficiencies of folate and vitamin B12, hemoglobinopathies, parasitic infestations, recurrent pregnancies, poor dietary intake, and socioeconomic factors also contribute significantly. Maternal anemia continues to be an important contributor to maternal morbidity and mortality in India and is associated with adverse pregnancy outcomes, including preterm birth, low birth weight, postpartum hemorrhage, increased need for blood transfusion, and perinatal mortality.

Given the high prevalence of anemia and the steadily increasing rates of cesarean delivery across the country, evaluating the impact of maternal anemia on perioperative and neonatal outcomes is particularly relevant in the Indian healthcare setting. Evidence generated from tertiary care centers can help guide antenatal screening strategies, optimize preoperative correction of anemia, and improve maternal and neonatal outcomes.<sup>[6]</sup>

Therefore, the present retrospective study was undertaken to evaluate the prevalence of maternal anemia among women undergoing cesarean delivery at a tertiary care center and to assess its association with maternal and perinatal outcomes.

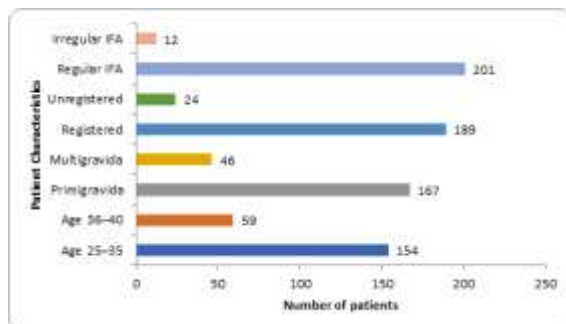
## MATERIALS AND METHODS

This retrospective study was conducted for 1 year between 1st January 2025 till 31<sup>st</sup> December 2025 in a tertiary care hospital. A total of 213 patients were included in this study. The inclusion criteria were full term, who are diagnosed as having anemia at the time of admission i.e Hb less than 10gm% planned for the caesarean section with age between 25 years to 40 years. Patients with comorbid illness like diabetes mellitus, pregnancy induced hypertension, fetal distress and patients undergoing caesarean section under general anesthesia were excluded from this study. Total number of blood and blood product transfusion done, blood grouping and perioperative complications were noted.

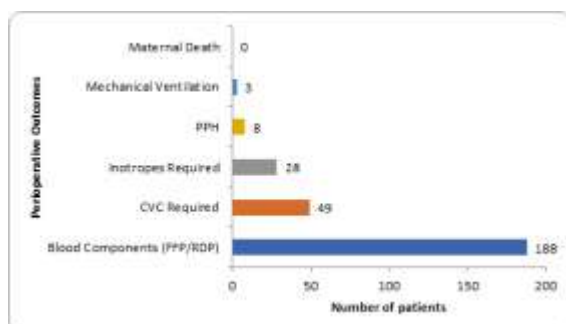
## RESULTS

A total of 213 pregnant women who underwent cesarean delivery during the study period were included in the analysis. As shown in graph 1 and 2 the majority of patients belonged to the 25–35 years age group 154, (72.3%), while the remaining 59 (27.7%) were aged 36–40 years. Most women were primigravida (167, 78.4%), whereas 46 (21.6%) were multigravida. A total of 189 (88.7%) women were registered antenatal cases, while 24 (11.3%) were unregistered. Regarding antenatal management, 201 (94.4%) patients had received regular iron and folic acid (IFA) supplementation, whereas 12 (5.6%) were either not receiving treatment or had irregular compliance. The most common blood group was O positive, observed in 163 (76.5%) patients, followed by B positive in 35 (16.4%), AB positive in 11 (5.2%), and O negative in 4 (1.9%) patients. The mean perioperative blood transfusion requirement was  $3 \pm 1$  units. In addition to packed red blood cells, 188 (88.3%) patients received blood components in the form of fresh frozen plasma (FFP) and random donor platelets (RDP). Single donor platelets (SDP) and cryoprecipitate were administered to 4 (1.9%) patients. Central venous catheterization was required in 49 (23.0%) patients for perioperative hemodynamic monitoring and vascular access,

while 28 (13.1%) patients required inotropic support to maintain hemodynamic stability. Severe postpartum hemorrhage (PPH) occurred in 8 (3.8%) patients. No anesthesia-related complications were observed in the study population. However, 3 (1.4%) patients required elective endotracheal intubation and postoperative mechanical ventilation for continued hemodynamic stabilization. Importantly, no maternal deaths were observed during the study period. The lowest hemoglobin concentration recorded among the study participants was 3.9 g/dL, while the highest hemoglobin concentration was 9.8 g/dL.



**Graph 1: Shows patient characteristics**



**Graph 2: Shows patient outcome**

## DISCUSSION

The present retrospective study evaluated the clinical profile and perioperative outcomes of 213 anemic pregnant women undergoing cesarean delivery at a tertiary care center. The study demonstrated that the majority of women were aged 25–35 years, were primigravidae, and had received antenatal iron and folic acid supplementation. Despite a high proportion of registered antenatal cases and compliance with iron therapy, a substantial proportion of women presented with moderate to severe anemia requiring perioperative blood transfusion and blood component therapy. Importantly, although severe postpartum hemorrhage (PPH) occurred in a small proportion of patients (3.8%), there were no maternal deaths or anesthesia-related complications, highlighting the importance of multidisciplinary perioperative management in these high-risk patients. Maternal anemia remains one of the most significant public health challenges in developing countries,

particularly in India. According to the National Family Health Survey-5 (NFHS-5), more than half of pregnant women in India are anemic despite the implementation of national iron supplementation programs. Iron deficiency continues to be the leading cause, compounded by nutritional deficiencies, recurrent pregnancies, parasitic infestations, and poor socioeconomic conditions. Persistent anemia during pregnancy contributes substantially to maternal morbidity, increased healthcare utilization, and adverse neonatal outcomes. These findings emphasize that anemia continues to be an unresolved challenge even in tertiary healthcare settings.

The demographic characteristics observed in the present study are comparable to previous Indian studies, where the majority of women with severe anemia belonged to the reproductive age group of 20–35 years and were predominantly primigravidae. The high proportion of registered antenatal patients (88.7%) and women receiving iron and folic acid supplementation (94.4%) in our study reflects improved antenatal service utilization. However, the persistence of severe anemia despite supplementation suggests delayed initiation of therapy, poor compliance, malabsorption, or advanced anemia at presentation. Similar observations have been reported by Kalaivani, who highlighted that although iron supplementation programs have expanded considerably, maternal anemia continues to remain highly prevalent in India because of multifactorial etiologies beyond iron deficiency alone.<sup>[7]</sup>

Cesarean section in women with pre-existing anemia represents a significant perioperative challenge because even physiological surgical blood loss may precipitate hemodynamic instability and increase transfusion requirements. In the present study, the mean perioperative blood transfusion requirement was  $3 \pm 1$  units, and nearly 88.3% of patients required additional blood component therapy in the form of fresh frozen plasma and random donor platelets. These findings reflect the severity of anemia encountered in our cohort and the proactive transfusion strategy adopted to optimize oxygen delivery and coagulation during surgery. Dennis et al. demonstrated that perioperative anemia remains highly prevalent among women undergoing cesarean delivery and reported that nearly one-third of postoperative anemia could potentially be prevented by early diagnosis and aggressive treatment of iron deficiency during pregnancy. Their findings further emphasize that optimization of maternal hemoglobin before surgery can significantly reduce perioperative transfusion requirements.<sup>[8]</sup>

The present study also observed that 23.0% of patients required central venous catheterization and 13.1% required inotropic support during the perioperative period. These findings indicate that a considerable proportion of severely anemic women undergoing cesarean delivery require advanced

hemodynamic monitoring and cardiovascular support. Although there is limited literature specifically reporting central venous catheter utilization in obstetric anesthesia for maternal anemia, existing perioperative guidelines recommend invasive monitoring in patients with severe anemia, anticipated massive blood loss, or cardiovascular compromise. Early vascular access facilitates rapid transfusion of blood products, administration of vasoactive medications, and close hemodynamic assessment, thereby improving maternal outcomes in critically ill obstetric patients. Severe postpartum hemorrhage was observed in only 3.8% of women in our study. Previous studies have consistently demonstrated that maternal anemia is independently associated with increased risk of postpartum hemorrhage because of impaired uterine contractility, altered coagulation mechanisms, and reduced physiological reserve. A multicenter prospective cohort study from India involving more than 9,000 women reported that moderate-to-severe anemia significantly increased the risk of postpartum hemorrhage, particularly among women with severe anemia. Likewise, a prospective study evaluating coagulation profiles demonstrated reduced fibrinogen concentrations and prolonged coagulation parameters among women with severe anemia, suggesting a biological mechanism for the increased bleeding risk.<sup>[7]</sup>

Although only eight women developed severe postpartum hemorrhage, the absence of maternal mortality in our study is noteworthy. Maternal mortality associated with severe anemia has declined considerably in tertiary care institutions because of improvements in antenatal screening, availability of blood banks, standardized obstetric hemorrhage protocols, multidisciplinary obstetric anesthesia teams, and intensive care support. Earlier reports from North India documented significant maternal morbidity and mortality associated with postpartum hemorrhage, particularly among referred patients presenting with severe anemia and delayed intervention. Our findings therefore suggest that timely recognition, aggressive blood component replacement, and intensive perioperative monitoring can substantially improve maternal survival even among women with profound anemia.<sup>[9]</sup>

Another important finding in our study was the absence of anesthesia-related complications despite the lowest recorded hemoglobin level of 3.9 g/dL. Three patients required elective postoperative mechanical ventilation, and 13.1% required inotropic support to maintain cardiovascular stability. Elective postoperative ventilation in severely anemic patients is often performed to reduce myocardial oxygen demand, optimize tissue oxygenation, and allow gradual correction of anemia and hemodynamic abnormalities. These management strategies likely contributed to the favorable maternal outcomes observed in our cohort. The predominance of the O-positive blood group (76.5%) observed in our study is consistent with the

known distribution of ABO blood groups within the Indian population and has limited direct clinical significance with respect to maternal anemia. Nevertheless, awareness of blood group distribution facilitates preparedness for timely availability of compatible blood products in obstetric emergencies. The principal strength of the present study lies in its evaluation of perioperative anesthetic management, transfusion practices, invasive monitoring, and maternal outcomes among severely anemic women undergoing cesarean delivery in a tertiary care setting. Such comprehensive perioperative data remain relatively scarce in the existing literature, particularly from Indian centers.

However, several limitations should be acknowledged. The retrospective nature of the study limits causal inference and depends on the accuracy of medical records. The study was conducted at a single tertiary care center, which may limit generalizability to other healthcare settings. Additionally, neonatal outcomes, long-term maternal follow-up, iron indices, and comparisons with non-anemic women were not evaluated. Future multicenter prospective studies including maternal and neonatal outcomes and stratification according to anemia severity are warranted.

Overall, the findings of the present study reinforce the importance of early antenatal detection and correction of maternal anemia, meticulous perioperative planning, availability of blood and blood components, invasive hemodynamic monitoring when indicated, and coordinated multidisciplinary management involving obstetricians, anesthesiologists, hematologists, and intensivists. These strategies can substantially reduce perioperative morbidity and ensure favorable maternal outcomes even among women presenting with severe anemia undergoing cesarean delivery.<sup>[8-10]</sup>

### **Limitation of the study**

Being a retrospective, single-center study, it is subject to the inherent limitations of retrospective data collection, including potential selection bias and incomplete documentation. The relatively small sample size may also limit the generalizability of the findings to the broader obstetric population. In addition, the study primarily focused on maternal perioperative outcomes and transfusion practices and did not evaluate important neonatal parameters such as Apgar scores, neonatal intensive care unit (NICU) admissions, birth weight, or other neonatal outcomes. Furthermore, long-term maternal and neonatal follow-up was not available. Prospective multicenter studies with comprehensive maternal and neonatal outcome assessment are warranted to validate these findings.

## **CONCLUSION**

Maternal anemia remains a significant contributor to obstetric morbidity among women undergoing

cesarean delivery. Severe anemia was associated with increased perioperative blood transfusion, blood component therapy, invasive monitoring, and inotropic support. Nevertheless, timely multidisciplinary management and appropriate perioperative optimization resulted in favorable maternal outcomes, with no maternal mortality or anesthesia-related complications observed in this study. These findings emphasize the importance of early antenatal detection and correction of anemia to minimize perioperative risks. Strengthening antenatal care and optimizing hemoglobin levels before delivery may further improve maternal outcomes in high-risk pregnancies.

## REFERENCES

1. Adam I, Salih Y, Hamdan HZ. Association of Maternal Anemia and Cesarean Delivery: A Systematic Review and Meta-Analysis. *J Clin Med*. 2023 Jan 6;12(2):490
2. Dennis AT, Ferguson M, Jackson S. The prevalence of perioperative iron deficiency anaemia in women undergoing caesarean section-a retrospective cohort study. *Perioper Med (Lond)*. 2022 Aug 4;11(1):36
3. Adam I, Kheiri S, Sharif ME, Ahmed ABA, Rayis DA. Anaemia is associated with an increased risk for caesarean delivery. *Int J Gynaecol Obstet*. 2019 Nov;147(2):202-205
4. O'Donnell M, Dennis AT. A feasibility study of measuring maternal anaemia and postoperative outcomes after caesarean section. *Anaesth Intensive Care*. 2025 Mar;53(2):92-102
5. Wang R, Xu S, Hao X, Jin X, Pan D, Xia H, Liao W, Yang L, Wang S. Anemia during pregnancy and adverse pregnancy outcomes: a systematic review and meta-analysis of cohort studies. *Front Glob Womens Health*. 2025 Jan 31;6:1502585
6. Kalaivani K. Prevalence & consequences of anaemia in pregnancy. *Indian J Med Res*. 2009 Nov;130(5):627-33
7. Cheng TS, Zahir F, Solomi C 5th, Verma A, Rao S, Choudhury SS, et al. Does induction or augmentation of labor increase the risk of postpartum hemorrhage in pregnant women with anemia? A multicenter prospective cohort study in India. *Int J Gynaecol Obstet*. 2025 Apr;169(1):299-309
8. Dennis AT, Ferguson M, Jackson S. The prevalence of perioperative iron deficiency anaemia in women undergoing caesarean section-a retrospective cohort study. *Perioper Med (Lond)*. 2022 Aug 4;11(1):36
9. Kaul V, Bagga R, Jain V, Gopalan S. The impact of primary postpartum hemorrhage in "near-miss" morbidity and mortality in a tertiary care hospital in North India. *Indian J Med Sci*. 2006 Jun;60(6):233-40
10. Nair M., Choudhury M.K., Choudhury S.S., Kakoty S.D., Sarma U.C., Webster P., Knight M. Association between Maternal Anaemia and Pregnancy Outcomes: A Cohort Study in Assam, India. *BMJ Glob. Health*. 2016;1:e000026.