



ASSESSMENT OF HEMATOLOGICAL PARAMETERS AND INTRANATAL OUTCOMES AMONG NEWBORNS OF ANEMIC MOTHERS AT A TERTIARY CARE HOSPITAL IN NORTH COASTAL ANDHRA PRADESH

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Abstract

Introduction: The study emphasizes the high prevalence of maternal anaemia, particularly in low- and middle-income countries, and its implications for maternal and neonatal health.

Materials and Methods: The research involved 180 mother-newborn pairs over one year, focusing on maternal characteristics, severity of anaemia, neonatal hematological parameters, and intranatal outcomes.

Results: Key findings indicate that maternal anaemia, classified as mild, moderate, and severe, significantly correlates with adverse neonatal outcomes such as low birth weight, poor APGAR scores, and increased need for resuscitation and NICU admission. The mean maternal haemoglobin was notably low at 9.1 g/dL, and the rates of low birth weight among newborns were 16.7%, 34.1%, and 52.9% for mild, moderate, and severe anaemia, respectively. Statistical analysis revealed that higher severity of maternal anaemia correlates with lower neonatal haemoglobin and haematocrit values, confirming the impact of maternal health on neonatal outcomes. The data suggests that improved screening and management of maternal anaemia could lead to better neonatal health outcomes.

Conclusion: Overall, the study highlights the critical need for increased antenatal care, effective iron supplementation, and nutritional counseling to mitigate the effects of maternal anaemia on newborns, advocating for further multicenter studies for comprehensive understanding of these relationships.

Keywords: maternal and neonatal health, neonatal hematological, NICU, anaemia, NORTH COASTAL.

Introduction

Maternal anaemia is one of the most common nutritional and haematological disorders complicating pregnancy and continues to be a major public health problem, particularly in low- and middle-income countries. Pregnancy increases the need for iron and other nutrients required for blood cell formation, due to the increase in maternal blood volume, placental development, and foetal growth. If these increased needs are not adequately met, anaemia may develop or worsen during pregnancy. Iron deficiency is thought to be the leading cause of anaemia in pregnancy, but folate deficiency, vitamin B12 deficiency, infections, hemoglobinopathies, and chronic diseases may also play a role. Routine iron and folic acid supplementation in pregnancy is recommended by the World Health Organization (WHO) to reduce maternal anaemia and improve maternal and perinatal outcomes [1].

Maternal anaemia is clinically important because adequate maternal haemoglobin concentration is important to maintain oxygen delivery to the placenta and foetus. Maternal haemoglobin levels could be reduced, which could impair oxygen delivery and potentially affect foetal growth and health. A systematic review and meta-analysis was conducted by Sukrat et al. to investigate the association between maternal haemoglobin concentration and some adverse pregnancy outcomes such as low birth weight and preterm birth [2]. Likewise, a systematic review of studies from low- and middle-income countries reported that maternal anaemia was associated with increased risks of low birth weight, preterm birth, perinatal mortality, and neonatal mortality, with the burden being particularly relevant in South Asian populations [3].

The consequences of maternal anaemia may be clinically apparent during the intranatal and immediate neonatal periods and beyond the pregnancy. Anaemic mothers are at risk of delivering low birth weight, prematurity, intrauterine growth restriction and poor adaptation after birth. The intranatal period is especially important, as the newborn undergoes rapid physiological adjustments, including adaptation of the respiratory, cardiovascular, and haematological systems. Assessment of birth weight, gestational age, APGAR score, need for resuscitation and other immediate neonatal outcomes can provide important information regarding the condition of the newborn at birth [3,4].

Evaluation of neonatal haematological parameters in conjunction with clinical outcomes may provide insight into the possible effects of maternal anaemia on the foetal haematopoietic system. Changes in the neonatal haematological profile may be characterised by haematological parameters like haemoglobin concentration, haematocrit, red blood cell count, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and red cell distribution width. Maternal iron deficiency may influence foetal iron stores and potentially the neonatal haematological status as the requirements of iron for both the mother and foetus are increased markedly during pregnancy. However, the relationship may be influenced by the severity and duration of maternal anaemia, gestational age, maternal nutritional status, supplementation and other maternal or obstetric factors [2,5].

Maternal anaemia is an important public health problem in India and nutritional deficiencies and maternal anaemia continue to contribute substantially to poor maternal and child health outcomes. WHO has emphasised the significance of antenatal detection and management of anaemia as an integral part of comprehensive maternal and newborn care [1, 4]. Identification of newborns at increased risk due to maternal anaemia is important in tertiary care settings for appropriate intranatal assessment, early neonatal monitoring and timely intervention.

Maternal anaemia and adverse pregnancy outcomes have been widely studied in the literature; however, the association between the severity of maternal anaemia, neonatal haematological parameters and immediate intranatal outcomes may differ across populations and healthcare settings. Regional studies are therefore important as maternal nutritional status, antenatal care practices, socioeconomic characteristics and prevalence of nutritional deficiencies may vary between geographic populations. The data from tertiary care hospitals of North Coastal Andhra Pradesh serving both urban and rural populations can throw some useful insights into this association.

Hence the present study was conducted to evaluate the haematological parameters and intranatal outcomes among the newborns of anaemic mothers, in a tertiary care hospital of North Coastal region of Andhra Pradesh. The aim of this study is to evaluate the neonatal haematological profile and its correlation with significant intranatal parameters that will help in better identification and early monitoring of newborns born to mothers with anaemia.

Materials and Methods:

Study Design and Setting: A hospital based observational study was carried out to assess the haematological parameters and intranatal outcomes of neonates born to anaemic mothers. The present study was conducted in the department of obstetrics and gynaecology in collaboration with department of paediatrics/neonatology in a tertiary care teaching hospital “Great eastern medical school and hospital” in North Coastal region of Andhra Pradesh. Pregnant women admitted for delivery and their newborns during the study period were enrolled in the study.

Study Population: The study population included pregnant women diagnosed with anaemia during pregnancy and their live-born neonates. Maternal anaemia was defined as haemoglobin concentration <11 g/dL in pregnancy according to World Health Organization criteria. Anaemia was defined as mild (10.0–10.9 g/dL), moderate (7.0–9.9 g/dL) and severe (<7.0 g/dL) according to haemoglobin concentration.

Study Period: The study was conducted over a period of 12 months, from March 2016 to February 2017.

Sample Size and Sampling: A total of 180 mother-newborn pairs were included in the study. Participants were recruited using consecutive sampling among eligible women presenting to the hospital for delivery during the study period.

Inclusion Criteria:

The study included:

1. Pregnant women diagnosed with anemia during pregnancy or at admission for delivery.
2. Women with singleton pregnancies.
3. Women delivering a live-born infant at the study hospital.
4. Mothers who provided informed consent to participate in the study.
5. Newborns whose relevant maternal and neonatal clinical data were available.

Exclusion Criteria:

The following were excluded:

1. Mothers with known hematological disorders such as sickle cell disease or thalassemia.
2. Mothers with significant chronic systemic diseases likely to independently affect neonatal hematological parameters.

3. Multiple pregnancies.
4. Stillbirths.
5. Newborns with major congenital anomalies.
6. Newborns with conditions requiring immediate transfer before the required initial assessment could be completed.
7. Mothers who did not provide consent.

Data Collection: Maternal demographic and obstetric information was collected using a structured data collection proforma. Maternal variables included age, parity, gestational age, haemoglobin concentration, severity of anaemia, antenatal iron-folic acid supplementation, mode of delivery and relevant obstetric complications.

Neonatal data were recorded immediately after delivery. Parameters included sex, birth weight, gestational age, APGAR scores at 1 and 5 minutes, need for neonatal resuscitation and other relevant intranatal observations. Low birth weight was defined as a birth weight <2500 g.

Assessment of Neonatal Hematological Parameters: Standard aseptic precautions were used to obtain newborn blood samples from cord blood or peripheral blood samples after delivery in accordance with institutional protocol. Samples were analysed in the accredited clinical laboratory of the hospital using an automated haematology analyser.

Haematological parameters were evaluated in the following manner: - Haemoglobin (Hb) - • Haemoglobin / packed cell volume (PCV)

- Red blood cell (RBC) count
- Mean cell volume (MCV)
- Mean cell haemoglobin (MCH)
- Mean cell haemoglobin concentration (MCHC)
- Red blood cell distribution width (RDW)

Interpretation was based on the laboratory reference ranges for neonates.

Assessment of Intranatal Outcomes: The neonate was assessed shortly after delivery with APGAR scores at 1 and 5 minutes. Neonatal outcomes assessed included birth weight, gestational age, APGAR score, need for resuscitation, admission to the neonatal intensive care unit (NICU) and other clinically relevant neonatal complications.

Statistical Analysis: Data were entered in Microsoft Excel and analysed using appropriate statistical software. Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range according to the distribution of the data. Categorical variables were expressed as frequency and percentages.

Appropriate statistical tests were used to assess the association between the severity of maternal anaemia and neonatal haematological parameters and intranatal outcomes. Comparison of means of normally distributed continuous variables was done using Student's t-test/ANOVA and non-normally distributed variables using the Mann-Whitney U/Kruskal-Wallis test. Categorical variables were analysed by the chi-square test or Fisher's exact test. Correlation between maternal haemoglobin concentration and neonatal haematological parameters was assessed using Pearson's or Spearman's correlation coefficient. Statistically significant p-values were <0.05.

Ethical Considerations: The study was performed after getting approval from the Institutional Ethics Committee of the study hospital. The mothers who participated gave written informed consent. Patient

confidentiality was ensured throughout the study and the data obtained were used for research purpose only.

Results:

In the present study, 180 anaemic pregnant women with their live born newborns were included. Maternal and neonatal characteristics, severity of maternal anaemia, neonatal haematological parameters and intranatal outcomes were evaluated. Characteristics of a Mother. The mean maternal age was 25.8 ± 4.2 years and the majority of the mothers (132; 73.3%) were in the age group 21–30 years. 82 (45.6%) were primigravida and 98 (54.4%) were multigravida. The mean gestational age at delivery was 38.1 ± 1.6 weeks. Based on haemoglobin concentration, 72 (40.0%) of mothers had mild anaemia, 91 (50.6%) had moderate anaemia and 17 (9.4%) of mothers had severe anaemia. The mean maternal haemoglobin was 9.1 ± 1.4 g/dl.

Neonatal Characteristics

There were 180 newborns, 94 (52.2%) were males and 86 (47.8%) were females. The average birth weight was 2.71 ± 0.48 kg. Among the newborns, 52 (28.9%) had birth weight <2.5 kg and 128 (71.1%) had birth weight ≥ 2.5 kg. Mean gestational age of the newborns was 38.1 ± 1.6 weeks. There were 19 (10.6%) preterm newborns and 161 (89.4%) term newborns.

Neonatal Hematological Parameters

Mean neonatal haemoglobin concentration was 16.2 ± 2.1 g/dL and mean haematocrit was $48.5 \pm 6.1\%$. Mean RBC count was $4.72 \pm 0.58 \times 10^6/\mu\text{L}$. Mean values of MCV, MCH, MCHC and RDW were 103.2 ± 8.4 fL, 34.1 ± 3.2 pg, 33.0 ± 1.5 g/dL and $16.2 \pm 1.8\%$.

Intranatal Results The mean APGAR scores at 1 and 5 minutes were 7.4 ± 1.1 and 8.7 ± 0.8 respectively. Twenty-eight (15.6%) newborns had APGAR score <7 at 1 minute. Eight (4.4%) newborns had APGAR score <7 at 5 minutes. Neonatal resuscitation was needed in 24 (13.3%) and NICU admission in 31 (17.2%) newborns. The most frequent indications for admission to NICU were respiratory distress, low birth weight, poor feeding and birth asphyxia .

Association Between Severity of Maternal Anemia and Neonatal Outcomes

Adverse neonatal outcomes increased progressively with increasing severity of maternal anaemia. Mothers with mild anaemia had 16.7% incidence of low birth weight in their new born, 34.1% in those with moderate anaemia and 52.9% in those with severe anaemia.

Similarly, APGAR score <7 at 1 min was found in 9.7%, 18.7% and 29.4% of newborns born to mothers having mild, moderate and severe anaemia respectively. NICU admission was 11.1% among newborns with mildly anaemic mothers, 19.8% among newborns with moderately anaemic mothers and 29.4% among newborns with severely anaemic mothers.

The three groups of maternal anaemia showed statistically significant differences in low birth weight and NICU admission ($p < 0.05$).

Comparison of Neonatal Hematological Parameters According to Maternal Anemia Severity

Compared to infants of mothers with mild and moderate anaemia, infants of mothers with severe anaemia had relatively lower neonatal haemoglobin and haematocrit values. The mean neonatal haemoglobin concentration was 16.7 ± 1.8 g/dL, 16.0 ± 2.0 g/dL and 15.2 ± 2.4 g/dL in newborns of mothers with mild, moderate and severe anaemia, respectively.

The mean neonatal haematocrit values were 49.8 ± 5.4 , 47.9 ± 6.0 and $45.6 \pm 7.1\%$, respectively. Neonatal

haemoglobin and haematocrit values were significantly different between categories of maternal anaemia ($p<0.05$).

Correlation Between Maternal Hemoglobin and Neonatal Parameters

Maternal and neonatal haemoglobin concentrations were positively correlated ($r=0.32$, $p<0.001$). Maternal haemoglobin was also positively correlated with neonatal birth weight ($r = 0.27$, $p<0.001$). Conversely, lower maternal haemoglobin concentration was associated with lower APGAR scores at 1 minute and greater likelihood of NICU admission.

To summarise, the findings of this study suggest that increased severity of maternal anaemia was related to poor neonatal haematological profile, and increased rate of adverse intranatal outcomes, particularly low birth weight, lower APGAR scores, requirement for resuscitation and NICU admission.

Variable	Mild anemia n=72	Moderate anemia n=91	Severe anemia n=17	Total n=180
Low birth weight	12 (16.7%)	31 (34.1%)	9 (52.9%)	52 (28.9%)
APGAR <7 at 1 min	7 (9.7%)	17 (18.7%)	5 (29.4%)	28 (15.6%)
APGAR <7 at 5 min	2 (2.8%)	5 (5.5%)	1 (5.9%)	8 (4.4%)
Resuscitation required	7 (9.7%)	14 (15.4%)	3 (17.6%)	24 (13.3%)
NICU admission	8 (11.1%)	18 (19.8%)	5 (29.4%)	31 (17.2%)

Discussion:

Maternal anaemia is a major public health concern and is especially pertinent to the South Asian population. Nutritional deficiencies and low iron intake have a significant role to play in the burden of anaemia in pregnancy. In this study, we evaluated the correlation of maternal anaemia, neonatal haematological parameters and immediate intranatal outcomes in 180 mother-newborn pairs. The study showed that the severity of maternal anaemia was linked to less favourable neonatal haematological parameters and a higher frequency of adverse intranatal outcomes, such as low birth weight, lower APGAR scores, the need for resuscitation, and NICU admission. In the present study mean maternal haemoglobin concentration was 9.1 ± 1.4 g/dL and moderate anaemia was the most frequent category. This finding emphasises the ongoing problem of clinically significant anaemia among pregnant women who attend tertiary-care hospitals. Maternal anaemia may be due to increased iron requirements in pregnancy, inadequate dietary intake, malabsorption, repeated pregnancy and other nutritional or medical causes. The high prevalence of moderate anaemia in present population emphasises the need for early antenatal screening and appropriate management. In the present study, low birth weight was found in 28.9% of the newborns. The frequency was 16.7% in mothers with mild anaemia, 34.1% in mothers with moderate anaemia and 52.9% in mothers with severe anaemia. This gradient is consistent with evidence from prior studies. In a systematic review and meta-analysis of low- and middle-income countries, Rahman et al. found that maternal anaemia was associated with an increased risk of low birth weight, preterm birth, perinatal mortality and neonatal mortality [3]. Similarly, Rahmati et al. reported that maternal anaemia, particularly anaemia in early pregnancy, is associated with low birth weight [6]. These results are in agreement with the possibility that impaired foetal growth and inadequate maternal

oxygen-carrying capacity lead to reduced birth weight. The present study found a positive correlation between maternal haemoglobin concentration and neonatal birth weight. Maternal anaemia can impair foetal growth by decreasing oxygen supply to the placenta and foetus. Maternal nutritional deficiencies associated with anaemia may also cause foetal growth restriction. In their systematic review and meta-analysis, Sukrat et al. observed that haemoglobin concentrations less than 11 g/dL were linked to increased risks of preterm birth, low birth weight, and small-for-gestational-age birth [7]. The results of the present study suggest that the severity of maternal anaemia may be an important factor that needs to be addressed, although it is unlikely to be the only determinant of birth weight.

An important finding of the present study was the relationship between severity of maternal anaemia and neonatal haematological parameters. The mean neonatal haemoglobin concentration was 16.7 ± 1.8 g/dL in newborns of mildly anaemic mothers and 15.2 ± 2.4 g/dL in newborns of severely anaemic mothers. A similar pattern was seen for haematocrit. The positive correlation between maternal and neonatal haemoglobin concentrations suggests that the maternal haematological status may potentially influence the neonatal haematological status. Previous studies have reported that maternal iron status may affect foetal iron availability. Studies on foetal iron status showed that infants of mothers with moderate or severe iron-deficiency anaemia have lower neonatal iron stores [7]. Therefore, maternal anaemia may have effects beyond delivery and may impact the infant's iron stores in early life. However, current findings should be interpreted with caution, as neonatal haemoglobin concentration is influenced by a number of factors, including gestational age, timing and method of cord clamping, blood loss, maternal iron status and the underlying aetiology of maternal anaemia. Moreover, maternal haemoglobin alone cannot confirm iron deficiency because anaemia in pregnancy can be due to several reasons. The study also showed a correlation between the severity of maternal anaemia and the immediate intranatal outcomes. The percentage of newborns with an APGAR score below 7 at one minute was 9.7% in newborns of mothers with mild anaemia and 29.4% in newborns of mothers with severe anaemia. Similarly, NICU admission was associated with the severity of maternal anaemia. The above observations could be attributed to impaired maternal-fetal oxygen transport and increased risk of foetal growth restriction or prematurity in pregnancies complicated by significant anaemia. Rahman et al. reported increased risks of preterm birth and perinatal mortality in women with anaemia in low- and middle-income countries [3].

We also noted a greater need for resuscitation in newborns born to mothers with moderate and severe anaemia. Increased need of resuscitation and a lower APGAR score may indicate impaired neonatal adaptation immediately after birth. However, these outcomes are multifactorial and may be affected by mode of delivery, gestational age, foetal growth, maternal obstetric complications and intrapartum events. Therefore, maternal anaemia should be regarded as one of the possible contributing factors, rather than an independent explanation for all adverse neonatal outcomes. The findings have implications for antenatal and intrapartum care. Routine screening for anaemia, identification of its underlying cause, appropriate iron-folic acid supplementation, dietary counselling and timely treatment of moderate and severe anaemia may help reduce potentially preventable adverse outcomes. WHO recommends antenatal iron and folic acid supplementation as an important intervention to reduce the risk of maternal anaemia and improve maternal and neonatal health [1].

Strengths and Limitations:

This study provides simultaneous information on maternal anaemia, neonatal haematological parameters and immediate intranatal outcome in a tertiary care hospital population. However, several limitations should be noted. First, the study was conducted at a single tertiary-care center and the results may not be directly generalisable to the entire North Coastal region of Andhra Pradesh. Second, because this was an observational study, we cannot infer causality between maternal anaemia and neonatal outcomes. Third, the observed associations could be influenced by potential confounding factors such as maternal nutritional status, compliance with iron supplementation, socioeconomic status, infections, hemoglobinopathies and other obstetric complications. Finally, the study primarily assessed haematological parameters at birth and did not assess longer-term neonatal iron status or neurodevelopmental outcomes.

Conclusion:

The present study shows that severity of maternal anaemia was associated with less favourable neonatal haematological parameters and adverse immediate intra-natal outcomes. Newborns of mothers with moderate and severe anaemia had lower mean haemoglobin and haematocrit values, and higher frequencies of low birth weight, lower APGAR scores, need for resuscitation, and NICU admission. These findings emphasise the necessity of early detection, severity assessment and appropriate management of maternal anaemia during pregnancy. Improving antenatal screening of anaemia, provision of adequate iron-folic acid supplementation, nutritional counselling and timely treatment may help improve maternal and neonatal outcomes. Prospective, multicenter studies that measure maternal iron status, neonatal ferritin and other iron indices, and longer-term infant outcomes would be useful in clarifying the relationship between maternal anaemia and neonatal haematologic health.

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