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FETOMATERNAL OUTCOMES OF ANEMIA IN PREGNANCY: A COHORT STUDY

Original Research

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ABSTRACT

Background: Anemia in pregnancy remains one of the most prevalent and critical public health challenges, particularly in low- and middle-income countries like Pakistan. It significantly contributes to adverse maternal and neonatal outcomes. Hemodynamic changes during the second and third trimesters exacerbate the clinical burden of anemia, making early identification and management essential for reducing associated risks. Despite global focus, region-specific data on fetomaternal implications of anemia are still limited and warrant further investigation.

Objective: To determine the association of fetomaternal complications with maternal anemia in the second and third trimester of pregnancy.

Methods: A prospective cohort study was conducted at the Department of Obstetrics and Gynecology, Imran Idrees Teaching Hospital, Sialkot, over a period of three months from January 26, 2025, to April 26, 2025. A total of 450 pregnant women aged 18–45 years with gestational age >16 weeks were enrolled. Hemoglobin levels were measured and participants were categorized into anemic (Hb <11 g/dL; n=225) and non-anemic (Hb ≥11 g/dL; n=225) groups. Maternal outcomes assessed included pregnancy-induced hypertension and postpartum hemorrhage, while fetal outcomes included preterm birth, intrauterine growth restriction, low birth weight, placental insufficiency, and Apgar score <7 at 5 minutes. Data were analyzed using SPSS version 25, and relative risk (RR) was calculated.

Results: Pregnancy-induced hypertension was observed in 121 (53.8%) anemic versus 76 (33.8%) non-anemic women (RR=1.494). Cesarean deliveries occurred in 117 (52.0%) vs. 91 (40.4%) (RR=1.260). Preterm birth was noted in 142 (63.1%) vs. 84 (37.3%) (RR=1.696), postpartum hemorrhage in 126 (56.0%) vs. 78 (34.7%) (RR=1.535), IUGR and low birth weight in 76 (33.8%) vs. 39 (17.3%) (RR=1.486), poor Apgar scores in 86 (38.2%) vs. 57 (25.3%) (RR=1.328), and placental insufficiency in 37 (16.4%) vs. 13 (5.8%) (RR=1.574).

Conclusion: Maternal anemia during the second and third trimesters is significantly associated with increased risk of both maternal and fetal complications, highlighting the need for proactive screening and timely intervention.

Keywords: Anemia, Apgar Score, Intrauterine Growth Restriction, Pregnancy, Pregnancy Complications, Postpartum Hemorrhage, Preterm Birth.

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INTRODUCTION

Anemia remains the most prevalent nutritional deficiency disorder globally, posing a significant burden on maternal and fetal health. According to the World Health Organization (WHO), a woman is diagnosed as anemic during pregnancy if her hemoglobin level falls to 11 g/dL or below in the first trimester and under 10.5 g/dL during the second and third trimesters (1). Despite advancements in antenatal care, anemia continues to be a major public health concern in many low- and middle-income countries, particularly across South East Asia, where its burden is deeply entrenched in both physiological and socio-economic contexts (2). While the prevalence of anemia in pregnancy is approximately 23% in developed nations, it nearly doubles in less affluent regions. Global estimates suggest an average prevalence of 56% in resource-limited countries, with variation ranging from 35% to as high as 100% depending on regional disparities (3,4). In Pakistan specifically, anemia in pregnancy affects nearly 51.5% of women, indicating a pressing healthcare challenge (5). The most common form of anemia encountered in pregnancy is iron deficiency anemia, which often originates early in gestation and may exacerbate due to the physiological demands placed on the mother's body. These demands include plasma volume expansion and increased iron requirements for fetal development. However, the pathogenesis of anemia in pregnancy is not solely biological. Contributing social determinants such as early marriages, adolescent pregnancies, limited birth spacing, poor dietary practices, inadequate antenatal iron supplementation, and the prevalence of endemic infections like malaria and helminthiasis further amplify the risk (6,7). By the third trimester, many women experience a significant drop in hemoglobin levels, which has been strongly associated with adverse maternal and neonatal outcomes (8).

The maternal complications of anemia are manifold, encompassing an increased susceptibility to infections, heightened risk of postpartum hemorrhage, and a greater likelihood of pregnancy-induced hypertensive disorders (9). From the fetal perspective, anemia contributes to intrauterine growth restriction, premature births, low birth weight, and increased perinatal mortality due to placental insufficiency (10). Moreover, emerging evidence indicates that severe maternal iron deficiency can have lasting neurodevelopmental consequences for the child, including cognitive deficits, behavioral issues, and poor academic performance, possibly due to disrupted neurotransmitter synthesis in the developing brain (11,12). Despite a broad understanding of the global and regional burden of anemia in pregnancy, there is a noticeable paucity of localized data assessing its fetomaternal outcomes within the Pakistani population. The condition remains largely underdiagnosed and undertreated, particularly in rural and marginalized urban areas, where access to healthcare services is limited. This underscores a critical gap in national obstetric care and public health policy. Addressing this gap through empirical investigation is essential to guide interventions that can improve maternal and neonatal outcomes. Therefore, the objective of the present study is to evaluate the fetomaternal outcomes associated with anemia during pregnancy in a Pakistani cohort, thereby contributing valuable evidence to inform clinical and public health strategies.

METHODS

This cohort study was conducted at the Department of Obstetrics, Sialkot Medical College Hospital, Sialkot, over a period of three months from January 26, 2025, to April 26, 2025, following formal ethical approval from the Institutional Review Board (MRC/IRB/23003). The study aimed to evaluate fetomaternal outcomes associated with anemia in pregnancy. A total of 450 antenatal patients were enrolled based on an expected anemia prevalence of 51.5% in pregnancy in Pakistan (5), with a 95% confidence level and 5% margin of error. Participants were divided into two equal groups: 225 anemic women with hemoglobin levels below 11 g/dL (exposed) and 225 non-anemic women with hemoglobin levels above 11 g/dL (unexposed). Eligibility criteria included pregnant females aged between 18 and 45 years presenting after 16 weeks of gestation. Women with known hematological disorders such as thalassemia or sickle cell anemia, systemic illnesses like rheumatoid arthritis or hypothyroidism, nutritional deficiencies unrelated to anemia, antepartum hemorrhage, congenital abnormalities, or other medical or musculoskeletal conditions that could independently affect maternal or neonatal outcomes were excluded from the study. Women meeting the inclusion criteria were selected through non-probability purposive sampling. Written informed consent was obtained from all participants after explaining the purpose and nature of the study in their native language.

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Data were recorded using a structured proforma that included demographic details such as maternal age, parity, and gestational age. Hemoglobin levels were measured during antenatal visits in the second and third trimesters using standard laboratory procedures. The study closely monitored antenatal, intrapartum, and postpartum periods to identify maternal complications including pregnancy-induced hypertension and postpartum hemorrhage, as well as fetal complications such as fetal growth restriction, preterm birth, intrauterine growth restriction, placental insufficiency, low birth weight, and low APGAR scores. Operational definitions were standardized for uniform assessment. Pregnancy-induced hypertension was defined as a systolic blood pressure ≥140 mmHg and/or diastolic ≥90 mmHg occurring after 20 weeks of gestation. Placental insufficiency was diagnosed via ultrasound in the third trimester based on the presence of uterine artery notching, indicating increased vascular resistance. Fetal growth restriction was defined as estimated fetal weight below the 10th percentile for gestational age. Postpartum hemorrhage was considered significant if blood loss exceeded 500 mL within 24 hours of delivery. Preterm birth referred to delivery between 20 and 36 weeks of gestation, and low birth weight was defined as birth weight less than 2500 grams according to WHO standards. An APGAR score of less than 7 at five minutes was considered poor neonatal adaptation. All collected data were coded and analyzed using IBM SPSS version 25. Frequencies and percentages were calculated for categorical variables. Relative risk (RR) was computed to assess the association between anemia and adverse fetomaternal outcomes, and an RR greater than 1 was considered statistically significant.

RESULTS

The study included a total of 450 pregnant women, divided equally into exposed (anemic) and unexposed (non-anemic) groups, each comprising 225 participants. The mean age of participants was 31.52 ± 8.10 years in the exposed group and 32.46 ± 7.87 years in the unexposed group. The mean gestational age was similar between the two groups, with 26.99 ± 5.49 weeks in the exposed and 26.70 ± 5.39 weeks in the unexposed group. The mean BMI was also comparable at 26.45 ± 4.73 kg/m² and 26.74 ± 4.62 kg/m², respectively. Among the exposed group, 16.4% were primigravida, compared to 15.6% in the unexposed group. Mean hemoglobin concentration in the exposed group was 8.78 ± 1.39 g/dL, whereas the unexposed group had a mean of 11.87 ± 0.44 g/dL. In terms of maternal complications, pregnancy-induced hypertension was reported in 53.8% of the exposed group compared to 33.8% in the unexposed group, yielding a relative risk (RR) of 1.494 (95% CI: 1.243–1.797). Cesarean section rates were also higher in the exposed group (52.0%) than in the unexposed group (40.4%), with an RR of 1.260 (95% CI: 1.048–1.516). Preterm delivery was observed in 63.1% of anemic women compared to 37.3% of non-anemic women, indicating an RR of 1.696 (95% CI: 1.391–2.067). Postpartum hemorrhage occurred in 56.0% of the exposed group versus 34.7% in the unexposed group, with an RR of 1.535 (95% CI: 1.273–1.850). Placental insufficiency was diagnosed in 16.4% of the exposed group and 5.8% of the unexposed group, with a corresponding RR of 1.574 (95% CI: 1.296–1.912).

Regarding fetal outcomes, intrauterine growth restriction (IUGR) and low birth weight were recorded in 33.8% of the exposed group and 17.3% of the unexposed group, both with an RR of 1.486 (95% CI: 1.244–1.774). The mean birth weight was 2524.87 ± 425.69 grams in the anemic group and 2663.51 ± 300.57 grams in the non-anemic group. Poor Apgar scores (less than 7 at 5 minutes) were reported in 38.2% of neonates born to anemic mothers compared to 25.3% in the unexposed group, resulting in an RR of 1.328 (95% CI: 1.108–1.593). Additionally, the mean Apgar score at 5 minutes was significantly lower in the exposed group (6.75 ± 1.93) compared to the unexposed group (7.46 ± 1.92), with a p-value < 0.001. Stratified analysis provided deeper insights into the association between anemia and fetomaternal complications across various demographic and obstetric subgroups. Among primigravida women, the incidence of pregnancy-induced hypertension was 20 in the exposed group versus 11 in the unexposed, while preterm birth occurred in 23 versus 12 women, respectively. A similar pattern was observed in primiparous women, with higher rates of both complications in the anemic subgroup (28 and 30 cases) compared to their non-anemic counterparts (14 and 18 cases). Women with parity of 2–3 also showed an elevated risk, with 73 cases of hypertension and 89 preterm deliveries in the anemic group, versus 51 and 54 cases in the non-anemic group. Age-based stratification revealed that anemia was associated with increased hypertensive disorders and preterm birth across all age groups. Among women under 25, hypertensive complications and preterm deliveries were more frequent in anemic participants (22 and 27 cases) compared to non-anemic ones (16 and 19 cases). This trend persisted in women aged 25–34 and those ≥35 years, where exposed groups consistently showed higher frequencies of adverse outcomes. Similarly, when stratified by gestational age brackets, women presenting before 28 weeks exhibited more adverse outcomes if anemic, with 49 hypertensive cases and 55 preterm births, compared to 30 and 35 in the non-anemic group. These differences remained evident in the 28–32 weeks and >32 weeks categories, underscoring the impact of anemia regardless of gestational age at presentation.

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Table 1: Baseline demographics of females included in the study (n = 450)

	Group	
	Exposed	Unexposed
n	225	225
Age (years)	31.52 ± 8.10	32.46 ± 7.87
Gestational age (weeks)	26.99 ± 5.49	26.70 ± 5.39
BMI (kg/m^2)	26.45 ± 4.73	26.74 ± 4.62
Parity		
Primigravida	37 (16.4%)	35 (15.6%)
Primiparous	47 (20.9%)	43 (19.1%)
Parity 2-3	141 (62.7%)	147 (65.3%)
Hemoglobin (g/dl)	8.78 ± 1.39	11.87 ± 0.44

Table 2: Relative risk showing risk of association of adverse Fetomaternal outcomes with anemia

	Group		RR (95% CI)
	Exposed	Unexposed	
Pregnancy induced hypertension	121 (53.8%)	76 (33.8%)	1.494 (1.243, 1.797)
Cesarean delivery	117 (52.0%)	91 (40.4%)	1.260 (1.048, 1.516)
vaginal delivery	108 (48.0%)	134 (59.6%)	
Gestational age at delivery	36.26 ± 1.89	37.36 ± 2.00	0.000
Preterm birth	142 (63.1%)	84 (37.3%)	1.696 (1.391, 2.067)
Postpartum hemorrhage	126 (56.0%)	78 (34.7%)	1.535 (1.273, 1.850)
Intrauterine growth restriction	76 (33.8%)	39 (17.3%)	1.486 (1.244, 1.774)
Birth weight	2524.87 ± 425.69	2663.51 ± 300.57	0.000
Low birth weight	76 (33.8%)	39 (17.3%)	1.486 (1.244, 1.774)
Apgar score at 5 minutes	6.75 ± 1.93	7.46 ± 1.92	0.000
Poor Apgar score	86 (38.2%)	57 (25.3%)	1.328 (1.108, 1.593)
Placental insufficiency	37 (16.4%)	13 (5.8%)	1.574 (1.296, 1.912)

Table 3: Stratified Analysis of Fetomaternal Outcomes

Stratification Variable	Pregnancy-induced HTN (Exposed)	Pregnancy-induced HTN (Unexposed)	Preterm Birth (Exposed)	Preterm Birth (Unexposed)
Primigravida	20	11	23	12
Primiparous	28	14	30	18
Parity 2–3	73	51	89	54
Age < 25 years	22	16	27	19
Age 25–34 years	59	43	71	48

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Stratification Variable	Pregnancy-induced HTN (Exposed)	Pregnancy-induced HTN (Unexposed)	Preterm Birth (Exposed)	Preterm Birth (Unexposed)
Age ≥ 35 years	40	17	44	17
Gestational age < 28 weeks	49	30	55	35
Gestational age 28–32 weeks	41	28	52	31
Gestational age > 32 weeks	31	18	35	18

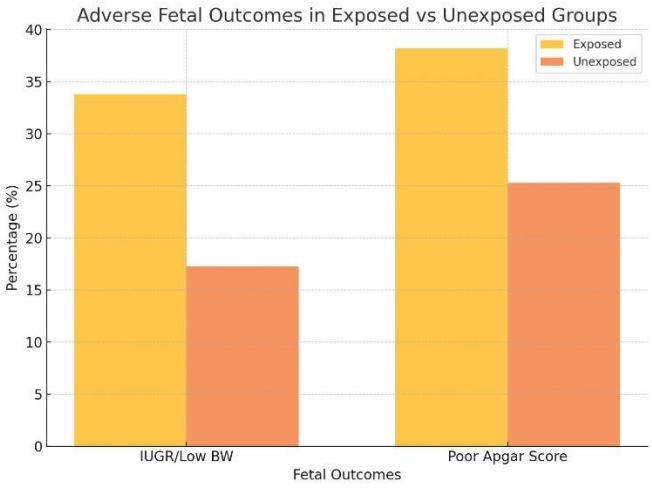


Figure 1 Adverse Fetal Outcomes in Exposed vs Unexposed Groups

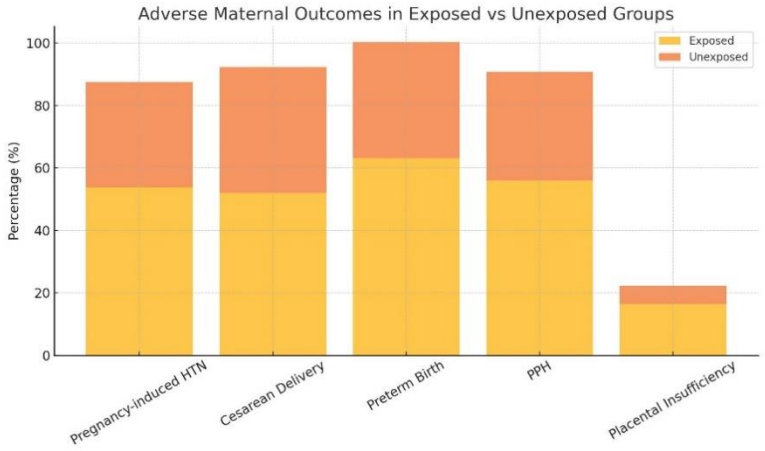


Figure 2Adverse Maternal Outcomes in Exposed vs Unexposed Groups

DISCUSSION

The findings of the present study reinforced the association between maternal anemia and adverse fetomaternal outcomes. The risk of pregnancy-induced hypertension, cesarean delivery, preterm birth, postpartum hemorrhage, intrauterine growth restriction, low birth weight, and poor neonatal Apgar scores was significantly higher among anemic women compared to their non-anemic counterparts. Notably, 53.8% of women in the anemic group experienced hypertensive disorders of pregnancy, compared to 33.8% in the non-anemic group, with a relative risk of 1.494. Similar trends were observed for cesarean deliveries (RR = 1.260), preterm births (RR = 1.696), postpartum hemorrhage (RR = 1.535), IUGR and low birth weight (RR = 1.486), poor Apgar score at five minutes (RR = 1.328), and placental insufficiency (RR = 1.574), indicating a consistently elevated burden of complications in the presence of anemia. These results align with multiple previous studies conducted locally and internationally (13,14). A local study conducted in southern Pakistan found that 52% of pregnant women had moderate anemia, with 12% having severe anemia requiring transfusion, and reported similar adverse outcomes (15). Another regional analysis reported that 53.3% of anemic mothers underwent cesarean section and had a threefold increase in low-birth-weight neonates compared to non-anemic mothers (16). The current findings are in agreement with research from other regions where the prevalence of cesarean delivery among anemic mothers exceeded 70%, and vaginal delivery was substantially reduced (17). Additionally, other large-scale studies have supported that anemia in pregnancy predisposes to serious maternal outcomes such as shock, postpartum hemorrhage, intensive care unit admission, and even maternal mortality, particularly with moderate to severe anemia (13,18,19). These studies also indicated a higher risk of perinatal mortality, poor neonatal adaptation, and prolonged hospital stay, corroborating the trends observed in the current cohort.

The high prevalence of anemia among pregnant women in this study underscores a persistent public health concern, particularly in low-resource settings. One of the key strengths of this study was its prospective cohort design and equal group distribution, allowing a direct comparison of exposed and unexposed individuals with relative risk calculation. The inclusion of a broad range of maternal and fetal

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outcomes adds further depth to the analysis. Moreover, the study employed standardized definitions and robust data collection methods, enhancing the validity of outcomes. However, certain limitations must be acknowledged. The study did not stratify anemia by severity—mild, moderate, or severe—although prior literature indicates that increasing severity correlates with worsening outcomes (20,21). Additionally, the study did not account for confounding variables such as nutritional status, compliance with iron supplementation, or underlying infections, which may influence hemoglobin levels and outcomes. Furthermore, socioeconomic status, education, and access to antenatal care were not assessed, despite their well-established role in determining maternal health. The absence of data on NICU admission rates, neonatal mortality, and maternal hospitalization duration represents another limitation, as these are important indicators of perinatal health burden. Future research should aim to incorporate anemia subtypes and stratification by severity, alongside adjusting for potential confounders through multivariate analysis. Larger multicenter studies are also needed to improve the generalizability of findings across diverse populations. In conclusion, the study highlights the substantial burden of maternal anemia on pregnancy outcomes. These findings support the need for early screening, nutritional interventions, and health system strengthening to mitigate anemia-related complications and improve maternal and neonatal health outcomes in resource-limited settings.

CONCLUSION

This study concludes that maternal anemia during the second and third trimesters is strongly associated with a higher incidence of adverse fetomaternal outcomes. In a resource-constrained setting like Pakistan, where the prevalence of anemia remains significantly high, the associated complications contribute to increased maternal morbidity and neonatal care burdens. These findings underscore the urgent need for routine antenatal screening of hemoglobin levels to enable early detection and timely intervention. Strengthening preventive strategies and ensuring adequate maternal nutrition can play a pivotal role in minimizing these risks and improving pregnancy outcomes at both individual and population levels.

AUTHOR CONTRIBUTION

Author	Contribution
Arooj Fatima*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Huma Afridi	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Hafsa Mubashir	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published

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