

Original Research

Received 12 July 2026

Revised 02 Aug 2026

Accepted 15 Aug 2026

Natural Resources for Human Health 2026, Vol. 6 (18s): 31–36

KEYWORDS:

APGAR score; Low Birth Weight; Maternal Anemia; Preterm

Maternal Anemia During Pregnancy: A Major Determinant of Adverse Neonatal Outcomes in Margono Soekarjo Regional General Hospital – A Cross-Sectional Study

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ABSTRACT: Background: Maternal anemia may compromise uteroplacental perfusion and increase the risk of adverse neonatal outcomes, such as preterm birth, low Apgar scores, fetal distress, IUGR, and low birth weight. Maternal hemoglobin levels may serve as an early predictor of neonatal complications and guide timely interventions to improve neonatal well-being.

Methods: A cross-sectional analytical study was conducted using secondary medical record data of pregnant women with anemia and delivered at Prof. Dr. Margono Soekardjo Hospital, Purwokerto, Indonesia, January 2025 - January 2026. Consecutive sampling was applied. Associations between maternal anemia and neonatal outcomes were analyzed using the Chi-square test and multivariable logistic regression.

Results: A total of 112 samples were included, with 23% having hemoglobin levels <11 g/dL. Chi-square analysis showed significant associations between maternal anemia and preterm birth, low birth weight, and low 5-minute Apgar score ($p < 0.05$; RR = 5.19; RR = 4.91; RR = 4.02). Multivariable logistic regression confirmed that maternal anemia was independently associated with an increased risk of preterm birth, low birth weight, and low Apgar score ($p < 0.05$).

Conclusion: Maternal anemia is significantly associated with adverse neonatal outcomes. Early detection and management of anemia during pregnancy may help reduce perinatal complications.

1. INTRODUCTION

Anemia in pregnancy is one of the most common nutritional disorders globally and remains the most significant public health issue. It is defined as a decreased haemoglobin level, leading to oxygen insufficiency because blood cannot carry enough oxygen.[¹] World Health Organization (WHO) Global Anaemia Estimates 2025 stated that the prevalence of anemia in pregnancy reaches 40% in 2023, globally while only 10% countries have shown progress to reach global target of lowering anaemia by 50% in 2030.[²] The burden of this disease remains high, particularly in lower-middle income countries (LMICs), which were affected by high rate of maternal malnutrition and limited access to standardized antenatal care.[³]

Iron deficiency is the main etiology of anemia in pregnancy (50– 60% of cases). Increased plasma volume in pregnancy is able to cause hemodilution that masks iron deficiency while maternal iron requirement is increasing for fetal and placental development.[4] Pregnant women deliver with uncorrected maternal anemia although antenatal screening and iron supplementation have been recommended because of the late diagnosis, low therapeutic adherence, limited access to antenatal care, and poor quality of antenatal care. Anemia in pregnancy leads to chronic hypoxia for mother and fetus, potentially increasing the risk of preventable neonatal outcomes.[5]

Studies have shown that anemia in pregnancy is associated with unfavourable neonatal outcomes, including preterm deliveries, low birth weight (LBW), small gestation age (SGA), low APGAR score, and increased perinatal morbidities.[6] Population-based meta-analyses and cohort studies consistently reported that pregnant women with anemia have a higher risk of having those outcomes than healthy pregnant women.[7] Pathophysiologically, the decline of maternal haemoglobin level will reduce the oxygen transport capacity to the placenta, which leads to placental insufficiency, chronic fetal hypoxia, fetal growth restriction, and neonatal adaptive disorders after delivery.[8-10] Furthermore, iron deficiency during pregnancy also has the potential to disrupt fetal neurological development by disrupting myelination, neurotransmitter synthesis, and epigenetic regulation.

Although much international scientific evidence has reported the correlation between maternal anemia and neonatal outcomes, the data from a regional-referral hospital in Indonesia are lacking. The population characteristics, maternal nutritional status, healthcare access, diagnostic criteria, and obstetric practice differences may affect the magnitude of their association. Therefore, scientific evidence from the local population is essential for the development of appropriate prevention and management strategies in Indonesia. This study aims to analyze the correlation between maternal anemia and neonatal outcomes in Prof. Dr. Margono Soekarjo General Hospital, Purwokerto. The study findings may contribute to strengthening the scientific evidence about the impact of maternal anemia during pregnancy on neonatal outcomes, also serving as a scientific basis to optimize early detection, anemia management in pregnancy, and antenatal care quality optimization in order to decrease the incidence rate of preventable neonatal outcomes. The present study aims to analyze the correlation between maternal anemia during pregnancy and neonatal outcomes in Prof. Dr. Margono Soekarjo General Hospital, Purwokerto, Indonesia.

2. MATERIALS AND METHODS

2.1 Study Design

This was an analytic study with a cross-sectional design, using secondary data from medical records of pregnant women with anemia who gave birth in Prof. Dr. Margono Soekarjo General Hospital, Purwokerto, Indonesia, from January 2025 to January 2026.

2.2 Ethical Clearance

This study had been approved by Ethical Committee of Research Ethics, Margono Soekarjo General Hospital.

2.3 Sample Recruitment and Collection

We use consecutive sampling in the present study. The participants were pregnant women with anemia who met inclusion criteria such as: Giving birth at a gestational age of > 28 weeks, having a complete medical record about anemia status and neonatal outcomes, and giving consent to participate in the present study voluntarily. The exclusion criteria were pregnant women with chronic haemolytic disease such as thalassemia and sickle cell disease, multiple pregnancies, fetuses with major congenital disorders, and incomplete or illegible medical.

2.4. Statistical Analysis

The results were analysed using Statistical Package for Social Sciences (SPSS) software. Univariate analysis was done for all variables. The correlation between maternal anemia and neonatal outcomes was analysed using the Chi-square test, while multivariate analysis was done using multivariate logistic regression. A p-value < 0.05 was considered statistically significant.

3. RESULTS AND DISCUSSION

3.1 Demographic Data

One hundred and twelve pregnant women who met the inclusion criteria were included in this study. Based on the results of the haemoglobin test during pregnancy, 26 participants (23.2%) had maternal anemia (Hb < 11 g/dL), while 86 participants (76.8%) did not have maternal anemia. Bivariate analysis was done using the Chi-square test to assess the correlation between maternal anemia and neonatal outcomes, including premature deliveries, fetal complications, low birth weight, and low 5-minute APGAR (Table 1).

Table 1. The Analysis Results

Parameters	Hemoglobin Levels		<i>P-value</i>	RR
	Anemia	Not Anemia		
Gestational Age			0.000*	5.192
Preterm (<37 weeks)	18	26		
Aterm (≥37 weeks)	8	60		
Fetal Complications			0.729	0.850
Yes	9	33		
No	17	53		
5-minutes APGAR Score			0.006*	4.024
Low (<7)	9	10		
Adequate (≥7)	17	76		
Birth Weight			0.001*	4.917
Low birth weight (<2,500 grams)	18	27		
Normal (2,500 – 4,000 grams)	8	59		

3.2. Correlation Between Variables

The analysis result found that maternal anemia had a statistically significant correlation with premature deliveries, low birth weight, and low 5-minute APGAR ($p < 0.05$). For premature deliveries, pregnant women with anemia had a 5.19 times higher risk of having a premature delivery than pregnant women without anemia (RR = 5.19; $p < 0.05$). This finding indicates that anemia during pregnancy is associated with a higher risk of premature delivery before 37th gestational age. Neonates from mothers with anemia during pregnancy had a 4.91 times higher risk of having low body weight (< 2,500 grams) than neonates from healthy mothers (RR = 4.91; $p < 0.05$). These findings indicated a significant correlation between maternal anemia and fetal growth disorders, which leads to low birth weight. The risk of having a low 5-minute APGAR score was also 4.02 times higher than that of pregnant women without anemia (RR = 4.02) (Table 1).

Multivariate logistic analysis was done to control confounding factors. The analysis reported that maternal anemia remains an independent risk factor for the incidence of premature birth, low birth weight, and low 5-minute APGAR score ($p < 0.05$). Therefore, neonates from mothers with anemia had a significantly higher risk of having the above-mentioned outcomes than neonates from healthy mothers. Overall, these findings support that anemia during pregnancy is one of the main risk factors that should be detected and treated antenatally to decrease neonatal morbidities.

3.4 Discussion

We found that the prevalence of maternal anemia is 23.2% among pregnant women who gave birth in Prof. Dr. Margono Soekarjo General Hospital, Purwokerto. Although it is lower than the reported global prevalence rate from WHO, this finding indicates that anemia remains an important health issue because one in four pregnant women had anemia. It also indicates that maternal anemia still has the potential to affect neonatal outcomes in a tertiary referral hospital; thus, detection and management during antenatal care remain priorities. This finding is consistent with various cohort studies and recent systematic reviews, which found that anemia in pregnancy remains one of the main risk factors for maternal and fetal morbidities, particularly in developing countries.[11-13]

The present study also found that maternal anemia is significantly associated with a 5.19 times higher risk of premature birth than pregnant women who do not have anemia. The increased risk indicates that anemia is not only an indicator of poor nutritional status, but also a contributing factor to premature delivery. This finding is consistent with various cohort and meta-analysis studies which found that anemia during pregnancy increases the risk of premature birth (gestational age < 37 weeks),

particularly if anemia occurs in the first and second trimester or anemia persists until late pregnancy.[12,14,15] The correlation between those variables is quite complex. Declined haemoglobin level reduces blood capacity to carry oxygen, leading to suboptimal uteroplacental perfusion. Placental chronic hypoxia will increase reactive oxygen species (ROS) generation, activating inflammatory pathways, increasing pro-inflammatory cytokine production such as interleukin-6 and tumor necrosis factor- α , and triggering prostaglandin synthesis, which has a role in cervical maturation and uterine contraction. Furthermore, chronic hypoxia also disrupts spiral artery remodelling; thus, placental function decreases and increases the risk of premature birth.[14,15]

Another finding in this study is the significant correlation between maternal anemia and low birth weight incidence, in which low birth weight risk is almost 5 times higher in the maternal anemia group than the non-anemia group. It is consistent with a recent meta-analysis that involves more than 50,000 pregnant women in Sub-Saharan Africa, finding that the risk of low birth weight is more than three times higher in maternal anemia. Some systematic reviews also have similar findings, concluding that maternal anemia is an independent risk factor for infants with low birth weight in various populations.[12,16] Physiologically, oxygen and nutrition transfer sufficiency through the placenta is crucial for fetal growth. Reduced oxygen-carrying capacity triggers maternal blood flow redistribution as compensation, but it is commonly insufficient to meet fetal metabolic requirements, leading to uteroplacental insufficiency, intrauterine growth restriction, and decreased fetal fat tissue and muscle mass deposition, which results in low birth weight. Iron deficiency also disrupts mitochondrial function, trophoblast cell proliferation, and placental angiogenesis, which further aggravate fetal growth.[12,16]

In addition to influencing birth weight, the present study also found that neonates from the maternal anemia group had a 4.02 times higher risk of having low 5-minute APGAR scores. Low APGAR score reflects physiologic transition disruption after birth since APGAR score is an important indicator of neonates' adaptation to the extrauterine environment. This finding is consistent with recent observational studies and systematic reviews, which found that maternal anemia is associated with increased incidence of neonatal respiratory depression, resuscitation requirement, and neonatal intensive care.[11,17] The correlation between them may appear as a result of chronic fetal hypoxia during pregnancy. Decreased oxygen reserve causes the fetus to have long-term metabolic compensation, leading to lower adaptation ability to circulatory and respiratory changes. Furthermore, iron-deficiency anemia is also known to correlate with fetal central nervous system development disorders through myelination, neuronal energy metabolism, and neurotransmitter synthesis disruption. Although long-term neurologic manifestations are not analysed in the present study, those mechanisms can explain the low adaptation ability in neonates at birth.[11,18]

In contrast with other outcomes, the present study did not find a significant correlation between maternal anemia and fetal complication ($p = 0.729$). It may occur due to a relatively small sample size, leading to limited statistical power to detect any discrepancies. Furthermore, fetal complication variables in the present study may consist of some heterogeneous clinical conditions leading to an inapparent overall effect of anemia on each complication. Other factors that may be involved are obstetric care quality in referral hospitals, which enables early detection and intervention for fetal conditions; therefore, severe complications can be minimized although maternal anemia is present. This finding indicates that maternal anemia does not affect all neonatal outcomes directly; it may also be affected by other obstetric factors such as hypertension in pregnancy, intrauterine infection, and placental disorders.[12,13]

Multivariate logistic regression analysis found that maternal anemia remains an independent risk factor of premature birth, low birth weight, and low APGAR score after the confounding factors were controlled. These results are consistent with various large-scale cohort studies which found that the correlation between anemia and neonatal outcomes remains significant after adjusting for maternal age, parity, body mass index, comorbidities, and socioeconomic status.[12,18] The clinical implications from the present study are important for antenatal care in Indonesia. Hemoglobin level screening should be done periodically during pregnancy, not only in the first visit. Other than iron and folic acid supplementation based on recommendations, a comprehensive approach such as nutritional education, increasing iron supplementation adherence, detecting comorbid diseases, and treating other etiologies of anemia is required. A recent meta-analysis found that iron-folic acid supplementation can decrease the incidence of maternal anemia and also decrease the risk of premature birth and low birth body weight.[17]

This study has several limitations. The cross-sectional design cannot explain the cause-and-effect correlation directly. Furthermore, using medical records may hinder the analysis of other important variables such as ferritin level, maternal nutrition status, iron-supplementation adherence, inflammatory status, and the severity of anemia. However, the present study gave an

initial description of the correlation of maternal anemia with neonatal outcomes in the referred referral hospital population in Indonesia and may be a scientific basis for prospective analysis with larger sample sizes. Overall, the present study found that maternal anemia is an important risk factor for premature birth weight, low birth weight, and lower 5-minute APGAR score. This finding is consistent with recent international scientific evidence that highlights the importance of prevention, early detection, and anemia management during pregnancy as one of the effective strategies to improve neonate outcomes and decrease perinatal morbidities.[12,16,17]

4. CONCLUSION

The present study found that maternal anemia is an independent risk factor for unfavourable neonatal outcomes such as premature deliveries, low birth weight, and low 5-minute APGAR score. Therefore, early detection and optimized maternal anemia management are crucial to decrease neonatal morbidity. Reinforcing regular haemoglobin level screening, adequate iron supplementation, nutritional education, and improving treatment adherence are expected to improve neonatal outcomes. A prospective cohort study design is recommended for future studies with a larger sample size and accounting for other variables such as anemia severity, iron status, maternal nutrition status, and other confounding factors to get a more comprehensive result about the correlation between maternal anemia and neonatal outcomes.

ACKNOWLEDGEMENTS

None

AUTHOR CONTRIBUTIONS

ARU: Conceptualization, investigation, methodology, data analysis, data interpretation, Writing - Drafting.

AK: Conceptualization, investigation, methodology, data interpretation.

Harry Akza Putrawan: Data interpretation, methodology, and supervision

SDK: Data interpretation, supervision, and writing—Review & Editing

NRA: Supervision and writing—Review & Editing

DMS: Supervision and writing—Review & Editing

FUNDING

The present study was not sponsored by any individual, institution, or organization

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

This study had been approved by Ethical Committee of Research Ethics, Margono Soekarjo General Hospital (Number 000.9.2/09822).

DATA AVAILABILITY STATEMENT

The data were available by requests.

REFERENCES

- [1] World Health Organization. Anaemia. Geneva: WHO; 2025. Available from: <https://www.who.int/news-room/fact-sheets/detail/anaemia>. Accessed July 5, 2026
- [2] World Health Organization. WHO Global Anaemia estimates, 2025 edition. Geneva: WHO; 2025. Available from: https://www.who.int/data/gho/data/themes/topics/anaemia_in_women_and_children. Accessed July 5, 2026
- [3] Stevens GA, Beal T, Mbuya MNN, et al. Anaemia in women of reproductive age in low- and middle-income countries: progress towards the 2025 global nutrition target. *Bull World Health Organ*. 2022;100(8):522-531.

- [4] Shand AW, Kidson-Gerber GL. Anaemia in pregnancy: a major global health problem. *Lancet*. 2023;401(10388):1550-1551.
- [5] Bothwell TH. Iron requirements in pregnancy and strategies to meet them. *Am J Clin Nutr*. 2000;72(1 Suppl):257S-264S.
- [6] Rahman MM, Abe SK, Rahman MS, et al. Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: systematic review and meta-analysis. *Am J Clin Nutr*. 2016;103(2):495-504.
- [7] Azzam A, El-Masry S, El-Gohary A, et al. Anemia in pregnancy: a systematic review and meta-analysis of prevalence, determinants, and health impacts in Egypt. *BMC Pregnancy Childbirth*. 2025;25(1):123.
- [8] Li X, Zhou K, Huang H, et al. Maternal anemia during pregnancy and adverse maternal outcomes: a systematic review and meta-analysis. *Front Glob Womens Health*. 2025;6:1502585.
- [9] Zhang M, Li Y, Wang Q, et al. Association between anemia during pregnancy and adverse pregnancy outcomes in China: a cohort study of 18,948,443 women. *JAMA Netw Open*. 2021;4(9):e2129564.
- [10] Yang X, Dong Q, Li L, et al. Iron deficiency and iron deficiency anemia during pregnancy: associations with labor and delivery outcomes in the USA. *JAMA Netw Open*. 2024;7(5):e2422546.
- [11] Li X, Zhou K, Huang H, Chen X, Wang L, Su X, et al. Anemia during pregnancy and adverse pregnancy outcomes: a systematic review and meta-analysis. *Front Glob Womens Health*. 2025;6:1502585.
- [12] World Health Organization. *WHO global anaemia estimates, 2025 edition*. Geneva: World Health Organization; 2025.
- [13] Alem AZ, Efendi F, McKenna L, Felipe-Dimog EB, Chilot D, Tonapa SI, et al. Prevalence and factors associated with anemia in women of reproductive age across low- and middle-income countries based on national data. *Sci Rep*. 2023;13:20335.
- [14] Zhang Y, Li X, Liu Y, Ren Y, Wang L, Zhu W, et al. Maternal anaemia during early pregnancy and the risk of neonatal outcomes: a prospective cohort study in Central China. *BMJ Paediatr Open*. 2025;8(1):e001931.
- [15] Chen AC, Donovan A, Ned-Sykes R, Andrews NC. Noncanonical role of transferrin receptor 1 is essential for intestinal homeostasis. *Proc Natl Acad Sci USA*. 2015;112:11714-9.
- [16] Sangkhae V, Nemeth E. Effects of maternal iron status on placental and fetal iron homeostasis. *J Clin Invest*. 2021;131(18):e127341.
- [17] Zhao Z, Li Y, Wang X, Chen Y, Zhang L, Liu H. Effects of prenatal iron deficiency on neurological development and behavioral phenotypes in offspring: mechanisms and therapeutic perspectives. *Front Neurosci*. 2025;19:1244773.