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Original Article

Anemia in Pregnancy and Maternal–Fetal Outcomes: A Review of Current Evidence

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Abstract-

Background: Anemia remains one of the most common medical complications encountered during pregnancy worldwide, with the World Health Organization (WHO) estimating that more than one in three pregnant women globally are affected. Despite being largely preventable and treatable, maternal anemia continues to be strongly associated with adverse maternal and perinatal outcomes, particularly in low- and middle-income countries. ***Objective***: To review and synthesize current evidence on the prevalence, etiology, and consequences of anemia in pregnancy, and to examine its association with maternal and fetal outcomes including preterm birth, low birth weight, postpartum hemorrhage, preeclampsia, and perinatal mortality. ***Methods***: A narrative and data-synthesis approach was used, drawing on recent systematic reviews, meta-analyses, population-based cohort studies, and World Health Organization global estimates published between 2021 and 2026. Hemoglobin (Hb) thresholds were defined according to WHO criteria (Hb <11 g/dL in pregnancy), and outcomes were stratified by anemia severity where data permitted. ***Results***: Global anemia prevalence among pregnant women was estimated at 35.5% in 2023, with substantially higher rates in low- and middle-income regions, particularly sub-Saharan Africa and South Asia. Maternal anemia was associated with increased odds of low birth weight (OR 1.65, 95% CI 1.45–1.87), preterm birth (OR 2.11, 95% CI 1.76–2.53), perinatal mortality (OR 3.01, 95% CI 1.92–4.74), stillbirth (OR 1.95, 95% CI 1.15–3.31), and maternal mortality (OR 3.20, 95% CI 1.16–8.85). Anemia was also independently associated with severe maternal morbidity (adjusted OR 2.04, 95% CI 1.86–2.23) and postpartum hemorrhage in several cohorts. ***Conclusion***: Anemia in pregnancy is a major, largely preventable contributor to adverse maternal and fetal outcomes. Strengthening early antenatal hemoglobin screening, targeted iron and micronutrient supplementation, and management of underlying causes such as iron deficiency, hemoglobinopathies, and infection should remain central to maternal health programs, particularly in high-burden settings.

Keywords: *Anemia; Pregnancy; Maternal outcomes; Fetal outcomes; Preterm birth; Low birth weight; Iron deficiency.*

INTRODUCTION

Anemia, defined by the World Health Organization (WHO) as a hemoglobin (Hb) concentration below 11 g/dL during pregnancy, is one of the most prevalent nutritional and hematological disorders affecting women of reproductive age worldwide[1,2]. According to the 2025 WHO Global Anaemia Estimates, approximately 35.5% of pregnant women aged 15–49 years were anemic in 2023, a figure that has remained largely unchanged despite global commitments to reduce anemia prevalence by 50% by 2030[1]. The burden is markedly uneven: pregnant women in low- and middle-income countries (LMICs), particularly in sub-Saharan Africa and South Asia, face anemia prevalence rates exceeding 40–60%, compared with substantially lower rates in high-income regions[3,4].

Pregnancy itself induces a state of physiological hemodilution, with plasma volume expanding disproportionately relative to red cell mass, which can mask or exacerbate underlying iron deficiency[5]. Iron deficiency remains the leading cause of anemia in pregnancy globally, accounting for the majority of cases, followed by folate and vitamin B12 deficiency, hemoglobinopathies such as thalassemia and sickle cell disease, chronic infections including malaria and helminthiasis, and inflammatory or chronic disease states[5,6]. The increased iron requirement during pregnancy—driven by expanding maternal red cell mass, fetal and placental growth, and anticipated blood loss at delivery—often outpaces dietary intake, particularly among women with poor pre-pregnancy iron stores, short inter-pregnancy intervals, multiple gestation, or adolescent pregnancy[6].

The clinical significance of maternal anemia extends well beyond maternal symptoms such as fatigue, dyspnea, and reduced work capacity. A growing body of cohort and meta-analytic evidence links maternal anemia to a spectrum of adverse pregnancy outcomes. Maternal anemia reduces the oxygen-carrying capacity of blood, compromising uteroplacental perfusion and fetal oxygen delivery[7,8]. This mechanism has been implicated in fetal growth restriction, low birth weight (LBW), and preterm birth, with recent pooled estimates from large meta-analyses reporting odds ratios for LBW and preterm birth of approximately 1.65 and 2.11, respectively[8]. Anemia has similarly been associated with increased risk of small-for-gestational-age infants, fetal hypoxia, intrauterine growth restriction, neonatal asphyxia, and lower Apgar scores at birth, the latter potentially mediated through fetal anaerobic metabolism and acidosis[9,10].

On the maternal side, anemia in pregnancy has been linked to a higher risk of postpartum hemorrhage, gestational hypertensive disorders including preeclampsia, puerperal infection, and severe maternal morbidity, with one large United States cohort reporting an adjusted odds ratio of 2.04 for severe maternal morbidity among anemic women[11,12]. Severe anemia, in particular, carries an elevated risk of maternal mortality, and anemia remains a leading indirect contributor to maternal deaths globally, especially where access to blood transfusion services and emergency obstetric care is limited[8,13]. Importantly, recent evidence also highlights that the timing and trajectory of anemia matter: anemia detected in the first trimester appears to carry distinct risk compared with anemia that develops or persists later in gestation, and resolution of anemia by the third trimester may reduce, though not eliminate, associated risks[14].

Despite the substantial and consistent observational evidence linking maternal anemia to adverse outcomes, the 2024 United States Preventive Services Task Force review concluded that current evidence remains insufficient to determine whether universal screening and treatment of iron-deficiency anemia in pregnancy directly reduces the incidence of adverse maternal or infant outcomes, underscoring a persistent gap between epidemiological association and interventional proof[15]. This tension—between strong associative data and limited high-quality interventional evidence—motivates continued investigation into the burden, determinants, and outcome profile of anemia in pregnancy. The present article reviews current evidence on the epidemiology of anemia in pregnancy and synthesizes its documented associations with maternal and fetal outcomes, with the aim of informing clinical screening practices and antenatal care policy, particularly in high-burden settings.

MATERIALS AND METHODS

Study Design

This article was designed as a narrative review with quantitative data synthesis, integrating findings from recently published systematic reviews, meta-analyses, large population-based cohort studies, and official WHO global health statistics. The review was structured to address three objectives: (1) to summarize the global and regional prevalence of anemia in pregnancy; (2) to identify the principal maternal and fetal outcomes associated with maternal anemia; and (3) to quantify, where possible, the magnitude of these associations using pooled effect estimates reported in the literature.

Search Strategy and Data Sources

A structured literature search was conducted across PubMed/MEDLINE, the Cochrane Library, Embase, Web of Science, and the WHO Global Health Observatory, covering publications from January 2018 through June 2026. Search terms combined Medical Subject Headings (MeSH) and free-text keywords including “anemia,” “anaemia,” “iron deficiency anemia,” “pregnancy,” “maternal outcomes,” “fetal outcomes,” “preterm birth,” “low birth weight,” “postpartum hemorrhage,” “preeclampsia,” “perinatal mortality,” and “small for gestational age,” combined using Boolean operators, consistent with search strategies used in comparable published systematic reviews on this topic[8,9]. Reference lists of retrieved articles were hand-searched to identify additional relevant studies.

Inclusion and Exclusion Criteria

Studies were eligible for inclusion if they: (1) enrolled pregnant women with anemia defined according to WHO criteria (hemoglobin <11 g/dL, or hematocrit <33%, adjusted for gestational age and altitude where applicable); (2) reported at least one maternal or fetal/neonatal outcome compared against a non-anemic control group or a continuous hemoglobin gradient; and (3) were published as cohort studies, case-control studies, systematic reviews, or meta-analyses in peer-reviewed journals. Studies were excluded if they: (1) focused exclusively on multiple gestations; (2) lacked a comparator or control group; (3) were case reports, editorials, or conference abstracts without extractable outcome data; or (4) reported outcomes unrelated to maternal or perinatal health.

Anemia Classification

Anemia severity was classified using WHO thresholds applied during pregnancy: mild anemia (Hb 10.0–10.9 g/dL), moderate anemia (Hb 7.0–9.9 g/dL), and severe anemia (Hb <7.0 g/dL). Where individual studies used alternative classification systems, the closest equivalent WHO category was used for synthesis to allow comparability across data sources.

Outcome Variables

Maternal outcomes assessed included postpartum hemorrhage, preeclampsia and gestational hypertensive disorders, severe maternal morbidity, puerperal/peripartum infection, mode of delivery, and maternal mortality. Fetal and neonatal outcomes assessed included preterm birth (delivery before 37 completed weeks), low birth weight (birth weight <2500 g), small-for-gestational-age status, low Apgar score at 5 minutes (<7), neonatal intensive care unit admission, stillbirth, and perinatal mortality.

Data Synthesis and Analysis

Given the heterogeneity of source studies in design, population, and outcome definitions, a formal meta-analysis was not re-performed; instead, pooled effect estimates (odds ratios [ORs] and relative risks [RRs] with 95% confidence intervals) were extracted directly from published meta-analyses and large cohort studies and tabulated for comparative synthesis[8,11,12,16]. Prevalence estimates were drawn from WHO Global Anaemia Estimates (2025 edition) and the Global Burden of Disease-linked pooled analyses of population-representative survey data[1,3]. All extracted data were cross-checked against original source publications for accuracy. Descriptive synthesis was used to characterize patterns across anemia severity strata and outcome categories, and findings were organized into summary tables to facilitate interpretation.

RESULTS

The synthesized evidence is presented across four tables summarizing global prevalence, maternal outcomes, fetal/neonatal outcomes, and outcomes stratified by anemia severity, respectively.

Table 1. Global and regional prevalence of anemia in pregnant women

Region / Setting	Estimated Prevalence (%)	Data Source / Year
Global (pregnant women, 15–49 y)	35.5%	WHO Global Anaemia Estimates, 2023
Low- and middle-income countries	~40–45%	Pooled survey data, 2024
Sub-Saharan Africa	~40.5%	Regional estimate, 2023–2024
South Asia	>40%	Regional estimate, 2023–2024
High-income countries	<20%	WHO/World Bank, 2019–2023
Global range across countries (2019)	5.2–65.7%	WHO pooled analysis, 2000–2019

Source: WHO Global Anaemia Estimates (2025 edition)[1]; pooled population-representative analyses.[3],[7]

Table 2. Association between maternal anemia and maternal outcomes

Maternal Outcome	Effect Estimate (95% CI)	Interpretation
Severe maternal morbidity	aOR 2.04 (1.86–2.23)	Significantly increased risk
Maternal mortality	OR 3.20 (1.16–8.85)	Markedly increased risk
Postpartum hemorrhage	aOR 1.27–1.37 (0.99–1.79)	Increased risk; borderline in adjusted models
Preeclampsia / gestational hypertension	OR ~2–3-fold (non-linear)	Increased risk, U-shaped with Hb extremes
Cesarean delivery	Increased frequency (P<.05)	Increased risk
Puerperal / peripartum infection	Increased frequency (P<.05)	Increased risk

Source: Pooled cohort and meta-analytic data.[8,11,12]

Table 3. Association between maternal anemia and fetal/neonatal outcomes

Fetal / Neonatal Outcome	Effect Estimate (95% CI)	Interpretation
Low birth weight (<2500 g)	OR 1.65 (1.45–1.87)	Significantly increased risk
Preterm birth (<37 weeks)	OR 2.11 (1.76–2.53)	Significantly increased risk
Perinatal mortality	OR 3.01 (1.92–4.74)	Markedly increased risk
Stillbirth	OR 1.95 (1.15–3.31)	Significantly increased risk
Small for gestational age (SGA)	Increased odds (non-linear)	Increased risk
Low Apgar score (<7 at 5 min)	Increased odds	Increased risk
NICU admission	Increased frequency	Increased risk

Source: Pooled meta-analytic estimates from cohort studies (118 studies, n = 4,127,430 pregnancies).[8]

Table 4. Outcomes stratified by maternal anemia severity (illustrative synthesis)

Anemia Severity (Hb, g/dL)	Preterm Birth	Low Birth Weight	Maternal/Perinatal Risk
Mild (10.0–10.9)	Mildly increased	Mildly increased	Low-to-moderate increase
Moderate (7.0–9.9)	Moderately increased	Moderately increased	Moderate increase
Severe (<7.0)	Markedly increased	Markedly increased	Marked increase, including mortality risk

Severity gradient synthesized from non-linear dose-response relationships reported between maternal hemoglobin and adverse outcomes.[8]

Explanation of Findings

As shown in Table 1, anemia affects more than one-third of pregnant women globally, with a markedly disproportionate burden in LMICs, where prevalence frequently exceeds 40%[1,3,4]. This wide regional variation (ranging from approximately 5% to nearly 66% across countries) reflects differences in dietary iron intake, prevalence of infectious and parasitic disease, antenatal care access, and supplementation coverage[3,4].

Table 2 demonstrates that maternal anemia carries substantial risk for the mother herself. The adjusted odds ratio of 2.04 for severe maternal morbidity, and the markedly elevated odds ratio of 3.20 for maternal mortality, indicate that anemia is not simply a marker of poor nutritional status but an independent contributor to severe and life-threatening complications[11,16]. The association with postpartum hemorrhage was more modest and, in one large cohort, became non-significant after adjustment for confounders such as uterine fibroids and mode of delivery, suggesting that some of the observed association may be confounded or mediated by other obstetric factors[12].

Table 3 highlights the consistency of fetal and neonatal risk across multiple large meta-analyses. Pooled data from over four million pregnancies showed that maternal anemia increased the odds of low birth weight by 65% and preterm birth by more than two-fold, with perinatal mortality risk roughly tripled[8]. These findings are biologically consistent with the proposed mechanism of reduced maternal oxygen-carrying capacity leading to chronic fetal hypoxia, placental insufficiency, and impaired fetal growth[9,10].

Table 4 illustrates that the relationship between anemia and adverse outcomes is not linear but follows a dose-response gradient, with severe anemia (Hb <7.0 g/dL) associated with the greatest risk of preterm birth, low birth weight, and life-threatening maternal complications, while mild anemia carries a comparatively smaller, though still measurable, risk elevation[8,17]. This gradient supports the rationale for early identification and grading of anemia severity in antenatal care, rather than treating anemia as a binary diagnostic category.

DISCUSSION

The findings of this review reaffirm anemia in pregnancy as a major global maternal health concern with consistent, biologically plausible, and quantifiable associations with adverse maternal and fetal outcomes. The persistently high global

prevalence of 35.5%, essentially unchanged over the past two decades despite international nutrition targets, suggests that current public health interventions—primarily iron-folic acid supplementation programs—have achieved only partial success[1,3,4]. This stagnation is particularly concerning given that the WHO and World Health Assembly explicitly targeted a 50% reduction in anemia among women of reproductive age, a goal that fewer than 10% of countries are currently on track to meet[1,14].

The mechanistic basis for the observed associations is well established. Maternal anemia reduces the oxygen-carrying capacity of blood, which compromises uteroplacental perfusion and chronic fetal oxygen delivery, contributing to placental insufficiency, fetal growth restriction, and ultimately low birth weight and preterm birth[7,9]. The markedly elevated odds ratio for perinatal mortality (OR 3.01) and stillbirth (OR 1.95) observed in pooled analyses likely reflects the cumulative impact of chronic intrauterine hypoxia together with the increased likelihood of preterm delivery itself, since prematurity is independently associated with neonatal morbidity including respiratory distress, feeding difficulties, and neurodevelopmental sequelae[8,9]. Similarly, the association between anemia and reduced Apgar scores has been attributed to fetal anaerobic metabolism and resultant metabolic acidosis under conditions of chronic hypoxic stress[10].

On the maternal side, severe anemia compromises physiological reserve to tolerate the blood loss inherent to delivery, which may explain why women with anemia who experience postpartum hemorrhage are more likely to require transfusion, experience hemodynamic instability, or progress to severe maternal morbidity[11,12]. The substantially elevated odds ratio for maternal mortality (OR 3.20) is consistent with global maternal mortality surveillance data identifying anemia as a major indirect contributor to maternal deaths, particularly in settings with limited access to blood products and emergency obstetric services[8,13]. The dose-response relationship observed across anemia severity strata—with severe anemia conferring substantially greater risk than mild anemia—provides further support for a causal, rather than purely associative, interpretation of these relationships, though residual confounding by socioeconomic status, nutritional status, and access to care cannot be entirely excluded[17].

Notably, the relationship between anemia and adverse outcomes also appears to interact with other obstetric complications. Evidence from preeclamptic cohorts suggests that maternal anemia compounds the neonatal risk already conferred by hypertensive disorders of pregnancy, with anemic preeclamptic women showing substantially higher rates of preterm birth and neonatal intensive care admission compared with non-anemic counterparts[18]. This compounding effect suggests that anemia screening and correction may be particularly valuable in women who already carry other risk factors for adverse perinatal outcomes, supporting a risk-stratified rather than uniform approach to antenatal anemia management.

Despite this weight of observational evidence, an important caveat—highlighted by the 2024 US Preventive Services Task Force recommendation statement—is that current evidence remains insufficient to confirm that screening for and treating iron-deficiency anemia in pregnancy directly translates into improved maternal or infant outcomes at the population level[15]. This reflects the relative scarcity of high-quality randomized controlled trials evaluating anemia treatment against hard clinical endpoints, as opposed to the abundance of observational data describing the association between anemia and adverse outcomes. Furthermore, the timing of anemia onset and resolution appears clinically relevant: recent population-based data indicate that anemia identified in the first trimester carries elevated risk, and that resolution of anemia by late pregnancy mitigates—but does not fully eliminate—this excess risk, suggesting that early detection and sustained correction throughout pregnancy may be more beneficial than late or transient correction alone[14].

Taken together, these findings support the continued prioritization of early antenatal hemoglobin screening, routine iron and folic acid supplementation, and targeted investigation and treatment of underlying causes of anemia—including hemoglobinopathies, parasitic infection, and chronic inflammatory states—particularly in high-burden, low-resource settings where both anemia prevalence and the consequences of severe anemia are greatest[1,6,8]. Future research should prioritize well-designed interventional trials that directly assess whether correction of maternal anemia, particularly when initiated early in pregnancy, causally reduces rates of preterm birth, low birth weight, severe maternal morbidity, and perinatal mortality, in order to close the current evidence gap between strong observational association and confirmed clinical benefit.

CONCLUSION

Anemia in pregnancy remains a highly prevalent and largely preventable condition that is consistently and substantially associated with adverse maternal and fetal outcomes, including low birth weight, preterm birth, postpartum hemorrhage, severe maternal morbidity, perinatal mortality, and maternal mortality. The strength and dose-dependence of these associations, together with the biologically plausible mechanism of impaired oxygen delivery, underscore the clinical importance of early hemoglobin screening, graded severity assessment, and timely correction of anemia during antenatal care. While interventional evidence directly linking anemia treatment to improved hard outcomes remains limited, the magnitude and consistency of observational associations support maintaining anemia prevention and treatment as a core

pillar of maternal health programs, particularly in high-burden, resource-limited settings. Closing the gap between observational evidence and confirmed interventional benefit through well-designed clinical trials should be a priority for future obstetric and public health research.

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