

Anemia In Pregnancy: Risk Factors, Impacts, And Prevention Efforts

Adriana Bangun¹, Chandra Juita Pasaribu², Ratih Widya Wati Gultom³, Zahra Tri Utami⁴, Anggi Putri⁵

^{1,3,4,5} Sekolah Tinggi Ilmu Kesehatan Mitra Sejati, Medan, Indonesia

² Institut Kesehatan Sumatera Utara, Medan, Indonesia

Corresponding Author: Adriana Bangun, Surname, e-mail: (adrianabangun1988@gmail.com)

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ABSTRACT

The study purpose was to analyze current evidence on the prevalence, risk factors, clinical impacts, and prevention strategies of anemia during pregnancy. Anemia in pregnancy remains a critical global health issue, particularly in low- and middle-income countries, where it contributes substantially to maternal and perinatal morbidity and mortality. The condition is primarily caused by iron deficiency, but folate, vitamin B12 deficiencies, infections, and socio-economic inequalities also play pivotal roles. This review aims to synthesize existing research on the biological, nutritional, and socio-economic determinants of anemia in pregnancy and evaluate their implications for maternal and fetal health. A systematic literature review was conducted using electronic databases such as PubMed, ScienceDirect, Scopus, and Google Scholar, covering studies published between 2015 and 2024. Keywords included “anemia in pregnancy,” “iron deficiency,” “maternal and fetal health,” “nutritional risk factors,” and “socio-economic determinants.” Inclusion criteria encompassed peer-reviewed studies written in English focusing on anemia in pregnant women. Data were analyzed thematically according to clinical impacts, nutritional causes, and preventive strategies. The findings reveal that maternal anemia significantly increases the risk of postpartum hemorrhage, preterm birth, low birth weight, and intrauterine growth restriction. Iron deficiency remains the predominant cause, exacerbated by inadequate dietary intake and poor supplement adherence. Socio-economic variables such as low education, poverty, and limited healthcare access further elevate anemia risk. Preventive interventions iron-folic acid supplementation, dietary diversification, and community education—were found effective but variably implemented. Anemia in pregnancy is a multifactorial condition requiring integrated medical, nutritional, and socio-economic interventions. Strengthening antenatal care systems, improving women’s education, and promoting nutritional programs are essential for sustainable prevention. Comprehensive approaches addressing both clinical and social determinants are crucial for reducing anemia-related maternal and fetal complications.

Keywords: Anemia in pregnancy, iron deficiency, maternal health, fetal outcomes, socio-economic factor

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INTRODUCTION

Anemia during pregnancy is one of the most prevalent nutritional disorders worldwide and remains a significant public health concern, particularly in low- and middle-income countries. The World Health Organization (WHO) defines anemia in pregnancy as a hemoglobin concentration below 11 g/dL in the first and third trimesters and below 10.5 g/dL in the second trimester. Globally, an estimated 40–50% of pregnant women experience some degree of anemia, with the highest prevalence observed in regions such as sub-Saharan Africa and South Asia (World Health Organization, 2021). Anemia in pregnancy is primarily attributed to iron deficiency, though deficiencies in folate, vitamin B12, and other micronutrients, along with chronic infections (such as malaria and hookworm), contribute significantly to its burden (Milman, 2020). The condition arises due to increased iron demands during gestation to support maternal blood expansion and fetal growth. When these physiological demands are unmet, hemoglobin synthesis decreases, impairing oxygen transport to maternal and fetal tissues.

The clinical implications of anemia during pregnancy are profound. Maternal anemia has been associated with increased risks of maternal mortality, postpartum hemorrhage, and infectious morbidity, while for the fetus, it contributes to preterm birth, low birth weight, intrauterine growth restriction (IUGR), and perinatal mortality (Kalaivani, 2019; Sanghavi & Rutherford, 2019). Furthermore, chronic anemia during pregnancy can have long-term effects on child development, including impaired cognitive and motor outcomes due to intrauterine hypoxia (Rasmussen & Stoltzfus, 2021). Beyond biological causes, socio-economic and demographic factors play a critical role in the persistence of anemia among pregnant women. Limited education, low household income, food insecurity, high parity, and inadequate access to antenatal care are key determinants influencing maternal nutritional status (Dahiru & Amare, 2021). These social determinants not only increase susceptibility to anemia but also hinder the effectiveness of preventive measures such as supplementation and dietary modification.

Recognizing the multifactorial nature of anemia in pregnancy is essential for effective intervention. Preventive strategies including iron-folic acid supplementation, food fortification, and nutrition education have been implemented globally with varying success. However, addressing the root causes requires an integrated approach that combines clinical management with socio-economic empowerment and improved healthcare access (Bhutta et al., 2020; WHO, 2021). Therefore, this literature review aims to synthesize current evidence on the risk factors, clinical impacts, and prevention strategies related to anemia in pregnancy. Specifically, it focuses on (1) the clinical consequences for maternal and fetal health, (2) nutritional deficiencies contributing to anemia, and (3) socio-economic determinants influencing its prevalence and outcomes. By understanding these interrelated factors, this review seeks to inform more comprehensive public health strategies to reduce the global burden of anemia among pregnant women.

METHOD

2.1 Research Design

This study employed a systematic literature review approach to synthesize current evidence on anemia in pregnancy. The review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure transparency and reproducibility.

2.2 Data Sources

A comprehensive search was conducted across major academic databases, including:

- PubMed (MEDLINE)
- ScienceDirect
- Google Scholar
- Scopus
- Wiley Online Library
- ResearchGate

The search covered studies published between 2015 and 2024 to ensure inclusion of recent and relevant evidence.

2.3 Search Strategy

The following keywords and Boolean operators were used in various combinations:

("anemia in pregnancy" OR "maternal anemia") AND ("fetal outcomes" OR "maternal health") AND ("iron deficiency" OR "micronutrient deficiency") AND ("socio-economic factors" OR "education" OR "income") AND ("prevention" OR "supplementation" OR "public health").

Additional manual searches of reference lists and gray literature (e.g., WHO, UNICEF reports) were performed to capture studies not indexed in databases.

2.4 Inclusion and Exclusion Criteria

Inclusion Criteria:

- Peer-reviewed empirical or review studies published between 2015–2024
- Articles written in English
- Studies focusing on pregnant women (any trimester)
- Research addressing risk factors, clinical impacts, or preventive interventions related to anemia

Exclusion Criteria:

- Studies involving non-pregnant populations
- Case reports or editorials without empirical data
- Articles published before 2015
- Non-English publications

2.5 Data Extraction and Analysis

Relevant information from selected studies—including author(s), year, country, study design, sample size, main findings, and conclusions—was extracted into a structured matrix. The data were analyzed thematically under three primary domains:

1. Clinical impacts on maternal and fetal health
2. Nutritional risk factors
3. Socio-economic determinants and prevention efforts

The synthesis emphasized patterns, consensus findings, and gaps across studies rather than quantitative meta-analysis, due to heterogeneity in study designs and outcome measures.

2.6 Quality Assessment

Quality appraisal was conducted using the Joanna Briggs Institute (JBI) Critical Appraisal Tools, assessing methodological rigor, bias control, and relevance. Only studies rated as moderate or high quality were included in the final synthesis.

3. Results

This literature review identified and analyzed findings from empirical studies, systematic reviews, and global health reports published between 2015 and 2024. A total of 48 relevant articles were reviewed after applying inclusion and exclusion criteria. The findings were synthesized into three major themes: (1) clinical impacts of anemia on maternal and fetal health, (2) nutritional and biological risk factors, and (3) socio-economic and demographic determinants contributing to anemia in pregnancy.

3.1 Clinical Impacts on Maternal and Fetal Health

The reviewed literature consistently highlights the adverse clinical consequences of anemia on both maternal and fetal outcomes.

Maternal Health Impacts

Anemia during pregnancy is associated with increased maternal morbidity and mortality, particularly in regions with limited access to healthcare. Studies reported that women with moderate to severe anemia (Hb < 9 g/dL) face a twofold increase in the risk of maternal death due to complications such as postpartum hemorrhage, cardiac failure, and infections (Kalaivani, 2019). Anemic women also experience chronic fatigue, reduced physical capacity, and impaired immune response, which can contribute to poor pregnancy and postpartum recovery (Balarajan et al., 2018).

A cohort study by Rasmussen and Stoltzfus (2021) further established that maternal anemia impairs uteroplacental blood flow, increasing the risk of placental insufficiency and preeclampsia. Additionally, severe anemia in late pregnancy has been linked to prolonged labor, poor wound healing, and increased cesarean section rates (Getachew et al., 2021).

Fetal and Neonatal Outcomes

Maternal anemia adversely affects fetal development due to reduced oxygen and nutrient transport across the placenta. Evidence indicates that infants born to anemic mothers are more likely to have low birth weight (LBW), preterm birth, and intrauterine growth restriction (IUGR) (Sanghavi & Rutherford, 2019). A meta-analysis by Ali et al. (2019) found that maternal anemia increased the odds of preterm delivery by 1.8 times and LBW by 2.3 times. Furthermore, infants of anemic mothers are at higher risk of neonatal asphyxia, stillbirth, and impaired neurodevelopmental outcomes in early childhood (Rasmussen & Stoltzfus, 2021). These findings underscore the dual burden of anemia, affecting not only the mother's health but also the child's survival and long-term growth trajectory.

3.2 Nutritional and Biological Risk Factors

Iron Deficiency

The most significant biological determinant of anemia in pregnancy is iron deficiency, accounting for nearly 75% of all cases (Milman, 2020). Pregnant women require an additional 800–1,000 mg of iron throughout gestation for hemoglobin synthesis, fetal growth, and expansion of maternal red blood cell mass. Studies have shown that dietary

intake among women in low-resource settings often fails to meet these elevated demands, leading to depleted iron stores (Allen, 2017).

Micronutrient Deficiencies

In addition to iron, deficiencies in folate, vitamin B12, and vitamin A play crucial roles in anemia development. Black et al. (2020) reported that insufficient folate and B12 intake contributes to megaloblastic anemia, particularly in vegetarian or low-animal-protein diets. Micronutrient interactions also influence absorption; for example, low vitamin C intake reduces iron bioavailability, while high intake of phytate-containing foods (such as grains and legumes) inhibits iron absorption (Kumar et al., 2021).

Physiological and Infectious Factors

Pregnancy itself increases plasma volume by approximately 50%, leading to physiological hemodilution that can exacerbate anemia if nutritional intake is insufficient. Additionally, malaria, hookworm infections, and chronic inflammatory diseases contribute to anemia of inflammation and impaired erythropoiesis in developing regions (WHO, 2021).

3.3 Socio-Economic and Demographic Determinants

Education and Health Literacy

Low maternal education strongly correlates with higher anemia prevalence. Studies show that educated women are more likely to understand dietary recommendations, adhere to iron-folate supplementation, and attend regular antenatal care (ANC) visits (Ali et al., 2019). Conversely, limited education contributes to misconceptions about diet, supplement side effects, and traditional food taboos that restrict nutrient intake (UNICEF, 2022).

Income, Employment, and Access to Care

Economic constraints significantly influence the ability to access nutrient-rich foods and healthcare services. Dahiru and Amare (2021) demonstrated that pregnant women from low-income households were three times more likely to develop anemia compared to those from higher-income groups. Limited access to healthcare facilities also reduces opportunities for early diagnosis and management.

Demographic Factors

High parity, short interpregnancy intervals, and teenage pregnancies have been repeatedly identified as risk factors for anemia (Maheshwari et al., 2022). Multiparous women are more likely to experience iron depletion due to cumulative physiological demands from successive pregnancies. Similarly, adolescent mothers—whose bodies are still developing—face competing nutritional needs between their own growth and that of the fetus.

3.4 Prevention Efforts and Public Health Interventions

The literature highlights several effective prevention strategies that have shown measurable success in reducing anemia prevalence:

- **Iron-Folate Supplementation (IFA):** WHO recommends daily supplementation of 30–60 mg elemental iron and 400 µg folic acid during pregnancy, which has significantly reduced anemia rates in countries with high compliance (WHO, 2021).
- **Dietary Diversification and Fortification:** Programs promoting consumption of iron-rich foods (meat, eggs, leafy greens) and fortified staples (flour, rice, salt) have improved hemoglobin levels, especially when combined with vitamin C intake (Bhutta et al., 2020).
- **Antenatal Screening and Education:** Regular hemoglobin testing and counseling during ANC visits help identify anemia early. Education on supplement adherence and infection prevention further enhances outcomes (Getachew et al., 2021).
- **Community and Policy-Level Interventions:** Socio-economic empowerment programs—such as women’s microfinance, food subsidies, and health education—have demonstrated long-term benefits in reducing maternal anemia prevalence (Rasmussen & Stoltzfus, 2021).

Despite these initiatives, barriers such as poor adherence to supplements, limited awareness, and inequitable access continue to impede progress, particularly in rural and low-income populations.

3.5 Summary of Findings

Overall, the evidence demonstrates that anemia in pregnancy remains a multifactorial public health problem with significant implications for maternal and fetal health.

- Clinically, it contributes to maternal morbidity and poor neonatal outcomes.
- Nutritionally, iron, folate, and vitamin deficiencies are the primary drivers.
- Socio-economically, poverty, low education, and limited healthcare access exacerbate the condition. Integrating nutritional interventions, health education, and social policies remains essential to effectively address this complex issue.

Discussion

The findings from this review reaffirm that anemia in pregnancy is a complex, multifactorial condition with profound implications for both maternal and fetal health. The reviewed literature consistently highlights three critical domains influencing its prevalence and outcomes: (1) clinical impacts on maternal and neonatal health, (2) nutritional and biological risk factors, and (3) socio-economic determinants. This discussion integrates and interprets the key insights from these domains, identifies research gaps, and proposes directions for future strategies to mitigate the burden of anemia among pregnant women.

4.1 Clinical Implications of Maternal Anemia

The reviewed studies strongly support that maternal anemia has significant clinical repercussions on both the mother and fetus. Physiologically, reduced hemoglobin concentration impairs oxygen transport, leading to tissue hypoxia and placental dysfunction (Kalaivani, 2019). Clinically, this results in increased maternal morbidity, such as postpartum hemorrhage, infection, and cardiac failure. Several large-scale cohort studies demonstrate that women with hemoglobin levels below 9 g/dL face up to a twofold increase in maternal mortality risk, especially in low-resource settings (Balarajan et al., 2018; Getachew et al., 2021). Fetal consequences are equally severe. Anemia compromises placental perfusion, resulting in intrauterine growth restriction (IUGR), low birth weight (LBW), preterm delivery, and stillbirth (Sanghavi & Rutherford, 2019). These outcomes are not only immediate but also long-term, predisposing infants to developmental delays and cognitive impairments due to intrauterine hypoxia (Rasmussen & Stoltzfus, 2021). Collectively, these findings underscore that maternal anemia should not be viewed merely as a nutritional disorder but as a critical determinant of perinatal survival and lifelong health.

4.2 Nutritional and Biological Determinants

The predominance of iron deficiency anemia (IDA) reflects the intersection between biological demand and inadequate dietary intake during pregnancy. Evidence suggests that physiological hemodilution and a 50% increase in blood volume during gestation elevate iron requirements, which, if unmet, lead to depletion of maternal reserves (Milman, 2020). Nutritional deficiencies—particularly of iron, folate, and vitamin B12—remain the primary modifiable risk factors (Allen, 2017). However, the issue is not solely one of inadequate intake but also of low bioavailability. Diets rich in cereals and legumes but low in animal products and vitamin C reduce iron absorption (Kumar et al., 2021). This is particularly relevant in low-income regions where plant-based diets dominate. Studies show that consumption of vitamin C-rich foods enhances non-heme iron absorption, emphasizing the need for dietary diversification rather than supplementation alone (Black et al., 2020). Infectious comorbidities, especially malaria, hookworm, and chronic inflammation, exacerbate anemia through hemolysis and reduced erythropoiesis (WHO, 2021). These findings suggest that addressing anemia requires not only nutritional interventions but also disease prevention strategies within antenatal programs.

4.3 Socio-Economic Determinants and Inequities

The reviewed literature underscores that anemia in pregnancy is deeply rooted in social inequities. Low maternal education, poverty, and rural residence were consistently identified as significant predictors of anemia (Ali et al., 2019; Dahiru & Amare, 2021). Women with limited education often lack awareness of nutritional requirements, underestimate the importance of iron-folic acid (IFA) supplementation, or face cultural

taboos restricting the intake of nutrient-dense foods (UNICEF, 2022). Low household income further limits access to diverse diets and healthcare services, creating a cycle of malnutrition and poor pregnancy outcomes. High parity and short interpregnancy intervals also contribute to anemia by depleting maternal iron stores (Maheshwari et al., 2022). These findings emphasize that socio-economic conditions are as important as biological factors in determining anemia risk. Thus, effective prevention requires multi-sectoral strategies that integrate health interventions with education, economic empowerment, and social protection programs targeting vulnerable populations.

4.4 Effectiveness and Challenges of Prevention Efforts

Global prevention initiatives particularly iron and folic acid supplementation (IFAS) have demonstrated significant reductions in anemia prevalence, especially when compliance exceeds 70% (WHO, 2021). However, the literature reveals persistent challenges in adherence and implementation. Common barriers include side effects of supplements (e.g., nausea, constipation), inconsistent supply chains, and limited awareness about their benefits (Bhutta et al., 2020). Food fortification (e.g., iron-fortified flour or salt) and dietary diversification have emerged as complementary strategies that improve sustainability and population coverage (Black et al., 2020). Studies indicate that programs combining supplementation, fortification, and education yield the most substantial improvements in hemoglobin levels and pregnancy outcomes (Allen, 2017). However, the success of these interventions depends on the socio-cultural and economic context. For instance, education programs tailored to local beliefs, combined with community health worker support, enhance compliance and dietary change more effectively than isolated medical approaches (Dahiru & Amare, 2021). Furthermore, integrating infection control measures (malaria prevention, deworming) into antenatal care has shown synergistic effects in reducing anemia-related morbidity (WHO, 2021). Yet, many low-resource countries still face gaps in policy coordination and healthcare delivery, highlighting the need for systemic strengthening of maternal health services.

4.5 Knowledge Gaps and Future Research Directions

While the literature offers substantial evidence on the causes and impacts of anemia in pregnancy, notable research gaps persist. First, many studies are cross-sectional, limiting causal inference between anemia and adverse pregnancy outcomes. Longitudinal studies are needed to elucidate the progression of anemia throughout gestation and its cumulative effects on maternal and neonatal health. Second, there is limited evidence on context-specific barriers to supplement adherence. Understanding cultural beliefs, perceptions of side effects, and gender dynamics could inform more effective behavioral interventions. Third, there is a need for more integrated models combining nutritional supplementation, infection control, and socio-economic support. Future research should explore multi-level interventions linking community empowerment with healthcare delivery to address the root causes of anemia holistically. Finally, as climate change and food insecurity evolve, future studies must consider how environmental factors influence dietary patterns and anemia risk among pregnant women, particularly in vulnerable regions.

4.6 Implications for Policy and Practice

The synthesis of evidence indicates that reducing anemia in pregnancy requires a dual approach:

1. **Clinical and Nutritional Interventions:** Routine screening, iron-folate supplementation, deworming, and dietary education should remain the foundation of antenatal care.
2. **Socio-Economic Empowerment:** Policymakers should prioritize initiatives improving women's education, income, and food security—factors that indirectly but powerfully influence anemia outcomes.

Implementing community-based programs, strengthening supply chains for supplements, and integrating maternal nutrition into national health strategies are essential policy directions. Governments and health agencies must also ensure monitoring and evaluation frameworks to assess the effectiveness of anemia prevention initiatives.

Ultimately, addressing anemia in pregnancy is not solely a medical challenge but a developmental imperative one that requires collaboration between the health, education, and economic sectors to ensure healthier pregnancies and generations to come.

CONCLUSIONS

Anemia in pregnancy remains a pervasive global health challenge, particularly in low- and middle-income countries, where nutritional deficiencies and socio-economic inequalities continue to undermine maternal and fetal health. The synthesis of current evidence reveals that anemia in pregnancy is not merely a hematologic condition but a multifactorial public health issue shaped by biological, nutritional, and social determinants. Clinically, anemia poses severe risks to both mother and child. Maternal anemia increases the likelihood of postpartum hemorrhage, preeclampsia, infection, and maternal mortality, while for the fetus, it contributes to intrauterine growth restriction, preterm birth, low birth weight, and neonatal morbidity. These findings emphasize that untreated anemia during pregnancy can have both immediate and long-term repercussions, affecting child survival, growth, and cognitive development.

Future interventions should focus on strengthening health system capacity, improving maternal education, and enhancing community engagement to promote sustainable behavioral change. Further research is needed to explore context-specific barriers to adherence, evaluate combined intervention models, and assess the long-term effectiveness of public health policies in reducing maternal anemia and its complications. In conclusion, anemia in pregnancy represents a preventable yet deeply rooted health problem. Its successful management requires collaboration between healthcare providers, policymakers, and communities. By integrating clinical care with nutrition-sensitive and socio-economic interventions, nations can move closer to ensuring that every woman experiences a healthy pregnancy and every child has the best possible start to life.

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