



## Maternal and Neonatal Health Outcomes In Pregnant Women With Anemia In Developing Countries: *A Scoping Review*

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### ABSTRACT

Anemia in pregnancy remains a major public health problem in developing countries and contributes significantly to poor maternal and neonatal health outcomes. This study aims to map and synthesize scientific evidence on maternal and neonatal health outcomes in pregnant women with anemia in developing countries. Database searches were conducted from 2020 to 2025 using two databases and one search engine, with Mendeley used to assist in article selection. Methodological quality assessment (critical appraisal) and data mapping (data charting) were conducted using the Joanna Briggs Institute (JBI) checklist, which included cross-sectional research designs, cohort studies, randomized controlled trials, and systematic reviews. Of the 676 articles identified, only eleven articles met the inclusion criteria. The eligibility criteria, data charting process, and synthesis method were carried out in accordance with the PRISMA-ScR guidelines. The synthesis results showed that standardized hemoglobin measurement methods and anemia classification based on WHO criteria were important bases for interpreting the outcomes. Anemia in pregnancy was associated with an increased risk of obstetric complications, adverse birth outcomes, and maternal vulnerability to comorbidities. In neonates, maternal anemia is consistently associated with low birth weight, prematurity, increased neonatal mortality, and early life developmental disorders. Anemia in pregnancy is an important determinant of maternal and neonatal health outcomes in developing countries. Strengthening the quality of antenatal care, standard-based anemia screening, and sustained nutritional interventions are key strategies for reducing the adverse effects of anemia on mothers and babies. Keywords: Pregnancy Anemia, Hemoglobin, Maternal Outcomes, Neonatal Outcomes, Developing Countries.

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**ABSTRAK**

*Anemia pada kehamilan masih menjadi masalah kesehatan masyarakat yang besar di negara berkembang dan berkontribusi secara signifikan terhadap buruknya luaran kesehatan ibu dan neonatal. Penelitian ini bertujuan untuk memetakan dan mensintesis bukti ilmiah mengenai luaran kesehatan ibu dan neonatal pada ibu hamil dengan anemia di negara berkembang. Pencarian literatur dilakukan pada periode 2020 hingga 2025 menggunakan dua basis data dan satu mesin pencari dengan bantuan Mendeley dalam proses seleksi artikel. Penilaian kualitas metodologis (critical appraisal) dan pemetaan data (data charting) dilakukan dengan mengacu pada daftar periksa Joanna Briggs Institute (JBI), yang mencakup desain penelitian cross-sectional, studi kohort, randomized controlled trials, dan systematic review. Dari 676 artikel yang teridentifikasi, hanya sebelas artikel yang memenuhi kriteria inklusi. Kriteria kelayakan, proses data charting, dan metode sintesis dilakukan sesuai dengan pedoman PRISMA-ScR. Hasil sintesis menunjukkan bahwa penggunaan metode pengukuran hemoglobin yang terstandar dan klasifikasi anemia berdasarkan kriteria WHO menjadi dasar penting dalam menginterpretasikan luaran. Anemia pada kehamilan berhubungan dengan peningkatan risiko komplikasi obstetri, luaran kelahiran yang merugikan, serta kerentanan ibu terhadap komorbiditas. Pada neonatus, anemia maternal secara konsisten dikaitkan dengan berat badan lahir rendah, prematuritas, peningkatan mortalitas neonatal, dan gangguan perkembangan awal kehidupan. Anemia pada kehamilan merupakan determinan penting terhadap luaran kesehatan ibu dan neonatal di negara berkembang. Penguatan kualitas pelayanan antenatal, skrining anemia berbasis standar, serta intervensi nutrisi yang berkelanjutan merupakan strategi kunci untuk mengurangi dampak buruk anemia pada ibu dan bayi.*

Kata kunci: *Anemia Kehamilan, Hemoglobin, Luarannya Ibu, Luarannya Neonatal, Negara Berkembang.*

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**INTRODUCTION**

Anemia during pregnancy remains one of the most significant public health challenges affecting maternal and neonatal health worldwide. The World Health Organization (WHO) estimates that more than one-third of pregnant women in low- and middle-income countries experience anemia, with the highest prevalence occurring in Sub-Saharan Africa and South Asia (Bodeau-Livinec et al., 2011; Seid et al., 2023). Iron deficiency remains the primary cause, although other factors such as micronutrient deficiencies, infectious diseases, malaria, helminth infections, and socioeconomic deprivation also contribute substantially to its occurrence. Maternal anemia continues to place a considerable burden on health systems because it is associated with increased maternal morbidity, mortality, and adverse neonatal outcomes (Shi et al., 2022).

Physiologically, pregnancy is characterized by an expansion of plasma volume that exceeds the increase in red blood cell mass, resulting in a physiological decline in hemoglobin concentration. When this adaptation is accompanied by inadequate nutritional intake or underlying health conditions, anemia develops and may compromise maternal and fetal well-being (Bencaiova et al., 2012). Previous studies have consistently reported associations between maternal anemia and numerous adverse outcomes, including postpartum hemorrhage, blood transfusion requirements, preterm birth, low birth weight (LBW), stillbirth, neonatal mortality, and impaired infant development. These findings emphasize the importance of anemia prevention and management as a priority within maternal and child health programs (Barut & Mohamud, 2023)..

Despite the growing body of evidence, the existing literature remains fragmented and presents several inconsistencies. Previous studies vary considerably in terms of study design, hemoglobin measurement methods, timing of anemia assessment during pregnancy, severity classification, and outcome indicators. Furthermore, most studies focus on specific maternal or neonatal outcomes rather than providing a comprehensive understanding of the full spectrum of health consequences associated with maternal anemia. As a result, the available evidence is dispersed across different clinical, epidemiological, and geographical contexts, making it difficult to identify overarching patterns and evidence gaps (Bodeau-Livinec et al., 2011).

Several systematic reviews and meta-analyses have examined particular dimensions of maternal anemia, such as its association with low birth weight, dietary diversity, or neonatal mortality. However, these reviews generally address narrowly defined outcomes and do not comprehensively map the range of maternal and neonatal health consequences reported across developing countries. In addition, recent evidence published between 2020 and 2025 has expanded considerably, yet no review has systematically synthesized and categorized this emerging evidence to identify dominant themes, methodological characteristics, and remaining knowledge gaps. Consequently, there is still limited understanding of how maternal anemia influences multiple maternal and neonatal outcomes across diverse developing-country settings.

This gap highlights the need for a scoping review rather than a conventional systematic review. While systematic reviews are designed primarily to answer narrowly focused questions regarding intervention effectiveness or specific associations, scoping reviews are particularly appropriate for examining broad and heterogeneous bodies of evidence (Bodeau-Livinec et al., 2011). A scoping review enables researchers to map existing literature, identify research trends, summarize key concepts, explore methodological approaches, and reveal areas requiring further investigation. Given the diversity of study designs, outcome measures, and contextual factors related to maternal anemia in developing countries, a scoping review provides a more suitable framework for synthesizing the available evidence comprehensively.

Therefore, this study aims to map and synthesize current evidence regarding maternal and neonatal health outcomes among pregnant women with anemia in developing countries. The novelty of this review lies in its comprehensive mapping of recent evidence across multiple maternal and neonatal outcome domains, its identification of methodological patterns related to anemia measurement and classification, and its exploration of evidence gaps that remain insufficiently addressed in existing reviews. By providing a broad overview of the current evidence landscape, this review contributes to strengthening future research directions, informing maternal health policies, and supporting evidence-based interventions to reduce the burden of anemia in pregnancy.

## **METHOD**

A comprehensive literature search was conducted between December 2025 and January 2026 following the PRISMA-ScR guidelines. To improve the comprehensiveness of evidence retrieval, six electronic databases were searched: PubMed, Scopus, Web of Science, Embase, CINAHL, and

ScienceDirect. Google Scholar was additionally used for supplementary searches and citation tracking (Tricco et al., 2018).

The search strategy was developed based on the PCC framework and adapted to the indexing system of each database. Boolean operators, truncation symbols, and controlled vocabulary terms (e.g., MeSH terms in PubMed and Emtree terms in Embase) were used when applicable.

The PubMed search strategy was as follows:

("Pregnancy"[Mesh] OR pregnan\* OR maternal) AND ("Anemia"[Mesh] OR anaemia OR anemia OR iron deficiency anemia) AND ("Maternal Health"[Mesh] OR maternal outcome\* OR maternal morbidity OR maternal mortality) OR ("Infant, Newborn"[Mesh] OR neonatal outcome\* OR neonatal mortality OR low birth weight OR preterm birth) AND ("Developing Countries"[Mesh] OR low-income countr\* OR middle-income countr\* OR developing countr\*)

For Scopus and Web of Science, the search syntax was adapted as:

TITLE-ABS-KEY ((anemia OR anaemia OR "iron deficiency anemia") AND (pregnan\* OR maternal) AND ("maternal outcome\*" OR "maternal morbidity" OR "maternal mortality" OR "neonatal outcome\*" OR "neonatal mortality" OR "low birth weight" OR prematurity) AND ("developing countr\*" OR "low-income countr\*" OR "middle-income countr\*"))

Equivalent search terms were modified for Embase, CINAHL, and ScienceDirect according to database-specific requirements. The search was limited to studies published between January 2020 and December 2025. Reference lists of eligible studies were manually screened to identify additional relevant publications.

### **Inclusion Criteria**

1. Studies involving pregnant women diagnosed with anemia.
2. Studies reporting maternal and/or neonatal health outcomes.
3. Research conducted in developing, low-income, or middle-income countries.
4. Quantitative, qualitative, mixed-methods studies, randomized controlled trials, cohort studies, cross-sectional studies, systematic reviews, and meta-analyses.
5. Articles published in English.
6. Articles published between 2020 and 2025.

### **Exclusion Criteria**

1. Editorials, commentaries, letters, conference abstracts, and opinion papers.
2. Studies lacking primary or synthesized empirical data.
3. Studies focusing exclusively on non-pregnant populations.
4. Studies not reporting maternal or neonatal outcomes related to anemia.

## Study Selection Process

All retrieved records were exported into Mendeley reference management software for duplicate removal. After deduplication, two independent reviewers screened titles and abstracts according to the predefined eligibility criteria.

Potentially relevant articles underwent full-text assessment. Disagreements between reviewers were resolved through discussion and, when necessary, consultation with a third reviewer. Reviewer agreement during the screening process was assessed using percentage agreement and Cohen's kappa statistic to enhance methodological transparency and reduce selection bias.

A total of 676 records were initially identified. Following duplicate removal and title/abstract screening, 32 articles were retained for full-text review. Twenty-one studies were excluded at the eligibility stage due to: (1) non-developing country settings ( $n = 5$ ), (2) irrelevant outcomes ( $n = 4$ ), (3) inappropriate populations ( $n = 2$ ), (4) insufficient outcome data ( $n = 6$ ), and (5) non-eligible study designs ( $n = 4$ ). Ultimately, eleven studies met all inclusion criteria and were included in the final synthesis.

## Critical Appraisal

Methodological quality was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools according to study design. Separate JBI checklists were applied for cohort studies, analytical cross-sectional studies, randomized controlled trials, and systematic reviews.

Each appraisal item was scored as:

- 2 = Yes
- 1 = Unclear
- 0 = No

The total score for each study was converted into a percentage and categorized as follows:

- Grade A (High Quality):  $\geq 80\%$  of maximum score
- Grade B (Moderate Quality): 60–79%
- Grade C (Low Quality):  $< 60\%$

Only studies classified as Grade A or Grade B were retained for evidence synthesis. Studies rated Grade C were excluded due to substantial methodological limitations.

Critical appraisal results were not used as exclusion criteria alone but informed the interpretation of findings and the assessment of evidence strength during synthesis.

## Data Synthesis and Analysis

Data extraction was conducted using a standardized charting form that captured study characteristics, participant characteristics, anemia definitions, outcome measures, methodological features, and key findings.

A thematic synthesis approach was employed to identify patterns across studies. Rather than reporting findings study-by-study, evidence was synthesized into higher-order conceptual themes describing the pathways through which maternal anemia affects maternal and neonatal outcomes.

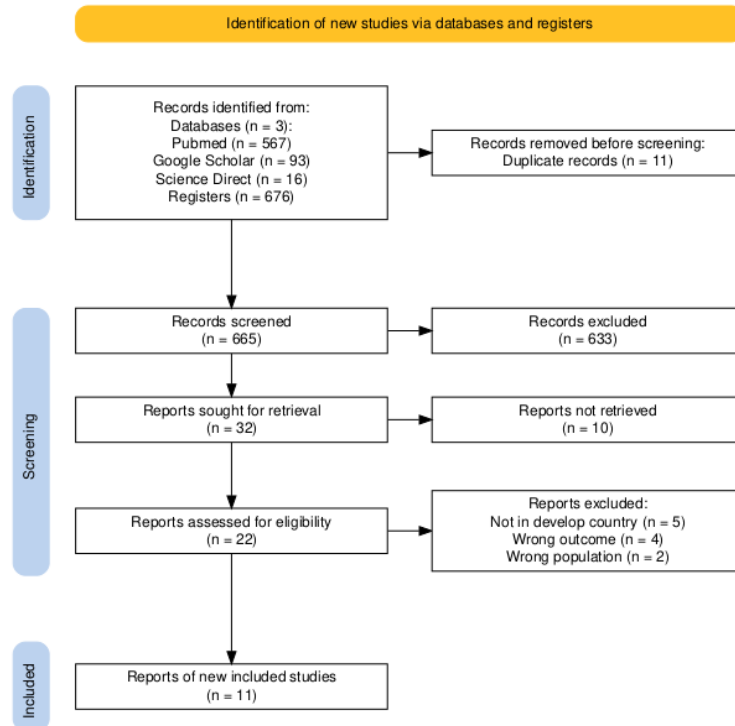
Based on the synthesis, three overarching domains emerged:

1. Maternal Health Consequences of Anemia
  - Obstetric complications (postpartum hemorrhage, blood transfusion, ICU admission)
  - Maternal comorbidities (HIV infection, hypertensive disorders, nutritional vulnerability)
2. Adverse Birth Outcomes
  - Low birth weight
  - Prematurity
  - Stillbirth and perinatal mortality
3. Neonatal and Infant Health Consequences
  - Neonatal mortality
  - Infant mortality
  - Early developmental and respiratory complications

The evidence further supports a conceptual pathway whereby maternal anemia reduces oxygen-carrying capacity and placental perfusion, increasing maternal physiological vulnerability, which subsequently contributes to adverse birth outcomes and neonatal morbidity and mortality. This analytical framework enabled interpretation beyond individual study findings and facilitated identification of recurring mechanisms linking maternal anemia to maternal and neonatal health outcomes across developing-country settings.

#### (1) Selecting appropriate articles

After manually conducting a literature search using the previously defined keywords across several databases and search engines, the researchers identified 676 articles. Next, all articles underwent a screening process to determine their suitability for the topic. Based on screening results, 11 articles met the predetermined inclusion and exclusion criteria and were selected for further analysis. The systematic article selection process was then presented using the PRISMA flow diagram (2020) to illustrate the identification, screening, and selection stages. The PRISMA flowchart in this study is as follows:



**Table 1. Data Extraction**

| No | Title                                                                     | Author and Year        | Country | Aim of the study                                                                                                                           | Type of study | Method                                                | Result                                                                                                                                                                                                                                                                                                                      |
|----|---------------------------------------------------------------------------|------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1 | Maternal anemia is associated with adverse maternal and neonatal outcomes | (Edelson et al., 2023) | Uganda  | We aimed to characterize the association of maternal anemia with maternal, neonatal, and placental outcomes in a resource-limited setting. | Quantitative  | Data from a prospective cohort of 352 pregnant women. | Hemoglobin < 10g/dl was present in 17/352 (5%) of women. Significantly more women with moderate or severe anemia were HIV-infected: 14/17 (82%) versus 162/335 (48%) (p = .006). Blood transfusions (2/17, 12% versus 5/335, 2%, p = .04) and neonatal deaths (2/17, 12% versus 9/335, 3%, p = .01) were more common in the |

|    |                                                                                                                    |                         |          |                                                                                                                                                      |              |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                |
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|    |                                                                                                                    |                         |          |                                                                                                                                                      |              |                                                                                 | anemia group. Placental thickness was lower in the anemia group (1.4 cm versus 1.7 cm, $p = .04$ ).                                                                                                                                                                                                                                                            |
| A2 | Perinatal outcomes in anemic pregnant women in public hospitals of eastern Ethiopia                                | (Debella et al., 2023)  | Ethiopia | This study aimed to assess the perinatal outcomes in anemic pregnant women in eastern Ethiopia.                                                      | Quantitative | Cross-sectional study                                                           | 61.9% of anemic pregnant women had an adverse perinatal outcome. Most common adverse outcomes: preterm birth, congenital anomalies, stillbirth. Significant factors associated with adverse outcomes: Educational status (AOR 2.11 [95% CI 1.245–3.58]) Antenatal care follow-up (AOR 2.75 [95% CI 1.47–5.18]) Hemoglobin level (AOR 4.1 [95% CI 2.609–6.405]) |
| A3 | The association of maternal anemia with adverse maternal and fetal outcomes in Somali women in a prospective study | (Barut & Mohamud, 2023) | Somalia  | This study aimed to examine the association between the severity of Anaemia during pregnancy and the risk of adverse maternal and foetal outcomes in | Quantitative | Prospectively enrolled pregnant women delivering from May 1 to December 1, 2022 | - 1186 women included (mean age 26.9 years) Incidence of maternal Anaemia: 64.8% (mild 33.8%, moderate 59.8%, severe 6.4%) Anaemia associated with increased: Oxytocin administration (OR 2.25)                                                                                                                                                                |

|    |                                                                                        |                        |          |                                                                                                                                            |              |                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                             |
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|    |                                                                                        |                        |          | Somali women.                                                                                                                              |              |                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                        | Postpartum haemorrhage (moderate OR 4.93; severe OR 41.30) Maternal-blood transfusion (moderate OR 9.66; severe OR 301.50) Maternal ICU admission (severe OR 8.33) Severe anemia associated with: Preterm delivery (OR 2.50) Low birth weight (OR 3.45) Stillbirth (OR 4.02) Placental abruption (OR 58.04) |
| A4 | The effect of maternal anemia on low birth weight among newborns in Northwest Ethiopia | (Engidaw et al., 2022) | Ethiopia | This study aimed to assess the effect of late-trimester maternal anemia on low birth weight among full-term infants in Northwest Ethiopia. | Quantitative | The primary data were collected cross-sectionally from February 1 to April 30, 2019.<br><br>A systematic random sampling technique was used to select 211 participants for the primary data collection. | - Prevalence of maternal anemia: 16.11%.<br>Prevalence of newborn anemia: 30.33%. Mean birth weight: 3.19 ± 0.49 kg.<br>Low birth weight proportion: 12.32%.<br>Maternal anemia increased the risk of LBW by 4.19 times (COR) and 3.51 times (AOR).<br>Maternal education ("unable to read and write" and "secondary education") was significantly associated with LBW |                                                                                                                                                                                                                                                                                                             |

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| A5 | Anemia and adverse outcomes in pregnancy: subgroup analysis of the CLIP cluster-randomized trial in India | (Bone et al., 2022) | India | To measure the prevalence of anemia and iron supplementati on, and to assess the impact of anemia severity in early pregnancy on adverse maternal and perinatal outcomes. | Cluster-randomized controlled trial | Experimental Research - Study | - Prevalence of anemia: 88.5% had anemia (32.5% mild, 53.0% moderate, 0.6% severe). - Iron supplementation : >99% of women took iron supplements by delivery. - Blood transfusion: Risk increased progressively with anemia severity—mild (RR 2.16), moderate (RR 2.37), severe (RR 5.70). - Hemorrhage & sepsis: No significant association between anemia severity and antepartum hemorrhage, postpartum hemorrhage (except severe anemia), or sepsis. - Hypertension & pre-eclampsia: U-shaped relationship: mild and moderate anemia had a lower risk of hypertension and pre-eclampsia; severe anemia had a higher risk. - Perinatal outcomes: 17% |
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|    |                                                                                                                                                            |                     |        |                                                                                                                                                             |                                     |                                              | of mild/moderate anemia pregnancies and 29% of severe anemia pregnancies had adverse perinatal outcomes; however, adjusted analyses showed no consistent association due to wide confidence intervals.                                                                                                                                                                                                                                                                                               |
| A6 | Inadequate dietary diversity during pregnancy increases the risk of maternal anemia and low birth weight in Africa: A systematic review and meta-analysis. | (Seid et al., 2023) | Africa | To determine the pooled estimate of the association between inadequate dietary diversity during pregnancy, maternal anemia, and low birth weight in Africa. | Systematic review and meta-analysis | A systematic review of observational studies | A total of 22 publications, including 9,696 participants, were included in the final meta-analysis. The pooled adjusted odds ratio (AOR) for inadequate dietary diversity and maternal anemia was 2.15 (95% CI, 1.66–2.65), while that for low birth weight was 2.04 (95% CI, 1.46–2.63). The highest pooled estimate of maternal anemia was reported in Cameroon (AOR = 9.8, 95% CI: 1.68–17.92), followed by Ethiopia (AOR = 2.6, 95% CI: 1.95–3.25). Similarly, the pooled estimates of low birth |

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|    |                                                                                                                                                       |                                 |                                                                                                                                                                                                                                                                    |              |                          | weight were highest in Cameroon (AOR = 3.04, 95% CI: 1.19–4.88) and Ethiopia (AOR = 1.8, 95% CI: 1.29–2.39).                                                                                                                 |
| A7 | Hemoglobin concentrations and adverse birth outcomes in South Asian pregnant women: findings from a prospective Maternal and Neonatal Health Registry | (Ali et al., Pakistan 2020)     | The objective of this study was to assess associations between maternal hemoglobin concentrations and adverse birth outcomes across the range of Hb concentrations in South Asian pregnant women, and to evaluate factors related to Hb concentrations by country. | Quantitative | Prospective cohort study | - Mean Hb concentration: 9.9 g/dL (India 10.0; Pakistan 9.5). - Severe anemia (Hb <7 g/dL) was much higher in Pakistan (6.9%) than in India (0.2%).                                                                          |
| A8 | Maternal anemia and risk of adverse maternal health and birth outcomes in Bangladesh: A nationwide population-based survey                            | (Kabir et al., Bangladesh 2022) | To explore the association of maternal anemia with a range of adverse maternal health and birth outcomes in Bangladesh.                                                                                                                                            | Quantitative | Cross-sectional study    | - Prevalence of anemia: 44%. Adverse maternal health outcomes: - Higher likelihood of pregnancy complications among anemic women (AOR 1.39, 95% CI 1.09–2.41). - Lower likelihood of menstrual irregularities (AOR 0.79, 95% |

|    |                                                                                                                                             |                            |                                                                                                                    |                                                                                                                                |              |                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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|    |                                                                                                                                             |                            |                                                                                                                    |                                                                                                                                |              |                                                                                       | <p>CI 0.58–0.94). - Lower likelihood of diabetes (AOR 0.78, 95% CI 0.49–0.98). - Lower likelihood of hypertension (AOR 0.79, 95% CI 0.60–0.96). Adverse birth outcomes: - Preterm birth: higher among anemic mothers (AOR 2.03, 95% CI 1.01–4.25). - Early neonatal mortality: higher among newborns of anemic mothers (AOR 1.87, 95% CI 1.06–5.10). - Perinatal mortality: higher likelihood (AOR 1.54, 95% CI 1.09–3.52).</p> |
| A9 | Maternal anemia and risk of neonatal and infant mortality in low- and middle-income countries: a secondary analysis of 45 national datasets | (Tsamantioti et al., 2025) | Sub-Saharan Africa, South & Southeast Asia, Latin America & Caribbean, North Africa/West Asia/Europe, Central Asia | To investigate the association between maternal Anaemia and neonatal and infant mortality in low- and middle-income countries. | Quantitative | Secondary analysis of pooled nationally representative cross-sectional surveys (DHS). | <p>- Anaemia prevalence: 23.2% mild, 24.3% moderate, 2.0% severe. - Deaths: 2,668 neonatal deaths (25.2 per 1000); 3,756 infant deaths (35.6 per 1000). Key Findings: - Moderate Anaemia: Increased odds of neonatal (aOR 1.20; 95% CI 1.06–1.35) and infant mortality. - Severe Anaemia: Strongly</p>                                                                                                                          |

|     |                                                                                      |                         |         |                                                                                             |              |                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----|--------------------------------------------------------------------------------------|-------------------------|---------|---------------------------------------------------------------------------------------------|--------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |                                                                                      |                         |         |                                                                                             |              |                       | <p>increased odds of neonatal (aOR 1.89; 95% CI 1.46–2.44) and infant mortality.</p> <p>- Severe Anaemia nearly doubled early neonatal mortality risk (aOR 1.94; 95% CI 1.47–2.55).</p> <p>- Mild Anaemia: No increased risk of neonatal or infant mortality.</p> <p>- Hemoglobin (continuous): Each 1 g/dL increase reduced the odds of neonatal and infant mortality.</p> <p>- Regional variation: Strongest associations found in South &amp; Southeast Asia and Sub-Saharan Africa.</p> <p>Interpretation: "Moderate and severe maternal anemia in low- and middle-income settings is associated with increased risks of neonatal and infant mortality.</p> |
| A10 | Effect of maternal anemia on the pregnancy course and delivery as well as growth and | (Zouhairi et al., 2025) | Morocco | To determine the prevalence of anemia in pregnant women and the effects of the pathology on | Quantitative | Cross-Sectional Study | <p>- Prevalence of maternal anemia: 44.1%.</p> <p>- Strong associations found between anemia and: • husband's</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

|                                                                  |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| neuropsychomotor development of newborn: A cross-sectional study | the course of delivery and pregnancy, as well as its effects on the growth and neuropsychomotor development of the newborn. | profession (80% of wives of unemployed men were anemic) • nonmonitoring of pregnancy (80% of women with no prenatal visits were anemic) • history of maternal anemia (68.9% recurrent anemia). - Most frequent maternal complications: premature rupture of membranes (PRM) (22.20%) and high risk of scar uterus (17.50%). - Delivery patterns: Cesarean delivery is more common in anemic women (60.7%). - Newborn-complications: prematurity and respiratory distress were the most frequent (30.40%). - Neonatal development: The majority of newborns had normal weight (82%), normal Apgar score (87.4% scored 10/10), and good archaic reflexes (90.1%). - Significant |
|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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|---------|----------------------------------------------------------------------------------------------------------------------|-----------------------|--------|----------------------------------------------------------------------------------------------------------------|-------------------------------------|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |                                                                                                                      |                       |        |                                                                                                                |                                     |                                                                          | associations were found between maternal anemia and neonatal complications ( $\chi^2 = 8.113$ , $P = 0.005$ ).                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| A1<br>1 | Effects of maternal anemia on low birth weight in Sub-Saharan African countries: Systematic review and meta-analysis | (Belete et al., 2025) | Africa | To evaluate the effect of maternal anemia on low birth weight in the context of Sub-Saharan African countries. | Systematic review and meta-analysis | Databases searched: PubMed, Embase, Scopus, Cochrane, and Web of Science | - Total included studies: 21 studies with 51,923 participants. - Overall effect: Women with anemia had significantly higher odds of having LBW infants (OR = 3.37; 95% CI: 2.66–4.27; $I^2 = 96.7\%$ ). - Subgroup analysis: • Ethiopia studies: AOR = 4.34 (95% CI: 4.24–4.43). • Studies published 2015–2019: AOR = 2.91 s (95% CI: 2.03–4.17). • Cross-sectional studies: AOR = 3.64 (95% CI: 2.65–5.08). - Publication bias: Asymmetrical funnel plot indicated potential bias. - Sensitivity analysis: Removing individual studies did not significantly alter the overall estimate. |

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Conclusion:  
 “Maternal anemia during pregnancy was identified as a significant risk factor for low birth weight. Early identification and proper care of anemia during pregnancy may reduce the incidence of low birth weight.”

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## RESULTS AND DISCUSSION

### Study Selection

A total of 676 records were identified through database searching. After duplicate removal and title–abstract screening, 32 articles were assessed for full-text eligibility. Twenty-one articles were excluded because they were conducted outside developing countries ( $n = 5$ ), reported irrelevant outcomes ( $n = 4$ ), involved inappropriate populations ( $n = 2$ ), provided insufficient outcome data ( $n = 6$ ), or used non-eligible study designs ( $n = 4$ ). Ultimately, eleven studies met all inclusion criteria and were included in this scoping review.

### Editor Revision Note:

Replace the current low-resolution PRISMA figure with a high-resolution PRISMA 2020 flow diagram (minimum 300 dpi) and ensure that all boxes, arrows, and text are clearly readable.

### Characteristics of Included Studies

To improve readability, the detailed data extraction table was condensed into a summary table presenting only the most relevant study characteristics.

**Table 2.** Summary of Included Studies on the Impact of Maternal Anemia on Maternal, Fetal, Neonatal, and Birth Outcomes

| Study ID | Country/Region | Design          | Sample/Source         | Main Outcome                                  |
|----------|----------------|-----------------|-----------------------|-----------------------------------------------|
| A1       | Uganda         | Cohort          | 352 pregnant women    | Maternal complications and neonatal mortality |
| A2       | Ethiopia       | Cross-sectional | Anemic pregnant women | Adverse perinatal outcomes                    |

| Study ID | Country/Region     | Design                            | Sample/Source            | Main Outcome                    |
|----------|--------------------|-----------------------------------|--------------------------|---------------------------------|
| A3       | Somalia            | Prospective cohort                | 1,186 pregnant women     | Maternal and fetal outcomes     |
| A4       | Ethiopia           | Cross-sectional                   | 211 participants         | Low birth weight                |
| A5       | India              | Cluster RCT                       | CLIP Trial               | Maternal and perinatal outcomes |
| A6       | Africa             | Systematic Review & Meta-analysis | 22 studies               | Maternal anemia and LBW         |
| A7       | Pakistan/India     | Prospective cohort                | Maternal Registry        | Birth outcomes                  |
| A8       | Bangladesh         | Cross-sectional                   | National survey          | Maternal and birth outcomes     |
| A9       | LMICs              | Secondary Analysis                | DHS 45 national datasets | Neonatal and infant mortality   |
| A10      | Morocco            | Cross-sectional                   | Pregnant women           | Neonatal development            |
| A11      | Sub-Saharan Africa | Systematic Review & Meta-analysis | 21 studies               | Low birth weight                |

The eleven included studies represented diverse methodological approaches and geographical settings across developing countries. Five studies employed observational cross-sectional designs, three used prospective cohort approaches, one was a cluster-randomized controlled trial, and two were systematic reviews with meta-analyses. Geographically, the studies were conducted in Sub-Saharan Africa, South Asia, North Africa, and multi-country low- and middle-income country settings. Ethiopia contributed the highest number of primary studies, reflecting the substantial burden of maternal anemia in East Africa. The broad geographical distribution enhances the contextual relevance of the review and allows comparison of maternal and neonatal outcomes across different healthcare systems and socioeconomic environments.

This scoping review demonstrates that maternal anemia remains a significant determinant of adverse maternal and neonatal outcomes across developing countries. However, the evidence synthesized in this review suggests that the relationship between maternal anemia and adverse outcomes is not uniform across settings. Variations in outcome magnitude, anemia prevalence, and risk estimates indicate substantial heterogeneity between studies, reflecting differences in socioeconomic conditions, nutritional status, healthcare infrastructure, disease burden, and methodological approaches.

One important finding is the consistent association between moderate-to-severe maternal anemia and adverse maternal outcomes, including postpartum hemorrhage, blood transfusion, intensive care admission, and obstetric complications. Nevertheless, the strength of these associations varied considerably across studies (Barut & Mohamud, 2023; Debella et al., 2023). For example, studies from Somalia and Uganda reported stronger associations between severe anemia and maternal complications than those observed in the Indian CLIP trial. This discrepancy may be explained by differences in access to antenatal care, anemia screening programs, and emergency obstetric services.

In settings where routine anemia detection and treatment are limited, women are more likely to enter labor with severe untreated anemia, thereby increasing vulnerability to hemorrhage and other complications. Conversely, in settings with widespread iron supplementation and structured antenatal monitoring, the adverse consequences of anemia may be partially mitigated (Engidaw et al., 2022).

The findings also highlight substantial heterogeneity in neonatal outcomes. Low birth weight emerged as the most consistently reported consequence across studies from Ethiopia, Bangladesh, South Asia, and Sub-Saharan Africa. Biological explanations for this association are well established. Maternal anemia reduces oxygen transport capacity and may impair placental development and nutrient transfer, resulting in fetal growth restriction and reduced birth weight. However, the magnitude of this association differed across countries (Debella et al., 2023; Tsamantioti et al., 2025). Meta-analytic evidence from Sub-Saharan Africa reported stronger effects than some South Asian studies. These differences may reflect variations in maternal nutritional status, prevalence of infectious diseases such as malaria and HIV, food insecurity, and healthcare access. Therefore, maternal anemia should not be interpreted solely as an isolated hematological condition but as part of a broader context of maternal vulnerability (Kabir et al., 2022).

Contradictory findings were identified in several studies, particularly regarding hypertensive disorders and pregnancy complications. While some studies reported increased risks among anemic women, others observed weak or non-significant associations (Barut & Mohamud, 2023; Engidaw et al., 2022). The Indian cohort study even reported a U-shaped relationship, whereby both low and high hemoglobin concentrations were associated with adverse outcomes. These inconsistencies may arise from differences in gestational age at hemoglobin measurement, anemia severity classification, population characteristics, and adjustment for confounding variables. Such findings suggest that maternal hemoglobin concentration may function as a marker of overall maternal health status rather than a direct causal factor in all outcomes (Kabir et al., 2022; Tsamantioti et al., 2025).

Differences between countries constitute another important contextual factor. Studies conducted in Ethiopia, Somalia, and Uganda generally reported higher prevalence of severe anemia and stronger associations with adverse outcomes than studies from Morocco or some South Asian settings (Edelson et al., 2023). These differences likely reflect variations in healthcare infrastructure, availability of skilled birth attendants, antenatal care coverage, laboratory capacity, and nutritional support programs. Countries with weaker maternal health systems often face delayed diagnosis and inadequate management of anemia, thereby increasing the likelihood of complications. In contrast, countries with more developed maternal health services may reduce the progression from mild anemia to severe disease through early detection and treatment (Barut & Mohamud, 2023).

Healthcare infrastructure emerged as a critical determinant influencing both maternal and neonatal outcomes. Several studies indicated that inadequate antenatal care attendance was associated with worse outcomes among anemic women (Zouhairi et al., 2025). This finding suggests that healthcare access may modify the effect of anemia on pregnancy outcomes. Women who receive regular antenatal care are more likely to undergo hemoglobin screening, receive iron and folic acid supplementation, nutritional counseling, and referral for high-risk management when necessary. Consequently, adverse outcomes observed in many low-resource settings may reflect not only the biological effects of anemia but also systemic weaknesses in maternal healthcare delivery (Barut & Mohamud, 2023).

Another important source of heterogeneity relates to methodological differences across studies. The included evidence consisted of cross-sectional studies, prospective cohorts, randomized trials, and systematic reviews. Differences in study design affect the ability to establish temporal relationships and causal inferences (Ali et al., 2020). Furthermore, although most studies adopted WHO

hemoglobin thresholds, variations remained in the timing of anemia assessment, laboratory methods, and adjustment procedures. Some studies measured anemia during early pregnancy, whereas others assessed hemoglobin at delivery. Because hemoglobin concentrations fluctuate throughout pregnancy, these methodological differences may contribute to inconsistent findings across studies (Zouhairi et al., 2025).

The review also identified important social determinants influencing anemia-related outcomes. Educational attainment, household socioeconomic status, dietary diversity, and access to maternal healthcare repeatedly emerged as factors associated with both anemia prevalence and adverse outcomes. These findings suggest that interventions focusing exclusively on iron supplementation may be insufficient. Effective prevention strategies require broader approaches addressing maternal nutrition, women's education, poverty reduction, and healthcare accessibility (Belete et al., 2025).

Overall, the evidence indicates that maternal anemia functions through a complex pathway involving biological, social, and health-system mechanisms. While the adverse effects of moderate and severe anemia are consistently observed across developing countries, the magnitude of risk is strongly shaped by contextual factors. Therefore, policies aimed at reducing maternal and neonatal morbidity and mortality should combine clinical management of anemia with efforts to strengthen healthcare infrastructure, improve antenatal care coverage, and address underlying social determinants of maternal health (Ali et al., 2020).

## **CONCLUSIONS**

This scoping review demonstrates that maternal anemia remains a major determinant of adverse maternal and neonatal health outcomes across developing countries. The synthesis of eleven studies consistently shows that moderate-to-severe anemia during pregnancy is associated with an increased risk of postpartum hemorrhage, blood transfusion, intensive care admission, preterm birth, low birth weight, neonatal mortality, and infant mortality. These findings confirm that materna Importantly, the review identified substantial heterogeneity across countries and study settings. The magnitude of adverse outcomes varied according to differences in nutritional status, disease burden, socioeconomic conditions, and healthcare infrastructure. Studies conducted in countries with limited antenatal care coverage, inadequate anemia screening, and weaker maternal health services generally reported stronger associations between maternal anemia and adverse outcomes than studies from settings with better healthcare a The review further highlights methodological variations in anemia assessment, timing of hemoglobin measurement, and outcome reporting, which contribute to inconsistencies across studies and limit direct comparisons. Nevertheless, the overall evidence strongly supports the use of standardized WHO-based anemia classification and routine hemoglobin screening to improve evidence comparability and clinical decision-making. From a policy perspective, reducing the burden of maternal anemia requires integrated interventions that extend beyond iron supplementation alone. Strengthening antenatal care services, improving nutritional support, expanding access to maternal health services, and addressing underlying socioeconomic vulnerabilities are essential strategies for improving maternal and neonatal outcomes in developing countries. Future research should prioritize longitudinal and intervention-based studies to better understand causal pathways and evaluate context-specific approaches for preventing anemia-related complications.

## **LIMITATIONS**

This literature review study has several limitations. First, the literature search was only conducted through *PubMed*, *ScienceDirect*, and Google Scholar, so it is possible that relevant articles from other

databases were not identified. Second, the publication of articles from 2020–2025 may have excluded older but still relevant studies. Third, most of the articles included were observational studies (*cross-sectional* and *cohort*), so the findings show associations rather than strong causal relationships. Fourth, there is heterogeneity across studies in hemoglobin measurement methods and timing, population characteristics, and the context of health services in developing countries, limiting direct comparisons. In addition, the process of searching, selecting, and charting data was carried out by a single *reviewer*, potentially introducing selection bias despite repeated reviews to ensure consistency.

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