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Research Article

Maternal and Childhood Iron Deficiency: Clinical Implications and Global Trends in Anemia Prevalence

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Abstract

Anaemia remains a global public health challenge, characterized by low haemoglobin levels or reduced red blood cell count, leading to impaired oxygen delivery to tissues. It disproportionately affects vulnerable groups, including young children, pregnant and postpartum women, and those of menstruating age. In 2023, global anaemia prevalence affected 30.7% of women aged 15–49 and 39.8% of children aged 6–59 months. Major aetiologies include nutritional deficiencies (particularly iron, folate, and vitamin B12), infections, chronic diseases, inherited haemoglobin disorders, and chronic inflammation. Anaemia contributes significantly to maternal and child mortality, impaired cognitive and physical development in children, and reduced productivity in adults, perpetuating social and economic burdens. Although the World Health Organization advocates multi-sectoral strategies—such as dietary diversification, micronutrient supplementation, and addressing underlying determinants like infectious diseases and gender inequities—global progress remains insufficient to meet the 2030 target of a 50% reduction in anaemia prevalence. This review synthesizes current evidence on the prevalence, causes, and clinical consequences of iron deficiency and anaemia, with a focus on maternal and child populations. By analysing data from WHO, UNICEF, and peer-reviewed literature, we examine the biological role of iron, impacts of deficiency on health outcomes, and evolving intervention strategies. Special emphasis is placed on updated haemoglobin cut-offs, nutritional guidelines, and regional epidemiological trends—including data from Central Asia and low-income countries—to inform future public health initiatives and clinical practice aimed at reducing the global burden of anaemia.

Keywords: anemia, pregnancy, prevalence, hemoglobin, treatment, prevention

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1. Introduction

Iron is an essential micronutrient that plays a fundamental role in numerous physiological processes. It is a critical component of hemoglobin, the red blood cell protein responsible for carrying oxygen from the lungs to all body tissues. Iron is also required for myoglobin in muscle tissue and for the activity of various iron-dependent enzymes involved in cellular respiration, DNA synthesis, and immune function [1]. Consequently, adequate iron levels are vital for maintaining physical performance, cognitive function, and overall health.

Iron deficiency (ID) is the most prevalent micronutrient deficiency worldwide and a major cause of anemia. According to the World Health Organization (WHO), ID affects approximately 2 billion people globally, with the highest prevalence in low- and middle-income countries [2]. Women of reproductive age (15–49 years) are particularly vulnerable. Worldwide, anemia is estimated to affect 29% of non-pregnant women and 38% of pregnant women, with iron deficiency accounting for over 50% of these cases [3].

The elevated iron requirements in women of reproductive age are largely due to menstrual blood loss, which averages 30–40 mL per cycle and can result in a daily iron loss of 0.5–1.0 mg [4]. During pregnancy, an additional 500–1,000 mg of iron is required to support maternal blood volume expansion, fetal growth, and placental development [5]. Lactation also increases iron demands, as breast milk provides an essential source of iron for the infant [6].

Iron insufficiency and iron deficiency anemia (IDA) have serious consequences for women of reproductive age. IDA is associated with fatigue, decreased physical work capacity, impaired cognitive function, and reduced immune competence [7]. In pregnancy, ID and IDA can lead to preterm birth, low birth weight, and increased maternal morbidity and mortality. Moreover, infants born to iron-deficient mothers are at greater risk of iron deficiency during infancy, which can further impair growth and development [8].

Given the significant health burden and intergenerational impact of iron deficiency, addressing this issue among women of reproductive age is a public health priority. Strategies to combat ID and IDA include iron fortification of staple foods, targeted iron supplementation programs, and dietary diversification to incorporate more iron-rich foods [9]. Understanding the physiological roles of iron, the unique challenges faced by women in this life stage, and evidence-based interventions is essential for improving maternal and child health outcomes. The causes of IDA in pregnant women are presented in Table **1**.

Table 1: Causes of Maternal Iron Deficiency Anemia.

Category	Causes	Comments
Deficiency Anemias	- Iron deficiency - Folic acid deficiency - Vitamin B12 deficiency	The most common cause is iron deficiency anemia.
Anemias in Chronic Diseases	- Infections (HIV, tuberculosis, pyelonephritis) - Autoimmune diseases	Iron availability is reduced due to inflammation. Ferritin may be normal or elevated.

Table 1: Continued.

Category	Causes	Comments
Blood Loss	- Obstetric (placental abruption, ectopic pregnancy) - Gastrointestinal bleeding – Hemorrhoids	Leads to a decrease in circulating iron and red blood cells.
Hereditary and Hemolytic Anemias	- Sickle cell anemia - Thalassemia - Hemolytic anemias (autoimmune, enzymatic)	Often diagnosed before pregnancy, but it may worsen during gestation.
Toxic and Drug-Induced Causes	- Exposure to heavy metals (lead) - Side effects of medications	May cause hemolysis, bone marrow suppression, or folate deficiency.
Dietary and Social Factors	- Malnutrition - Vegetarian/vegan diet – Alcoholism	Affect the absorption of iron and vitamins.

2. Materials and Methods

This review is based on a narrative synthesis of existing literature, official guidelines, and epidemiological data related to iron deficiency and anemia. A targeted literature search was conducted using PubMed and official websites of the World Health Organization (WHO) and UNICEF. The review focused on: Peer-reviewed journal articles published between 1991 and 2024 (n = 8). WHO and UNICEF reports and guidelines (n = 4).

Inclusion criteria:

Studies and guidelines addressing iron metabolism, iron requirements, anemia prevalence, and public health strategies. The population focuses on pregnant women, menstruating women, and young children.

Exclusion criteria:

Studies unrelated to iron metabolism or anemia

Articles lacking population-based or clinical relevance

-Priority was given to systematic reviews, clinical guidelines, and population-based studies, particularly those with global or regional data (e.g., Kazakhstan and other low-income countries). No statistical analysis was conducted, as the purpose of this review is to provide a qualitative summary of current knowledge and trends.

3. Results

The review emphasizes that anemia and iron deficiency are still quite common in young children and women of reproductive age, especially in low- and middle-income nations. The study may highlight that areas like South Asia, Sub-Saharan Africa, and Central Asia—including Kazakhstan—report higher-than-average anemia rates among pregnant women and children, with prevalence frequently surpassing 40%, by synthesizing WHO and UNICEF data [10].

The findings are expected to confirm that iron deficiency is still the leading cause of anemia globally, responsible for about 50% of cases, especially during pregnancy and menstruation, when iron requirements are significantly elevated [11]. Studies show that this deficiency leads to serious clinical outcomes, including increased risk of preterm delivery, low birth weight, maternal mortality, and impaired cognitive and physical development in children [12].

Global prevalence figures add urgency to the issue. McLean et al. (2009) used WHO's Vitamin and Mineral Nutrition Information System to estimate that between 1993 and 2005, anemia affected over 30% of women of reproductive age and nearly 40% of preschool-aged children.

Figure **1** discusses the estimated prevalence of anemia among women and children across world regions, highlighting the burden in South Asia, Sub-Saharan Africa, and Central Asia (including Kazakhstan). Another anticipated result is the identification of the persistent gap between guideline recommendations and implementation. Despite global efforts—including WHO's daily iron supplementation programs and food fortification initiatives—many countries remain off track to meet the 2030 anemia reduction targets. Barriers such as poor access to supplements, limited awareness, and dietary inadequacies due to socioeconomic constraints are expected to be recurring themes in the literature [13].

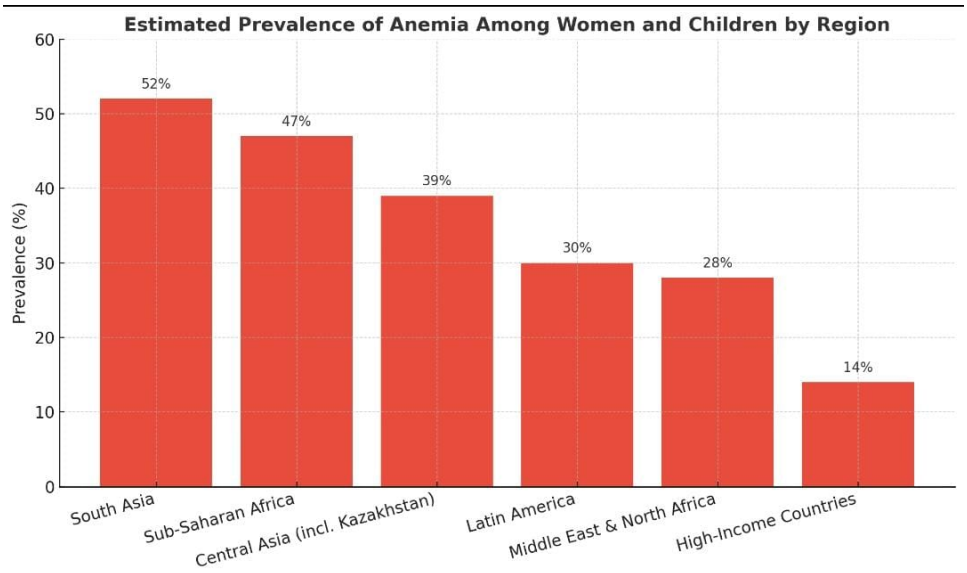

Figure 1: Estimated global and regional prevalence of anemia among women and children. Data indicate the highest burden occurs in South Asia, Sub-Saharan Africa, and Central Asia, underscoring the urgent need for region-specific public health interventions.

The review may also reveal emerging trends, such as updated haemoglobin thresholds for different trimesters of pregnancy, allowing for earlier and more accurate diagnosis of anemia. Regional statistics may further demonstrate that Central Asian countries, including Kazakhstan, while making some progress, still face significant challenges in reducing anemia rates due to infrastructure and health education limitations [14].

Crucially, the study is likely to support the notion that addressing iron deficiency necessitates a multi-sectoral strategy encompassing nutrition, education, sanitation, reproductive health, and socioeconomic development in addition to clinical care. The increasing agreement that anemia is a sign of systemic injustice and public health neglect in addition to being a medical ailment is supported by this holistic viewpoint [15] .

Ultimately, the review's findings could strengthen the call for more integrated, evidence-based, and culturally sensitive interventions that address both the biological and social dimensions of iron deficiency and anemia.

4. Discussion

Iron deficiency, particularly in the form of anemia, continues to affect a significant portion of the global population—especially pregnant women, menstruating women, and young children, as confirmed by multiple studies and global reports. Table **2** shows a visual overview of the major causes, health impacts, and public health interventions related to iron deficiency and anemia, especially among women and children.

Table 2: Iron Deficiency and Anemia: Causes, Consequences, and Intervention Strategies.

Section	Items	Comment
Overview	Iron deficiency particularly in form of anemia	General definition
Causes	Inadequate dietary intake Increased iron requirement Blood loss	Main causes
Adverse Outcomes	Maternal and perinatal complications Premature birth with low birth weight Reduced cognitive and physical development Decreased work productivity	Consequences
Target Groups	Pregnant women Menstruating women Young children Low-income countries	Vulnerable populations
Strategies	Dietary diversification Iron supplementation Food fortification	Prevention and management

*Adapted and compiled by the author based on WHO (2016; 2021), Allen (2000), Bothwell (2000), and Lutter (2008) – illustrating the relationship between iron deficiency, vulnerable populations, physiological effects, and key intervention strategies.

According to Allen, iron deficiency during pregnancy is associated with increased risks of maternal mortality, low birth weight, and preterm delivery. She emphasizes that these adverse outcomes are preventable with timely intervention [16].

Bothwell reinforces this by noting that iron requirements in pregnancy rise sharply in the second and third trimesters, and dietary intake often fails to meet these demands without supplementation [17].

Lutter focuses on the effects of iron deficiency in the early years of infancy, connecting it to immune system weakness and long-term developmental problems [18].

Hallberg and Rossander-Hultén found that latent iron deficiency frequently occurs in menstruating women whose monthly iron loss is not compensated by adequate iron intake [19]. This is especially true in populations with limited access to iron-rich foods and low dietary diversity.

Iron serves many functions beyond oxygen transport. Beard discusses the importance of iron for cognitive function, muscle metabolism, and immune response. His research shows that even mild deficiency can impair cognitive and physical endurance, particularly in children and adolescents [20].

These findings are supported by Haas and Brownlie, who comprehensively reviewed studies demonstrating a direct association between iron deficiency and reduced physical work capacity. This not only affects individual well-being but also overall economic productivity [21].

Global prevalence data underscore the urgency of the situation. Using the WHO's Vitamin and Mineral Nutrition Information System, McLean et al. estimated that between 1993 and 2005, anemia affected approximately 40% of preschool-aged children and over 30% of women of reproductive age [22].

Stevens et al. expanded on this by analyzing data from 1995 to 2011, revealing limited progress over time in many low- and middle-income countries, including those in Central Asia [23].

To address this burden, the World Health Organization (2016) introduced guidelines recommending daily iron supplementation for women and adolescent girls, especially in regions with high anemia prevalence. The 2024 WHO guideline update further refined hemoglobin cut-offs for anemia by trimester, enabling more accurate diagnosis during pregnancy. Moreover, the Global Anaemia Estimates (2021) report and the joint UNICEF-WHO (2021) publication both stress the importance of integrated approaches, including food fortification, deworming, education, and routine screening.

Despite these efforts, implementation remains inconsistent. Barriers such as poor access to supplements, cultural dietary patterns, and low awareness persist, particularly in rural and underserved communities [24].

Therefore, iron deficiency must be addressed not only as a medical condition but also as a public health and equity issue requiring coordinated, sustainable strategies.

5. Conclusion

Iron deficiency remains one of the most widespread yet overlooked health issues, silently affecting millions of women and children around the world. This review underscores that despite decades of global efforts, progress in reducing anemia—especially among vulnerable groups such as pregnant women and young children—has been uneven and slow. The consequences of iron deficiency extend beyond health, influencing birth outcomes, child development, and even national economic productivity. To move forward, solutions must go beyond supplementation and address root causes—such as poverty, inadequate diets,

limited healthcare access, and low awareness—through coordinated action at all levels, from households to health systems.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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References

[1] Milman N. Iron and pregnancy: a delicate balance. Ann Hematol. 2006;85(9):559–Milman N. Iron and pregnancy: a delicate balance. Annals of Hematology. 2006;85(9):559–565. https://doi.org/10.1007/s00277-006-0105-3

[2] Means RT. Iron Deficiency and Iron Deficiency Anemia: Implications and Impact in Pregnancy, Fetal Development, and Early Childhood Parameters. Nutrients. 2020;12(2):447. https://doi.org/10.3390/nu12020447

[3] Benson AE, Shatzel JJ, Ryan KS, Hedges MA, Martens K, Aslan JE, et al. The incidence, complications, and treatment of iron deficiency in pregnancy. European Journal of Haematology. 2022;109(6):633–642. https://doi.org/10.1111/ejh.13870

[4] Al-Naseem A, Sallam A, Choudhury S, Thachil J. Iron deficiency without anaemia: a diagnosis that matters. Clinical Medicine. 2021;21(2):107–113. https://doi.org/10.7861/clinmed.2020-0582

[5] Elmore C, Ellis J. Screening, Treatment, and Monitoring of Iron Deficiency Anemia in Pregnancy and Postpartum. Journal of Midwifery & Women's Health. 2022;67(3):321–331. https://doi.org/10.1111/jmwh.13370

[6] Davidson EM, Simpson JA, Fowkes FJI. The interplay between maternal-infant anemia and iron deficiency. Nutrition Reviews. 2023;81(4):480–491. https://doi.org/10.1093/nutrit/nuac066

[7] Igbinosa I, Berube C, Lyell DJ. Iron deficiency anemia in pregnancy. Current Opinion in Obstetrics and Gynecology. 2022;34(2):69–76. https://doi.org/10.1097/gco.0000000000000772

[8] Basu S, Kumar D, Anupurba S, Verma A, Kumar A. Effect of maternal iron deficiency anemia on fetal neural development. Journal of Perinatology. 2018;38(3):233–239. https://doi.org/10.1038/s41372-017-0023-5

[9] Kirthan JPA, Somannavar MS. Pathophysiology and management of iron deficiency anemia in pregnancy: a review. Annals of Hematology. 2024;103(8):2637–2646. https://doi.org/10.1007/s00277-023-05481-2

[10] Mirza FG, Abdul-Kadir R, Breymann C, Fraser IS, Taher A. Impact and management of iron deficiency and iron deficiency anemia in women's health. Expert Review of Hematology. 2018;11(9):727–736. https://doi.org/10.1080/17474086.2018.1502081

[11] Abu-Ouf NM, Jan MM. The impact of maternal iron deficiency and iron deficiency anemia on child's health. Saudi Medical Journal. 2015;36(2):146–149. https://doi.org/10.15537/smj.2015.2.10289

[12] Dai AI, Demiryürek S, Aksoy SN, Perk P, Saygili O, Güngör K, et al. Maternal Iron Deficiency Anemia as a Risk Factor for the Development of Retinopathy of Prematurity. Pediatric Neurology. 2015;53(2):146–150. https://doi.org/10.1016/j.pediatrneurol.2015.04.002

[13] Al-Suhiemat AA, Shudifat RM, Obeidat H. Maternal Level of Education and Nutritional Practices Regarding Iron Deficiency Anemia Among Preschoolers in Jordan. Journal of Pediatric Nursing. 2020;55:e313–e319. https://doi.org/10.1016/j.pedn.2020.08.019

[14] World Health Organization. Strategies to Prevent Anaemia: Recommendations from an Expert Group Consultation. New Delhi, India, 5–6 December 2016. https://iris.who.int/bitstream/handle/10665/312109/recommendations_on_anaemia-eng.pdf

[15] Kumar ShBh, Arnipalli ShR, Mehta P, Carrau S, Ziouzenkova O. Iron Deficiency Anemia: Efficacy and Limitations of Nutritional and Comprehensive Mitigation Strategies. Nutrients. 2022; 14(14), 2976. https://doi.org/10.3390/nu14142976

[16] Allen LH. Anemia and iron deficiency: effects on pregnancy outcome. The American Journal of Clinical Nutrition. 2000;71(5 Suppl):1280S–1284S. https://doi.org/10.1093/ajcn/71.5.1280s

[17] Bothwell TH. Iron requirements in pregnancy and strategies to meet them. The American Journal of Clinical Nutrition. 2000;72(1Suppl):257S-264S. https://doi: 10.1093/ajcn/72.1.257S.

[18] Lutter CK. Iron deficiency in young children in low-income countries and new approaches for its prevention. The Journal of Nutrition. 2008;138(12):2523–2528. https://doi.org/10.3945/jn.108.095406

[19] Hallberg L, Rossander-Hultén L. Iron requirements in menstruating women. The American Journal of Clinical Nutrition. 1991;54(6):1047–1058. https://doi.org/10.1093/ajcn/54.6.1047

[20] Beard JL. Iron biology in immune function, muscle metabolism and neuronal functioning. The Journal of Nutrition. 2001;131(2S–2):568S–579S. https://doi.org/10.1093/jn/131.2.568S

[21] Haas JD, Brownlie T IV. Iron deficiency and reduced work capacity: a critical review of the research to determine a causal relationship. The Journal of Nutrition. 2001;131(2S–2):676S–688S. https://doi.org/10.1093/jn/131.2.676S

[22] McLean E, Cogswell M, Egli I, Wojdyla D, de Benoist B. Worldwide prevalence of anaemia, WHO Vitamin and Mineral Nutrition Information System, 1993–2005. Public Health Nutrition. 2009;12(4):444–454. https://doi.org/10.1017/s1368980008002401

[23] Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F, et al. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data. The Lancet Global Health. 2013;1(1):e16–e25. https://doi.org/10.1016/s2214-109x(13)70001-9

[24] Anand T, Rahi M, Sharma P, Ingle GK. Issues in prevention of iron deficiency anemia in India. Nutrition. 2014;30(7–8):764–770. https://doi.org/10.1016/j.nut.2013.11.022