



**ANEMIA IN PREGNANT WOMEN:
EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND
APPROACHES TO CLINICAL MANAGEMENT**

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ABSTRACT

Anemia in pregnant women is one of the most common health concerns in contemporary obstetric practice. It is characterized by a reduction in hemoglobin concentration in the blood and may adversely affect maternal health and fetal development. Iron deficiency is the most common cause of anemia during pregnancy, primarily because of the increased physiological demand for this essential micronutrient. This article examines the epidemiology, underlying pathophysiological mechanisms, clinical manifestations, diagnostic methods, current treatment strategies, and preventive approaches related to anemia in pregnant women. Particular attention is given to the physiological changes in maternal blood composition, including pregnancy-associated hemodilution, which must be distinguished from pathological anemia. The article also discusses the role of iron deficiency, folate and vitamin B12 deficiencies, chronic inflammatory conditions, and inherited hemoglobin disorders in the development of anemia during pregnancy. A comprehensive diagnostic approach is essential for identifying the underlying cause and selecting appropriate treatment. Laboratory assessment generally includes a complete blood count, erythrocyte indices, and serum ferritin measurement, with additional investigations performed when clinically indicated. Management strategies depend on the severity of anemia, the



gestational age, the underlying etiology, and the patient's response to treatment. Oral iron supplementation is generally the first-line treatment for confirmed iron-deficiency anemia, whereas intravenous iron may be considered in selected cases when oral treatment is ineffective, poorly tolerated, or insufficient to replenish iron stores. Correction of other nutritional deficiencies and appropriate management of chronic or inherited conditions are also important components of individualized care. Preventive measures include a balanced diet, routine antenatal screening, and iron and folic acid supplementation in accordance with international recommendations and national clinical protocols. Untreated or severe anemia may increase the risk of adverse maternal and perinatal outcomes. Therefore, early identification, accurate diagnosis, appropriate treatment, and continued monitoring are essential for protecting maternal health and supporting normal fetal development. A coordinated approach to the prevention and management of anemia during pregnancy can contribute to improved maternal and neonatal outcomes.

Introduction: Pregnancy is accompanied by substantial physiological changes in a woman's body. These changes include an increase in circulating blood volume, greater oxygen requirements, and an increased demand for nutrients necessary for fetal growth and development. Consequently, the need for iron, folic acid, vitamin B12, and other nutrients involved in erythrocyte production increases during pregnancy. Anemia is a condition characterized by a hemoglobin concentration below the established diagnostic threshold for the relevant stage of pregnancy. It may develop as a result of iron deficiency, vitamin deficiencies, chronic diseases, blood loss, or inherited disorders affecting hemoglobin production. Although some changes in hemoglobin concentration are physiological during pregnancy, a clinically significant reduction requires appropriate investigation to determine its underlying cause. Timely identification of anemia is particularly important because moderate to severe anemia may be associated with adverse maternal and perinatal outcomes. Depending on its severity and etiology, anemia may impair maternal well-being, reduce physical capacity, and compromise the body's ability to respond adequately to the physiological demands of pregnancy and childbirth. Therefore, the screening, diagnosis, treatment, and prevention of anemia constitute essential components of comprehensive antenatal care.



Main part: Anemia remains a major global public health concern, particularly among women of reproductive age and pregnant women. According to estimates published by the World Health Organization (WHO), anemia affected approximately 35.5% of pregnant women aged 15–49 years in 2023. This substantial prevalence highlights the continuing importance of anemia prevention and management within maternal healthcare systems. The prevalence of anemia varies according to socioeconomic conditions, dietary quality, access to healthcare services, the prevalence of infectious and chronic diseases, and the availability of preventive interventions. Higher rates are reported in many low- and middle-income countries, where nutritional deficiencies, limited access to antenatal screening, and underlying health conditions may contribute to the burden of disease. Iron-deficiency anemia is the most common form encountered during pregnancy. Nevertheless, the epidemiological burden of anemia cannot be explained by iron deficiency alone. Folate deficiency, vitamin B12 deficiency, chronic inflammation, parasitic infections in relevant settings, blood loss, and inherited hemoglobin disorders may also contribute to its development. The identification of the specific cause is essential because treatment strategies differ according to the underlying mechanism. For example, iron supplementation may be beneficial in iron-deficiency anemia but is not an appropriate substitute for targeted treatment of vitamin B12 deficiency or inherited hemoglobin disorders. Consequently, epidemiological assessment should be accompanied by appropriate diagnostic evaluation and consideration of local nutritional and healthcare conditions.

The pathophysiology of anemia during pregnancy is associated with changes in circulating blood volume, increased iron requirements, and potential disturbances in erythrocyte production. These mechanisms may occur independently or simultaneously, depending on the woman's nutritional status and underlying health conditions. During pregnancy, plasma volume increases more substantially than the circulating red blood cell mass. This disproportionate expansion results in a relative reduction in hemoglobin concentration, a phenomenon known as physiological hemodilution. Physiological hemodilution is a normal adaptation to pregnancy and should not automatically be interpreted as pathological anemia. However, the presence of a reduced hemoglobin concentration may also indicate an underlying nutritional deficiency or another disease process. Differentiating physiological changes from clinically significant anemia therefore requires consideration of gestational age, laboratory findings, clinical history, and, when indicated, additional diagnostic tests. The interpretation of hemoglobin concentrations should follow the relevant clinical guidelines, as diagnostic thresholds may differ according to the trimester of pregnancy and the guideline being applied. Iron is an essential component of hemoglobin and is necessary for the transport of oxygen from the lungs to peripheral tissues. It also contributes to numerous cellular processes, including energy metabolism and normal cellular function. During pregnancy, iron requirements increase because of the expansion of maternal red blood cell mass, fetal growth, placental development, and the anticipated blood loss associated with childbirth. If dietary intake and available iron stores are



insufficient to meet these demands, iron deficiency may develop. Initially, the body's iron stores decline, which can be reflected by a reduction in serum ferritin concentration. As the deficiency progresses, iron availability becomes insufficient for normal hemoglobin synthesis. This may lead to iron-deficiency anemia, commonly characterized by reduced hemoglobin levels and, in more established cases, microcytosis and hypochromia. The severity of the condition depends on the extent of iron depletion, the duration of the deficiency, the physiological demands of pregnancy, and the presence of additional contributing factors. Early identification of iron deficiency is important because depleted iron stores may precede the development of overt anemia. In addition to iron deficiency, anemia during pregnancy may result from inadequate folate or vitamin B12 levels. Both nutrients are essential for DNA synthesis and normal erythrocyte maturation. Their deficiency may impair cell division and produce megaloblastic changes, often accompanied by an increased mean corpuscular volume. Chronic inflammatory diseases can also contribute to anemia by altering iron regulation and erythropoiesis. In inflammatory states, the hormone hepcidin may increase, reducing intestinal iron absorption and limiting the release of stored iron into the circulation. This mechanism can restrict the availability of iron required for erythrocyte production, even when iron is present in body stores. Inherited disorders, including thalassemia and other hemoglobinopathies, may cause anemia through abnormalities in hemoglobin synthesis or erythrocyte survival. These conditions require a distinct diagnostic approach because their management differs from that of nutritional iron deficiency. Other potential causes include blood loss, hemolysis, chronic kidney disease, and certain infectious diseases. Therefore, anemia during pregnancy should be regarded as a multifactorial clinical condition in which physiological adaptations and pathological mechanisms must be carefully distinguished. The clinical manifestations of anemia depend on the degree of hemoglobin reduction, the speed at which anemia develops, its underlying cause, and the woman's overall health status. Common symptoms may include fatigue, weakness, reduced exercise tolerance, dizziness, headaches, and difficulty concentrating. Some women may experience palpitations or shortness of breath, particularly during physical activity. In more severe cases, anemia may place additional strain on the cardiovascular system and impair the body's capacity to meet increased oxygen demands. However, mild anemia may be asymptomatic or associated with nonspecific complaints. Furthermore, fatigue, dizziness, and shortness of breath may also occur during an uncomplicated pregnancy. These symptoms alone are therefore insufficient to establish a diagnosis. Clinical assessment should include a detailed medical and obstetric history, evaluation of dietary habits, consideration of previous anemia or blood loss, and assessment of any relevant chronic diseases. Physical examination may provide additional information, but laboratory investigations remain essential for confirming anemia and identifying its cause. The principal diagnostic investigation is a complete blood count, which includes hemoglobin concentration, hematocrit, erythrocyte count, and red blood cell indices. These parameters help establish the presence of anemia and provide preliminary information



about its possible etiology. According to the American College of Obstetricians and Gynecologists (ACOG), pregnant women should be screened for anemia using a complete blood count during the first trimester and again at approximately 24–28 weeks of gestation. Further testing may be indicated when symptoms develop, anemia is identified, or additional risk factors are present.

First, a complete blood count helps identify reduced hemoglobin levels and evaluate erythrocyte characteristics. The mean corpuscular volume and other red blood cell indices may help distinguish microcytic, normocytic, and macrocytic patterns. Nevertheless, these patterns are not independently diagnostic and should be interpreted in the context of the patient's clinical findings.

Second, serum ferritin measurement provides information about the body's iron stores. A reduced ferritin concentration is an important indicator of iron deficiency. However, ferritin is also an acute-phase reactant and may be normal or elevated in the presence of inflammation, potentially complicating the interpretation of iron status. Third, vitamin B12 and folate concentrations may be assessed when a nutritional deficiency is suspected, particularly in patients with macrocytosis, dietary risk factors, or other relevant clinical findings.

Fourth, additional investigations may include serum iron, transferrin saturation, total iron-binding capacity, inflammatory markers, reticulocyte count, and tests for hemoglobinopathies. Depending on the clinical presentation, evaluation for blood loss, hemolysis, chronic disease, or other underlying conditions may also be necessary.

The interpretation of laboratory results must take gestational age into account because physiological changes during pregnancy affect several hematological parameters. Hemoglobin thresholds may differ between trimesters and among clinical guidelines. Therefore, diagnostic decisions should be based on the applicable recommendations and the overall clinical context rather than on an isolated laboratory value.

The management of anemia during pregnancy depends on its underlying cause, severity, gestational age, associated conditions, and the patient's response to treatment. The principal objectives are to correct the underlying deficiency or disease, improve hemoglobin concentration when appropriate, replenish depleted nutrient stores, and reduce the risk of maternal and perinatal complications.

For confirmed iron-deficiency anemia, oral iron preparations are generally considered first-line treatment. Their purpose is to improve iron availability for hemoglobin synthesis, increase hemoglobin concentration, and restore depleted iron stores. The choice of preparation, dosage, and duration of therapy should be determined by a qualified healthcare professional according to the severity of the deficiency, gestational age, laboratory findings, and treatment tolerability. Dietary factors and interactions with other medications may influence iron absorption. Patients should therefore receive appropriate instructions regarding the prescribed preparation and its administration. Gastrointestinal adverse effects, including nausea, abdominal discomfort, and



constipation, may occur and can affect adherence to treatment. If adverse effects develop, the patient should consult the treating clinician before changing the treatment regimen. Depending on the clinical circumstances, the clinician may consider adjusting the dosing schedule, changing the preparation, or evaluating whether an alternative treatment is appropriate. Treatment response should be assessed through follow-up laboratory testing. Inadequate improvement may indicate poor adherence, an incorrect or incomplete diagnosis, impaired absorption, ongoing blood loss, inflammation, or another underlying condition.

Intravenous iron may be considered in selected pregnant women, particularly during the second and third trimesters, when oral iron is not tolerated, fails to produce an adequate response, cannot be absorbed sufficiently, or is unlikely to replenish iron stores within the available time. The decision to use intravenous iron should be based on an individualized assessment of the patient's clinical condition, hemoglobin concentration, iron status, gestational age, and treatment requirements. Intravenous iron is administered under medical supervision because infusion-related reactions and other adverse effects may occur. The formulation and total replacement dose should be selected by the treating healthcare professional in accordance with the relevant clinical protocol. The use of intravenous iron during the first trimester is generally avoided because safety data during early pregnancy are limited. Consequently, treatment decisions must take account of the stage of pregnancy and the urgency of correcting the deficiency.

When anemia is caused by folate or vitamin B12 deficiency, the relevant deficiency must be corrected using an appropriate treatment regimen. Identifying the underlying cause is particularly important because the treatment of one nutritional deficiency may not adequately address another. For suspected vitamin B12 deficiency, appropriate assessment is important before folic acid is used as the sole treatment, since folate supplementation may improve the hematological abnormalities while allowing neurological complications of vitamin B12 deficiency to progress. Anemia associated with chronic inflammatory conditions, kidney disease, inherited hemoglobin disorders, or hemolysis requires individualized management. In such cases, the primary disease and its contribution to anemia should be addressed, and specialist consultation may be necessary. Red blood cell transfusion is not a routine treatment for uncomplicated iron-deficiency anemia. It may be required in selected cases involving severe anemia, significant bleeding, hemodynamic instability, or other serious clinical circumstances. The decision should be guided by the patient's clinical status, symptoms, gestational age, and the urgency of treatment rather than by hemoglobin concentration alone.

Regular follow-up is an essential component of anemia management. After treatment has commenced, repeat blood tests should be performed at an appropriate interval to evaluate the hematological response and determine whether the treatment plan remains effective. If the expected improvement in hemoglobin concentration does not occur, the clinician should reassess treatment adherence, tolerability, diagnostic accuracy, iron absorption, and the



possibility of continuing blood loss or coexisting disease. Monitoring should not focus exclusively on hemoglobin normalization. In iron-deficiency anemia, replenishing iron stores is also important because hemoglobin may improve before body iron reserves have been fully restored. Continued assessment during pregnancy and, when indicated, after delivery can help identify persistent deficiency and reduce the risk of recurrent anemia. Treatment duration should therefore be determined according to laboratory findings, clinical circumstances, and applicable guidelines.

The prevention of anemia should begin before conception whenever possible. Preconception counseling, adequate nutrition, identification of pre-existing deficiencies, and timely treatment of underlying conditions can help improve a woman's hematological status before pregnancy begins. A balanced diet should include iron-containing foods such as meat, fish, legumes, and iron-fortified products. Animal-derived foods generally provide heme iron, which is more readily absorbed than the non-heme iron found in plant-based foods. Vitamin C-rich fruits and vegetables can enhance the absorption of non-heme iron when consumed as part of the same meal. Dietary measures are important but may not be sufficient to meet the increased iron requirements of pregnancy in all women. For this reason, preventive supplementation is recommended in accordance with international guidance and national clinical protocols. The World Health Organization recommends daily supplementation with 30–60 mg of elemental iron and 400 micrograms of folic acid during pregnancy to prevent maternal anemia and improve pregnancy outcomes. The appropriate preventive regimen should be implemented in accordance with applicable national recommendations and the advice of the treating healthcare professional. Folic acid is particularly important for fetal development because adequate intake before conception and during early pregnancy helps reduce the risk of neural tube defects. Iron supports maternal erythropoiesis and the increased physiological demands associated with fetal and placental growth. Regular antenatal visits and laboratory screening are also essential preventive measures. They allow healthcare professionals to identify anemia at an early stage, investigate potential causes, and initiate appropriate interventions before the condition becomes more severe. In addition, preventive strategies should address relevant contributing factors, including inadequate dietary intake, chronic disease, infections in populations at risk, and limited access to healthcare services. Public health initiatives that improve nutritional education, antenatal screening, and access to appropriate supplementation may contribute to reducing the burden of anemia among pregnant women.

Untreated or severe anemia may adversely affect maternal health and pregnancy outcomes. The magnitude of the risk depends on the severity and duration of anemia, its underlying cause, the stage of pregnancy at which it develops, and the timeliness of treatment. Maternal complications may include pronounced fatigue, reduced physical capacity, and diminished physiological reserve during childbirth. Severe anemia may also reduce a woman's ability to tolerate additional blood loss and may complicate recovery during the postpartum



period. Anemia during pregnancy has also been associated with adverse perinatal outcomes, including an increased risk of preterm birth and low birth weight. The relationship between anemia and these outcomes is influenced by the severity of the condition, the timing of its onset, nutritional status, coexisting diseases, and other maternal and socioeconomic factors. It is important to recognize that the presence of anemia does not inevitably result in complications. Appropriate screening, accurate diagnosis, effective treatment, and continued antenatal monitoring can help reduce preventable risks and improve maternal and neonatal health. Consequently, anemia should be addressed as an important component of comprehensive maternal healthcare. Particular attention should be given to women with severe anemia, persistent symptoms, inadequate treatment response, or underlying conditions requiring specialized care.

Conclusion: Anemia in pregnant women remains a significant clinical and public health concern that requires timely diagnosis, appropriate treatment, and effective prevention. Iron deficiency is the most common cause; however, a comprehensive diagnostic assessment should also consider folate and vitamin B12 deficiencies, chronic inflammatory conditions, blood loss, and inherited hemoglobin disorders. Modern approaches to the management of anemia during pregnancy include routine hemoglobin assessment, evaluation of iron stores when indicated, identification of the underlying etiology, individualized treatment selection, and systematic monitoring of therapeutic effectiveness. Oral iron is generally the first-line treatment for confirmed iron-deficiency anemia, while intravenous iron may be appropriate in selected cases when oral therapy is ineffective, poorly tolerated, or insufficient to meet clinical requirements. Other causes of anemia must be managed according to their specific pathophysiological mechanisms. Preventive measures, including adequate nutrition, antenatal screening, and iron and folic acid supplementation in accordance with WHO recommendations and national clinical protocols, play an important role in reducing the burden of anemia during pregnancy. Early recognition and effective management may help decrease the likelihood of adverse maternal and perinatal outcomes. In conclusion, a comprehensive and individualized approach to anemia in pregnant women is essential for protecting maternal health, supporting fetal development, and improving pregnancy outcomes. Strengthening preventive interventions, ensuring access to antenatal care, and promoting evidence-based clinical management should remain priorities in maternal healthcare.

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