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Prevalence Of Iron Deficiency Anemia In Pregnant Women

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Abstract

Iron deficiency anemia (IDA) is a serious health issue that affects people worldwide and is a prevalent hematological condition during pregnancy. According to the World Health Organization, anemia during pregnancy is defined as a hemoglobin concentration of less than 11 g/dL. Iron deficiency is the cause of anemia in around 5080% of cases. The iron requirements of pregnancy, which specifically predisposes women to iron deficiency anemia (IDA), are mostly influenced by the increase in maternal blood volume, fetal development, placental development, and blood loss after delivery. The purpose of this study is to evaluate the prevalence, aetiology, diagnosis, and treatment options of iron deficiency anemia in pregnant women. The findings indicate that the prevalence of pregnancy-related anemia is around 41.8% globally, and the high rates in low- and middle-income nations can be explained by the prevalence of malnutrition, parasite infestations, limited access to healthcare, and socioeconomic limitations. In India, anemia has been a major problem for many pregnant women, especially in rural areas. Hemoglobin and serum ferritin levels play a major role in the diagnosis; nevertheless, therapy options include intravenous iron preparations, oral iron treatment, and preventative supplements. Reducing the issues associated with iron deficiency anemia (IDA) in mothers and newborns requires diagnosis, appropriate treatment, and other community health initiatives.

Keywords: Iron Deficiency Anemia; Iron Supplementation; Pregnancy; Maternal Health; Serum Ferritin.

1. Introduction

According to the definition by the World Health Organization, anemia in pregnancy is a hemoglobin of lower than 11 g/dL [1]. "This is well recognized as a diagnostic level of anemia in pregnant women and is a very significant indicator of maternal health. The most common form of pregnant anemia, iron deficiency anemia (IDA), is caused by insufficient iron in the blood to produce hemoglobin. This lowers the blood's ability to transport oxygen, which has a detrimental effect on the mother's and the unborn child's health. The main causes of IDA are insufficient food consumption (malnutrition), parasite infestations, long-term health problems, and parasitic diseases including malaria. The two variables are highly prevalent in the underdeveloped countries and iron deficiency in pregnant women remains to be even more of a burden [2].

Almost all cases of anemia are iron deficiency and it is experienced by more than two out of three pregnant women in underdeveloped countries. This makes it a significant global health concern for society. According to statistics from the National Family Health Survey (NFHS-4, 2015-2016), anemia affects 52.1% of pregnant women in rural India and 45.7% of pregnant women in urban areas. Additionally, during the first week following childbirth, 84% of women suffer from iron insufficiency. One out of five cases of maternal death is directly related to IDA, and a second half are indirectly due to its effects [3].

During pregnancy, iron plays a vital role in the development of placenta, fetal development and an increase in the amount of the blood volume of the mother. The main determinants of the development of the IDA are the amount of iron that is ingested in pregnancy, and the amount of iron that is deposited before pregnancy. Women are under-endowed in iron stores especially in environments that have limited resources especially due to the heightened physiological requirements [4]. The effectiveness of oral iron supplementation, which can raise hemoglobin levels by around 0.3–1.0 g/dL per week, is hindered by low compliance (22–64% because of gastrointestinal side effects). Given the frequency of IDA and its detrimental effects on both the mother and the fetus, iron supplements are typically administered to pregnant women as a preventative measure and a treatment. Low compliance and sporadic results hinder further evaluation of the existing treatment options [5]. The study will assess the efficacy of several treatments for iron deficiency anemia during pregnancy, point out their shortcomings, and offer recommendations for improving therapy to improve the mothers' health outcomes.

2. Epidemiology and Etiology of Anemia

2.1. Epidemiology of Anemia

Anemia has been found to afflict approximately 2 billion human beings or a third of the world population and therefore is one of the most prevalent health issues in the world [6]. In 2010, approximately 68.4 million years were living with disability as compared to 65.5 million years in 1990 and this implies that it is a significant burden of disease across the world. The global frequency fell a bit between 40.2% in 1990 and 32.9% in 2010; although this was not uniformly true among all groups and was slightly higher among men than women [7]. Women, especially those in the reproductive age are continuing to carry an incredibly heavy burden due to the loss of blood monthly, pregnancy and the added nutritional needs.

Low- and middle-income countries are the most common locations of anaemia, and there is a very high degree of dispersion in its geographic distribution [8]. Poverty, inadequate diet, inaccessibility to medical care, and prevalence of infectious diseases, are some of the factors that contribute to this imbalance. The most prevalent one is iron deficiency anemia (IDA), and it is estimated that about 50-80% of the cases [9]. This is even more so in the areas where chronic malnutrition is common. Subclinical deficiencies still persist and up to 20% of the population is affected by iron deficiency without anemia, despite a better healthcare system in the rich nations [10].

Newborns and young children have a high prevalence rate of anemia (47%), which is made worse by their fast development and iron requirements. Pregnant women are another high-risk population; around 42% of pregnant women worldwide are impacted [11]. Due to the growing fetus's higher iron requirements and the increased volume of maternal blood, pregnant women are more susceptible. Another 30 percent of women of reproductive age are also affected and this implies that this segment continues to bear a disproportionate burden, as well. Because low birth weight, premature delivery, and increased

neonatal morbidity and death are all linked to maternal anemia, the effects of anemia on subsequent generations are substantial as well [12].

2.2. Etiology of Anemia

There are many different factors that might contribute to anemia, and these factors often coexist, which is especially problematic in areas with low resources. Inadequate nutrition, hereditary illnesses, infections, and long-term health conditions are some of the most common reasons [13]. These nutritional deficiencies occur due to deficiencies in iron, folate, vitamin B12 and riboflavin, with the most common being the iron deficiency. Most anemia is caused by iron deficiency and almost half of all anaemias in the world can be attributed to iron deficiency (WHO, 2014) [14].

Anemia may be inherited and hemoglobinopathies are a significant cause like sickle cell disease and thalassemia in places where these diseases are prevalent. Infections are another significant cause especially in the underdeveloped countries. Parasitic diseases such as schistosomiasis and hookworm, bleeding and decreased red blood cell production due to diseases such as malaria, can result in chronic blood loss. Anemia of chronic illness can also be caused by inflammatory disorders and persistent infections, which lead to decreased erythropoiesis and poor iron use [15].

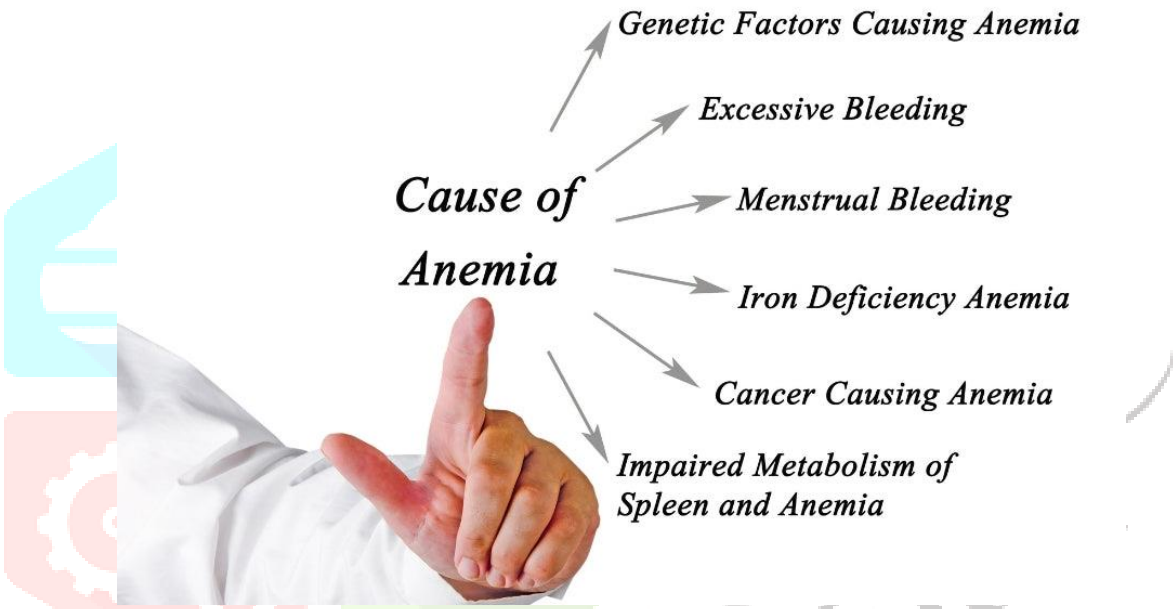

Figure 1: Etiology of Anemia

The other significant causes are systemic conditions that are long term e.g. chronic renal disease, cancer and autoimmune conditions. Anemia in these cases can be as a result of depressed bone marrow activity, chronic inflammation or low erythropoietin production. Additionally, anemia could be the result of the inadequate management of acute blood loss during the trauma, surgery, or obstetric problems [16].

Poverty, poor sanitation, unhealthy food and lack of medical facilities are some of the socioeconomic factors that determine anemia. These factors only make it difficult to detect and treat diseases at an early stage, but can also cause a high risk of nutritional deficiency and infection. Anemia is a complex condition in vulnerable and high-risk populations with multiple facets which require a holistic approach to prevention and treatment [17].

3. Iron Metabolism

Three factors—nutritional intake, iron loss, and current demand—represent the equilibrium of iron metabolism in healthy persons. Nutritional iron intake is affected by two factors: the amount of food digested and the body's absorption capacity for iron [18]. Digestive health and co-morbidities, including chronic inflammatory diseases, are major factors in iron absorption rates because they influence the synthesis of iron regulatory proteins and the peptide hepcidin, which can impede iron absorption in the long run [19]. The reticuloendothelial system, namely the spleen, is responsible for the elimination of erythrocytes, which in turn restores the body's iron stores. A new study has revealed the mechanisms by

which proteins in the intestines and liver regulate iron absorption in reaction to variations in iron status [20].

4. Iron Metabolism in Pregnancy

Fetal hepcidin controls the movement of iron from the mother's plasma to the fetal circulation throughout pregnancy. Iron influx into the plasma increases when hepcidin levels are decreased. Hepatocytes, macrophages, and enterocytes store iron when hepcidin levels are elevated [21]. Ferroportin absorption is facilitated by elevated hepcidin levels. The recommended daily dosage for exogenous iron is between 1 and 8 mg. To meet the growing requirement for iron, particularly during development stages, pregnancy, and breastfeeding, more exogenous iron is required. The need for iron is greatly enhanced in order to sustain the mother's blood volume and promote the growth of the fetus and placenta. Iron deficiency may occur in pregnant women both before and after childbirth. Approximately 1000 mg of iron are used up during pregnancy and breastfeeding. Pregnant women need thus take 27 milligrams of iron daily, compared to 8 milligrams for non-pregnant individuals. Ten milligrams must be taken daily by breastfeeding moms [22].

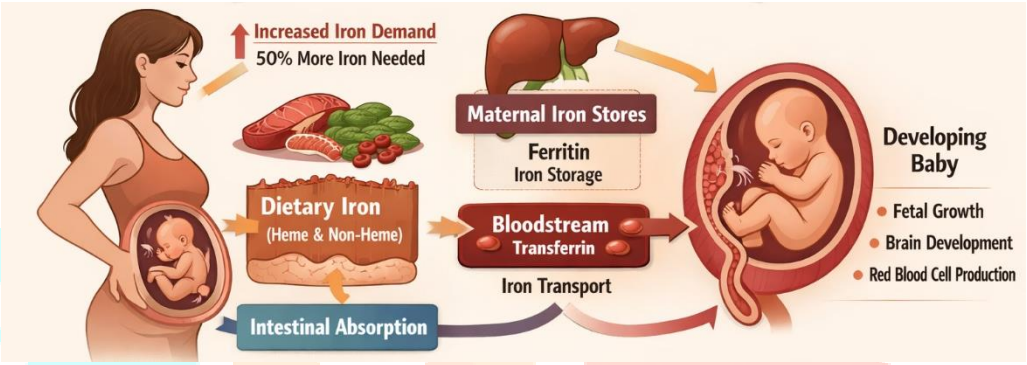

Figure 2: Iron Metabolism in Pregnancy

5. Iron Deficiency Anemia in Pregnancy

The worldwide rate of anemia during pregnancy is reported at around 41.8%; however, the frequency of iron deficiency without anemia is uncertain [23]. IDA is a frequent problem throughout gestation. The total amount of iron needed during pregnancy is significantly more than in a nonpregnant condition, even if menstruation temporarily reduces iron loss. This is due to the fact that the body needs iron at an exponential rate throughout pregnancy in order to expand plasma volume, make more red blood cells, support the development of the fetal-placental unit, and make up for iron loss after birth. On the basis of an average weight of 55 kg, pregnant women have a physiological iron need of around 1000-1200 mg [24].

The quantity comprises 350 mg that is associated with fetal and placental development, 500 mg that is associated with an increase in red cell mass, and 250 mg that is associated with blood loss after delivery. As the pregnancy advances, the body's iron requirements increase. Specifically, they are decreased during the first trimester (0.8 mg/day) and significantly higher during the third trimester (3.0-7.5 mg/day) [25]. Approximately 90% of expectant women have reserves below 500 mg, and nearly 40% have weak or nonexistent stores, which are insufficient to meet the increased iron requirements. Overt iron deficiency anemia is prevalent among expectant women in developed countries as well. It could be because their bodies can not adapt at a quick enough rate to keep up with the added demand or it could be because they do not get sufficient iron in their diet. Pregnancy iron deficiency anemia (IDA) may be a very severe health condition, when left unaddressed, it may have drastic consequences on both the health of the mother and the fetus [26].

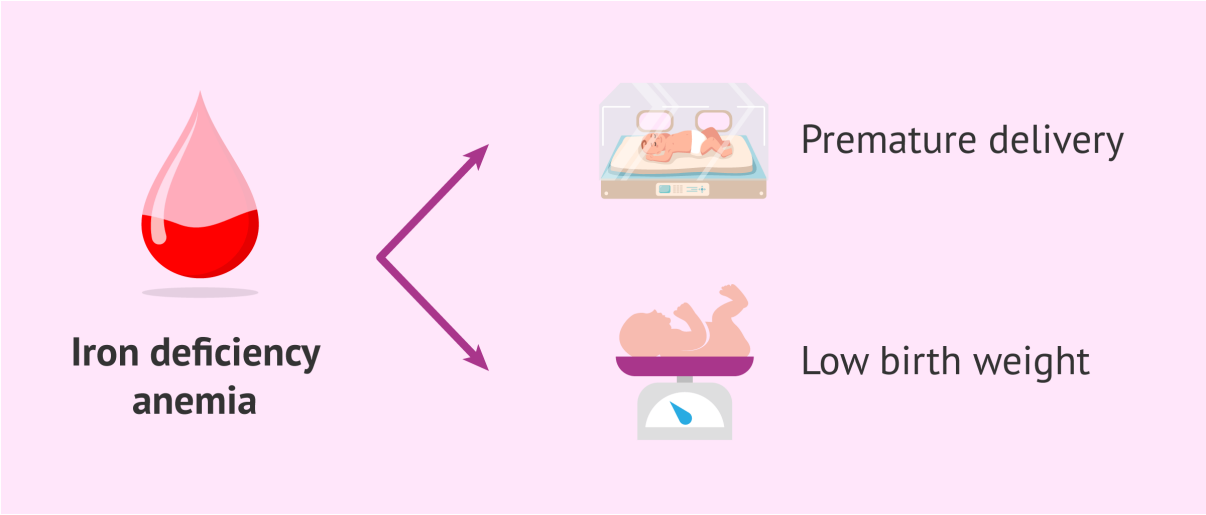

Figure 3: Iron Deficiency Anemia in Pregnancy

6. Clinical Impact of Iron Deficiency Anemia

Iron is an essential mineral that is required for many bodily processes and cellular activities. Numerous biological processes, including as DNA synthesis and redox reactions, rely on it, and it also plays a role in oxygen transport in red blood cells (erythrocytes) via hemoglobin (Hb) [27]. Further studies on animals have revealed that iron has an involvement in brain development and functioning. Low levels of iron lead to decreased enzyme activity and production of erythrocytes, which result in less oxygen to the tissues. As a result, a wide range of cognitive and physical consequences might result from iron deficiency anemia and iron shortage [28]. The clinical picture of iron deficiency/IDA can be described by the presence of such symptoms as fatigue, irritability, weakness, loss of hair, and deteriorated attention and work performance, depending on the severity of the illness [29].

7. Diagnosis of Iron Deficiency Anemia

In order to diagnose iron deficiency anemia (IDA) or iron deficiency, a laboratory test should be conducted. In order to diagnose anemia, hemoglobin levels cannot be relied upon, as it is a disorder with a variety of potential causes [30]. The diagnostic certainty can be achieved by measuring the levels of serum ferritin and red blood cell count. It is advisable to evaluate serum ferritin (SF) levels at the onset of pregnancy, as they are the most reliable indicator of iron deficiency. A serum ferritin (SF) level below 30 g/L strongly implies that iron stores have been depleted, even in the absence of anemia. A hemoglobin concentration of less than 11 g/dL in the first trimester, 10.5 g/dL in the second trimester, and 11 g/dL in the third trimester is required to diagnose iron deficiency anemia in pregnant women. This is associated with an SF value below 30 g/L [31]. In such instances, iron treatment should be taken into account. Even in the presence of anemia, ferritin levels may appear to be normal or even elevated in the context of chronic diseases or inflammatory processes. This happens because ferritin is a protein that is involved in the acute phase. To help rule out infections or inflammation, C-reactive protein (CRP) levels can be evaluated. This could lead to a more precise diagnosis. After normalizing the CRP concentration, it is recommended to reevaluate the SF level in the event that the CRP result is elevated. If the patient shows no signs of anemia, it is unnecessary to evaluate SF levels again throughout pregnancy [32].

On the other hand, hemoglobin concentration has to be measured every trimester. When ferritin levels exceed 30 g/L, it is imperative to conduct additional diagnostic tests, including serum iron and transferrin saturation measurements, in addition to CRP measurement. Latent iron deficiency is indicated by a serum transferrin value of less than 15% in conjunction with a normal ferritin level, as transferrin releases a greater amount of iron from circulation to support erythropoiesis [33]. The diagnosis is aided by the evaluation of blood iron and transferrin levels; however, serum ferritin is the most appropriate method due to the fact that serum iron levels are subject to daily, intra-, and inter-individual fluctuations. Another factor that may assist in the diagnosis of iron deficiency during pregnancy is the soluble transferrin receptor (sTfR), particularly when ferritin levels are normal and CRP is elevated. It suggests an increase in cases of iron insufficiency or an increased requirement for iron in cells. Elevated sTfR levels during pregnancy are associated with increased erythropoiesis stimulation and a substantial iron need because of iron-dependent cellular proliferation [34].

A correlation between inhibited erythropoiesis and reduced levels of sTfR during the first trimester of pregnancy has been demonstrated in a multitude of studies. Additionally, the levels of sTfR are minimally affected by infections and inflammatory reactions. Additional testing is necessary to differentiate between anemia and other conditions, including infections, hemoglobinopathies, or chronic renal illness. Hb electrophoresis or chromatography is particularly recommended to exclude hereditary disorders such as β-thalassemia. Because vitamin B12 deficiency is common in megaloblastic anemia, measuring vitamin B12 levels is crucial. However, folic acid deficiency anemia is less common [35].

9. Management of Iron Deficiency Anemia

9.1 Prophylaxis

There is little information on the effect of iron prophylaxis during pregnancy on lowering the prevalence of iron deficiency worldwide and, therefore, maternal and fetal issues [36]. As a result, preventive iron supplementation's benefits and drawbacks remain debatable. The WHO advises daily iron supplementation for pregnant women who live in places where iron deficiency is more prevalent because preventive iron administration provides major advantages for those with low iron reserves.

Iron prophylaxis is also used in industrialized nations, nevertheless. The appropriate amount for prophylactic iron supplementation is still debatable, despite current standards recommending 60–120 mg of elemental iron daily. Lower doses show minimal effectiveness; on the other hand, dosages of 120 mg/day or above are linked to an increase in side effects, which reduces adherence [37].

9.2 Oral Iron Therapy

The main therapy recommended for moderate iron deficiency anemia and iron deficiency without anemia during pregnancy is oral iron supplementation. The many oral iron formulations include iron (II) salts, iron (III) polymaltose complex, and liposomal iron [38].

- **Iron (II) salts**

The three accessible ferrous iron salts are ferrous sulfate, ferrous gluconate, and ferrous fumarate. They don't appear to be superior to one another and all exhibit similar rates of adverse effects [39]. Elemental iron is frequently administered daily in doses of 100–200 mg to women with iron deficiency anemia (IDA). A daily intake of less than 100 mg of iron supplements is currently deemed insufficient by many scientists. Ferrous salts have poor and inconsistent absorption rates. Since some foods and mucosal luminal injury may restrict their absorption, it is recommended to give them a glass of orange juice or a similar source of vitamin C an hour before meals on an empty stomach to promote absorption. It is currently uncertain, nevertheless, if daily administration is equivalent to weekly or intermittent oral iron treatment [40]. Follow-ups should be conducted after two to four weeks to assess the therapy's efficacy. Oral iron supplementation should continue for at least four to six months after hemoglobin levels return to normal until a ferritin concentration of around 50 ng/mL and a transferrin saturation of at least thirty percent are attained [41].

- **Iron (III) polymaltose complex**

Dextriferron, an iron (III) polymaltose complex, is one of the few oral iron (III) compounds. This is categorized as a slow-release formulation because, in contrast to iron salts, the polymaltose that surrounds the trivalent iron allows for a gradual release from the complex, reducing the likelihood of negative consequences [42]. Additionally, eating it with meals increases its bioavailability. 100–200 mg daily is the recommended dose. According to some research, IPC has a better safety profile and is just as effective as iron salts [43].

- **Liposomal iron**

Liposomal iron, a formulation of ferric pyrophosphate combined with ascorbic acid and encapsulated inside a phospholipid membrane, is a novel oral iron supplement characterized by excellent absorption and minimal adverse effects, owing to its absence of direct interaction with the intestinal mucosa. Limited information exists on its application during gestation [44].

9.3 Intravenous Iron Therapy

In certain clinical situations, such as insufficient or nonexistent response to oral iron, reduced absorption from intestinal disorders, intolerance to oral iron, noncompliance, or the need for timely and adequate treatment (e.g., bleeding from placenta previa, advanced gestational age, etc.), oral iron therapy may be switched to intravenous therapy [45]. The use of earlier intravenous iron formulations was limited due to undesirable and often severe responses, including as allergies, shock, and fatality. The new iron complexes, on the other hand, guarantee better compliance, safety, and efficacy. Due to the increased frequency of adverse reactions, especially severe ones, iron dextran administration during pregnancy has been limited [46]. Iron gluconate has not been shown to cause any major adverse effects; nevertheless, this approach is not feasible since many infusions are required, which raises healthcare costs and reduces patient compliance. 125 mg is the maximum amount that can be taken in one dose. It should not be used in the first trimester due to its poor molecular stability [47]. Compared to oral iron therapy, intravenous iron therapy has the advantage of not affecting protein binding or intestinal iron absorption. The new formulations have a greater binding of iron to the carbohydrate core, which decreases the detrimental release of free iron. The detrimental consequences of free iron are mitigated due to the fact that it damages cells and tissues via peroxidation, which generates reactive oxygen species such as hydroxyl and oxygen radicals. New intravenous iron solutions make it possible to provide larger dosages in a single treatment. Ferric carboxymaltose (FCM), iron sucrose (IS), and iron polymaltose (IP) are among the intravenous iron formulations that are recommended for the treatment of iron deficiency anemia [48].

- **Iron sucrose**

When compared to oral iron, intravenous iron has a lower risk of side effects and is both effective and safe to use during pregnant. Compared to individuals given oral iron, those given intravenous iron had a rise in hemoglobin concentration of 1.3 to 2.5 g/dL over the course of 28 days. A single delivery's maximum dose cannot be more than 200 mg. For 100 mg, the infusion must last at least 15 minutes, and for 200 mg, it must last 30 minutes [49].

- **Iron polymaltose**

For improvements in hematological parameters, IV IP shows significant effectiveness. However, it has been linked to an increased incidence of side effects, including headache, heartburn, back pain, chest tightness, dyspnea, nausea, tachycardia, rash, and vomiting. The highest amount that can be administered intravenously is more than 2500 mg. The maximum dosage takes around four to five hours to provide [50].

- **Ferric carboxymaltose**

For intravenous iron treatment during pregnancy, FCM, Ferinject®, is the best formulation. Molecular stability is excellent in FCM. Ferinject is a safe and effective intravenous iron treatment during pregnancy, with fewer unfavorable side effects than oral iron, according to several randomized trials. Moreover, the placenta is not crossed by FCM [51]. The daily limit is 1000 mg/20 mL. The range of the administration rate must be 100–500 mg/min. The administration period is at least 15 minutes for doses ranging from 500 mg to 1000 mg [52].

Table: Management of Iron Deficiency Anemia in Pregnancy

Section	Subsection / Type	Key Details	Dosage / Duration	Advantages	Limitations / Adverse Effects
Prophylaxis	Iron supplementation (WHO recommendation)	Recommended in high-prevalence regions to prevent maternal & fetal complications	60–120 mg elemental iron/day	Prevents iron deficiency in low iron reserves	High dose (≥120 mg) → more side effects, ↓ compliance
Oral Iron Therapy	General	First-line treatment for mild IDA and iron deficiency without anemia	—	Easy, cost-effective	GI side effects, poor absorption
	Iron (II) salts (ferrous sulfate, gluconate, fumarate)	Most commonly used	100–200 mg/day	Widely available, effective	Poor absorption, GI irritation, food interference
		Administration advice	Empty stomach + Vitamin C	Improves absorption	Compliance issues
		Follow-up	2–4 weeks	Monitor response	—
		Continuation	4–6 months after Hb normalization	Replenishes iron stores	—
	Iron (III) polymaltose complex (IPC)	Slow-release formulation	100–200 mg/day	Better tolerance, fewer side effects	Slightly costly
	Liposomal iron	Ferric pyrophosphate + ascorbic acid	Not well established	High absorption, minimal GI irritation	Limited pregnancy data
Intravenous Iron Therapy	General	Used when oral iron fails or rapid correction needed	—	Rapid Hb improvement	Requires hospital setup
	Indications	Poor response, intolerance, malabsorption, noncompliance, late pregnancy	—	Effective in severe cases	—
	Iron sucrose (IS)	Safe & effective IV iron	Max 200 mg/dose	Better Hb rise than oral iron	Multiple infusions needed

		Infusion time	15–30 min	—	—
	Iron polymaltose (IP)	Effective but higher adverse effects	Up to >2500 mg total	High-dose administration possible	Headache, hypotension, nausea, etc.
		Infusion duration	4–5 hours	—	Long administration time
	Ferric carboxymaltose (FCM)	Preferred IV formulation (Ferinject®)	Max 1000 mg/day	High safety, rapid correction, no placental transfer	Cost
		Infusion time	≥15 min	Convenient single dose	—

10. Challenges and future outlook

Anemia of pregnancy is a significant health issue, especially iron deficiency anemia (IDA), as it is common in less developed countries where malnutrition, inadequate prenatal care, infection, and poor socioeconomic status are common [53]. Time lag to diagnosis through inefficient screening and lack of awareness of pregnant women is one of the fundamental issues in the treatment of IDA. Though hemoglobin is usually performed, a better indicator of iron deficiency is serum ferritin, which is not always available in the resource limited areas. Ineffective oral iron therapy adherence due to the gastrointestinal side effects of oral iron such as nausea, constipation and stomach discomfort reduces efficacy of treatment. Moreover, misdose, lack of follow-up and insufficient access to intravenous iron therapy aggravates already acquired anemia [54].

The improved prenatal screening and diagnosis, the enhancement of nutritional counselling, and the availability of diagnostic tools and safer iron preparations should be included in the future research. The focus of prevention ought to be given to early prevention as a priority in the public health policy by having regular supplements and nutrition education before and during the pregnancy. Further studies are required to come up with more palatable oral preparations and affordable intravenous drugs. Awareness campaigns and enhanced health facilities in the community can greatly alleviate iron deficiency anemia and increase maternal and baby outcomes [55].

Conclusion

Iron deficiency anemia (IDA) is the predominant nutritional condition impacting pregnant women globally, significantly contributing to maternal and fetal morbidity and death. Pregnant women are susceptible to anemia due to inadequate diets, diminished iron reserves, and heightened iron demands. Regular serum ferritin and hemoglobin assessments will facilitate early diagnosis and timely intervention. Oral and intravenous iron therapy are essential, contingent upon the patient's tolerance and severity of the condition. In addition to enhancing women's health, successful treatment reduces the risk of low birth weight, premature birth, and postpartum complications. To improve public health, it is essential to augment prenatal care services, increase dietary understanding, and expand accessibility to iron supplements." The global prevalence of iron deficiency anemia in pregnancy must be mitigated by enhanced preventive measures, prompt diagnosis, and legislative incentives.

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