International Research Journal of Education and Technology

Peer Reviewed Journal
ISSN 2581-7795

Evaluating the efficacy of herbal formulation moringa oleifera in iron deficiency anemia

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Abstract

Iron Deficiency Anemia (IDA) is the most widespread nutritional disorder globally, affecting an estimated two billion people, particularly in low- and middle-income countries (WHO, 2021). It is defined by a reduction in hemoglobin levels due to inadequate iron availability, which is essential for erythropoiesis—the production of red blood cells. Iron is a key component of hemoglobin, the oxygen-carrying protein in red blood cells, and its deficiency impairs oxygen transport, leading to a range of physiological consequences. IDA primarily manifests as microcytic (small red blood cells) and hypochromic (pale red blood cells) anemia, with common symptoms including fatigue, pallor, weakness, shortness of breath, dizziness, and impaired cognitive function (Camaschella, 2015)

The public health impact of IDA is profound, affecting both individuals and entire communities. In children, chronic iron deficiency can lead to developmental delays, decreased school performance, and increased susceptibility to infections due to weakened immune function (Lopez et al., 2016).

In pregnant women, severe IDA is associated with higher risks of maternal mortality, preterm birth, and low birth weight, contributing to increased neonatal morbidity and mortality (WHO, 2021). In adults, IDA reduces work capacity and productivity, leading to substantial economic losses, particularly in labor-intensive industries in developing nations. It is estimated that iron deficiency contributes to a 4% reduction in GDP in some lowincome countries due to decreased workforce efficiency and increased healthcare costs (Horton & Ross, 2003).

Keywords:- Iron Deficiency Anemia, vitamin , nitrates and antioxidants, and prevalent nutritional disorder

1.Introduction

Iron Deficiency Anemia (IDA) is the most widespread nutritional disorder globally, affecting an estimated two billion people, particularly in low- and middle-income countries (WHO, 2021). It is defined by a reduction in hemoglobin levels due to inadequate iron availability, which is essential for erythropoiesis—the production of red blood cells. Iron is a key component of hemoglobin, the oxygen-carrying protein in red blood cells, and its deficiency impairs oxygen transport, leading to a range of physiological consequences. IDA primarily manifests as microcytic (small red blood cells) and hypochromic (pale red blood cells) anemia, with common symptoms including fatigue, pallor, weakness, shortness of breath, dizziness, and impaired cognitive function (Camaschella, 2015).

The etiology of IDA is multifaceted, often stemming from inadequate dietary intake, poor absorption, chronic blood loss, or increased physiological demands. Insufficient iron consumption, particularly in vegetarian or low-protein diets, can lead to iron depletion over time. Malabsorption disorders such as celiac disease, inflammatory bowel disease, or Helicobacter pylori infections can further exacerbate iron deficiency by impairing intestinal iron absorption (DeLoughery, 2017). Chronic blood loss is another major cause, particularly in individuals with heavy menstrual bleeding, gastrointestinal ulcers, colorectal cancer, or parasitic infections, which are common in tropical regions (Kassebaum, 2016). Pregnant women, infants, and adolescents are at higher risk due to increased iron requirements during growth and development.

1.1 Global Prevalence and Impact

Iron Deficiency Anemia (IDA) is the most common nutritional disorder worldwide, affecting an estimated 1.62 billion people, which accounts for approximately 24.8% of the global population (WHO, 2021). The burden of IDA is disproportionately higher in developing countries, where poverty, food insecurity, and inadequate healthcare contribute to high prevalence rates. According to the Global Burden of Disease (GBD) study, IDA remains one of the leading causes of years lived with disability (YLDs), particularly among children under five, women of reproductive age, and pregnant women in South Asia, sub-Saharan Africa,

and parts of Latin America (Kassebaum, 2016). In low-income regions, IDA prevalence among pregnant women is estimated to be as high as 50%, while in preschool-aged children, it exceeds 40%, significantly impairing growth, cognitive function, and immune response (Stevens et al., 2013).

1.2 Causes of Iron Deficiency Anemia (IDA)

Iron Deficiency Anemia (IDA) arises from various factors that deplete the body's iron stores, leading to impaired hemoglobin synthesis and reduced oxygen transport capacity. The primary causes of IDA include inadequate dietary iron intake, chronic blood loss, malabsorption disorders, and increased physiological demands during periods of rapid growth or pregnancy.

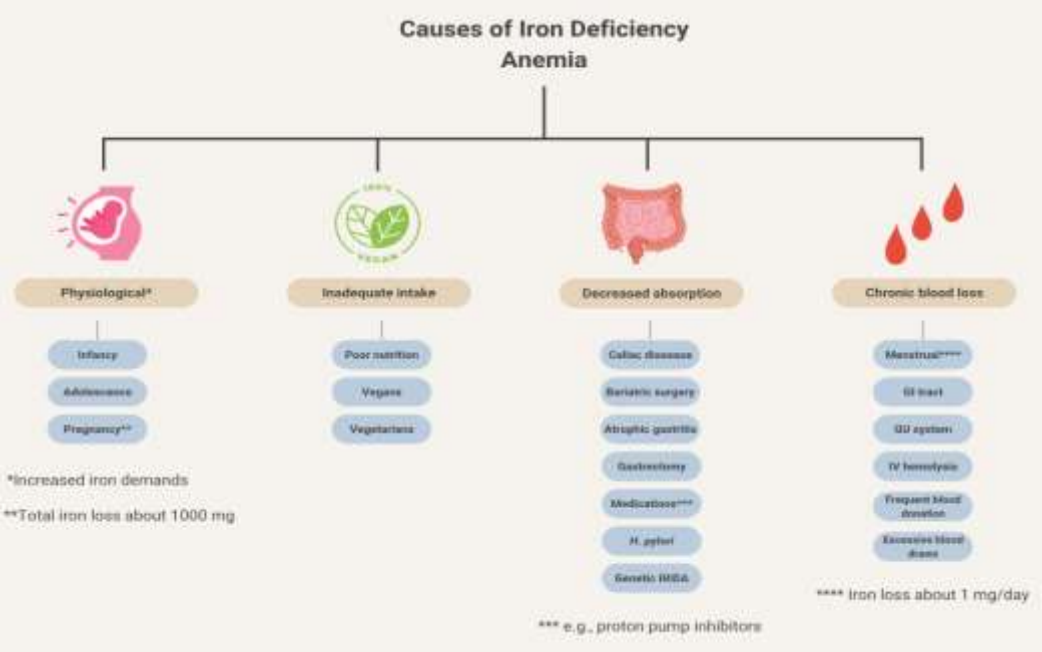


Figure no. -1.2

The duodenum is the primary site for iron absorption, and conditions that damage intestinal villi or cause chronic inflammation can significantly impair iron uptake, even in individuals consuming sufficient dietary iron. Certain medications, such as proton pump inhibitors (PPIs), which reduce stomach acid production, may also hinder iron absorption by altering the solubility of dietary iron. Increased physiological demands for iron during pregnancy, infancy, and adolescence place individuals at a heightened risk of IDA.

Pregnant women require significantly more iron to support fetal growth and increased blood volume, making them particularly vulnerable if their dietary intake is insufficient. Addressing the underlying causes of IDA requires a multifaceted approach, including improving dietary diversity, increasing awareness of iron-rich foods, treating underlying medical conditions, and implementing public health strategies such as iron supplementation and food fortification programs. Early diagnosis through screening programs and targeted interventions for high-risk populations are essential to reducing the global burden of IDA and its long-term health implications.

1.3 Symptoms and Complications of Iron Deficiency Anemia (IDA)

Iron Deficiency Anemia (IDA) manifests through various symptoms due to insufficient iron levels, leading to decreased hemoglobin production and impaired oxygen transport.

Common symptoms include fatigue, weakness, pale skin, dizziness, headaches, and shortness of breath. These manifestations result from the body's reduced capacity to deliver adequate oxygen to tissues.

Pregnant women with severe IDA face higher risks of preterm delivery, low birth weight infa

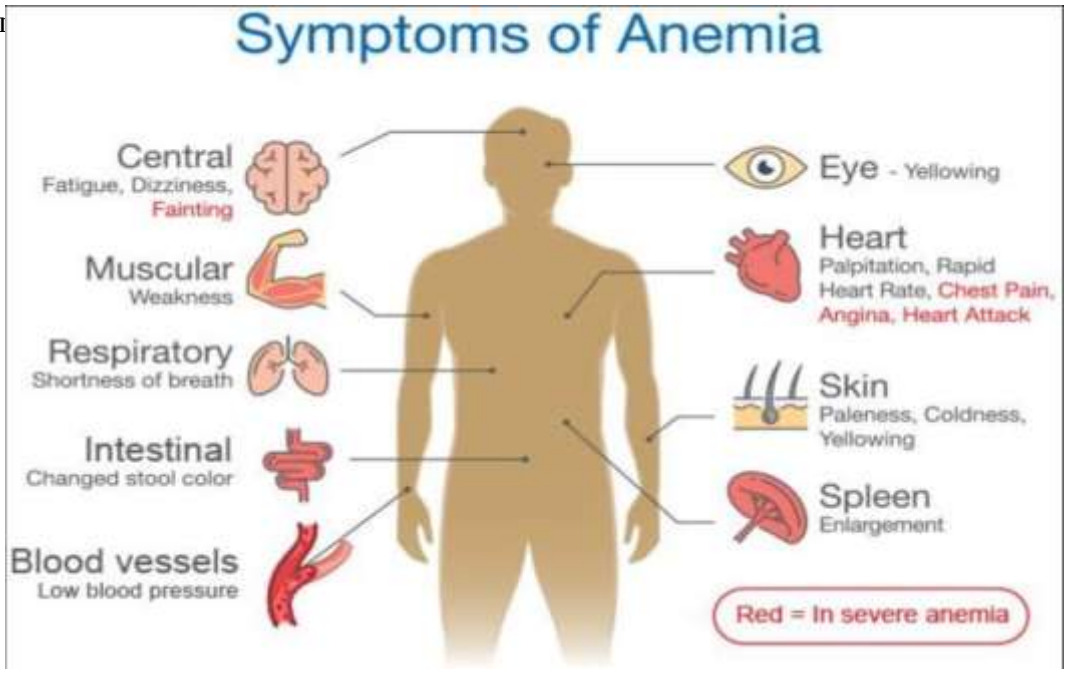
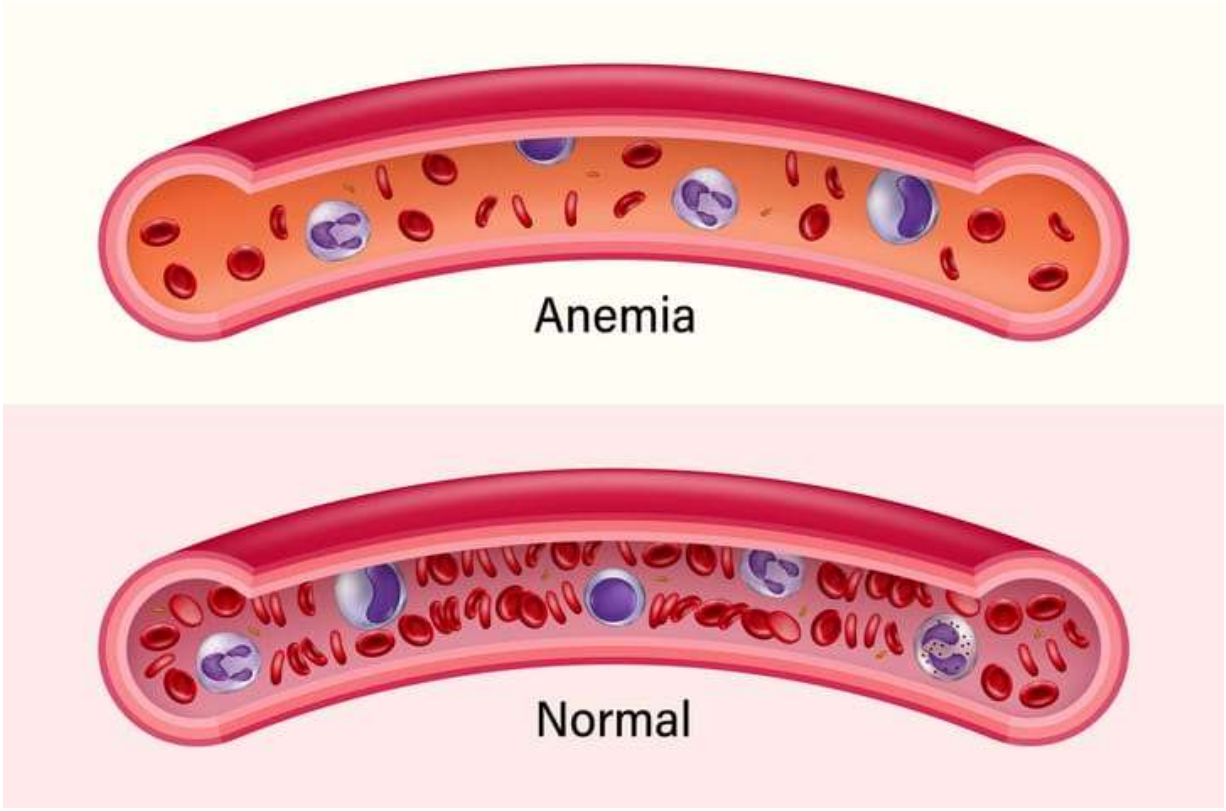


Figure no. -1.3

1.4 Current Treatment Approaches for Iron Deficiency Anemia (IDA)

Iron Deficiency Anemia (IDA) is primarily managed through a combination of iron supplementation, dietary modifications, and the consumption of iron-fortified foods. Oral ironsupplements, such as ferrous sulfate, ferrous gluconate, and ferrous fumarate, are the standard treatment for replenishing iron stores. These supplements are typically recommended on an empty stomach to enhance absorption; however, they may cause gastrointestinal side effects such as nausea, constipation, or dark stools (McDonagh & Macdougall, 2019). To improve tolerance, taking iron with food or using newer formulations like iron bis-glycinate can be beneficial. Additionally, vitamin C enhances iron absorption, while calcium, tea, and coffee inhibit it, making dietary pairing an important consideration in supplementation (Cappelllini et al., 2020).



2. Literature Review

2.1. Bhaskaran et al. (2016) conducted a clinical trial to evaluate the efficacy of Dhatryarishta, an Ayurvedic herbal formulation, in treating Iron Deficiency Anemia (IDA) in children. The study involved the administration of Dhatryarishta, which is a traditional herbal formulation known for its hematopoietic properties. The results indicated that the formulation significantly improved hemoglobin levels, iron stores, and overall blood health in children suffering from IDA. This study suggests that Ayurvedic formulations could offer a promising alternative to synthetic iron supplements, especially in pediatric populations who are more prone to gastrointestinal side effects.

2.2. Kim et al. (2024) conducted a meta-analysis to assess the safety and efficacy of East Asian herbal medicines in treating Iron Deficiency Anemia, focusing on herbs such as Astragalus membranaceus and Panax ginseng. Their review included data from various clinical trials and found that these herbal remedies could significantly improve iron levels and overall blood health in children and adults. The authors concluded that East Asian herbal formulations, particularly those containing adaptogenic herbs, offer promising potential for treating IDA, with a lower risk of adverse effects compared to conventional iron supplements. The study emphasized the need for standardized dosages and further randomized controlled trials to confirm these benefits.

2.3. Muchtaridi et al. (2020) reviewed multiple herbal formulations used in the management of IDA, focusing on the bioactive compounds that contribute to their therapeutic effects. The authors explored herbs such as Moringa oleifera, Spinacia oleracea, and Phyllanthus emblica, which are rich in iron, vitamin C, and other micronutrients essential for red blood cell production. The review emphasized that these plants not only help improve iron absorption but also have antioxidant properties that combat oxidative stress, a common issue in IDA. The authors highlighted the importance of these herbal remedies in countries with limited access to synthetic iron supplements, recommending more research to determine their effectiveness in clinical settings.

2.4. Wang et al. (2018) explored the use of nanotechnology in improving the bioavailability of iron in herbal formulations, specifically focusing on the incorporation of Astragalus

membranaceus with iron nanoparticles. They developed Fe_3O_4@Astragalus polysaccharide core-shell nanoparticles, which showed enhanced iron absorption and bioavailability in animal models. The authors emphasized that the combination of traditional herbal medicine with advanced nanotechnology could offer a novel, effective treatment for IDA, with fewer side effects compared to traditional iron supplements. This innovative approach could potentially open new avenues for herbal therapies in modern clinical practice.

3. Aim:

Evaluating the efficacy of Herbal Formulation moringa oleifera in iron deficiency anemia:

3.1. Objectives:

1. To evaluate the effectiveness of various herbal formulations in the management of Iron Deficiency Anemia (IDA), focusing on their impact on improving hemoglobin levels, iron stores, and overall blood health.
2. To examine the mechanisms by which herbal formulations enhance iron absorption, including the role of bioactive compounds such as antioxidants, vitamins, and minerals in improving iron bioavailability and reducing oxidative stress in IDA patients.
3. To assess the safety and potential side effects of herbal treatments for IDA, comparing their adverse effects with those associated with synthetic iron supplements and understanding their therapeutic window for long-term use.
4. To review the integration of traditional herbal remedies with modern pharmaceutical technologies, such as nanotechnology, to improve the bioavailability and efficacy of iron in herbal formulations for treating IDA.
5. To identify gaps in current research and suggest areas for future studies, particularly in the clinical validation of herbal formulations for IDA treatment and the standardization of dosages and formulation methods to optimize their therapeutic potential.

4. Plan of Work:

- Literature Review
- Selection Of Herbal Plants
- Collection Of Herbal Plants
- Authentication Of Herbal Plants
- Extraction Of Plants Part (Leaves)

- Result And Discussion
- Conclusion
- Reference

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5. Plant profile

In all parts of *Moringa oleifera*, the leaves ar , easy to obtain and process, and have d *oleifera* leaf has also been listed as a new re 2012. The leaves, as one of the main edible components that impact health such as high prc

5.1. Botanical Information :

Scientific name:–Moringa oleifera

Family:- Moringaceae

Genus:- Moringa

Kingdom:- Plantae

Order:- Brassicales

5.2. Chemical Constituents :

- Vitamins (A,B,C,E)
- Minerals (Iron Zinc Calcium etc.)
- Proteins
- Aminoacide
- Flovonoids
- Glucosinolates
- Alkaloids
- Saponins **Figure no. -5.2**
- Terpenes

5.3. Pharmacological Properties :

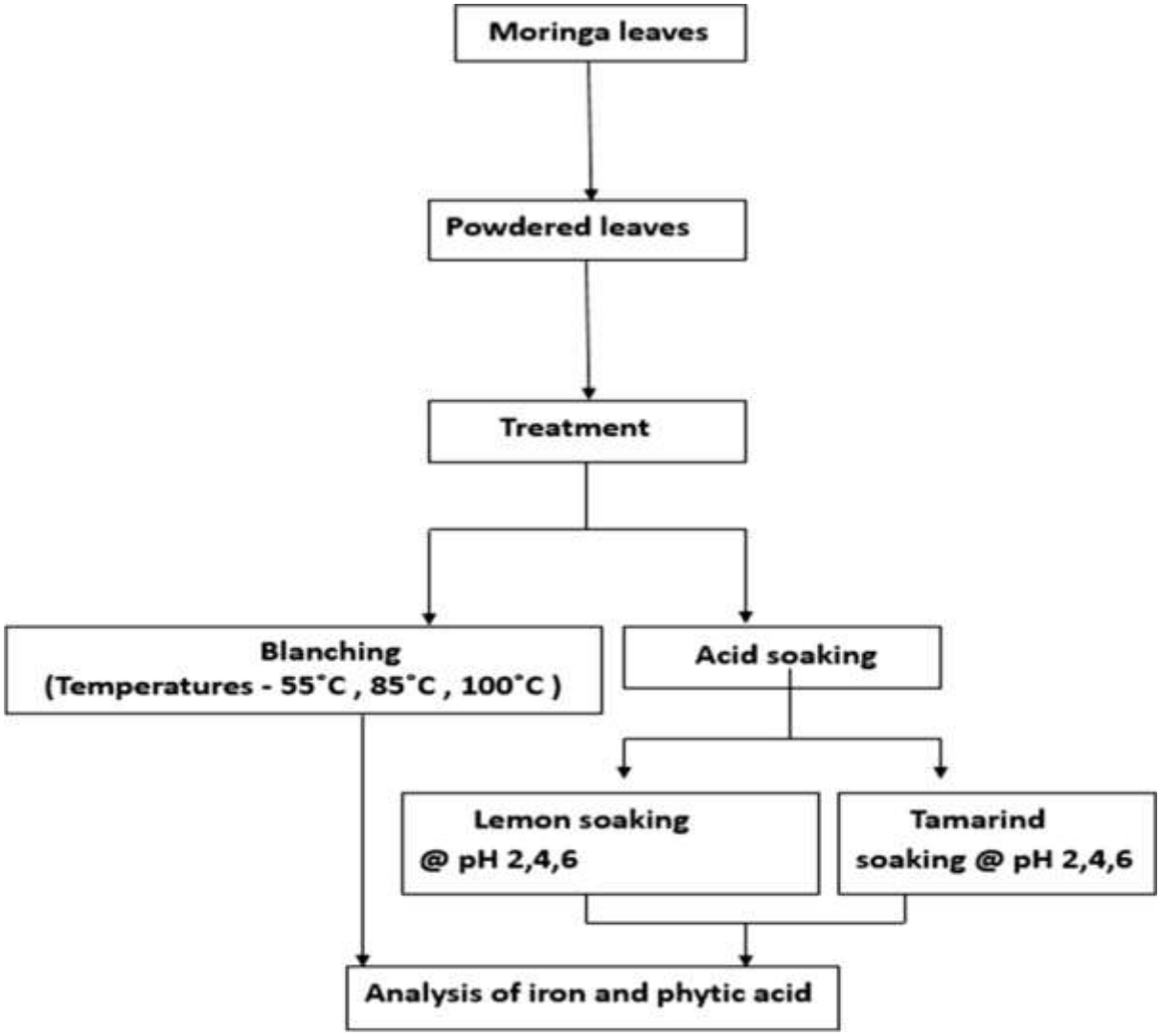
Antimicrobial
- Antiinfammatory
- Antioxidant
- Anti-diabetic
- Anticancer

5.4.Therapeutic Uses :

- Treatment of iron deficiency
- Treating anemia and sickle cell disease
- Reducing high blood pressure
- Treating edema
- Protecting the liver

6. Iron extraction method :-

To extract iron from moringa, one common method involves preparing a moringa extract and then potentiallyusing it in a green synthesis process to create iron nanoparticles. First, moringa leaves are dried and ground into powder. This powder is then mixed with water and heated, creating an xtract. This extract can be used in various ways, including to create iron anoparticles by reactinq it with iron salts.


Moringa leaves
Powdered leaves
Treatment
Blanching
(Temperatures - 55˚C , 85˚C , 100˚C)
Acid soaking
Lemon soaking
@ pH 2,4,6
Tamarind
soaking @ pH 2,4,6
Analysis of iron and phytic acid

Result and Discussion

Moringa oleifera has been extensively studied as a natural nutritional intervention for anemia due to its rich iron content, presence of vitamin c (which aids iron absorption), and, high bioavailability of micronutrients, several trials indicate that regular supplementation with moringa oleifera (in the form of leaf power, capsule, or juice) improve hemoglobin levels, reduces the severity of anemia, and enhance overall iron status significantly, especially in women of reproductive age, children, and adolescents.

Conclusion

Iron Deficiency Anemia (IDA) remains the most prevalent nutritional disorder worldwide, affecting billions of people, particularly in low- and middle-income countries. As a condition characterized by reduced hemoglobin levels due to insufficient iron availability, IDA has profound health and socioeconomic consequences. It significantly impairs cognitive function, physical performance, immune response, and maternal and child health, contributing to increased morbidity and economic losses. The etiology of IDA is multifaceted, with dietary insufficiencies, chronic blood loss, malabsorption disorders, and increased physiological demands being the primary contributing factors.

Ultimately, addressing IDA requires a multifaceted approach that includes improving nutritional awareness, enhancing healthcare accessibility, and developing effective iron delivery systems. Strengthening policies on food fortification, expanding screening programs for high-risk populations, and integrating IDA management into primary healthcare frameworks will be key to reducing the prevalence of this preventable condition. As research continues to explore innovative therapies, a concerted effort from policymakers, healthcare professionals, and researchers is necessary to ensure sustainable and accessible solutions for IDA prevention and treatment worldwide.

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