FICCI

IRON DEFICIENCY ANEMIA IN WOMEN AND CHILDREN



A WHITE PAPER

Message from Chairman, Task Force Malnutrition Eradication, Government of Maharashtra

सत्यमेव जयते

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Iron Deficiency Anemia (IDA) continues to be a widespread public health concern in India, affecting individuals across all age groups—women, men, adolescent girls and boys, pregnant women, and pre-school children. Despite its prevalence, the approach to addressing IDA remains largely casual and insufficient. Recent data reveals that 67.1% of children and 51.1% of adolescent girls suffer from IDA.

This condition is linked to numerous health issues and is deeply intertwined with malnutrition. Poor dietary intake of iron-rich foods and inadequate absorption of iron supplements significantly increase the risk of anemia. Moreover, many individuals are reluctant to take iron supplements in the form of tablets or syrups due to side effects such as constipation and gastrointestinal discomfort.

These challenges underscore the multi factorial nature of IDA. One critical aspect often overlooked is iron deficiency in adolescent girls, particularly during puberty. If left unaddressed, it can persist into pregnancy, contributing to premature births and further exacerbating malnutrition.

The white paper presents key insights and recommendations that can support enhanced governmental responses and targeted efforts to combat Iron Deficiency Anemia more effectively.

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MESSAGE

I am delighted to present this white paper, which highlights the potential for industry-led interventions and reaffirms our collective commitment to advancing nutrition through science, innovation, and policy. Nutrition is the foundation of a healthy and productive society, and addressing deficiencies, particularly anemia in women and children, continues to be a national priority.

In this context, food fortification has emerged as one of the most effective and sustainable strategies to combat micronutrient deficiencies, especially iron deficiency anemia, which affects a significant portion of our population. Tackling any persistent gap requires a coordinated, multi-sectoral approach, one that brings together government leadership, private sector innovation, and scientific rigor.

FICCI commends the Government of India and the Food Safety and Standards Authority of India (FSSAI) for their proactive policies, including the Fortification Regulation, which sets clear standards for iron, folic acid, and other essential micronutrients in staples. Initiatives such as the +F logo have also been pivotal in enhancing consumer awareness and enabling informed choices.

Be it fortifying staples such as wheat flour, rice, and edible oil or contributing to last-mile delivery through corporate social responsibility and public-private partnerships, the efforts of the food industry and scientific community are admirable.

The industry has been working tirelessly towards reformulation, innovation, and offering a diverse range of nutritious foods including prebiotics and dietary fibres that enhance iron absorption and cater to evolving consumer needs.

We firmly believe that the food industry is not just a participant, but a key enabler in India's journey to eradicate anemia. Besides, emphasizing on dietary diversity by including iron-rich foods can sustainably improve the overall nutrition status of India.

As we release this white paper, I am confident that it will serve as a valuable resource, bringing together insights and recommendations that will inspire stakeholders across sectors to strengthen their role in India's nutrition journey. Moving forward, FICCI stands committed to facilitating dialogue and action among stakeholders to ensure that good nutrition becomes a reality for every Indian.

Jyoti Vij
Director General
FICCI

Message From National President of Indian Association of Parenteral and Enteral Nutrition (IAPEN)



MR. SHIVSHANKAR TIMMANPYATI

National President, IAPEN

IAPEN INDIA ASSOCIATION
For
Parenteral and Enteral Nutrition

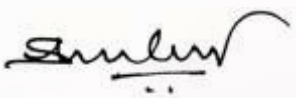
Iron Deficiency Anemia (IDA) is more than a medical concern-it is a nutrition challenge rooted in diets, food systems, and social practices.

For decades, our country has grappled with the paradox of being a food-secure nation while still carrying one of the world's heaviest burdens of anemia, particularly among women and children.

This advocacy paper is timely, as it connects evidence with actionable pathways-ranging from fortification and supplementation to dietary diversification and behavior change. The emphasis on integrating nutrition education with community-based programs reflects a shift from treatment to prevention.

As nutrition professionals, we recognize that solutions must go beyond iron tablets and fortified foods. Creating awareness about enhancers of absorption like vitamin C, prebiotics and culturally rooted practices such as fermentation and dietary diversification, can drive sustainable impact. Collaboration across government, academia, industry, and communities will be essential to turn this vision into reality.

This document will serve as a guide not only for policymakers but also for frontline nutrition workers and educators striving for an anemia-free India.



Mr. Shivshankar Timmanpyati

Meet the Authors



Dr. Raj Bhandari

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A renowned expert in pediatrics, public health and nutrition with over forty years of experience spanning clinical care, policy, and advocacy. He received training in health communication at Johns Hopkins University, Baltimore, USA. As a technical advisor to national and state governments in India and a leader in advocacy campaign with Annapoorna Trust, People to People Health Foundation and The Breakfast Revolution, he has played a pivotal role in shaping health and nutrition programs nationwide.

He is currently Senior Advisor NCEL, National Coop Export Ltd under aegis of Min of Cooperation, GoI. He is also the chairperson of DSMB project at ICMR - NIN. Dr. Bhandari has held prominent consultancy positions with UN agencies, contributed significantly to research and publications on child health and nutrition.

He has earned multiple accolades, including the Lifetime Achievement Award from the Indian Institute of Millets Research. His dedication to improving health outcomes for mothers and children continues to influence policy and inspire professionals in the field.



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Former Director of NIN, ICMR Hyderabad. With over 30 years of research experience in Nutrition, Food Safety, and Toxicology, he has made significant contributions to the field, including over 150 publications and chapters in four books. He has developed guidelines for probiotics in foods, GM food safety, biosimilar drugs, recommended dietary allowances, and dietary guidelines.

Serving as the Director of ICMR NIN from 2006 to 2012, He has also been a member and chairman of the Review Committee on Genetic Manipulations (RCGM) and a member of the Genetic Engineering Appraisal Committee (GEAC). He is a Fellow of the National Academy of Medical Sciences, the International Medical Scientists Academy, and the AP & Telangana Academies of Science.

He has held positions as the Past President of the Nutrition Society of India, Public Trustee of ILSI India, Chairman Knowledge center for functional foods, immunity and Gut health (KFFIG) of ILSI India. He is a member of the Governing Body of Nutrition Foundation India and the Scientific Advisory Committee of the Gut Microbiota and Probiotic Science Foundation

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Dr. Khadilkar is a member of several prestigious committees, including the International Childhood Vascular Function Evaluation Consortium and the International Child Waist Circumference References Establishment Consortium. She serves on the Local Research Advisory Committee at ICMR-National Institute for Research in Reproductive and Child Health, Mumbai and Dahanu. Additionally, she has guided 26+ PhD students



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A senior nutritionist & consultant , and former Professor at the University of Delhi's Institute of Home Economics with over 35 years of teaching and research experience. She has received several fellowships including the Australian Awards Fellowship, CCGHR fellowship, to undertake specialized training abroad.

She has been conferred the Nutrition Leadership Excellence Award by NIFTEM and Min. of Food Processing in 2022 and the Rajammal P Devadas Memorial Award 2020 by Nutrition Society of India for her outstanding contribution in applied nutrition.

Dr. Puri has guided over 50 MSc and PhD students and conducted numerous research projects, funded by national/international agencies like WHO, UNICEF, World Bank, ICMR, DST. She has more than 120 publications in journals, books and over 4000 citations and has several books to her credit. She has undertaken short term consultancy assignments for the UN WFP, WHO and UNICEF. She has extensive experience in conducting nutrition related clinical and implementation research and consultancy for CSR projects, nutrition strategy, food environments and regulations with NGOs and food industries.

Dr Puri has been a Member of Several National/International Committees, PRGs/Scientific Panels at FSSAI, ICMR, NDDB etc. She is also a member of several professional bodies including SAIFRN, IDF, NSI and IDA. She was Vice President of IDA, EC Member of NSI and India's representative on AFDA

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Currently, the Dean & Principal at Geetanjali Institute of Medical Sciences, Jaipur. He has been a Senior Professor and Head of the Department of Paediatric Medicine, as well as the Incharge of the Rare Disease Clinic at Sir Padampat Institute of Neonatal & Paediatric Health (JK Lone Hospital), SMS Medical College, Jaipur. He also serves as the Executive Director of the International Neonatology Association in Geneva and the past Chairperson of the Technical Committee on Rare Diseases for the Government of Rajasthan.

Dr. Gupta has held prestigious positions, including being on the Board of the International Paediatric Association and serving as the President of the International Society of Tropical Paediatrics. He has contributed to various editorial boards, including the Journal of Tropical Paediatrics (Oxford University Press) and the Indian Paediatrics and the Indian Journal of Practical Paediatrics. Dr. Gupta has received numerous fellowships and authored several books on rare diseases in pediatrics and pediatric neurology in the tropics.

He has also contributed to global publications and holds a patent for newborn care equipment. With extensive teaching experience, he has been an examiner for various universities and the National Board of Examination for D.N.B. exams.

Executive Summary

Burden and Impact: IDA affects approximately 1.8 billion people globally, with India contributing nearly a quarter of the cases. Vulnerable populations, including children and women of reproductive age, face significant health risks, such as cognitive impairments, adverse pregnancy outcomes, and economic losses estimated at 1.3% of India's GDP.

Prevalence and Contributing Factors: Recent data from NFHS-5 indicate a rising prevalence of anemia, particularly among children and adolescents. Key contributors include poor dietary iron intake, low bioavailability of non-heme iron, parasitic infections, and socioeconomic barriers such as poverty and lack of awareness.

Screening and Diagnosis: Early detection is critical for high-risk groups. While venous blood sampling remains the gold standard, non-invasive tools like hemoglobin color scales and pulse CO-oximetry are being explored for large-scale screening. Advances such as HemoCue Hb-801 and AnemiaPhone improve diagnostic accessibility.

Management Strategies: Government programs like AMB, WIFS, and NIPI aim to combat IDA through iron supplementation and nutrition interventions. Successful state-level initiatives, including Odisha's Mamata scheme, highlight the need for integrated strategies combining supplementation, dietary diversification, and deworming to enhance iron absorption.

Role of Healthcare Professionals: A multi-sectoral approach involving healthcare providers, policymakers, NGOs, and digital awareness campaigns is essential for effective IDA management. Strengthening supply chains, improving adherence through behavioral interventions, and leveraging technology can enhance program effectiveness.

Future Directions: Research should focus on optimizing iron supplementation, improving gut health, and addressing functional iron deficiency. Collaboration between healthcare professionals, researchers, and policymakers is crucial to develop context-specific interventions, improving screening, and ensure sustainable reductions in IDA prevalence.

Abbreviations

AMB	Anemia Mukt Bharat
ANN	Artificial Neural Network
CNNS	Comprehensive National Nutrition
DALYs	Survey Disability-adjusted life years
FOS	Fructooligosaccharides
FSSAI	Food Safety and Standards Authority of India
GDP	Gross Domestic Product
Hb	Hemoglobin
IAP	Indian Academy of Pediatrics
IDA	Iron Deficiency anemia
IFA	Iron and Folic Acid
I-NIPI-L	Intensified National Iron Plus Initiative – Logistics
IUD	Intrauterine Devices
IV	Intravenous
NFHS	National Family Health Survey
NGOs	Non-Governmental Organization
NIPI	National Iron Plus Initiative
NNACP	National Nutritional anemia Control Programme
NNAPP	National Nutritional anemia Prophylaxis Programme
NRHM	National Rural Health Mission
PEM	Protein-Energy Malnutrition
PDS	Public Distribution System
POC	Point of Care
SDGs	Sustainable Development Goals
TB	Tuberculosis
WHO	World Health Organization
WIFS	Weekly Iron and Folic Acid Supplementation

1. Burden of Iron Deficiency Anemia (IDA)

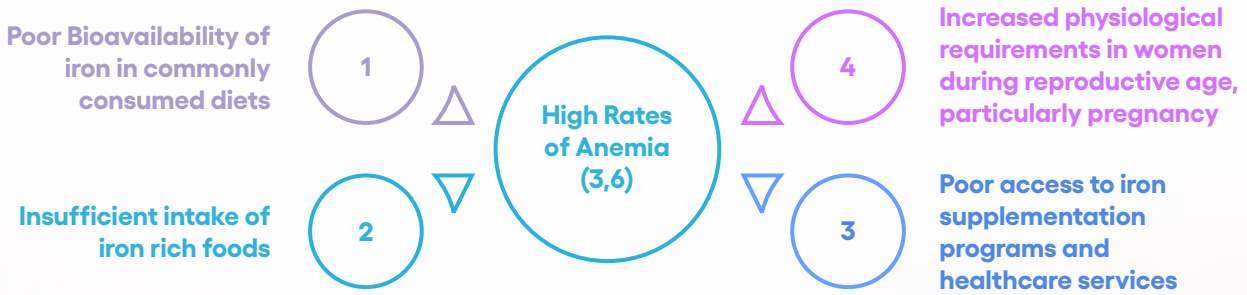
Iron Deficiency Anemia (IDA) is the most common nutritional disorder worldwide, affecting approximately

1.8 billion people, with developing nations experiencing the highest burden (1). With an estimated 447 million persons with anemia, India contributes to almost one quarter to the global burden (2).

In India, IDA is particularly prevalent among vulnerable groups such as children under five and women in adolescent and reproductive ages (3). Preconception anemia is a significant health issue, with 36.7% of women of reproductive age found to be anemic (hemoglobin (Hb) <12 g/dL) (4). Intergenerational anemia poses further challenges, as children of anemic mothers have a 26% point higher likelihood of being anemic, demonstrating the impact of poor health across generations. Additionally, anemia is prevalent among children, with approximately 67% of those under five affected, highlighting the widespread impact on young populations (5). National surveys indicate that a significant percentage of these groups suffer from anemia, highlighting the ongoing public health challenge (6). Understanding the prevalence, risk factors, and causes of IDA in India is crucial for developing effective interventions (3).

Addressing IDA in India may require a multi-faceted approach, including research, public health interventions, and tackling socio-economic factors to reduce the burden on vulnerable groups (3,6).

Several Factors Contributing to the High Rates of Anemia

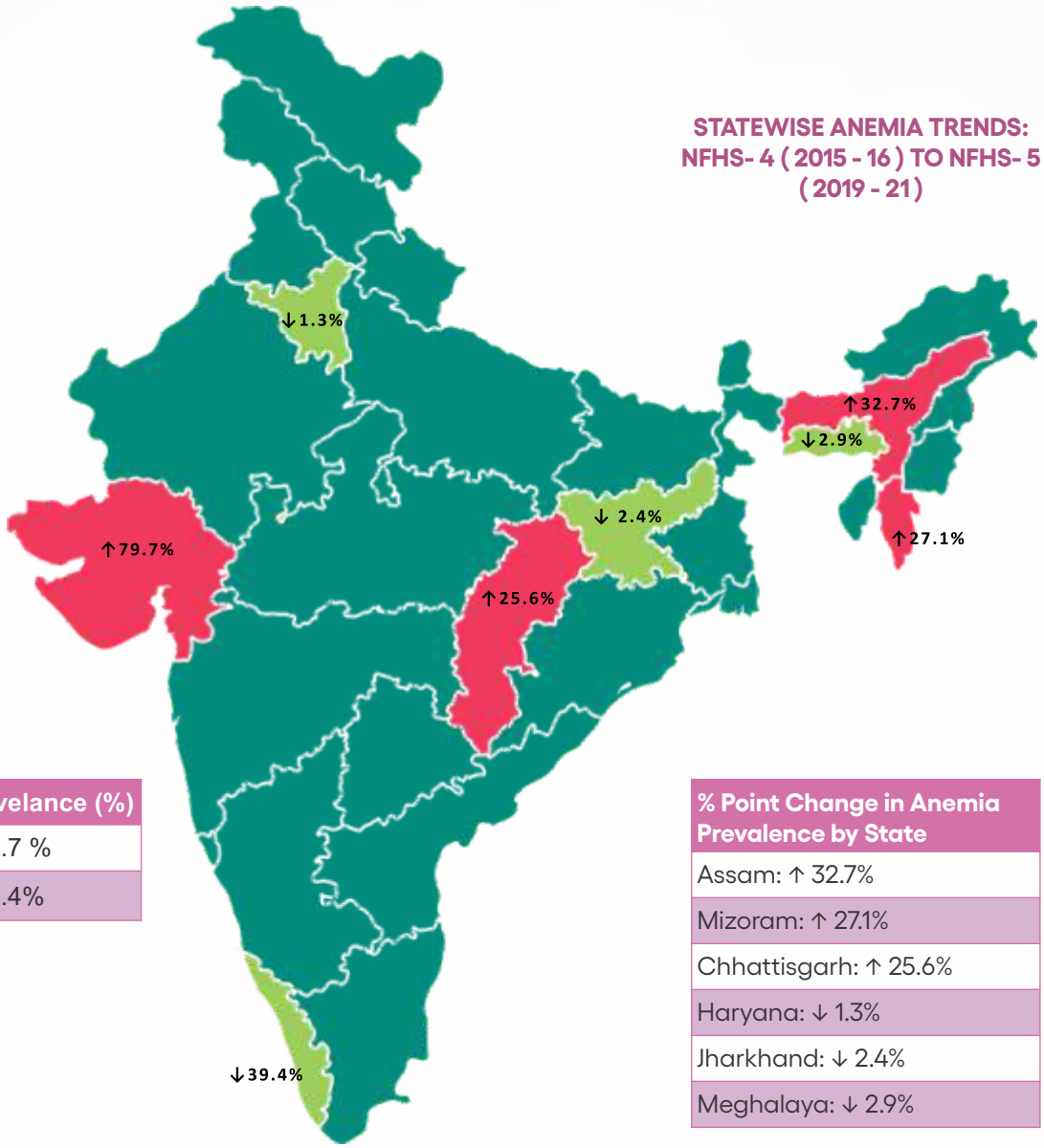


Maternal iron deficiency also contributes to socioemotional challenges in children through non-responsive caregiving (7). In pregnancy, IDA affects maternal and fetal outcomes, including preterm delivery, low birth weight, and infant mortality, with uncertain effects on reversing long-term cognitive consequences. Infants born to mothers with IDA face delayed development due to disrupted brain myelination (8). IDA during early childhood has significant impacts on cognitive, socioemotional, and motor development. Childhood IDA is linked to lasting cognitive deficits, including impaired memory and attention (7). The estimated yearly costs of IDA in 6–59-month-old children amount to intangible costs of 8.3 m Disability-adjusted life years (DALYs) and production losses of ₹2.098 trillion INR which equals to 1.3% of India's gross domestic product (9). These findings highlight the need for early interventions combining nutritional supplementation and psychosocial support to mitigate IDA's developmental impact.

2. Prevalence of Iron Deficiency Anemia

IDA is a critical public health issue in India, persisting across various demographic groups, particularly among vulnerable populations. The prevalence of anemia has notably increased over recent years, underscoring the urgency of addressing this issue to meet the Sustainable Development Goals (SDG), particularly those related to health (SDG 3). The most recent data from the National Family Health Surveys (NFHS-5) highlights a concerning upward trend in anemia prevalence (10).

State-wise Prevalence:



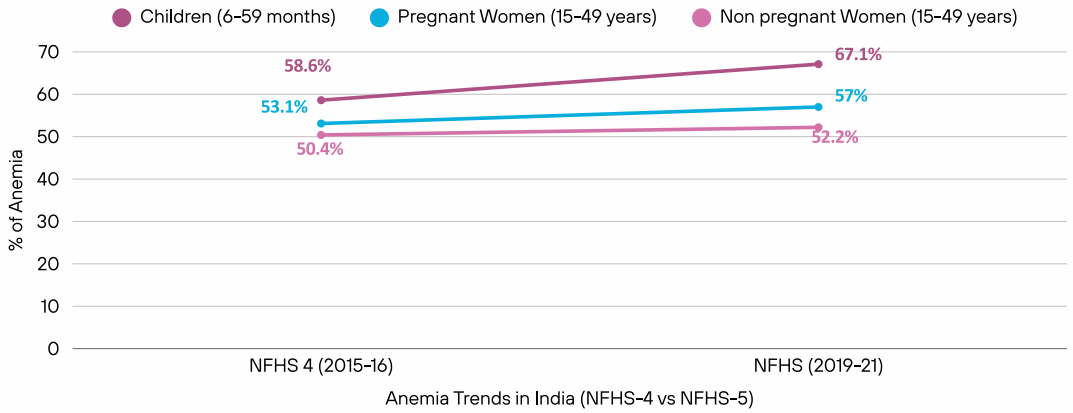
State	Prevelance (%)
Gujarat	↑ 79.7 %
Kerala	↓ 39.4%

% Point Change in Anemia Prevalence by State
Assam: ↑ 32.7%
Mizoram: ↑ 27.1%
Chhattisgarh: ↑ 25.6%
Haryana: ↓ 1.3%
Jharkhand: ↓ 2.4%
Meghalaya: ↓ 2.9%

Basis the NFHS 5 report, Gujarat has noted the highest prevalence (79.7%) while Kerala reported the lowest prevalence (39.4%) with a lower rate of 32% women affected with anemia, likely due to better healthcare infrastructure and nutrition programs (8).

2.1 Prevalence among Vulnerable Population

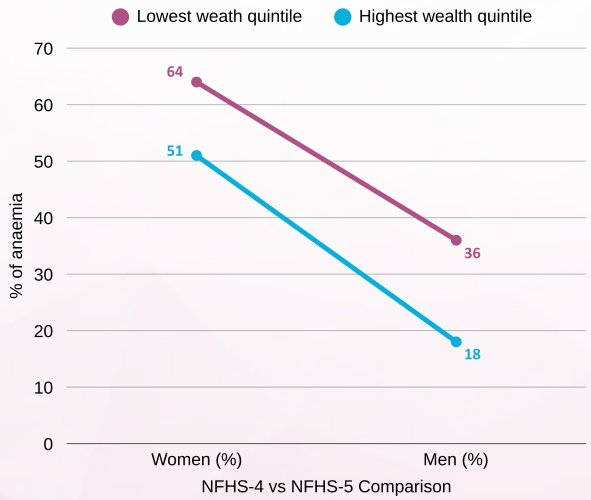
Among children, the statistics are particularly worrying, with 9% increase in anemia noted in children from NFHS 4 to 5.



Group	Children (6-59 months)	Non pregnant before women (15-49years)	Pregnant women (15-49 years)
NFHS 4 (2015-16)	58.6%	53.1%	50.4%
NFHS 5 (2019-21)	67.1%	57%	52.2%
Percent change	Increase by 8.5%	Increase by 3.9%	Increase by 1.8%

Figure 1: Prevalence of Anemia across different age and gender groups

According to the Comprehensive National Nutrition Survey (CNNS) 2016-18, the prevalence of anemia among pre-schoolers (aged 1–4 years) is 41%. Of these, 22% had mild anemia, 18% had moderate anemia, and 1% had severe anemia, indicating widespread iron deficiency during a critical phase of early development. The prevalence of iron deficiency, indicated by low serum ferritin levels, was found to be 32% among pre-school children, 17% among school-age children, and 22% among adolescents. Notably, female adolescents had a significantly higher prevalence of iron deficiency at 31%, compared to 12% in male adolescents (2).



Group	Lowest Wealth Quintile	Highest Wealth Quintile
Women (%)	64%	51%
Men (%)	36%	18%

Figure 2: Prevalence of anemia across urban and rural populations and across wealth quintiles

The graph highlights a clear socioeconomic disparity in anemia prevalence among Indian men and women, as reported in NFHS-4 and NFHS-5 comparisons. Women in the lowest wealth quintile exhibit the highest burden of anemia at 64%, while those in the highest wealth quintile show a significantly lower prevalence at 51%. Similarly, among men, anemia is present in 36% of individuals in the lowest wealth group, compared to just 18% in the highest wealth group. These findings indicate that wealth status is a significant determinant of anemia, with poorer populations, especially women, bearing a disproportionately high burden.

A parallel upward trend was noted in both urban and rural population over the last few years (Figure 2). The rising prevalence of IDA presents a significant public health challenge in India, with profound implications for maternal and child health, workforce productivity, and economic development. Tailored interventions addressing social, economic, and geographic disparities are critical to reversing these trends and achieving long-term improvements in public health outcomes.

3. Causes of Iron Deficiency Anemia in India

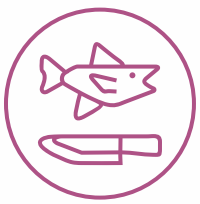
IDA can be caused by several causes which can broadly be divided into 3 types: nutritional, non-nutritional causes and social causes.

3.1 Nutritional Causes

Nutritional deficiencies and lack of dietary diversity, particularly of iron, are a significant factor contributing to the high prevalence of IDA in India (11). Moreover, iron losses due to pregnancy menstruation, significantly increase iron requirements, particularly in women of reproductive age (11).

Iron deficiency is also exacerbated by poor dietary intake of other multinutrients like folate, protein and vitamin B12, which are essential for effective erythropoiesis (12).

The Primary Sources of Dietary Iron Includes



Heme Iron
from animal-based foods such as meat, poultry, and fish



Non-Heme Iron
from plant-based foods such as legumes, millets and grains, and vegetables like green leafy vegetables

The higher predisposition to iron deficiency in diets is largely due to the low bioavailability (approximately only 10%) of non-heme iron. Adolescents, especially in resource-limited areas, continue to have low dietary intake of iron-rich foods, as many families rely heavily on cereal-based staple diets (13). A recent review article examined seven studies, five of which reported a higher prevalence of IDA among vegetarians (with diets prevalent in non-heme iron) compared to non-vegetarians (14).

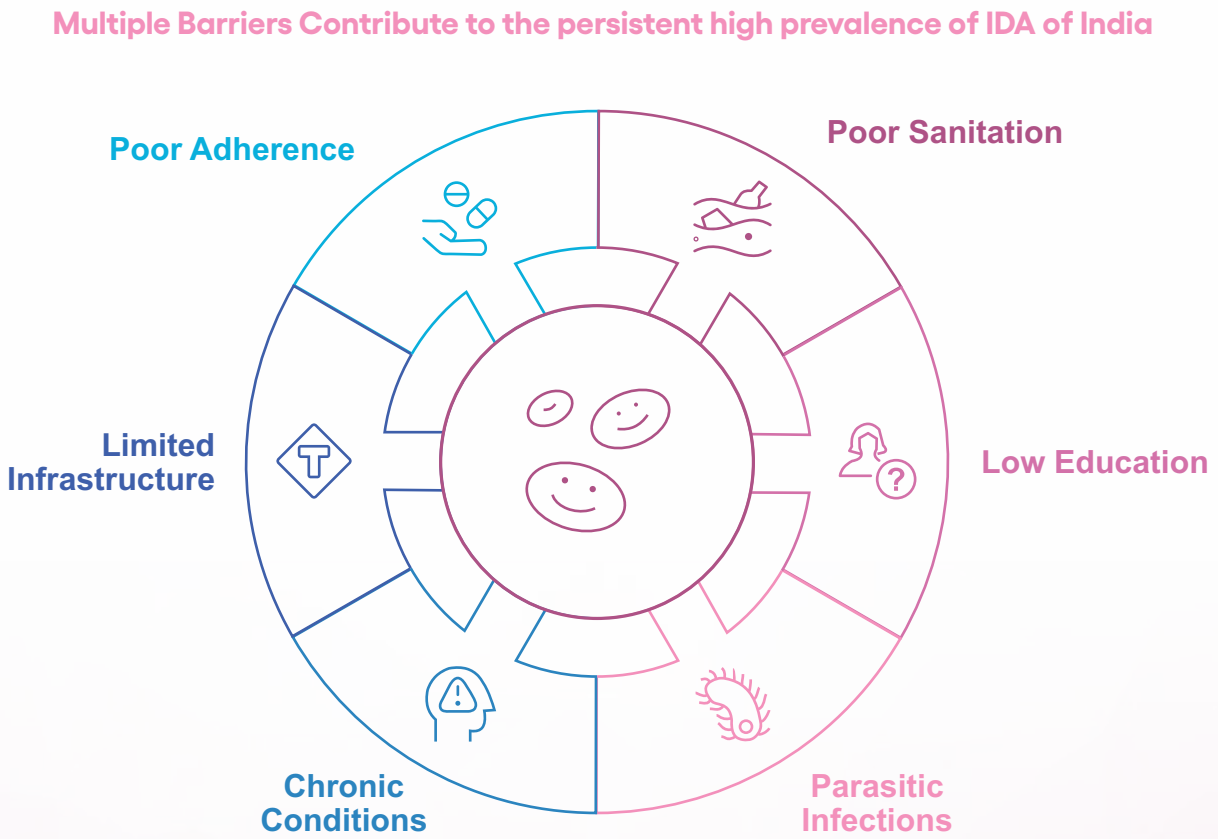
India faces further challenges due to dietary inhibitors such as phytates, polyphenols, and calcium present in staple foods like cereals, legumes, and tea, all of which reduce iron absorption (15).

Additionally, the presence of protein-energy malnutrition (PEM) can worsen iron absorption, further increasing the risk of iron deficiency.

Iron supplementation efforts are hindered by issues related to gastrointestinal side effects and the need for consistent adherence to long-term supplementation (16). Role of enhancers to increase iron absorption is further discussed in section 5.3.

3.2 Non-nutritional Causes

Multiple barriers contribute to the persistent high prevalence of IDA in India (15).

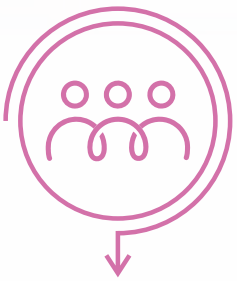


1. 1.Poor sanitation can lead to environmental enteropathy which causes micronutrient deficiencies in children as a result of gut inflammation and increased permeability. Chronic infections and inflammation associated with this condition contribute to anemia, ranging from mild to severe (17).
2. 2.Level of education was positively corelated with anemia prevalence, as over 62% of uneducated women are anemic, while the rate drops to below 50% among those with higher education levels. Addressing IDA in these high-risk groups requires targeted interventions focusing on improving access to healthcare, nutrition, and education (18).

3. 3.Parasitic infections like hookworm and malaria cause blood loss and impair iron absorption, exacerbating iron deficiency (11).
4. 4.Chronic conditions in adults, such as inflammatory bowel disease, and gastrointestinal disorders, including celiac disease, also hinder iron absorption (12,16).
5. 5.Limited infrastructure for screening and distributing iron supplements or fortified foods (12,16).
6. 6.Where iron supplementation is available, the challenge lies in driving behavioral change, as poor adherence to iron supplements leads to significant underutilization of both resources and potential health benefits (19).

Key issues in the IFA supply chain under the Anemia Mukt Bharat program were highlighted as inadequate forecasting, inventory management, and distribution. It found uneven availability of IFA supplements across districts (20).

3.3 Social Causes



Socioeconomic Factors

such as poverty and food Insecurity, limit access to iron-rich foods, especially bioavailable heme iron from animal products



Lack of Awareness

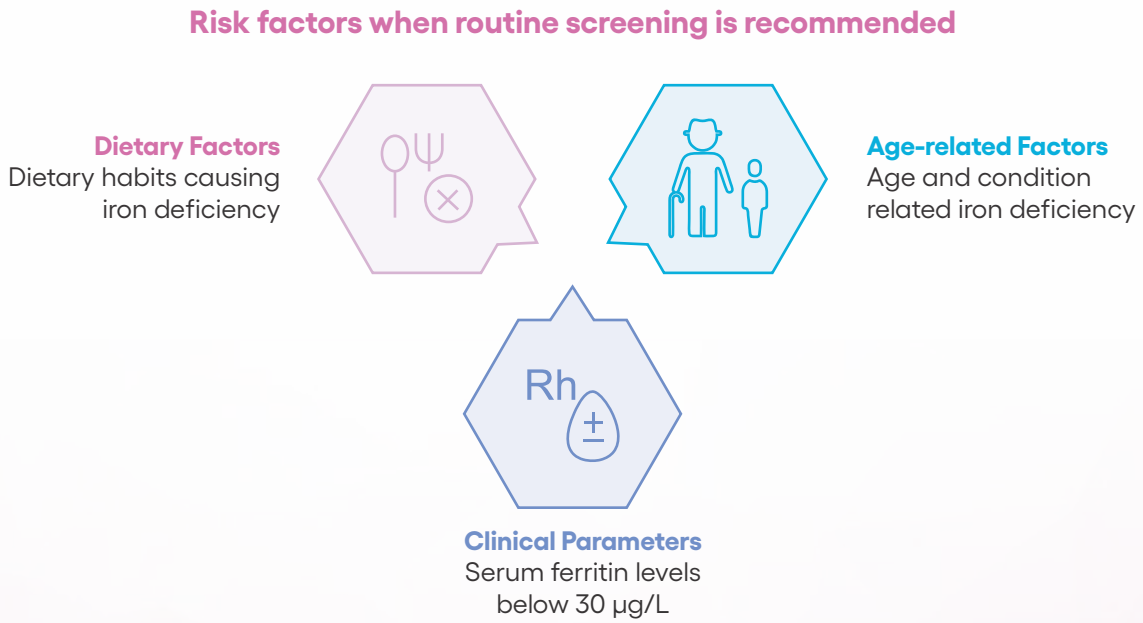
about iron-rich diets and delayed health-seeking behavior contribute to late diagnosis and treatment

4. Screening and Diagnosis

Screening and diagnosis play a pivotal role in combating iron deficiency anemia (IDA), particularly in vulnerable populations. Early detection helps prevent the progression to severe anemia, ensuring timely and targeted interventions. Invasive screening methods remain a cornerstone for reliable diagnosis, particularly in high-risk groups, by providing precise assessments of iron status.

4.1 Invasive

The Asian Expert Consensus on prevention and management of IDA in women highlights the importance of early screening for iron deficiency in high-risk groups, such as pregnant and non-pregnant adult women, adolescent girls, and perimenopausal women. These populations are particularly vulnerable due to increased iron demands, chronic blood loss, or poor dietary intake. The Asian Expert Consensus emphasizes the importance of assessing baseline iron status alongside dietary factors that influence iron absorption. The goal is to identify and monitor iron deficiency early to prevent progression to more severe anemia, particularly in regions where iron deficiency is prevalent (21). National Surveys including NFHS 5 and CNNS (2016-2018) used invasive diagnostic methods for determination of anemia. While NFHS 5 used capillary sampling at point-of-care, CNNS collected venous blood samples.



Advantages of Invasive Screening

Venous blood, which provides a more stable and uncontaminated sample, should remain the gold standard for accurate anemia diagnosis As shown by Boghani et al. (2017), haemoglobin measurements from venous blood using HemoCue showed strong overall agreement with the reference Coulter Counter method, while capillary samples demonstrated weaker correlations. anemia detection sensitivity was consistently higher with venous samples compared to capillary samples in both toddlers and pregnant women. Notably, over 40% of capillary–venous HemoCue pairs showed clinically relevant discrepancies, underscoring the superior accuracy and reliability of venous sampling across populations (22). Table 1 summarizes the different screening methods for anemia.

Challenges in Invasive Screening

Use of capillary blood samples, may produce inaccurate hemoglobin levels due to contamination by interstitial fluid and hemolysis (23). Studies indicate that capillary blood testing, while convenient, should be supported by confirmatory venous sampling to ensure accuracy in diagnosis (22).





Table 1: Different screening methods available for anemia

Method	Pros	Cons
Capillary Sampling (Point-of- Care)	Quick and convenient for use in point-of-care settings.	May lack precision, leading to unreliable results. Can be less accurate, especially in resource-limited settings.
Venous Blood Sampling	Generally more accurate and reliable. Suitable for comprehensive and precise testing.	Requires trained personnel. Needs proper infrastructure, which can be difficult to maintain in low-resource settings.

A community-based venous blood survey across eight Indian states concluded that anemia prevalence based on venous blood was lower than previous estimates from capillary blood, with IDA not being the primary cause of anemia, suggesting that other factors play a significant role (24). These findings have implications for anemia prevention strategies. Large-scale national surveys (e.g., NFHS 5 and CNNS) highlight disparities in results due to differences in blood sampling methods used, underlining the need for standardized approaches (5).

Latest Advances in Invasive Diagnostic Tools

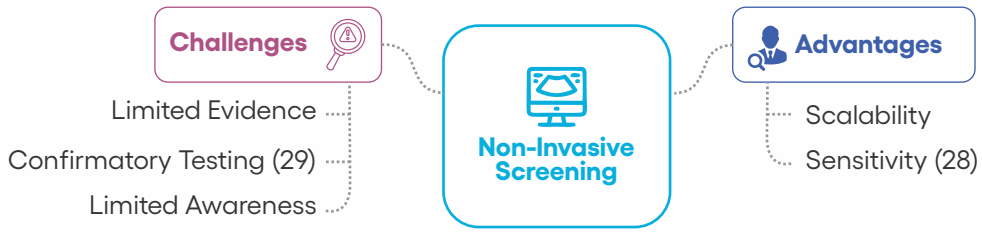
Devices such as the HemoCue Hb-801, which provides more accurate hemoglobin measurements than other portable systems, have shown promise (22). Additionally, by integrating advanced tools, healthcare systems can reduce diagnostic errors and improve early detection in both individual and mass screening contexts (25).

4.2 Non-invasive

Non-invasive methods for screening and diagnosis are increasingly favoured due to their convenience and reduced discomfort for patients. Tools such as hemoglobin color scales and non-invasive hemoglobin measuring devices, like pulse CO-oximetry, allow for rapid assessment without the need for blood samples.

Noninvasive hemoglobin testing with SpO2 (SpHb) provides similar accuracy as invasive point-of-care hemoglobin testing and may enable more efficient and effective patient care. It was found that instruments such as the Massimo spot check pulse CO-oximeter provided accurate noninvasive hemoglobin measurements in trauma patients, with strong correlation to invasive tests, 76% accuracy, and 95.4% sensitivity, making it a clinically useful tool for immediate Hgb assessment (26,27).

Non-invasive Screening: Advantages and Challenges



Latest advances in Non-Invasive Diagnostic Tools

Comparison of Anemia Screening Technologies

Characteristic	Transcutaneous Reflectance Spectroscopy (30)	Non-invasive Spectrophotometry (30)	AnemiaPhone (31)	Portable Point-of-Care Devices
Method	Light absorption analysis	Light absorption analysis	Finger-stick blood test	Measures iron biomarkers
Invasiveness	Non-invasive	Non-invasive	Minimally invasive	Non-invasive
Advantages	Hemoglobin level assessment	Avoids contamination	Rapid and affordable	Enhanced access
Potential	Early screening	Early screening	Point-of-need screening	Early screening

Non-invasive technologies show promise in terms of significant potential for early screening with regards to accuracy and reproducibility, potentially expanding their role in routine screening (32).

5. Management of Iron Deficiency Anemia

Effective management of IDA requires a multifaceted approach that includes identifying and addressing underlying causes, correcting iron deficiency through supplementation or dietary strategies, fortification and ensuring long-term adherence and follow-up.

5.1 Government Initiatives to combat IDA and Success Stories

The National Nutritional anemia Prophylaxis Programme (NNAPP), initiated in 1970, laid foundation of anemia control in India with its key learnings of broadening target groups that was adopted in National Nutritional anemia Control Programme (NNACP) launched in 1991 with increased dosage for pregnant women (28,33).

The Weekly Iron and Folic Acid Supplementation (WIFS) Programme and the National Iron Plus Initiative (NIPI) addressed gaps by focusing specifically on adolescents and young children, with weekly and syrup- based dosing for better adherence. More recently, the innovative approach of fortifying staples like rice and wheat with iron through the Public Distribution System (PDS) has further extended the reach of anemia interventions, though scaling and increasing public awareness will be critical to maximizing the impact (28, 32-35).

Table 2: Government Initiatives and Future Scope to Combat Anemia: (A Comparative Table)

Sno.	Government Initiative	Year	Beneficiaries	Intervention/ Dose	Key Achievements	Current Potential
1	National Nutritional anemia Prophylaxis Programme (NNAPP) (33,36)	1970	Children (1–5 years), Pregnant women, Lactating women, Intrauterine Device (IUD) acceptors	Children: 20 mg iron + 100 mcg folic acid daily; Pregnant women/IUD acceptors: 60 mg iron + 500 mcg folic acid	One of the pioneering national programs targeting anemia. Established iron and folic acid supplementatio n as essential interventions for vulnerable groups.	Potential to broaden the target group, especially to include adolescents and non-pregnant women. Strengthening supply chains and enhancing monitoring systems could further boost program effectiveness
2	National Nutritional anemia Control Programme (NNACP) (32,36)	1991	Children (1–5 years), Pregnant women, Lactating women, Intrauterine Device (IUD) acceptors	Children: 20 mg iron + 100 mcg folic acid; Pregnant women/IUD acceptors: 100 mg iron + 500 mcg folic acid	Successfully increased iron dosage for pregnant women. Continued focus on children and pregnant women, ensuring continuity from previous programs.	Room for improved health education on long-term dietary habits. Enhanced collaboration between the health, education, and agriculture sectors could lead to more integrated program outcomes.

Sno.	Government Initiative	Year	Beneficiaries	Intervention/ Dose	Key Achievements	Current Potential
3	Weekly Iron and Folic Acid Supplementatio n (WIFS) Programme (28,36)	2012	School-going adolescents (10–19 years), Out-of-school girls (10–19 years)	100 mg iron + 500 mcg folic acid weekly	Focused specifically on adolescents, filling an important gap. Weekly dosing reduced the daily burden for participants. Included dose monitoring to ensure adherence and effectiveness. Created awareness about food choices to enhance iron absorption.	Adherence could be improved by addressing potential side effects and raising awareness. Expanding reach to include out-of-school adolescents and addressing cultural barriers may further enhance the program's impact.
4	National Iron Plus Initiative (NIPI) (33,36)	2013	Children (6–59 months), Adolescents (10–19 years), Women (pregnant and lactating), Children (5–9 years)	Children (6–59 months): 1 ml Iron and Folic Acid (IFA) syrup (20 mg iron + 100 mcg folic acid) + age appropriate deworming with albendezole; Pregnant women: 100 mg iron + 500 mcg folic acid	Expanded coverage across more age groups, addressing both early childhood and adolescence. Syrup-based intervention for children ensured appropriate dosing.	Ensuring consistent coverage across all stages of life could enhance continuity of care. Strengthening supply chains and providing further training to healthcare workers can support better program delivery and counseling.
5	Anemia Mukt Bharat (Anemia Free India) (34,36)	2018	Children (6–59 months), Adolescents (10–19 years), Women (pregnant and lactating), Children (5–9 years)	1 ml Iron and Folic Acid (IFA) syrup (20 mg iron + 100 mcg folic acid) for children; 60 mg iron + 500 mcg folic acid for adolescents and women	Comprehensive, multi-sectoral approach with a wide range of beneficiaries. Successfully ensured iron and folic acid supplementation across key life stages, including children, adolescents, and women.	Enhanced coordination across different ministries could further streamline implementation. Additional efforts to promote behavior change, particularly in rural areas, may improve the program's reach and efficacy.

Sno.	Government Initiative	Year	Beneficiaries	Intervention/ Dose	Key Achievements	Current Potential
5	Anemia Mukt Bharat (Anemia Free India) (34,36)	2018	Children (6–59 months), Adolescents (10–19 years), Women (pregnant and lactating), Children (5–9 years)	1 ml Iron and Folic Acid (IFA) syrup (20 mg iron + 100 mcg folic acid) for children; 60 mg iron + 500 mcg folic acid for adolescents and women	Comprehensive, multi-sectoral approach with a wide range of beneficiaries. Successfully ensured iron and folic acid supplementation across key life stages, including children, adolescents, and women.	Enhanced coordination across different ministries could further streamline implementation. Additional efforts to promote behavior change, particularly in rural areas, may improve the program's reach and efficacy.
6	Anganwadi AMB (Anemia Mukt Bharat) (34)	2018	Children under 6 years, adolescent girls	Anganwadi AMB refers to the "Anemia Mukt Bharat" (anemia Free India) initiative implemented through Anganwadi centers. This program is part of India's broader strategy to combat anemia by distributing iron and folic acid supplements and promoting nutritional interventions. The centers also emphasize public health education and behavior change to support better iron absorption and nutrition.	Strengthened nutritional support through Anganwadi centers, ensuring that adolescents and children receive adequate iron and folic acid. Increased community engagement and outreach efforts helped raise awareness about child and adolescent health benefits.	Integrating dose monitoring could further improve adherence to iron and folic acid supplementation. Enhanced coordination between health and social welfare departments may streamline the program's execution and broaden its impact.

Sno.	Government Initiative	Year	Beneficiaries	Intervention/ Dose	Key Achievements	Current Potential
7	Mission Poshan 2.0 (32,33)	2021	Pregnant women, lactating mothers, children under 6 years	Mission Poshan 2.0 aims to strengthen nutritional content, delivery, outreach, and outcomes by merging supplementary nutrition programs with key health and nutrition interventions. This initiative supports Anganwadi services, focusing on fortified food distribution, nutritional education, and comprehensive health monitoring to tackle malnutrition.	Unified various nutrition schemes for more efficient resource utilization and cohesive implementation. Enhanced nutritional quality and reach through fortified food and improved logistics at Anganwadi centers. Reinforced community participation and awareness programs for sustained engagement.	Strengthening partnerships with local governments, NGOs, and private sectors could enhance program impact and reach. Leveraging technology for better tracking, transparency, and targeted delivery may improve efficiency and scalability. Continued emphasis on awareness campaigns and behavioral change initiatives can drive long-term success and sustainability.
8	Fortification of Staples (35,36)	2019	General population in selected districts	Fortification of staples like rice with iron and folic acid, distributed through Public Distribution Systems (PDS) According to Food Safety and Standards Authority of India (FSSAI), iron in fortified rice should be 28 mg- 42.5 mg per kg (37).	Innovative approach of staple food fortification to combat anemia. Enabled easy access to fortified rice and wheat through existing PDS, making the intervention scalable and accessible.	Scaling up this approach to a broader population could amplify its impact. Continuous efforts to improve public awareness of fortified staples and address any cultural or taste-related concerns could enhance acceptance and adoption.

State Level Strategies Implementation:

Comparison of Nutrition Schemes

Characteristic	Mamata Scheme, Odisha	Lalima Abhiyaan, Madhya Pradesh	Swabhimaan Scheme, Daman & Diu and Dadra & Nagar Haveli	PM Poshan
Objective	Incentive for pregnant, lactating mothers	Combat anemia, promote nutrition	Combat malnutrition, anemia, undernutrition	Provide meals, promote education
Target Group	Pregnant and lactating mothers	Children, adolescent girls, women of reproductive age	Pregnant women, lactating mothers, adolescent girls (11-14 years)	Children in government and government-aided schools
Key Intervention	Cash transfer in two installments	Free iron-folic acid tablets, awareness	Monthly take-home ration of nutritious food	Hot cooked meals
Year Started	2011	2015	2018	N/A

1.Mamata scheme, Odisha is a conditional cash transfer maternity benefit scheme in 2011 with overall, Rs.5,000 in two instalments provided as incentive to pregnant and lactating mothers. Notably, anemia during pregnancy declined relative to comparison groups, indicating improved maternal nutrition (38).

2.Lalima Abhiyaan by Madhya Pradesh's Women and Child Development Department aims to combat anemia and promote nutrition among children, adolescent girls, and women of reproductive age. The scheme, started in 2015, provides free iron-folic acid tablets, raises awareness about healthy diets, and operates collaboratively with Public Health, AYUSH, and School Education departments for widespread impact (39).

3.The "Swabhimaan Scheme," launched in 2018 in Daman & Diu and Dadra & Nagar Haveli, aims to combat malnutrition, anemia, and undernutrition among pregnant women, lactating mothers, and adolescent girls (11–14 years). Under the scheme, a monthly take-home ration of 7.5 kg of nutritious food is provided, addressing challenges like poor Anganwadi attendance and the loss of wages due to daily visits for cooked meals. The scheme enhances the Integrated Child Development Services (ICDS) program to improve the nutritional status of women and children in the region (40).

4.PM Poshan, a centrally sponsored scheme under the Ministry of Education, provides hot cooked meals to children in government and government-aided schools, addressing hunger and promoting education.

It aims to improve nutritional status and encourage school attendance, particularly among disadvantaged children. The scheme operates under the broader Integrated Child Development Services (ICDS) umbrella, alongside initiatives like Anganwadi Services and the Pradhan Mantri Matru Vandana Yojana (41).

Collaborative National initiates to tackle IDA in India

- The National Rural Health Mission (NRHM) highlights the critical need to improve access to healthcare services, especially in rural and underserved areas, where anemia prevalence is often highest.
- Integrating anemia prevention and treatment into existing maternal and antenatal care services, as done in NRHM, can significantly reduce anemia, particularly among pregnant women and children (42).
- Additionally, the Swachh Bharat Abhiyan reinforces the connection between sanitation and anemia, showing that public health education and better hygiene infrastructure can mitigate infection-related contributors to anemia (43).
- Finally, Mission Indradhanush emphasizes the success of targeted, mission-driven programs that reach hard-to-access populations, a model that anemia interventions should follow to ensure that iron supplementation and dietary education reach vulnerable groups in remote areas (44).

5.2 Medical Interventions

Guidelines by Indian Academy of Pediatrics (IAP) and evidences offer a comprehensive framework for managing IDA across diverse contexts (21,36,45).

Table 3: Guideline recommendations for iron supplementation

Age-group	Form of iron	Dosage	Other recommendations
Women in high- risk regions (46)	Ferrous sulfate, as a first-line treatment; severe IDA, intravenous iron formulations like ferric carboxymaltose	40–60 mg of elemental iron daily	Low-dose or alternate-day iron dosing to reduce gastrointestinal side effects like constipation, nausea, and cramping
Preterm infants (At 2 weeks of age)		Elemental iron: 2–4 mg/kg/day (maximum 15 mg)	Practice delayed cord clamping
6 months to 5 years (46)		Supplementation : I-NIPI-L: 20mg elemental iron + 100 mcg folic acid Twice a week (fixed days) Albendazole (400mg tablet twice a year) 1– 2 years: ½ tablet ≥2 years: 1 tablet	Treatment dosage for IDA: 3 mg/kg/day of elemental iron once daily, in the morning, or between meals, administered with water or juice is appropriate. ; The efficacy of once-daily administration is similar to three times/day. Administered for 2 additional months after Hb is normal

Age-group	Form of iron	Dosage	Other recommendations
5-10 years (46)	Ferrous sulfate	Supplementation : I-NIPI-L: 45mg elemental iron + 400 mcg folic acid Once a week (fixed days) Albendazole (400mg tablet twice a year	
10-19 years (46)	Ferrous sulfate	Supplementation : I-NIPI-L: 100mg elemental iron + 500 mcg folic acid Once a week (fixed days) Albendazole (400mg tablet twice a year)	

This table outlines age-specific iron supplementation and treatment guidelines for iron deficiency anemia (IDA), with recommended formulations, dosages, and additional measures. For women in high-risk regions, ferrous sulfate is preferred. Other recommendations being Low-dose or alternate-day iron dosing to reduce gastrointestinal side effects. Preterm infants are advised elemental iron starting from two weeks of age, with emphasis on delayed cord clamping. Children aged 6 months to 5 years receive biweekly supplementation and deworming, with higher therapeutic doses used for treating IDA. Older children (5–10 years) and adolescents (10–19 years) receive weekly iron-folic acid supplements and routine albendazole deworming, aligned with the I-NIPI-L programme.

Deworming can be an important public health measure in managing iron deficiency anemia, especially in regions where parasitic infections are common. Intestinal parasites such as hookworms, roundworms, and whipworms feed on the host's blood, causing significant iron loss and chronic anemia.

Regular deworming with anti-parasitic medications like albendazole or mebendazole effectively reduces worm burdens, improves nutrient absorption, and helps restore iron levels. These drugs are safe and widely used, often in single-dose regimens. Combining deworming with iron supplementation and nutritional education provides a comprehensive strategy for addressing anemia and enhancing overall health (47).

5.3 Nutritional Interventions

Along with inadequate dietary intake, the central issue remains the low bioavailability of dietary iron, with non-heme iron absorption often limited to 10%, and the high prevalence of inhibitors that reduce absorption (11,21).

There are 3 approaches to tackle nutritional issues: dietary diversification, food fortification and food supplementation. Dietary diversification includes the introduction of various food groups, encourages the inclusion or increased consumption of a variety of non-staple foods (e.g., fruits, vegetables, legumes, animal products) in the diet.

Fortification enhances the nutrient content of the food whereas supplementation involves administration of concentrated vitamins and minerals (e.g., capsules, tablets, injections) through healthcare initiatives or nutrition campaigns which might influence gut health (48).

Nutrients:

- Macronutrients, particularly proteins, are vital for hemoglobin production and iron metabolism. **Proteins** also aid enzyme production and transport proteins involved in iron metabolism.
- **Vitamin C** enhances the absorption of non-heme iron by converting ferric to ferrous (45) but its intake is often inadequate in Indian diets (12). To improve vitamin C status, prioritizing locally grown, vitamin C -rich foods like guavas, oranges and lemons with higher bioavailability is key (49).
- The addition of ascorbic acid (vitamin C) causes a substantial increase in the amount of iron absorbed from most iron compounds. In most studies, the co-addition of ascorbic acid and iron in a 2:1 molar ratio (6:1 weight ratio) increased iron absorption from foods 2- to 3-fold in adults and children (27). This ratio of ascorbic acid to iron is thus recommended for most foods; a higher ascorbic acid: iron molar ratio (4:1) can be used for high phytate foods according to WHO (50).
- Deficiencies in **vitamin B12 and folate** can lead to megaloblastic anemia, which may coexist with IDA, complicating treatment (46,47,51).
- **Zinc** deficiency further reduces iron absorption, as zinc supports immune function and iron metabolism (52).
- Additionally, **vitamin A** plays a role in mobilizing stored iron, and its deficiency can impair iron metabolism, exacerbating anemia (53). Thus, managing IDA requires a holistic approach, including adequate intake of proteins, vitamins, and other micronutrients (54).



- **Food groups** like meat, fish, and poultry not only provide heme iron, which is absorbed more efficiently than non-heme iron, but also boost the absorption of non-heme iron from plant sources (55).
- Haas et al. demonstrated that salt double fortified with iron and iodine improved iron status in rural women, suggesting it as a practical intervention for similar populations (56).
- Additionally, **traditional methods like fermentation** (used to prepare foods such as idli, dosa, and dhokla) reduce anti-nutritional factors like phytates, improving iron bioavailability (57).

- Recent studies also highlight that **maintaining gut health** is essential during iron supplementation, as high doses of iron can disrupt gut microbiota, leading to dysbiosis. Incorporating prebiotics such as fructooligosaccharides (FOS) found in foods like garlic, onions, and bananas, as well as pectin from fruits like apples and citrus, and a variety of soluble and insoluble fibers from legumes, oats, and whole grains, can support a healthy gut environment. These dietary strategies may enhance iron absorption and minimize gut-related side effects, especially in individuals prone to gastrointestinal symptoms (15).
- **Dietary counseling** is essential to educate individuals on the timing and combinations of foods to maximize iron absorption—such as consuming tea between meals rather than with food and pairing iron-rich meals with vitamin C sources like lemon or amla (55).

These practices make the Indian diet well-suited for maximizing iron intake, provided that enhancers are strategically included in meals (55).

6. Collaborative and Multi-Pronged Approach

Healthcare professionals like doctors and nutritionists, each play a crucial roles in combating IDA.

- Healthcare professionals are responsible for diagnosing and treating IDA, providing appropriate interventions such as iron supplementation, and educating communities on the importance of iron-rich diets.
- Healthcare Professionals contribute by studying the prevalence, causes, and effective interventions for IDA, focusing on both technical and operational feasibility to ensure successful program implementation in real-world settings.
- Policymakers, on the other hand, develop and enforce policies that support prevention efforts, such as food fortification and public health campaigns, while ensuring these programs are adequately funded and aligned with national health goals.
- Collaborations between the government and private sector help scale health initiatives.
    - Example: The partnership between the Government of India and Tata Trusts in the Anemia Mukt Bharat initiative to fortify foods and distribute iron supplements.
- Coordination between state and national governments ensures cohesive implementation of health programs.
    - Example: The Poshan Abhiyaan program works with states like Madhya Pradesh to conduct anemia screenings and nutrition education.
- Tech firms contribute through health-monitoring technology and community outreach CSR Initiatives.
    - Example: Infosys Foundation supports mobile health units and apps for anemia awareness as part of its CSR projects.
- These groups provide expertise and advocate for policy improvements.
    - Example: The Indian Academy of Pediatrics collaborates with health departments on campaigns like IAP Health Phone to spread nutritional information.
- Professional groups partner with government initiatives to promote dietary solutions.
    - Example: The Indian Dietetic Association conducts workshops on iron-rich foods and partners on community outreach efforts.

- Combating IDA effectively requires a strategy that integrates prevention, treatment, and education across multiple sectors. This approach combines healthcare delivery, nutritional education, policy support, and community engagement to create sustainable change (53,54).

Effective communication between these groups is essential to translating research findings into practical solutions and raising awareness about the economic and health impacts of IDA. Through this collaboration, comprehensive strategies can be developed to reduce the global burden of IDA (58).

- **Collaborative approaches** to addressing IDA in India involve coordinated efforts across multiple sectors, including industry, healthcare professionals, and policymakers.
    - Policymakers play a key role by ensuring the allocation of resources and the integration of innovative strategies, such as food fortification and biofortification (58).
    - Governments ensure regulatory frameworks and quality standards (58).
    - Researchers play a key role in developing innovative methods, focusing on both technical and operational feasibility to ensure successful program (58).
    - Industries, particularly in the food processing sector, are essential in implementing these techniques at scale, ensuring that fortified or iron-enhanced products reach the population that may enhance iron intake for vulnerable populations (59).
    - Healthcare professionals are essential in providing education, supplementation, and early interventions, particularly for women and children (59).
    - NGOs can work at the grassroots level to educate communities about iron-rich diets (59).

Collaborative efforts, backed by research and public policy, are crucial for the operational feasibility and success of these strategies, making iron-rich foods accessible and affordable, especially to vulnerable groups like children and women (59).

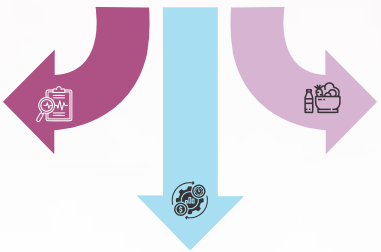
- **Creating Digital Awareness:**
    - Endorsements from influential figures and community champions, similar to the successful strategies employed in tuberculosis (TB) programs, and Pulse Polio Immunization could be leveraged to promote awareness and adherence to interventions for IDA (60).
    - With the growing influence of social media, platforms like Instagram Reels offer a powerful way to engage communities, even in rural areas. As most households now own at least one smartphone, these platforms provide a valuable opportunity to reach and educate both adults and children on important issues (61).
    - The government could explore the implementation of dedicated anemia educators, similar to the model of diabetes educators (62).
    - Effective collaboration fosters comprehensive solutions that address both the prevention and management of IDA, ultimately leading to improved public health outcomes (59).

7. Recommendations

Better coordination between public health initiatives and local healthcare systems, along with strengthened monitoring and evaluation frameworks, will be essential to ensure sustained progress in reducing anemia (38).

How to improve anemia Interventions?

Improve Diagnostic Tools
Switching to venous blood sampling can provide more accurate anemia prevalence estimates.



Targeted Food Fortification
Focusing on bloavailable iron and dietary changes can enhance intervention efficacy (63).

Optimize Supplementation Programs
Tailoring iron doses based on individual needs can prevent counter productive outcomes (34).

8. Future Directions

To address the critical gaps in the diagnosis and management of IDA, it is essential to follow a structured, multi-pronged approach that includes expert recommendations, scalable strategies, and context-specific interventions. The following points outline the key directions for implementation:

- **Expert Recommendations and Algorithm Development**
  - Develop a consensus-driven clinical pathway algorithm for the identification, screening, and treatment of IDA, with a focus on early detection and region-specific disparities, particularly in vulnerable populations such as pregnant women and children.
- **Screening and Diagnosis:**
  - Standardizing Diagnostic Criteria: Establish clear, standardized diagnostic criteria for markers like ferritin and hepcidin, especially during pregnancy, to ensure timely and accurate diagnosis.
  - Targeted Awareness and Screening Programs: Implement public health campaigns and screening initiatives to raise awareness about the risk of iron deficiency anemia, especially among women of reproductive age and those adhering to vegetarian diets.
  - Strengthening Screening and Awareness: Increase public awareness campaigns focused on the importance of early screening for IDA, utilizing tools like mobile health applications to enhance engagement and adherence.
- **Nutritional pathways:**
  - Promoting Dietary Diversity and Biofortification: Encourage dietary interventions that include biofortified crops and emphasize iron-rich food sources, especially for

populations with plant-based diets. Nutritional education should be integrated into public health initiatives to ensure widespread understanding of iron bioavailability. Dietary diversity links to better health status and simple methods like kitchen gardening can aid to improvement in nutritional security.

  - Addressing Functional Iron Deficiency and Gut Health: Explore therapeutic interventions targeting the hormone hepcidin and anti-inflammatory treatments that improve iron absorption in patients with chronic diseases. Additionally, promoting gut health through prebiotics and probiotics may enhance iron absorption and prevent dysbiosis during supplementation.

- **Research:**
  - Addressing Non-Adherence: Conduct comprehensive research to understand the barriers to adherence to iron supplementation, particularly in low-resource settings. Tailored interventions should address cultural practices, misconceptions, and access issues.
- **Behavioural Change Communication (BCC) Strategies to Tackle Anemia:**
  - Promote IFA Supplementation and Deworming: Educate and motivate individuals to consistently follow Iron-Folic Acid supplementation and deworming schedules.
  - Improve Feeding Practices: Encourage appropriate infant and young child feeding practices through targeted messaging and demonstrations.
  - Dietary Diversification: Advocate for increased intake of iron-rich foods, emphasizing diet diversity, quantity, frequency, and fortified options, while leveraging locally available resources.
  - Delayed Cord Clamping: Raise awareness among healthcare providers and families about the benefits of delaying cord clamping by 3 minutes after delivery in health facilities.
- **Ensuring Access to Intravenous Iron**

Strengthen public health infrastructure to ensure that both oral and intravenous iron therapies are consistently available, especially in regions with high prevalence of IDA and limited healthcare access.

- **Leveraging Digital Health Technologies:**
  - Integrate digital health tools like telemedicine and mobile applications to improve patient screening, patient follow-up, education, and adherence to treatment plans. These technologies can help bridge healthcare gaps in underserved regions.
  - An et al. developed a point-of-care (POC) microchip electrophoresis device that uses AI algorithms to detect anemia and (Hb) variants. The system analyzes whole blood mixed with a calibrator, separating Hb subtypes through electrophoresis. An artificial neural network (ANN) then calculates Hb concentration and identifies anemia status with high sensitivity and specificity. This AI-based POC platform allows quick and accurate anemia and Hb variant detection, even in resource-limited areas, without requiring skilled personnel, potentially transforming community healthcare by improving access and reducing overcrowding in urban areas (64).

- The integration of AI in POC testing has the potential to revolutionize healthcare, particularly in remote and underserved regions. By providing reliable and accurate diagnostic tools without the need for specialized training, this technology could significantly enhance the quality of care, reduce healthcare disparities, and improve the overall quality of life for people living in rural and resource- limited environment.

- **Policy and Multisectoral Collaboration:**
  - Encourage collaboration between policymakers, healthcare professionals, and community leaders to design and implement context-specific interventions that consider socio-cultural dietary habits and improve the accessibility of iron supplementation.

Checklist for Implementation (65,66)

- ✓ *Regular point of care screening for iron deficiency, particularly in high-risk populations.*
- ✓ *Early initiation of iron supplementation (oral or IV as appropriate).*
- ✓ *Nutritional counselling with a focus on dietary diversity and iron-rich diets.*
- ✓ *Incorporating gut health strategies during iron therapy.*
- ✓ *Utilizing digital platforms for follow-up and patient education.*
- ✓ *Strengthening policy efforts to support sustainable iron fortification programs.*

By following these directions, scaling up awareness, and resolving critical gaps, healthcare systems can achieve sustained improvements in IDA management and outcomes across diverse populations.

9. Conclusion

Iron Deficiency Anemia (IDA) stands as one of India's most urgent and persistent public health crises, disproportionately impacting women and children and perpetuating cycles of poor health, impaired cognitive development, and reduced national productivity. Despite the establishment of robust national programs such as Anemia Mukt Bharat and large-scale food fortification initiatives, progress remains hindered by persistent gaps in compliance, awareness, and effective program delivery.

To break this cycle, India must move beyond incremental improvements and embrace a bold, holistic, and multi-sectoral strategy that is both evidence-based and context-specific. The following are critical, actionable imperatives drawn from the white paper's recommendations and implementation checklist:

1. Mandate Regular, High-Quality Screening

- Institutionalize regular point-of-care screening for iron deficiency, especially in high-risk populations, using standardized, accurate diagnostic tools (preferably venous sampling over capillary for reliability). Early detection enables timely intervention, preventing severe anemia and its long-term consequences.

2. Accelerate Early and Tailored Supplementation

- Ensure rapid initiation of iron supplementation (oral or IV as appropriate), with dosing tailored to individual needs and supported by robust follow-up. Optimized supplementation prevents counterproductive outcomes and improves adherence, especially when side effects are proactively managed.

3. Embed Nutritional Counseling and Dietary Diversity

- Integrate nutritional counseling into all public health and clinical touchpoints, emphasizing dietary diversity, iron-rich foods, and enhancers of absorption (e.g., vitamin C, fermented foods). Dietary interventions, when culturally tailored and community-driven, can sustainably improve iron status and overall nutrition.

4. Prioritize Gut Health for better iron absorption

- Incorporate gut health strategies-such as prebiotics, and dietary fibers-to minimize gastrointestinal side effects and enhance iron absorption. Maintaining gut health improves both the efficacy and tolerability of iron supplementation, supporting long-term adherence.

5. Leverage Digital Platforms for Education and Adherence

- Utilize digital health platforms and mobile applications for patient education, follow-up, and adherence monitoring, especially in underserved regions. Digital tools can bridge healthcare gaps, scale awareness, and empower both providers and patients for better outcomes.

6. Strengthen Policy and Multi-Sectoral Collaboration

- Intensify policy efforts to support sustainable iron fortification, ensure cross-sectoral collaboration (government, academia, industry, NGOs), and align resources for maximum impact. Only a coordinated, multi-pronged approach can address the complex, interlinked causes of IDA and ensure equitable access to solutions.

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