

Anemia's Blind Spot: Time to Rethink the Strategies

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ABSTRACT

Despite several government programs and initiatives to reduce anemia, it continues to be a menace to public health. Its etiology is complex, where poor nutrition, frequent infections, poverty, and lack of awareness all play a part, making it multifactorial. Cultural beliefs, poor health education, and weak healthcare delivery systems also hinder the fight against anemia. In addition, genetic disorders like thalassemia, sickle cell anemia, etc., prevalent in some communities also play a role, making the issue more complicated. In developing countries like India, anemia is considered mainly as a deficiency of iron without any special focus on the globin part of hemoglobin. All the tests are based on iron, and while addressing anemia, iron-based interventions are in practice. The globin (protein) part always remains unaddressed, which may be an unnoticed reason for anemia. Indirect evidence has shown that providing good-quality protein helps in improving the hemoglobin status of individuals. There are other nutritional factors other than the iron, such as copper, zinc, magnesium, Vit B9, Vit B12 and other micronutrients, which have a role in anemia control and need to be taken into consideration while dealing anemia. There can be several hypotheses regarding the above fact, which need to be tested using various epidemiological methods and data to conclude conclusively. So this opens a new area of research in anemia control. To combat anemia holistically, stringent policy implementation, public participation, along with understanding hidden reasons and their timely addressal, is paramount in combating this long-standing health challenge.

Keywords: Anemia, Healthcare, Hemoglobin, Iron Deficiency, Milk

INTRODUCTION

According to the World Health Organization (WHO), anemia is defined as a hematological condition where there is a deficiency of red blood cells or hemoglobin in the blood, reducing the ability to transport oxygen in the body. [1] It continues to be a major public health issue, primarily affecting women, children, and pregnant women. This condition is characterized by fatigue, weakness, dizziness, and in severe cases, can lead to organ damage or even death. Despite numerous national programs its prevalence is alarmingly high in India, presenting a persistent challenge to public health professionals across the country.[1,2] As per WHO, anemia affects about 50% of women and 70% of children in India which can be attributed to several causes, iron deficiency being the primary.[2] Other factors like poor dietary intake, limited bioavailability of iron, parasitic infections and menstrual blood loss are major contributors along with malnutrition, poverty, and lack of access to proper

healthcare facilities.[3]

The prevalence of anemia in India is also influenced by a multitude of factors. In rural areas with restricted access to healthcare and nutritious food, the rate of anemia is significantly higher.[4] Even though the government of India has implemented several policies, like National Iron Plus Initiative (NIPI) and the Integrated Child Development Services (ICDS) program, which provide iron supplements to vulnerable populations, these programs have not been fully effective in curbing the incidence of anemia. Public health professionals in India face many hurdles in their efforts to control anemia, lack of effective implementation of existing programs being the primary.[1,3] The distribution of iron supplements faces hurdles like inconsistent supply chains, poor adherence to supplementation regimens, a lack of community participation, and awareness about the requirement for supplementation.[2]

In India, management of anemia requires a comprehensive and multifaceted approach where coordinated effort is required to improve access to nutritious foods. Healthcare policies to address underlying health conditions, such as infections that contribute to anemia, should be implemented and adhered to.[1,4] Demography in India, with high rates of genetic disorders like thalassemia and sickle cell anemia, requires targeted interventions through mass screening, genetic counseling, and public awareness campaigns. Additionally, focus on maternal health and holistic view is crucial for sustainable and effective management of anemia, especially in populations where iron supplementation alone has not yielded desired improvements.[1,5]

Apart from iron, several micronutrients play essential roles in preventing anemia. Vitamins like B12 and folate which are essential for production and maturation of red blood cells and its deficiency can result in pernicious anemia, whose symptoms include tiredness, pale skin, weakness, and sometimes neurological issues like tingling or numbness in the extremities. Folate, or vitamin B9 can lead to megaloblastic

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anemia, characterized by large, immature red blood cells. [6] Folate and B₁₂ remain crucial for DNA synthesis in red blood cells; a 2024 study linked B₁₂ and folate deficiencies in pregnant individuals with celiac disease to adverse fetal outcomes and maternal anemia. Copper is vital for iron metabolism, as it supports the function of ceruloplasmin, which helps mobilize iron from stores; copper deficiency can result in iron-refractory anemia. Clinical reports, including pediatric cases on enteral feeds, underscore copper's importance in preventing macrocytic anemia. Magnesium regulates neuromuscular transmission, plays a key role in Vit D metabolism, PTH secretion and function. PTH increases renal magnesium reabsorption, but chronic hyperparathyroidism may lead to magnesium wasting or normal-high levels, depending on kidney function. In PHPT patients, lower serum magnesium levels were associated with lower hemoglobin levels independent of serum calcium, albumin, e GFR and PTH. Zinc, though less directly involved in hemoglobin synthesis, is important for erythropoiesis, and immune function. Zinc deficiency frequently co-occurs with other micronutrient deficits. Adequate levels of these micronutrients are vital for effective erythropoiesis, and their deficiency can not only cause anemia but also hinder recovery despite iron supplementation. [6,7] Anemia of chronic disease (ACD) is often observed in individuals with long-term illnesses, such as infections, inflammatory diseases, or cancers where the body's immunity is depleted which impairs the production of erythropoietin, a hormone that stimulates red blood cell production causing anemia. Hemolytic anemia is caused by the premature destruction of red blood cells in the bloodstream. This can result from autoimmune disorders, infections, inherited genetic conditions, or reactions to certain drugs. Aplastic anemia is a condition where inadequate red blood cells are produced, the symptoms of which include fatigue, frequent infections, and easy bruising.[8,9] Chronic blood loss is another major contributor to anemia. Causes of chronic blood loss include gastrointestinal issues like ulcers or hemorrhoids, as well as heavy menstrual periods.[1] Protein deficiency can contribute to anemia in several ways. A lack of sufficient protein can impair hemoglobin production, reducing the oxygen-carrying capacity of the blood leading to anemia.[10] Moreover, proteins play a key role in the functioning of the bone marrow, where red blood cells are produced whose deficiency may result in normocytic anemia. Transferrin is a protein responsible for transporting iron throughout the body. Its deficiency can disrupt iron metabolism, making it difficult for the body to properly utilize iron leading to anemia. Protein malnutrition is observed in diseases like kwashiorkor where anemia is common.[3] A balanced diet plays a critical role in the prevention and management of anemia. This is achieved by ensuring adequate intake of essential nutrients required for the production of red blood cells. Iron is essential for the formation of hemoglobin. [11] Structurally, hemoglobin is composed of two main components: heme and globin. Iron containing porphyrin

ring known as heme is responsible for binding oxygen and this component has received overwhelming attention in both clinical and research settings, especially in context of anemia, a condition characterized by reduced hemoglobin levels. Iron supplementation has been largely focused on during treatment protocols and public health strategies, often neglecting the equally important globin component. The Globin part of hemoglobin consists of four polypeptide chains (typically two alpha and two beta chains in adult hemoglobin) that surround and support the heme groups. Beside stabilizing the heme part, this protein also plays a key role in the structural integrity and functional capacity of the hemoglobin molecule. Even when iron level is adequate, mutations and deficiencies in the globin chains, as seen in conditions like thalassemia or sickle hemoglobinopathies. [12]

Despite this, the globin component has been largely overlooked in mainstream anemia treatment primarily emphasizing on iron intake. Protein -building blocks (like essentials amino acids and co- factors) required for effective globin synthesis, have been frequently ignored in nutritional interventions. Moreover, socio-economic factors such as protein- energy malnutrition, common in low-resource settings, further hinder adequate globin production but remain underemphasized. At the research-level the disproportionate focus on iron biomarkers and supplementation trials has overshadowed the need to understand and address globin chain synthesis, regulation, and its nutritional and genetic determinants [13]

While diet is paramount in addressing anemia, dietary supplements might be necessary to meet the nutritional needs of women and children. Iron supplementation is the most common and effective treatment for iron-deficiency anemia. They are used to replenish iron stores in the body and are advised for pregnant women, children, and women of reproductive age.[14] These are available as ferrous sulfate or ferrous fumarate tablets. Folate and vitamin B₁₂ supplements are vital for preventing folate deficiency anemia and pernicious anemia.[3] A paradigm shift- from iron-centric approaches to integrated strategies is required to deal anemia extensively, that support globin synthesis, considering micronutrients deficiencies through adequate nutrition, protein intake and consideration of genetic factors. This holistic view is crucial for sustainable and effective management of anemia, especially in populations where iron supplementation alone has not yielded desired improvements. [1,2] In areas with widespread nutritional deficiencies the intake of multivitamin and mineral supplements is essential for controlling anemia in the population.[11]

Malnutrition and anemia are two critical public health challenges where malnutrition encompasses both under-nutrition and over-nutrition and anemia is a condition primarily caused by a deficiency of iron and other essential nutrients.[15,16] In this context, milk plays a significant role in alleviating malnutrition and preventing or managing anemia as it is rich in calcium, vitamin B₁₂ and D, riboflavin and phosphorus. Milk is considered a "complete super food"

due to its wide array of nutrients which supports growth, tissue repair, immune function, and muscle development. [17–20] For infants and young children, breast milk is often the most critical source of nutrition, providing all the essential nutrients required for the first six months of life. It contains not only protein, fat, vitamins, and minerals but also immune-boosting compounds that protect infants from infections.[17] For older children and adults, milk continues to provide a rich and good quality source of protein and essential vitamins and minerals.[18] Although milk is not a significant source of iron, it plays a supportive role in preventing and managing anemia through the nutrients it contains. The riboflavin in milk supports the body's capacity to prevent and manage anemia.[16]

While milk offers essential nutrients that can help alleviate malnutrition, it should not be considered a standalone solution to combat anemia. Lactose intolerance makes its consumption and utilization less. Additionally, the cost and accessibility of milk in some regions may limit its potential to combat malnutrition and anemia effectively.[17,19] Results from studies conducted in tribal belts of eastern India revealed that milk consumption showed positive effects on malnourished children, helping reduce stunting and thinness. It also improved cognitive skills in schoolchildren. The study concluded that milk boosts calcium and vitamin B12 levels in children from a tribal region but does not significantly impact vitamin D levels.[19,20]

Anemia is a hazard in many third-world countries caused by nutritional deficiencies, infectious diseases, parasitic infections, and chronic health conditions. Countries such as Nigeria, Ethiopia, and Bangladesh are particularly affected and anemia is a leading cause of morbidity in these nations. In African countries poor dietary intake and inadequate access to iron-rich foods results in anemia. Deficiencies in folate and vitamin B12 in populations in Ethiopia causes anemia to become a pervasive problem.[21,22]

Infectious diseases like malaria which is an endemic in many parts of Sub-Saharan Africa, especially in countries like Nigeria, Uganda, and Tanzania contributes to anemia. The *Plasmodium* parasite destroys red blood cells, directly leading to anemia and children under five are particularly vulnerable to it. In Bangladesh, parasitic infections such as hookworms also contribute to anemia resulting from poor sanitation.[21,23] Chronic diseases like tuberculosis (TB) and chronic kidney disease (CKD) further contribute to anemia in Indonesia, where fewer red blood cells might be produced, leading to anemia. Lack of access to effective medical treatments, such as iron supplements or surgical interventions, worsens this issue, affecting women's health and productivity. The impact of anemia in third-world countries is profound where it severely affects children's growth and cognitive development. In Nigeria, where malaria is prevalent, children with anemia are more likely to suffer from infections like pneumonia and diarrhea due to a weakened immune system.[21–24]

Despite various government initiatives to address the issue of anemia, the current strategies are not fully effective.

The focus remains largely on iron supplementation, overlooking the essential role of other micronutrients and the globin(protein) component of hemoglobin. This narrow approach misses key nutritional factors that are critical for effective diagnosis and treatment of Anemia. A more comprehensive strategy addressing both iron, protein and micronutrients deficiencies is urgently needed. Improving nutrition is crucial, promoting the consumption of iron and protein rich foods should be propagated, increasing access to healthcare should be ensured and early diagnosis and treatment of infectious diseases like malaria and tuberculosis should be done.

India has made progress in addressing anemia through government programs like the National Iron+ Initiative, The Anemia Mukht Bharat (AMB) Program launched in 2018, and is focused on the distribution of iron and folic acid supplements to children, adolescents and women.[25,26] Poshan Abhiyaan integrates nutrition-focused interventions like food fortification to address malnutrition and anemia. [27] Improved Health and Nutritional Education and Integrated Child Development Services (ICDS)- focuses on the health and nutritional education of children, pregnant women, and lactating mothers through schools, anganwadis, and primary health care centers respectively.[28,29]

CONCLUSION

While steady progress has been made in recent years, the control of anemia in India remains an ongoing challenge. Public health professionals must continue to adapt their strategies to tackle the root causes of anemia in the country. But we need to look beyond the conventional strategies of addressing iron deficiency anemia and include the other micronutrients and good sources of protein in the food plate of the common man to combat anemia in a formidable way. An integrated approach that combines nutritional interventions, improved healthcare access, public awareness campaigns, and genetic screening is essential to control anemia. Only through sustained and collaborative efforts will India be able to significantly reduce the burden of anemia, improve the quality of life for its citizens, and ensure healthier generations to come.

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