CFAES SCHOOL OF ENVIRONMENT AND NATURAL RESOURCES

Iron Deficiency Anemia: Efficacy and Limitations of Nutritional and Comprehensive Mitigation Strategies

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BACKGROUND

In this review we discuss how Iron deficiency anemia (IDA) affects the well-being of the young generation and the economic advancement of developing countries, such as India.

The imbalance between iron intake/absorption/storage and iron utilization/loss culminates into IDA. Emerging critical risk factors for IDA include a composition of cultural diets, infections, genetics, inflammatory conditions, metabolic diseases, dysbiosis, and socioeconomic parameters.

Anemia is a condition in which hemoglobin (Hb) concentration is characterized by reduced concentrations of hemoglobin (Hb) in the blood below cut-off levels, and/or a diminished number of red blood cells.

Severe iron deficiency can reduce Hb levels, decrease erythropoiesis, and result in hypo proliferative microcytic anemia, which is defined as iron deficiency anemia (IDA).

IDA is the major anemia condition that affects more than 6 million individuals of all segments of the population and contributes to approximately 840,000 deaths, worldwide.

Particularly in India, more adolescents (10–20% of the studied adolescent population) were diagnosed with IDA compared to other countries (2–6%).

FINDINGS

In India, dietary iron intake is grossly inadequate and insufficient in most of the states, further investigation revealed the paradoxical relationship between iron intake and IDA (Figure 1A).

Iron availability has two interdependent components: accessibility and absorption (Figure 2), and Fe independence and dependence manifest (Figure 3). differently as well (Figure 4).

FINDINGS

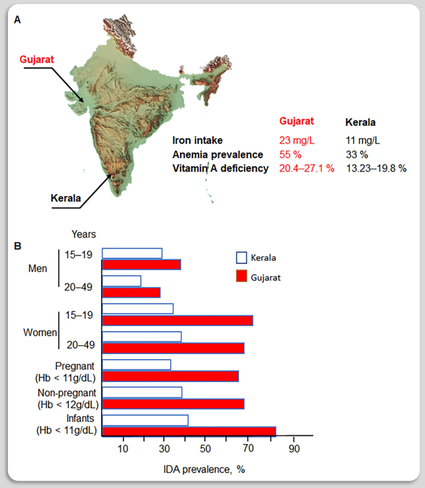

Figure 1. Prevalence of IDA in Gujarat in all population subsets compared to Kerala. IDA is higher in Gujarat compared to Kerala despite higher iron intake in Gujarat; shown in **(A)** and **(B)** from 2019–2021.

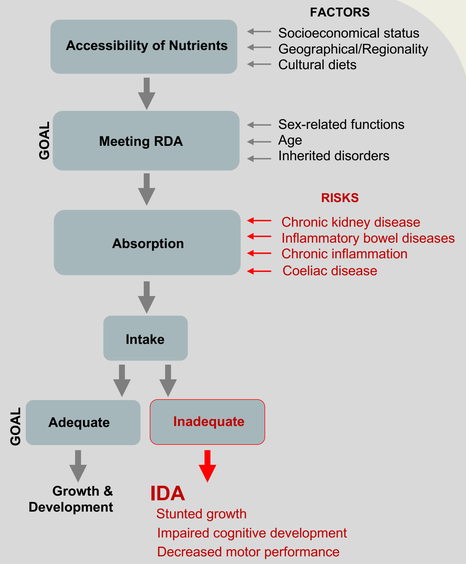

Figure 2. The pathogenesis mechanism of IDA depends on both accessibility of nutrients and their absorption. Socioeconomic and cultural factors influence the dietary amount and its composition.

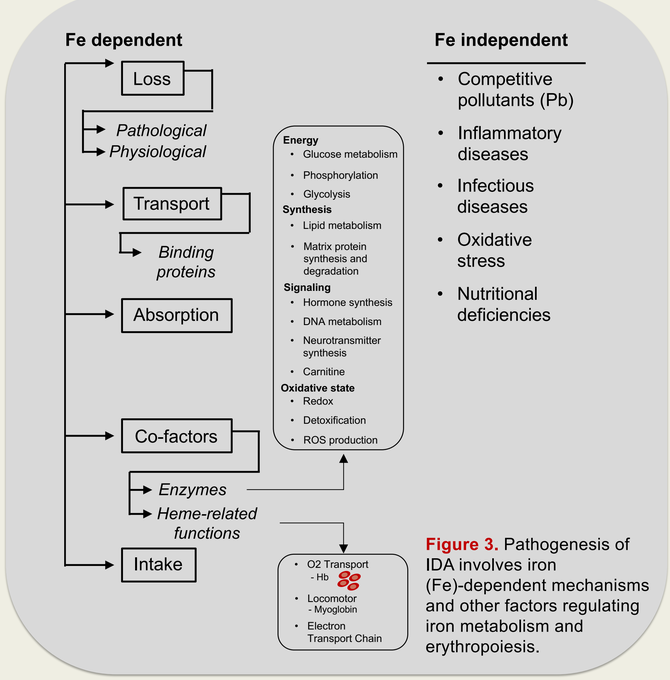

Figure 3. Pathogenesis of IDA involves iron (Fe)-dependent mechanisms and other factors regulating iron metabolism and erythropoiesis.

DISCUSSION

Meta-analysis revealed that inadequate concurrent intake of dietary iron from Indian staple foods, especially rice and millets, is one of the major etiological factors for the high prevalence of IDA in India.

Several cultural and biological traits could worsen iron availability, intake, and absorption in the Indian population, including lack of bioavailable heme iron in the diets of vegetarians, representing 33% of adults in South Asia vs. 2.4% of the US population.

CONCLUSION

The most effective strategies include mass food fortification with iron, targeted iron supplementation program/intervention, control of hookworm and malaria, education to the general public about iron-rich sources of plant- and animal-based foods.

However, these strategies need to be multi-factorial and tailored to Indian regional cultural traditions as well as the dietary, genetic, environmental, and pathophysiological factors contributing to IDA.

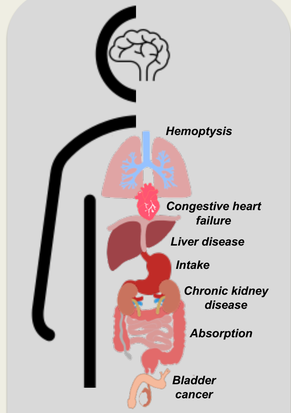

Figure 4. Complications associated with IDA.

FUTURE DIRECTIONS

There is an urgent need for operational and system research to increase compliance among beneficiaries. Further research is needed to optimize the dose and frequency of supplementation (daily vs. weekly), and absorption/bioavailability in clinical and community set-ups. It is crucial to identify a cost-effective solution for diets and supplements to improve their accessibility to populations at risk for IDA and public compliance with their use.

SOURCES

CONTACT