Journal of Advances and Scholarly Researches in Allied Education
Vol. 20, Issue No. 3, July-2023, ISSN 2230-7540

Iron deficiency Anaemia with regards to nutrition and health

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Abstract - Iron deficiency anemia (IDA) is a prevalent nutritional disorder affecting a significant portion of the global population, particularly in developing countries. It is characterized by insufficient iron levels, leading to decreased red blood cell production and reduced oxygen transport capacity. This condition results in symptoms such as fatigue, weakness, and impaired cognitive function, which can substantially impact overall health and productivity. The primary causes of IDA include inadequate dietary iron intake, poor iron absorption, and chronic blood loss. Nutritional interventions, including increased consumption of iron-rich foods and fortification strategies, play a crucial role in the prevention and management of IDA. This paper reviews the relationship between nutrition and iron deficiency anemia, discussing the importance of dietary sources of iron, the impact of dietary enhancers and inhibitors on iron absorption, and the role of public health initiatives in addressing this global health challenge.

Keywords: Iron deficiency anaemia, Nutrition, Health

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INTRODUCTION

Iron deficiency anemia (IDA) is the most common type of anemia worldwide, particularly affecting women, children, and individuals in low-income regions. Iron is an essential mineral required for the production of hemoglobin, a protein in red blood cells responsible for transporting oxygen throughout the body. When iron intake or absorption is insufficient to meet the body's needs, iron stores are depleted, leading to reduced hemoglobin production and subsequent anemia. This condition manifests through symptoms such as chronic fatigue, weakness, shortness of breath, and cognitive impairments, which can hinder daily activities and quality of life. The etiology of IDA is multifaceted, involving factors such as dietary deficiencies, impaired absorption, and increased physiological demands. Addressing IDA requires a comprehensive understanding of the nutritional aspects of iron intake, including the types of dietary iron, factors influencing iron bioavailability, and effective public health strategies to enhance iron nutrition in vulnerable populations.

NUTRITION

The ideal ratio of nutrients to entire meals is what nutrition is all about, allowing the body to function at its best. It is the act of providing nourishment or receiving nourishment, particularly the process by which a living thing absorbs food and uses it for tissue regeneration and growth. Food consumption and nutrition have a direct impact on people's physical performance and productivity. One of the main environmental elements influencing the preservation of physical fitness and health is nutrition. The quality and quantity of food consumed has a significant impact on the nutritional status of any community or population. The body receives nutrients from food, which support the maintenance of our health and nutritional state. For instance, an apple can be considered food since it can be consumed, broken down, and then used by the body to absorb nutrients. These substances support the body in performing its daily tasks and preserving health. One must consume the necessary amount of nutrients through food on a daily basis in order to maintain good health and nutrition. This is because better nutrition enhances one's ability to perform physically by improving stamina and facilitating the body's efficient oxygen transport during physical labour. It goes without saying that deprivation of sufficient nourishment for extended periods of time causes fatigue and a decrease in physical stamina (Satyanarayane et al., 1979).

Because nutrition has an impact on development, it is significant. Studies have shown that by providing a gene with the precise chemicals or nutrients needed to express the gene's full developmental potential, diet may also alter how a particular genetic component is produced (Rosales, Reznick & Zeisel,

2009). Put another way, diet regulates how the body and brain grow.

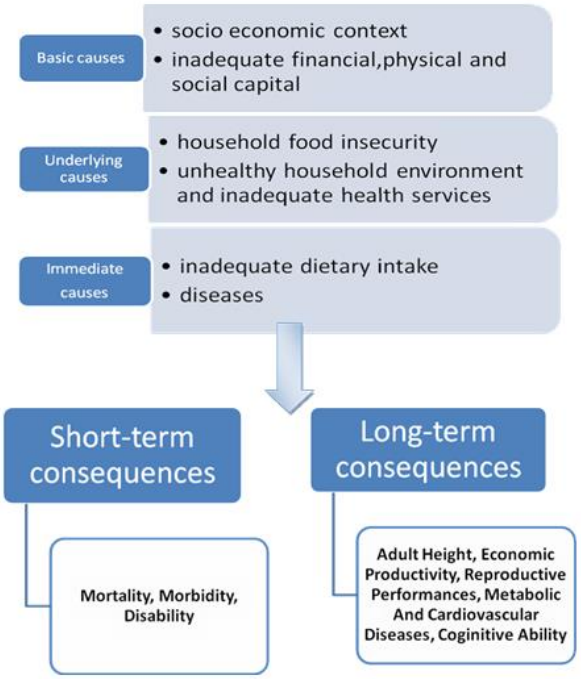

Figure 1: Malnutrition Causes and Consequences

Iron Deficiency Anaemia

Many nutrients are found in food. Many vital nutrients aren't accessible to the body in enough amounts when the proper kinds of meals aren't consumed in enough amounts. Consequently, a number of deficiency disorders manifest. Protein Energy Malnutrition (PEM), Vitamin A insufficiency, Iron malabsorption problems, and Vitamin B complex insufficiency are among the most prevalent deficient disorders.

Iron insufficiency is a common dietary concern, which is odd considering that iron is one of the most plentiful elements in the universe. This is because the majority of the iron that people consume via food has poor solubility and is hence not easily available. Approximately 2.5–5 billion individuals, particularly in poor nations, are at risk for micronutrient deficiencies; this is particularly true for pregnant women and babies (Rush, 2000). Iron deficiency is a public health crisis on an epidemic scale, impacting more people than any other ailment. Anaemia affects 90% of the world's population, with a prevalence of 2% among pregnant women and 40% among preschool-aged children (WHO, 2005).

Although there are many potential causes of anaemia, iron deficiency is generally considered to be the greatest public health concern. Iron deficiency is responsible for around half of the cases of anaemia, according to the World Health Organisation. The majority of children's observational studies have linked iron deficiency anaemia to delayed motor and cognitive development as well as behavioural issues.

The iron-containing protein haemoglobin is essential for delivering oxygen to working tissues all day long (National Academies of Sciences, 2002), as is the iron-containing protein enzymes. Delays in psychomotor development, poor physical growth, increased morbidity, and iron deficiency anaemia (IDA) may occur when haemoglobin levels are low and other iron markers, including transferrin saturation (iron reserves), are abnormally high. Studies on animals have shown that neurotransmitters, which are essential for subsequent brain processes, may be impaired in the presence of an iron deficit in early development. The proper functioning of several enzymes in brain tissue depends on iron. Heme proteins are the most common kind of cytochrome involved in energy generation.

A number of significant nutritional issues are impacting the growth and development of the world's adolescents, which in turn threatens their ability to make a living as adults. Iron needs during adolescence To comprehend why some individuals are more prone to developing iron deficiency anaemia, it is crucial to comprehend the need for iron consumption and its bioavailability. A serious risk to future safe motherhood in girls, anaemia occurs when the quantity or oxygen-carrying capability of red blood cells is inadequate to fulfil physiological demands, and it also reduces focus in job and academic performance. Adequate iron consumption is one component of a healthy diet that contributes to adolescent growth and development (WHO 2008).

CAUSES OF ANEMIA

Poverty, illiteracy, ignorance, and a general lack of understanding of iron deficiency anaemia, its symptoms, and the nutritional worth of various vegetables are the main factors that contribute to the prevalence of this condition in India. In 2015, Park A lack of iron in the diet is a common cause of iron-deficiency anaemia (IDA).

Anaemia due to a lack of iron does not manifest itself suddenly. Iron depletion is the first stage of iron shortage, when the body's iron stores decrease but red blood cell iron stores stay steady. Iron depletion becomes iron deficiency, which in turn leads to IDA, unless treated. Iron deficiency anaemia occurs when the body does not have an adequate amount of iron. Blood loss, an unhealthy diet, or an inadequate iron absorption rate are the most common causes of an iron deficiency.

- Blood loss
- Poor diet
- Inability to absorb enough iron
- The Maternal–Fetal Bridge of Iron Deficiency

- Malaria
- Hookworm
- Iron Diet and Malabsorption

RISK FACTORS FOR ANEMIA

More than one lakh women in India die of pregnancy-related fatalities, with 22,000 of those deaths being attributed to nutritional anaemia. This makes anaemia the leading cause of maternal mortality, accounting for one fifth of all maternal deaths. Of all maternal fatalities, severe anaemia is responsible for 20.3%. Women who are anaemic have a five- to tenfold higher risk of death from infection and bleeding than women who are not anaemic. Low birth weight, increased risk of permanent brain damage in babies, and intra-uterine development retardation are all ways in which maternal anaemia affects the health of their unborn children. Experiencing anaemia is more common when:

- Age of preschool, when development is at its peak.
- Iron deficiency and fast growth occur throughout adolescence.
- During pregnancy, both the mother's tissues and the foetus experience fast development.

BODY MASS INDEX (BMI)

One reliable indicator of dietary health is body mass index. Body mass index (BMI) is the most used height-weight index, which is based on the Quetlet's index. Using the given weight (in kilogrammes) and height (in metres squared), one may determine their body mass index (BMI). One reliable indicator of dietary health is body mass index. Body mass index (BMI) is the most used height-weight index, which is based on the Quetlet's index. A person's BMI may be determined from their weight (in kilogrammes) and height squared (in metres squared) by using the formula provided by (Garrow, 2000).

Table 1.1 BMI Categories

BMI	Nutritional status
Below 18.5	Underweight
18.5–24.9	Normal weight
25.5-29.9	Pre-obesity
30.0–34.9	Obesity class I
35.0–39.9	Obesity class II
Above 40	Obesity class III

$$BMI = \frac{Weight\ (kg)}{Height\ (m^2)}$$

MAGNITUDE OF THE PROBLEM

Iron shortage is the root cause of 30%-50% of cases of anaemia in various populations, including children. Several hundred million exhibit iron deficiency anaemia out of 1.6 billion individuals who are anaemic, therefore, iron deficiency is the leading global cause of anaemia. Some of the two billion individuals on Earth suffer from iron deficiency anaemia due to a lack of iron in their diet. Thus, the worldwide incidence of anaemia may be used to infer the health impact of iron deficiency. In less developed regions, the prevalence of anaemia is five times higher than in more developed regions. Anaemia affects more than half of the world's children and, in certain places, is even more common than 100%. With the exception of males who are not yet old, 40–50% of the population in the same areas is anaemic throughout their lives (McLean et al. 2009). Developed countries have a much lower illness burden. Anaemia due to iron insufficiency is less common in the US across all age groups and sexes. Iron deficiency anaemia affects around 5 million of the 10 million Americans who are iron deficient.

RECOGNIZING IRON DEFICIENCY ANEMIA

The severity of the anaemia is a major factor in the clinical presentation of this illness. Age, sex, race, and the kind of blood sample (finger stick vs. venous) all have a role in the haemoglobin levels that are considered to be indicative of anaemia. The detection of haemoglobin levels within 1-2 g/dL of reference values may be accomplished with a 95% degree of accuracy using portable instruments or optical colour matching in the absence of automated testing. A patient may express dissatisfaction with their mental performance or an aversion to cold. Reports of exhaustion and dyspnea due to physical exertion are common. It is possible to detect glossitis or dysphagia at presentation, albeit it is unusual. If these characteristics are recognised, it may prompt the necessary diagnostic procedures and treatment.

Presently, ferritin is the most important metric for identifying severe iron insufficiency and therapy efficacy. Up to 4,500 iron molecules may be contained inside the ferritin protein complex structure, which functions as a cage. When there is no stainable iron in the bone marrow and the serum ferritin level is 15 µg/L or below, it is considered a diagnostic of iron deficiency. Erythropoiesis may still be impacted even at ferritin levels as high as around 40 µg/L. Erythroblasts release more soluble transferrin when iron is lacking. Soluble transferrin receptor to ferritin ratios are used to identify erythropoiesis in patients with iron deficiency. Iron reserves may not be accurately reflected by serum ferritin levels when there is substantial inflammation. Despite the lack of substantial iron storage in the bone marrow, ferritin levels over 400 µg/L are often

seen in individuals suffering from chronic renal illness (Rocha et al. 2009).

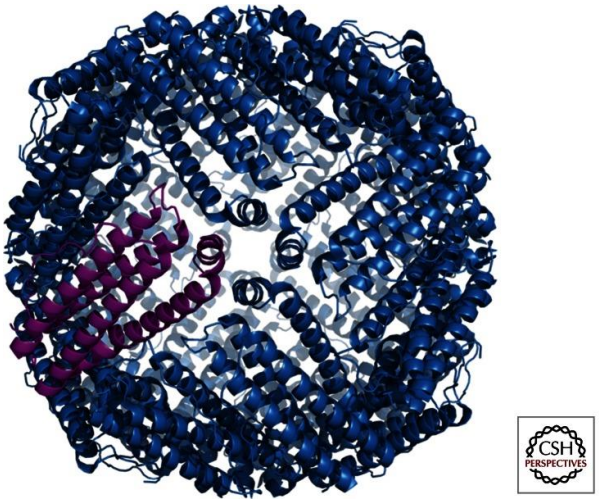

Figure 2: 3-D ribbon representation of the ferritin protein cage

SOLVING THE GLOBAL PROBLEM

Iron Fortification

In order to cure or prevent iron deficient anaemia, iron fortification is still the backbone of the industry. The most vulnerable demographic for this illness is, without a doubt, pregnant and menstrual mothers and their offspring, Schoolchildren in developing countries may have their iron and other micronutrient needs met to lower the prevalence of anaemia. In situations where quick treatment helped decrease transfusion needs, intravenous iron formulations with better toxicity profiles have recently been employed. Dosing with caution is necessary to avoid iatrogenic iron excess due to the high iron content of intravenous treatment. It is recommended that treatment be maintained until the anaemia is fully cured and the body's iron reserves have been restored. A normal hematocrit and serum ferritin level of 50-100 µg/L (equivalent to about 400-800 mg of iron in the blood for otherwise healthy persons) is required to achieve these objectives (Magnussen et al. 2008).

Delayed Clamping of the Umbilical Cord

Infants at risk of iron deficiency should get extra care. Delaying umbilical cord clamping is a simple manoeuvre that, together with maternal iron supplementation, might assist accomplish this. Delay in umbilical cord clamping was determined to be a safe treatment in 1954. It was not previously thought that placental transfusion may be a good supply of iron. It was shown in the 1960s that a substantial increase in the red cell volume may be achieved by delaying clamping for a few minutes during placental transfusion. For a baby weighing 3.5 kg, a 5-minute delay adds 166 mL of blood volume. After a vaginal birth, the baby may be placed on the mother's belly to facilitate placental transfusion, which involves clamping the umbilical chord after it stops pulsing. Clamping close to the placenta should enhance the amount of blood supplied to the infant in situations when delayed clamping is not an option, such as after a caesarean section or in other clinical settings. More evidence of the efficacy of delayed clamping in avoiding iron insufficiency in the first six months of life emerged in the 1990s. Unfounded fears of polycythemia, hyperbilirubinemia, and elevated blood viscosity may have halted the widespread use of adaptive placental transfusion up to this point. Crucially, in a study including 400 low-risk pregnancies, a three-minute lag in umbilical cord clamping after birth did not result in any of these issues (Andersson et al. 2011).

Fundamental Iron Biology Understanding

Basic research is expected to play a significant role in facilitating advancements in iron deficient anaemia treatment on a worldwide scale. The last ten years have seen substantial progress in this area, with the discovery and development of hepcidin biology being the most notable. Iron deficiency anaemia will inevitably find new uses in the future as hepcidin biology advances. In order to improve dosage regimens, it is beneficial to recognise that hepcidin expression is quite variable and affected by a circadian cycle. Research into the timing of hepcidin expression in response to iron supplementation for iron insufficiency is another uncharted territory in the quest to find the best treatment. To find out whether a quick burst of treatment will increase the likelihood of success for certain patients or groups, clinical trials comparing oral and intravenous medicines would be helpful.

CONCLUSION

Iron deficiency anemia remains a significant public health issue with profound implications for individual health and societal productivity. Nutritional strategies are pivotal in preventing and managing IDA, emphasizing the importance of adequate dietary iron intake and the enhancement of iron absorption. Ensuring access to iron-rich foods, promoting dietary diversity, and implementing food fortification programs are essential measures to combat this condition. Additionally, public health initiatives must address the socio-economic and cultural factors influencing dietary habits and iron intake. By integrating nutritional education, improved dietary practices, and targeted supplementation programs, the global burden of iron deficiency anemia can be significantly reduced, leading to better health outcomes and improved quality of life for affected populations.

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