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A review on causes of micronutrient (Iron) deficiency in India and it's treatments

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Abstract
Iron deficiency is the most prevalent micronutrient deficiency all over the world. The most affected group of population by iron deficiency is women and children and is one of the most common causes of anemia among them. It is prevalent in many countries of the developing world accounts to more women ratio than men ratio. In India, especially among child and female it is more prevalent nutritional problem. According to National Family Healthy Survey (NFHS-3) children below age of three years (78.9%) and women (55%) and men followed only at 24%.

Iron deficiency may occur due to the low intake of iron in diet which is caused due to poor diet and poverty, in women the cases are high they are found more anemic due to menstruation and poor dietary intake, However, some of the cause should be sought in case of all patients. To exclude a source of gastrointestinal bleeding medical procedure like gastroscopy/colonoscopy is utilized to evaluate the level of iron deficiency in patients without a clear physiological explanation. Inevitably, the accurate management of this disorder improves the quality of life, improves the symptoms of iron deficiency, and lessens the requirement for blood transfusion. The treatment options include oral iron supplement and intravenous iron therapy. However, this mode of treatment is not tolerable by some patients while it is insufficient in a certain subset of patients. Therefore, intravenous iron supplementation is considered undesirable approach and there is not much clarity on the safety concerns associated with this approach in case of very high doses or in the presence of very high ferritin levels. The objective of the review is to provide a critical summary and an update of the causes, diagnosis and treatment options of iron deficiency.

Keywords: micronutrient, iron, deficiency, treatments

Introduction
Iron, in the form of various combined ores, is one of the most common elements, constituting about 5% of the earth's crust. Iron is biometal that is essential for life, mainly because of its ability to accept and release electrons readily by switching between ferrous (Fe2+) and ferric (Fe3+) ions. This shift of electron between iron and donor/recipient molecules leads to several vital functions in the body. It serves as an oxygen carrier to the tissues, as a transport medium for electrons within cells, and as an integrated part of important enzyme systems in various tissues.

Iron deficiency is the state in which there is insufficient iron to maintain the normal physiological function of tissues. Iron deficiency without the occurrence of anemia is possible before the concentration of hemoglobin falls below the threshold for the specific sex and age group. (D. Errayya, 2014) [2].

Anaemia can be defined by a condition in which the total haemoglobin (Hb) level or number of red blood cells (RBCs) is poorly lowered. The World Health Organisation (WHO) defines anaemia as Hb<130 g/L in men older than 15 years, 110 g/L in pregnant women, and <120 g/L in non-pregnant women older than age 15 years. Iron deficiency anaemia (IDA) is a certain anaemic condition arising due to the inadequate iron to form normal RBCs. IDA is usually caused by insufficient iron intake, chronic blood loss, and increased iron demand. The prevalence of IDA varies across the world. Iron deficiency is a common cause of anemia worldwide. Iron deficiency is more than a hematological disorder and affects various other body organs. Lack of screening in large population, concomitant folic acid and B, deficiency, need to distinguish from other causes of microcytic anemia are challenges associated with diagnosis of iron deficiency anemia. Although oral iron is commonest treatment modality used, it is associated with several disadvantages such as need for long term therapy, gastrointestinal adverse effects, and poor patient compliance. Parenteral iron can overcome the shortcomings of oral iron and can replenish iron stores faster and to complete extent as against oral iron. Older parenteral irons such as iron dextran are associated with the risk of anaphylaxis. Choosing the right iron preparation, time constraint in anemia correction

especially during pregnancy lack of public awareness, correction of associated with hookworm infestations are several other challenges in prevention and management of iron deficiency anemia (R. Perhar, 2015) [5].

World health organization definition of anaemia

Iron is an important dietary mineral associated with many body functions like oxygen transport in the blood. Iron deficiency anaemia is characterized by incomplete haemoglobin synthesis that results in microcytic and hypochromic red blood cells. Due to inadequate haemoglobin, the ability of blood to deliver oxygen to the other body cells and tissues is reduced.

Causes of iron deficiency

Iron deficiency anemia occurs when your body doesn't have enough iron to produce hemoglobin. Hemoglobin is the part of red blood cells that gives blood its red color and enables the red blood cells to carry oxygenated blood throughout your body. If you aren't consuming enough iron, or if you're losing too much iron, your body can't produce enough hemoglobin, and iron deficiency anemia will eventually develop.

Causes of iron deficiency anemia include

- **Poverty:** it is one of the major cause of anemia India as the poverty ratio is very high in India as a result people fail to take proper nutrition in their diet which leads to many deficiency diseases including anemia.
- **Poor sanitation:** poor sanitation leads to the occurrence of malaria and worm infestation which is an ultimate cause of anemia.
- **Vegetarian diet:** In India maximum number of population is vegetarian the vegetarian diet which includes the plant based food are not better absorbed than the animal based food.
- **Lack of vit C in diet:** lack of vit C in diet leads to low absorption of iron in our body which results in it's deficiency.
- **Frequent blood donation:** people who routinely donate blood may have increased risk of iron deficiency as blood donation on the regular basis can deplete the iron stores in our body.
- **Blood loss:** Blood contains iron within red blood cells. So if you lose blood, you lose some iron. Women with heavy periods are at risk of iron deficiency anemia because they lose blood during menstruation. Slow, chronic blood loss within the body-such as from a peptic ulcer, a hiatal hernia, a colon polyp or colorectal cancer-can cause iron deficiency anemia. Gastrointestinal bleeding can result from regular use of some over-the-counter pain relievers, especially aspirin.
- **A lack of iron in your diet:** Your body regularly gets iron from the foods you eat. If you consume too little iron, over time your body can become iron deficient. Examples of iron-rich foods include meat, eggs, leafy green vegetables and iron-fortified foods. For proper growth and development, infants and children need iron from their diets, too.
- **An inability to absorb iron:** Iron from food is absorbed into your bloodstream in your small intestine. An intestinal disorder, such as celiac disease, which affects your intestine's ability to absorb nutrients from digested food, can lead to iron deficiency anemia. If part of your small intestine has been bypassed or removed surgically, that may affect your ability to absorb iron and other nutrients.
- **Pregnancy:** Without iron supplementation, iron deficiency anemia occurs in many pregnant women because their iron stores need to serve their own increased blood volume as well as be a source of hemoglobin for the growing fetus. (Swagate Yadavar, 2013) [8]

R. Perhar, 2015 [5] studied that, nutritional deficiencies of iron followed by folic acid deficiency are major causes of anemia in India. This is due to low dietary intake of iron (less than 20 mg/day), low folate intake (less than 70 meg/day) and poor bioavailability of iron due to high amount of phytates and tannins in the food. The other important contributing factors are chronic blood loss due to hookworm infestation, recurrent malaria or heavy menstrual bleeding, tuberculosis, HIV and deficiency of other important nutrients such as vitamin B12, riboflavin and copper. High prevalence of anemia during pregnancy leads to poor fetal iron stores at birth. Coupled with low breast milk concentration of iron, this is responsible for increased prevalence of anemia in early childhood.

Jeffery L, 2013 [4] studied that Iron deficiency anemia arises when the balance of iron intake, iron stores, and the body's loss of iron are insufficient to fully support production of erythrocytes. Iron deficiency anemia rarely causes death, but the impact on human health is significant. In the developed world, this disease is easily identified and treated, but frequently overlooked by physicians. In contrast, it is a health problem that affects major portions of the population in underdeveloped countries. Overall, the prevention and successful treatment for iron deficiency anemia remains woefully insufficient worldwide, especially among underprivileged women and children. Here, clinical and laboratory features of the disease are discussed, and then focus is placed on relevant economic, environmental, infectious, and genetic factors that converge among global populations.

Tesfaye M, 2015 [10] reviewed that, causes of anemia in developing countries are multi-factorial, which include nutritional (iron, folate, and vitamin B_{12}) deficiencies, infections (such as malaria and intestinal parasitic infection [IPI]), and chronic illness. Iron deficiency anemia is a condition in which anemia occurs due to lack of available iron to support normal red cell production. The prevalence of iron deficiency and subsequent anemia increases at the start of adolescence. In girls, this is caused by increased requirements of nutrition for growth, exacerbated a few years later by the onset of menstruation, but subsides for boys. The physical and physiological changes that occur in adolescents place a great demand on their nutritional requirements and make them more vulnerable to nutritional deficiencies. Adolescents are at high risk of iron deficiency and anemia. This is due to rapid pubertal growth with sharp increase in lean body mass, blood volume, and red cell mass, which increases iron requirements for myoglobin in muscles and Hb in the blood. Iron requirement increases two- to three folds from a preadolescent level of ~0.7-0.9 mg iron/day to as much as 1.37-1.88 mg iron/day in adolescent boys and 1.40-3.27 mg iron/day in adolescent girls. Anemia in adolescence has serious implications for a wide range of outcomes, and nearly all of the functional consequences of iron deficiency are strongly related to the severity of anemia. It causes reduced resistance to infection, impaired physical growth and mental development, and reduced physical fitness, work capacity, and school performance.

Riyadh A Alzaheb, 2017 [6] Studied that an overall prevalence of IDA among its sample of apparently healthy young Saudi female university students of 12.5%. The study also reported that the main risk factors in relation to contracting anemia were inadequate intakes of iron and vitamin C, frequent tea consumption, infrequent red meat consumption, and a past personal history of IDA. The findings presented here suggest a need for focused education and awareness strategies designed to improve nutritional habits by encouraging the consumption of rich sources of iron in the diet (eg, red meat), as well as by building understanding of which food and beverages can improve (eg, vitamin C-rich foods) and hinder (eg, polyphenol-rich beverages, such as tea) iron bioavailability. The current work has set a benchmark for possible future research in the form of randomized trials which would help to build greater understanding of this health issue and would also support the development of a strong and suitable public health policy which can efficiently tackle IDA.

Symptoms of IDA

Patients with iron deficiency anaemia present with symptoms that are associated with all anaemias such as pallor of the skin, conjunctivae, nail beds, fatigue, vertigo, syncope, exertional dyspnoea progressing to breathlessness at rest, tachycardia headache, and a cardiac systolic flow murmur. The patients may also show dyspnoea at rest angina pectoris and haemodynamic instability in severe cases.

Iron deficiency rapidly affects the epithelial cells thereby leading to dryness and roughness of the skin, dry and damaged hair, koilonychias and alopecia. In mild-to-moderate iron deficiency loss of tongue papillaeis reported. Atrophic glossitis is also noted in severe cases. Iron deficiency may be associated with restless legs syndrome.

Diagnosis of IDA

IDA diagnosis necessitates the laboratory investigation. IDA should not be presumed unless confirmed by laboratory testing in addition to evidence of low iron stores. Further, iron deficiency should be distinguished from the other causes of anaemia owing to its associations with the underlying disorders that necessitate particular investigation while the treatment for this is simple, safe and effective. The initial examination of anaemia follows a simple process widely used in haematology. The evaluation of the primary reason for anaemia includes a complete blood count (CBC), peripheral blood smear, reticulocyte count, and serum iron indices. A CBC can be helpful in determining the mean corpuscular volume (MCV), which measures the average size of RBCs, and mean corpuscular haemoglobin concentration, which measures the concentration of haemoglobin in a given amount of packed RBCs. The common characteristics of IDA include hypochromic RBCs, microcytic and low iron stores. Although microcytic anaemia is characterized by small red blood cells and iron deficiency, up to 40% of patients with IDA have normocytic RBCs. Other reasons of microcytic anaemia include chronic inflammatory diseases, thalassaemia, lead poisoning, and sediroblastic anaemia. The red cell distribution width (RDW) is a measure used in combination with the MCV to differentiate between mixed causes for anaemia from that of a single cause. An elevated RDW value signifies a variation in the size of the red blood cell. In addition, RDW may also be elevated at the early stages of IDA and folate with or without the deficiency of vitamin B12, both of which cause macrocytic anaemia. White blood cell (WBCs) and platelet counts help to distinguish isolated anaemia from pancytopenia. (Tafere, 2016) [9].

Population	Hb Diagnostic of anaemia (g/dL)a
Children aged 6 months to 6 years old	<11.0
Children aged 6-14 years old	<12.0
Adult men	<13.0
Adult non-pregnant women	<12.0
Adult pregnant women	<11.0

Salma Aldallal (2016) [7]

Tafere Gebreegziabher, 2017 studied that Median (IQR) Hb was 138 (127, 151) g/L. Based on an altitude-adjusted (1708 m) cutoff of 125 g/L for Hb, 21.3% were anemic. Plasma ferritin was <15 μg/L in 18.6% of the women. Only one woman had α-1-acid glycoprotein (AGP) >1.0 g/L; four women (2%) had > 5 mg/L of C-reactive protein (CRP). Of the 43 women who were anemic, 23.3% (10 women) had depleted iron stores based on plasma ferritin. Three of these had elevated soluble transferrin receptors (sTfR). Hemoglobin (Hb) concentration was negatively correlated with sTfR ($r = -0.24$, $p = 0.001$), and positively correlated with ferritin ($r = 0.17$, $p = 0.018$), plasma iron ($r = 0.15$, $p = 0.046$), transferrin saturation (TfS) ($r = 0.15$, $p = 0.04$) and body iron ($r = 0.14$, $p = 0.05$). Overall prevalence of iron deficiency anemia was only 5%.

Fatin Al-Sayes, 2011 [1] concluded that, Iron deficiency is the most prevalent nutritional problem in many parts of the world and the most common cause of anemia in Saudi Arabia especially among female. Accordingly, this study was designed to determine the prevalence of iron deficiency and iron deficiency anemia among apparently healthy Saudi young female university students studying at King Abdulaziz University in Jeddah province. Three hundred ten blood samples were collected from the students. Their ages ranged between (18 and 23) years. The data collected consisted of two sections: (A) included sociodemographic data on students such as age, height, weight, social habits, diseases symptoms, menstrual, dietary, and medical history and (B) consisted of laboratory results carried out on each subject. 50.2% of students were normal and hence considered as control group. 25.9% of students had deficient iron store and 23.9% of students had iron deficiency anemia. There was a significant correlation between iron deficiency and iron deficiency anemia with inadequate meat intake and impaired exercise capacity. Furthermore, pallor and past medical history of iron deficiency anemia were statically significant variables. Therefore, it is recommended to use screening and educational programs for iron deficiency anemia among female as high risk groups. Iron supplement and food iron fortification are required in order to overcome this simple but common health problem.

Treatment options

Iron supplements Iron tablets can help restore iron levels in our body. If possible, our should take iron tablets on an empty stomach, which helps the body absorb them better. If they upset your stomach, you can take them with meals. You may need to take the supplements for several months.

Diet

Diets that include the following foods can help treat or prevent iron deficiency:

- Red meat

- dark green, leafy vegetables
- dried fruits
- nuts
- iron-fortified cereals

Additionally, vitamin C helps your body absorb iron. If you're taking iron tablets, a doctor might suggest taking the tablets along with a source of vitamin C, such as a glass of orange juice or citrus fruit.

Treating the underlying cause of bleeding

Iron supplements won't help if excess bleeding causes the deficiency. A doctor may prescribe birth control pills to women who have heavy periods. This can reduce the amount of menstrual bleeding each month. In the most severe cases, a blood transfusion can replace iron and blood loss quickly. (Swagate Yadavar, 2013) [8].

Prevention

When iron deficiency is caused by inadequate iron intake, iron deficiency anemia can be prevented by eating a diet high in iron-rich foods and vitamin C. Mothers should make sure to feed their babies breast milk or iron-fortified infant formula.

Foods high in iron include

- Meat, such as lamb, pork, chicken, and beef
- beans
- pumpkin and squash seeds
- leafy greens, such as spinach
- raisins and other dried fruit
- eggs
- seafood, such as clams, sardines, shrimp, and oysters
- iron-fortified dry and instant cereals

Foods high in vitamin C include

- Fruits such as oranges, grapefruits, strawberries, kiwis, guavas, papayas, pineapples, melons, and mangoes
- broccoli
- red and green bell peppers
- Brussels sprouts
- cauliflower
- tomatoes
- leafy greens

(Jacquelyn, 2015) [3]

Conclusion

In India, especially among child and female iron deficiency is more prevalent nutritional problem. According to National Family Healthy Survey (NFHS-3) children below age of three years (78.9%) and women (55%) and men followed only at 24%. The main causes of iron deficiency in India includes poverty, poor diet, intake of less non-veg diet and pregnancy. Many other causes included blood loss, lack of iron in diet, inability to absorb iron, lack of vit C in diet. The early diagonisis is very important hence it may lead to some serious problems CBC the complete blood count is the best test for diagnosing the hemoglobin level in blood. The early treatments are of beneficial use, they can treat anemia at early stage, the treatments include iron supplementation in the form of tablets, consumption of green leafy vegetables and iron rich diet.

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