Review Article

A Review on Anaemia

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ABSTRACT

A frequent haematological condition called Anemia is distinguished by a reduction in the amount of red blood cells or haemoglobin, which impairs the body's ability to supply oxygen to its tissues. It remains an important global public health concern affecting people of all ages and genders, especially in developing nations such as India. Fatigue, weakness, pallor, dizziness, dyspnea, and diminished job ability are some of the indications of the illness that greatly impair quality of life. Numerous etiological causes, such as nutritional deficiencies (iron, vitamin B_{22}, and folic acid), excessive blood loss, chronic illnesses, bone marrow problems, and accelerated destruction of red blood cells, may lead to anaemia. Numerous forms of anaemia, including hemolytic anaemia, pernicious anaemia, and iron-deficiency anaemia, the pathogenesis, clinical manifestation, and treatment of sickle cell anaemia, thalassaemia, and aplastic anaemia vary. While treatment is customised to the underlying cause and may involve nutritional therapy, iron supplementation, vitamin replacement, blood transfusion, or advanced medical procedures, the basis for diagnosis is clinical evaluation and laboratory studies. To ensure that the burden of disease is reduced, preventive efforts that emphasise early identification, public health initiatives, balanced nutrition, and supplement programs are essential. Current developments in Anemia treatment outcomes have been enhanced by management, which includes targeted medicines and better intravenous iron formulations. To reduce problems and enhance overall health outcomes, comprehensive prevention, prompt diagnosis, and efficient care are crucial.

Keywords: Anaemia, iron-deficiency anaemia, pernicious anaemia, Haemolytic anaemia, Thalassemia, sickle cell anaemia, and aplastic anaemia; nutritional deficiency; haemoglobin; public health.

INTRODUCTION

When there are not enough healthy red blood cells in the body or haemoglobin, it is known as anaemia. Red blood cells in anaemia are crucial for delivering oxygen to every area of the organ tissue. Normal bodily functions are impacted by a decreased oxygen supply. A person who has anaemia frequently feels weak and exhausted all the time.[1-2] They might also experience breathlessness and vertigo. One common sign is skin that seems pale. The most frequent cause of anaemia in the world is iron deficiency. Vitamin deficits, such as those in folic acid and vitamin B12, can also cause anaemia.[3-4] Anaemia can be brought on by periods that are heavy. or excessive blood loss from injuries. The formation of red blood cells can be lowered by some chronic illnesses.[5-6] Anaemia can affect people of all ages and genders. They might also experience breathing difficulties and vertigo. A pale appearance of the flesh is a common symptom. The most common reason for anaemia is a lack of iron within the body. Deficiency of vitamins such as folic acid and vitamin B12 can also result in anaemia. Excessive loss of blood due to injury or heavy menstrual cycles may cause anaemia. Certain chronic diseases can reduce the generation of red blood cells. Anaemia can happen at any age and in both genders.[7-8] It is usually diagnosed through blood tests. Treatment varies according to the underlying cause. A nutritious and balanced diet helps in preventing anaemia. With timely medical care, anaemia can be effectively managed or cured. One is anaemia. A widespread blood condition that arises when the level of the body's red blood cells or haemoglobin falls below normal, reducing the blood's ability to deliver oxygen to tissues. Since oxygen is essential for energy production and normal cellular function, this deficiency often results in symptoms such as tiredness, weakness, lightheadedness, shortness of breath, pale complexion, and decreased work capacity. The advancement of anaemia can be attributed to several causes, such as insufficient consumption or absorption of vital minerals like iron, vitamin B_{12}, and folate.[9, 10]

Anaemia impacts people in all age ranges. and is recognized as significant blood loss due to injury, surgical procedures, heavy menstruation, or internal bleeding, is a common cause of anaemia, as it reduces the total number of red blood cells in circulation.[11] Anaemia may additionally arise from reduced red blood cell generation in the bone marrow due to nutritional deficiencies, bone marrow disorders, or chronic systemic diseases. In addition, red blood cells are prematurely destroyed in certain inherited diseases like sickle cell disease, thalassemia, and glucose-6-phosphate dehydrogenase deficiency, in addition to acquired disorders like hemolytic anaemia caused by autoimmunity.[12]

Long-term illnesses, chronic infections, inflammatory conditions, and the application of specific medications, including chemotherapeutic agents and some antibiotics, can further interfere with normal blood formation and red blood cell survival, thereby contributing to the evolution of anaemia.[13] Anaemia is recognised as a significant

worldwide health issue, especially in low- and middle-income countries where nutritional deficiencies and chronic diseases are highly prevalent. Proper diagnosis, effective prevention strategies, and timely treatment are crucial in reducing complications, improving quality of life, and enhancing overall health outcomes in affected populations.[14]

Occurrence:

In India, anaemia continues to be a significant public health issue affecting a significant amount of the population, irrespective of age or geographic location. Infants, young children, teenagers, expectant mothers, lactating mothers, and women who are of reproductive age. most commonly affected.[15] The high incidence of anaemia is primarily attributed to inadequate intake of essential nutrients such as iron, folic acid, and vitamin B_{12}, along with poor absorption due to dietary patterns that predominantly consist of plant-based and cereal-rich foods containing low levels of bioavailable iron.[16] Various social and economic factors contribute significantly to the high prevalence of anaemia in India. Food insecurity, poor sanitation, poverty, and lack of awareness regarding healthy dietary practices increase susceptibility to anaemia among vulnerable populations. Anaemia is further aggravated by recurrent infections; parasitic infestations such as hookworm and malaria; and chronic illnesses that affect regular production of red blood cells or lead to continuous blood loss.[17]

In women, the danger of anaemia is markedly increased due to early marriage, multiple pregnancies, short birth intervals, and frequent menstrual blood loss, which collectively deplete iron stores.[18] Anaemia is observed in both urban and rural populations in India; however, its determinants differ, with urban populations being affected mainly due to poor dietary choices, lifestyle changes, and a rising burden of chronic health disorders, while the prevalence is higher in rural populations. because the prevalence is higher in rural areas. services and inadequate nutritional support.[19] The widespread prevalence of anaemia in India has severe repercussions, such as diminished physical growth in children, increased risks to maternal and infant health, reduced work capacity and productivity, and an overall decline in quality of life.[20] Given its extensive burden and long-term health and socioeconomic consequences, anaemia continues to pose a major challenge to India's public health system and necessitates sustained interventions such as nutrition education, iron and micronutrient supplementation, food fortification programs, effective disease control measures, and improved access to quality healthcare services.[21]

Types of anaemia:

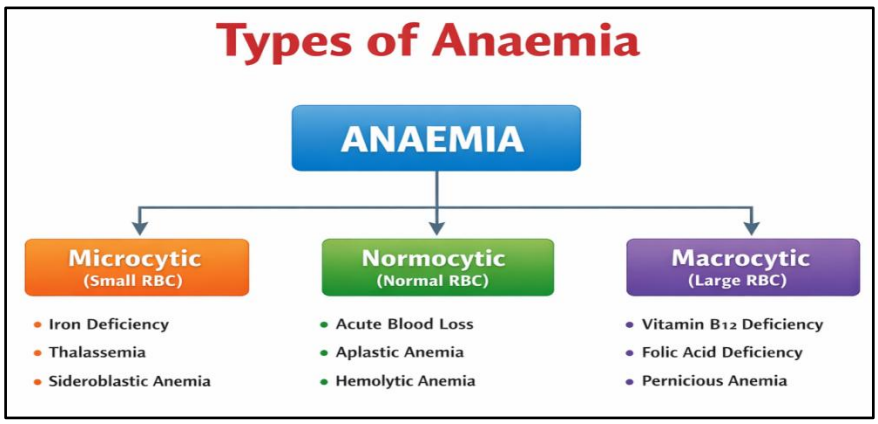

Figure 1: Types of anaemia

The cause of aplastic anaemia is decreased generation of haemoglobin; megaloblastic anaemia is brought on by defective maturation, and the cause of iron-deficient anaemia is problems in haemoglobin synthesis.[22] While hemoglobinopathies such as sickle cell anaemia and some types of thalassemia result in the development of aberrant haemoglobin, thalassemia is characterised by genetic abnormalities in haemoglobin production and maturation.[23] Furthermore, significant red blood cell loss or destruction can cause anaemia, as seen in hemolytic anaemias. Low socioeconomic position, poor nutrition, helminthic and other infectious diseases, illiteracy, and genetic blood problems are some of the environmental and socioeconomic variables that further impact the condition. Iron deficiency, hookworm infestation, and folate inadequacy are some of the main causes of the high incidence of anaemia in many countries.[24]

1. Iron-deficiency anaemia:

A prevalent form of anaemia found all over the world, including in India, is iron deficiency anaemia (IDA), which is brought about by the body not having enough iron. The creation of haemoglobin, a protein found in red blood cells, which transports oxygen throughout the body, depends on iron. Low iron levels result in a reduction in haemoglobin production, which lowers the creation of red blood cells as well as causes anaemia.[25] Additionally, numerous physiological processes depend on iron, which makes iron deficiency very serious. Because of their higher iron needs, women and adolescents have a higher chance of developing iron deficiency anaemia. Healthcare practitioners

frequently advise taking iron supplements in addition to a source of vitamin C, such as orange juice or fresh citrus fruits, because vitamin C plays a major part in improving iron absorption. The condition can be improved through an iron-rich diet and iron supplementation.[26]

***Symptoms*:** Because of the blood's decreased ability to carry oxygen, the hallmark of deficiency anaemia is a variety of symptoms. Additionally, pallor of the skin as well as mucosal membranes, affected people also report weakness, weariness, and easy tiredness. As the illness worsens, palpitations, headaches, dizziness, and shortness of breath upon exertion may develop. Brittle or spoon-shaped nails (koilonychia), hair loss, glossitis with a smooth and sore tongue, and angular cracks at the corners of the mouth are some distinguishing characteristics.[27] Additionally, patients may have pica, an unusual hunger for materials like chalk, clay, or ice. Iron deficiency anaemia in kids and teenagers can cause impaired focus, agitation, stunted growth, and worse academic achievement. Symptoms like chest pain, fainting, and heightened susceptibility to infections may be observed in severe or persistent cases.[28]

2. Pernicious anaemia:

Early management is important to prevent permanent nerve damage. Pernicious anaemia is a form of megaloblastic anaemia that results from a lack of vitamin B_{12}. It arises when the body is not able to produce intrinsic factor, a substance released by the stomach that is required for vitamin B_{22} to be absorbed. Thus, the formation of red blood cells is disrupted, consequently generating red blood cells abnormally large as well as young red blood cells with reduced oxygen-carrying capacity. The condition is frequently brought on by an autoimmune process that damages the gastric parietal cells.[29] Pallor, weakness, and exhaustion are typical symptoms. breathlessness, and neurological signs such as tingling, numbness, and memory problems. Glossitis and digestive disturbances may also occur. Pernicious anaemia is more frequently seen in older adults. Diagnosis is made through blood tests showing low vitamin B_{12} levels and antibodies against intrinsic factor. Lifelong vitamin B_{12} therapy, usually given by injections, is the mainstay of treatment. Early management is important to prevent permanent nerve damage.[30]

Symptoms: A combination of neurological, gastrointestinal, and haematological symptoms is present in pernicious anaemia, which is brought on by a vitamin B_{12} shortage brought on by poor absorption. Because the synthesis of red blood cells has decreased, common symptoms include weakness, exhaustion, pallor, and dyspnea. As the anaemia worsens, patients may also have headaches, palpitations, and dizziness. The gastrointestinal symptoms included diarrhoea, decreased appetite, weight loss, and glossitis; it is distinguished by a smooth, beefy-red tongue.[31]

3. Haemolytic aneamia:

Haemolytic anaemia is a condition marked by the early death of red blood cells before the completion of their normal lifespan. This rapid red blood cell disintegration leads to a decreased ability of the blood to carry oxygen. The bone marrow attempts to compensate by boosting the formation of red blood cells, but this response is often insufficient. Hemolytic anaemia can be classified as inherited or acquired. Inherited forms include diseases like sickle cell anaemia and thalassemia.[32] Acquired causes may include autoimmune diseases, infections, certain drugs, or mechanical injury to red blood cells· Common clinical features include fatigue, weakness, pallor, and shortness of breath. Jaundice may result from an increase in bilirubin levels from red cell breakdown. Dark-colored urine and splenomegaly are also frequently observed. Blood tests that reveal anaemia are used for diagnosis. elevated reticulocyte count, and markers of hemolysis. Management depends on the underlying causes. Early diagnosis and appropriate treatment are essential to prevent complications.[33]

Symptoms: The symptoms of anaemia caused by hemolysis are manufactured by the body's compensatory reaction to anemia as well as the early death of red blood cells. Because of reduced oxygen delivery to tissues, common symptoms include weakness, exhaustion, pallor, and dyspnea.[34] Jaundice, which is frequently accompanied by dark-colored urine, is a typical feature brought on by accelerated haemoglobin breakdown and raised bilirubin levels. When the spleen becomes overactive in eliminating damaged red blood cells, patients may develop splenomegaly and unease in the left upper abdomen.[35]

4. Sickle cell anaemia:

An example of sickle cell anaemia, an inherited blood disorder brought about by a genetic alteration in haemoglobin. The abnormal haemoglobin produced, known as haemoglobin S, results in red blood cells. becoming hard, sticky, and sickle-shaped, especially when oxygen levels are low. These abnormally shaped cells have a shorter lifespan, resulting in chronic anaemia, and they can obstruct small blood vessels, resulting in excruciating agony episodes and tissue damage. Common symptoms include fatigue, pallor, recurrent painful crises, breathlessness, and frequent infections. The illness is passed on in an autosomal recessive fashion.[36] Diagnosis is made through blood investigations, often during newborn screening. Treatment aims to reduce symptoms and prevent complications and may involve pain management, vaccinations, antibiotics, and blood transfusions, with bone marrow transplantation in extreme circumstances.[37]

Symptoms: Sickling of sickle cells is caused by red blood cells. Anaemia, a genetic hemolytic condition marked by repeated occlusive episodes and persistent anaemia. Fatigue, weakness, pallor, and dyspnea are typical signs of chronic hemolysis and decreased oxygen delivery. A defining characteristic is painful occlusive crises, which usually manifest as excruciating bone, joint, chest, or abdominal discomfort. Due to increased haemoglobin breakdown, patients may experience jaundice and black urine.[38]

5. Thalassemia:

Thalassaemia is an inherited blood illness where the body produces abnormal red blood cells as well as reduced amounts of haemoglobin. The two main forms of the illness are alpha thalassaemia and beta thalassaemia. An extreme kind of alpha thalassaemia, known as hydrops fetalis, and a serious form of beta thalassaemia, called thalassaemia major anaemia, can cause significant health complications. Thalassemia affects both males and females and is more commonly seen in populations from Italy, Greece, the Middle East, Asia, and Africa.[39] Haemoglobin inside red blood cells is composed of globin alpha and beta chains, which are essential for carrying oxygen all across the body. When the body can't produce adequate amounts of these protein chains, red blood cells are unable to function effectively, leading to reduced oxygen transport. The creation of globin chains is regulated by genes, and defects or lack of these genes result in thalassemia. This state is inherited and passed down from one generation to the next.[40]

***Symptoms*:** Chronic hemolytic anaemia is the outcome of thalassemia, an inherited haemoglobin condition marked by decreased or nonexistent globin chain production. Because of the blood's diminished ability to carry oxygen, typical symptoms consist of weakness, exhaustion, pallor, and dyspnea.[41] Due to persistent hemolysis, patients may get jaundice and black urine. Growth retardation, delayed puberty, and poor physical development are common in moderate-to-severe types, particularly thalassemia major.[42]

6. Aplastic anaemia:

Aplastic anaemia is a serious condition. The location of the bone marrow is unable to produce sufficient amounts of blood cells, including platelets, white blood cells, and red blood cells. This results in reduced oxygen delivery, increased risk of infections, and problems with blood clotting.[43] The disorder may develop due to exposure to harmful chemicals, radiation, certain medications, viral infections, or autoimmune reactions, and in some cases, it may be inherited. Individuals with aplastic anaemia often experience fatigue, weakness, frequent infections, shortness of breath, easy bruising, and prolonged bleeding. Diagnosis is made through blood investigations and bone marrow examination. Management depends on how serious the condition is and may involve blood transfusions, immunosuppressive drugs, or bone marrow transplantation.[44]

***Symptoms*:** Pancytopenia and hypocellular marrow are the hallmarks of aplastic anaemia, a bone-marrow-failing illness that causes a range of clinical symptoms. Fatigue, weakness, pallor, and dyspnea are typical signs of anaemia. Easy bruising, petechiae, epistaxis, gum bleeding, and prolonged bleeding from mild traumas are all signs of thrombocytopenia.[45]

Causes of anaemia:

Anaemia is a disease. That happens when the body doesn't possess a sufficient number of healthy red blood cells or sufficient haemoglobin to transport oxygen effectively. Among the most typical causes of anaemia is nutritional deficiency, particularly among the most popular, vitamin B_{12} or folic acid. Excessive blood loss as a result of heavy menstrual bleeding, accidents, surgery, or gastrointestinal disorders can cause anaemia as well.[46] Reduced red blood cell formation could happen as a result of bone marrow disorders such as aplastic anaemia. Chronic diseases like kidney disease, cancer, or long-term infections can disrupt red blood cell formation. Additionally, anaemia may develop due to accelerated red blood cell deterioration, a condition known as hemolytic anaemia. Genetic disorders, enhanced red blood cell deterioration, and thalassemias are inherited causes of anaemia.[47]

Pathophysiology of anaemia:

Anaemia is a condition where the blood's ability to carry oxygen is reduced because of a decline in haemoglobin concentration, red blood cells, or both. Its pathophysiology involves three primary mechanisms: Reduced synthesis of red blood cells, an overabundance of red blood cell destruction, and blood loss.

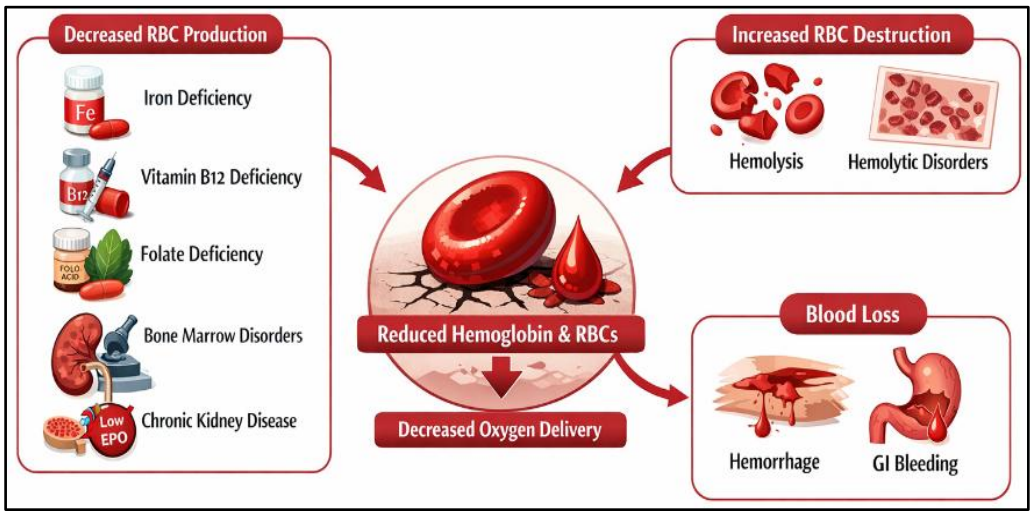

Figure 2: Pathophysiology of Anaemia

Reduced production may result from iron, vitamin B_{12}, or folate deficiency; bone marrow suppression; chronic inflammatory conditions; or decreased erythropoietin levels in kidney disease.[48] An increase in red blood cell degradation (hemolysis) occurs due to intrinsic defects such as haemoglobin abnormalities, membrane or enzyme defects, or extrinsic causes like autoimmune reactions, infections, or mechanical damage. Blood loss can be acute or chronic, with chronic loss commonly leading to iron deficiency. These processes lead to diminished oxygen delivery to tissues, resulting in tissue hypoxia. The body compensates by increasing heart rate, respiratory rate, and erythropoietin secretion to maintain oxygen supply.[49]

Nutritional treatment for anaemia:

The nutritional management of anaemia involves improving the diet to supply nutrients essential in order to make red blood cells. This includes increasing the consumption of iron-rich foods such as green leafy vegetables, pulses, meat, eggs, and whole grains, along with vitamin C–rich foods to aid iron absorption.[50] Adequate intake of folic acid from fruits and vegetables and vitamin B_{12} from animal or fortified foods is also necessary. Additionally, tea and coffee should be avoided around mealtimes, as they can reduce iron absorption.[51]

Soybean:

Soybeans are beneficial in the nutritional management of anaemia because it provides a good amount of iron, high-quality protein, and B-complex vitamins, all of which are essential for haemoglobin synthesis. Soybean is a highly nutritious legume that has a significant part in the dietary management of anaemia, particularly iron-deficiency anaemia.[52] Regular inclusion of soybeans and their products, such as tofu, soy milk, and roasted soy nuts, helps improve iron intake and supports the generation of red blood cells. It is a good plant-based source of non-heme iron, which is necessary for the synthesis of red blood cells and haemoglobin.[53] Additionally, iron and soybeans contain high-quality protein, which supports bone marrow function and aids in the creation of healthy blood cells.

Soybeans are also rich in folate (vitamin B_9), a key micronutrient required for DNA synthesis and normal maturation of red blood cells, thereby preventing megaloblastic anaemia.[54] Furthermore, soybeans provide vitamin B_6, copper, and magnesium, all of which contribute to effective iron metabolism and erythropoiesis. The presence of antioxidants and phytochemicals in soybeans helps reduce oxidative stress on red blood cells, improving their lifespan. Although soybeans contain phytates that may reduce iron absorption, this effect can be minimised by soaking, fermenting, or consuming them along with vitamin C-rich foods such as citrus fruits or tomatoes.[55] Regular inclusion of soybeans in the diet, in forms like boiled soybeans, soy flour, tofu, or soy milk, can help improve haemoglobin levels and support the prevention and management of anaemia.[56]

Peanuts:

Peanuts contribute to the nutritional treatment of anaemia because they contain iron, protein, folate, and important minerals necessary for red blood cell production.

Including peanuts and peanut products in the diet can help improve haemoglobin levels and reduce fatigue. Consuming them with vitamin C–rich foods further improves iron absorption and supports effective anaemia management.[57] Peanuts (Arachis hypogaea) are a nutritious legume that can support the dietary management of anaemia due to their content of non-heme iron, which contributes to haemoglobin synthesis and red blood cell formation. They also provide a good amount of plant-based protein, which is essential for bone marrow activity and the production of healthy blood cells.[58] In addition, peanuts are a source of folate and vitamin B_6, micronutrients required for DNA synthesis and proper maturation of red blood cells, thereby helping to prevent megaloblastic anaemia. Peanuts contain antioxidants and healthy fats that help protect red blood cells from oxidative damage and improve their lifespan.[59] Although the iron present in peanuts has lower bioavailability due to phytates and polyphenols, iron absorption can be enhanced by consuming peanuts along with vitamin C-rich foods such as lemons, oranges, or tomatoes.[60]

Corn flakes:

Cornflakes can be useful in the nutritional treatment of anaemia, especially when they are fortified with iron. They provide an easy and convenient source of dietary iron along with carbohydrates for energy. Regular consumption helps support haemoglobin formation and reduces the risk of iron deficiency. Cornflakes are especially beneficial for children and individuals with poor appetites. Taking them with vitamin C-rich fruits or fruit juices enhances iron absorption.[61] Protein and other nutrients can be added by consuming cornflakes with milk. Selecting enriched or fortified varieties further boosts their nutritional value. Thus, cornflakes can be incorporated into a balanced diet to help prevent and manage anaemia. Cornflakes are commonly used in the nutritional management of anaemia, particularly when they are iron-fortified, as they help increase daily iron intake.[62] Fortified cornflake supplies non-heme iron that supports haemoglobin synthesis and red blood cell production. They are rich in carbohydrates, providing energy that helps reduce weakness and fatigue commonly seen in anaemic individuals.[63] Many commercially available cornflakes are also enriched with B-complex vitamins such as folic acid and vitamin B_{12}, which are vital to red blood cell maturation and prevention of megaloblastic anaemia.[64] Cornflakes are easy to digest and palatable, making them especially suitable for children, elderly individuals, and patients with poor appetites. Iron absorption from cornflakes can be significantly improved when consumed with vitamin C–rich fruits or fruit juices such as orange, lemon, or guava. Adding milk increases protein, calcium, and overall nutritional value, further supporting blood formation. Thus, regular inclusion of

fortified cornflakes as part of a balanced diet can help prevent and manage iron-deficiency anaemia.[65]

Ragi:

Ragi contains high iron content. Ragi, sometimes called finger millet, is a great diet for the nutritional control of anaemia. Frequent use of ragi promotes the production of red blood cells in good health and raises haemoglobin levels. Because of its high nutritional richness, it is especially helpful for vegetarians, kids, and expectant mothers. Ragi can be easily incorporated into everyday meals because it can be made in several ways, including cereal, roti, dosa, or malt.[66] Iron absorption is improved, and its efficacy in managing anaemia is increased when ragi is consumed with meals high in vitamin C. Therefore, ragi is a cheap, readily accessible, and nutrient-dense food option for the avoidance and management of anaemia.[67]

Beet powder:

Beet powder raises haemoglobin levels; beetroot powder is helpful in the nutritional treatment of anaemia. Iron, folate, and vital antioxidants that promote red blood cell production can be found in it. Frequent consumption can lessen anaemia-related fatigue and weakness. Additionally, beetroot powder enhances vitality and blood flow. It is convenient to ingest because it is simple to add to milk, water, or other food preparations.[68] All age groups can easily incorporate beetroot powder into their daily diets. Iron absorption and efficacy are improved when beetroot powder is consumed with foods high in vitamin C. Therefore, beetroot powder can be applied as a natural and efficient dietary supplement to prevent and treat anaemia.[69]

Orange powder*:*

Orange powder is a high source of vitamin C, which improves the body's absorption of iron; it can help manage anaemia. The body uses iron from plant-based meals more effectively when it is consumed on a regular basis. Antioxidants that boost immunity and general health are also provided by it.[70] Orange powder is convenient to use because it can be readily combined with water or used in a variety of meal preparations. Consuming orange powder with foods high in iron raises haemoglobin levels. All age groups can easily incorporate it into their daily diet and preserve it. As a result, orange powder is a useful dietary supplement for both preventing and treating anaemia.[71]

Honey:

Honey helps increase haemoglobin levels and iron absorption, which is beneficial for the nutritional therapy of anaemia. Iron**,** copper, and manganese are trace minerals found in it that help produce red blood cells. Frequent use lessens the fatigue and weakness that are frequently linked to anaemia.[72] Honey also aids digestion and enhances appetite, which supports better overall nutrition. Additionally, by boosting hunger and facilitating digestion, honey supports improved overall nutrition.[73] Honey is a natural sweetener that is simple to incorporate into regular meals and drinks. Consequently, honey is a beneficial dietary supplement to aid in the management and prevention of anaemia.[74]

Mannitol:

For the nutritional treatment of anaemia, mannitol is ineffective. Iron, vitamins, and minerals needed for the formation of haemoglobin are not provided by this sugar alcohol, which is mainly employed in pharmaceutical and medical applications.[75] Mannitol hinders cells, in contrast to diets high in nutrients. Consequently, it plays no important part in treating or preventing anaemia.[76]

Vegetable:

Vitamins are needed for the development of red blood cells; vegetables are crucial in the nutritional treatment of anaemia. Particularly useful for raising haemoglobin levels are green leafy vegetables, including spinach, amaranth, fenugreek, and drumstick leaves. Additional veggies that promote blood production and general nutritional status include broccoli, pumpkin, and beetroot.[77] For vegetarians who rely on plant-based iron sources, regular consumption of these veggies is especially advantageous. Vegetables promote iron absorption, and their efficacy in managing anaemia is enhanced when consumed in conjunction with meals high in vitamin C. Vegetables are therefore essential for both managing and preventing anaemia**.**[78]

Legumes and nuts:

Legumes and nuts are beneficial in the nutritional treatment of anaemia because they provide iron, protein, folate, and other essential nutrients required for blood formation. Lentils, chickpeas, kidney beans, peanuts, and almonds help improve haemoglobin levels and support red blood cell production.[79] Including legumes and nuts regularly in the diet is especially important for vegetarians who depend on plant-based nutrient sources. Consuming legumes and nuts along with vitamin C–rich foods enhances iron absorption and improves their effectiveness. Therefore, legumes and nuts are valuable dietary components for the prevention and management of anaemia.[80]

Recent therapy for anaemia:

Iron therapy:

The cornerstone of therapy for iron-deficiency anaemia is iron therapy, which aims to raise low amounts of haemoglobin and restore the body's depleted iron reserves. Ferrous salts, like ferrous sulfate, ferrous fumarate, or ferrous gluconate, are most frequently used orally since they are efficient, affordable, and well absorbed.[81]

Red cell transfusion:

When treating severe or acute anaemia, red cell transfusion is a crucial therapeutic option, particularly when quick restoration of haemoglobin levels is necessary to avoid tissue hypoxia. To increase the blood's ability to carry oxygen, red blood cells are administered.[82] Individuals with very low haemoglobin levels, significant or ongoing blood

loss, symptomatic anaemia, or cardiovascular impairment should have red cell transfusions. It provides immediate clinical improvement, relieving symptoms such as breathlessness, fatigue, and dizziness.[83] Before transfusion, careful blood grouping, cross-matching, and screening for transfusion-transmitted infections are essential to ensure patient safety. Although effective, red cell transfusion is not a definitive treatment for anaemia and should always be combined with administration of the underlying causes.[84] Potential risks include transfusion reactions, iron excess brought on by frequent blood transfusions, and infections; therefore, its use should be judicious and based on clear clinical indications. Advanced red cell transfusion refers to the usage of modern transfusion strategies and specialised red blood products to improve safety, efficacy, and patient outcomes.[85] This includes leukocyte-reduced, irradiated, washed, and phenotype-matched dense cells of red blood, which help minimise transfusion-related complications such as febrile reactions, alloimmunization, and infection transmission. Restrictive transfusion protocols, which base infusions on clinical symptoms and haemoglobin thresholds rather than routine replenishment, are another aspect of advanced transfusion methods.[86]

Anaemia prevention and control:

Through a thorough public health and clinical strategy, anaemia prevention and control concentrate on lowering its incidence, raising haemoglobin levels, and treating underlying causes.[87] The foundation of prevention is adequate nutrition, which emphasises meals high in iron, folic acid, vitamin B_{12}, protein, and vitamin C. These diets should comprise legumes, green leafy vegetables, grains, millets, fruits, and, where appropriate, animal products. Programs that provide iron and folic acid supplements are essential for prevention, especially for susceptible populations like children, adolescents, pregnant women, and nursing mothers.[88] Regular screening and early diagnosis via haemoglobin measurement are additional control measures that allow for prompt and efficient treatment. In endemic locations, deworming, better sanitation, and access to potable water are essential. for preventing parasite infestations.[89]

CONCLUSION

Reduced haemoglobin or red blood cell counts result in anaemia, a common blood condition that impairs the body's capacity to provide oxygen to its tissues. All ages are affected; however, children, women of reproductive age, and women who are pregnant are more prone to experience it. The most frequent causes include blood loss, chronic illnesses, genetic problems, and nutritional deficiencies, particularly those related to iron, vitamin B_{12}, and folic acid. The symptoms of anaemia, which drastically lower quality of life, include weakness, exhaustion, pallor, dizziness, and dyspnea. Although the causes and clinical characteristics of various forms of anaemia differ, they all have comparable outcomes if left untreated. Using blood tests to get an early diagnosis is crucial for successful treatment. Depending on the underlying cause, treatment may involve medical therapy, dietary modifications, or supplements. Public health initiatives, supplement plans, and a balanced diet are all essential preventive measures. Anaemia is mostly preventable and cured with prompt care.

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