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Anemia Among Adolescent Girls: Prevalence, Underlying Causes, And Innovative Dietary Strategies for Sustainable Management

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ABSTRACT

Anemia is a global health concern affecting millions of people across diverse age groups, genders, and populations. This condition is characterized by a decreased quantity or quality of erythrocytes, resulting in less oxygen reaching tissues and organs. The pathogenesis of anemia is complex, involving nutritional deficiencies, chronic illnesses, genetic conditions, and blood loss. Among the most common causes are iron, vitamin B12, and folate deficiencies, particularly in developing countries. Chronic conditions such as chronic renal disease, inflammatory disorders, and malignancies further contribute to the pathogenesis of anemia. Anemia among adolescent girls is a critical public health issue, particularly in developing countries, where nutritional deficiencies, socioeconomic factors, and gender inequalities converge to exacerbate its prevalence. Adolescence is a period of rapid growth and physiological changes, resulting in significantly increased iron and micronutrient requirements. The primary causes of anemia in this demographic include iron deficiency resulting from poor dietary intake, menstrual blood loss, and inadequate iron absorption. Compounding these issues are factors such as early marriage, pregnancy, and limited access to healthcare, which amplify the risk. Anemia in adolescent girls has a detrimental impact on physical growth, cognitive development, academic performance, and immunity, ultimately diminishing their quality of life and long-term productivity. The consequences extend beyond individuals, impacting communities and national economies. Addressing this issue requires a multi-faceted approach involving dietary diversification, iron supplementation, nutrition education, and awareness programs targeting adolescents and their families.

Keywords: Anemia, Adolescent, Chronic Disease, Therapeutic Modalities, Nutrition Education

1. INTRODUCTION

The age group classified as adolescents is delineated as the span of life encompassing ages 10 to 19 years.[1] Developing nations represent approximately 5 million adolescents within the overall adolescent demographic in India, constituting an estimated 21%.[2] The World Health Organization (WHO) defines anemia as a pathological state in which the number of erythrocytes or the hemoglobin level in these cells is less than normal, or a decrease in the blood's oxygen-carrying capacity.[3] Currently, the incidence of anemia among adolescent females is escalating in India. Given that the adolescent phase marks the

onset of menstruation in females, they are predisposed to a heightened anemia.[4] The health of adolescent females is crucial in shaping the well-being of future populations in various ramifications. The cumulative repercussions of inadequate girls are manifested in elevated maternal mortality rates, the prevalence of low-birth-weight infants, increased perinatal mortality, fetal loss, and consequently diminished fertility rates.[5] Adolescent girls are accepted as a distinct phase within their life cycle that necessitates particular and focused consideration. Adolescence represents a critically significant demographic, serving as an "entrant" population for the role of parenthood. The health status during this developmental stage is crucial to health and well-being.[6] The health of adolescent females is predominantly neglected.[7] Three million weddings include girls aged 15-19 (Glimpses of Girlhood in India). Girls having their first child between the ages of fourteen and eighteen have low birth weight infants and postnatal problems.[8] Adolescent morbidity and death rates are increasing for a variety of causes. Teen morbidity and mortality rates are on the rise due to several reasons. The World Health Organization estimates that approximately 1.3 million adolescents die each year due to preventable or treatable conditions. Adolescents' primary health issues are sexual and reproductive health, nutrition concerns, and mental health concerns.[9] The adolescent demographic represents a critical period for nutritional deficiencies, thereby mitigating potential long-term implications. Within this age cohort, female adolescents are particularly susceptible and often receive insufficient attention regarding their dietary needs, health status, educational opportunities, and holistic growth and development.[10] Anemia is alternatively characterized as a diminished quantity of circulating erythrocytes or a pathological state in which the erythrocyte count (and, consequently, their oxygen transport capacity) is inadequate to fulfill physiological requirements.[11] Although it is most frequently identified through a decreased haemoglobin concentration or a lowered hematocrit.[12] Anemia may also be diagnosed using erythrocyte count, mean corpuscular volume, reticulocyte count in the bloodstream, blood smear evaluation, or haemoglobin electrophoresis.[13] At the population level and within clinical settings, haemoglobin concentration is the predominant haematological evaluation used and is the most prevalent criterion for diagnosing anemia.[14] A fundamental aspect of hemoglobin that facilitates oxygen delivery to bodily tissues elucidates the typical clinical manifestations of anemia, which include fatigue, dyspnea, and tachycardia.[15] Clinical signs, patients' medical histories, and anemia in scenarios where haematological data are inaccessible; however, their efficacy in detecting anemia is inherently constrained.[16]

2. MATERIALS & METHODS

This study used a descriptive and analytical design, combining both qualitative and quantitative data to evaluate anemia among adolescent girls. Secondary data were collected from NFHS-4 (2015–2016), NFHS-5 (2019–2021), peer-reviewed journals (2002–2024), WHO reports, and national health documents, including Anemia Mukt Bharat. Studies focusing on anemia prevalence, causes, symptoms, complications, and treatment in adolescent girls (10–19 years) were included. Data were systematically analyzed through thematic synthesis and comparative methods, with key findings presented using charts and tables to show trends, risk factors, and regional differences.

3. RESULTS AND DISCUSSION

1. Prevalence of Anemia

Understanding the pathophysiology and iron deficiency is essential for addressing its global prevalence. This study emphasizes the consequences of identifying inherited and acquired disorders, including parasitic infections, which exacerbate their severity. Anemia is significantly associated with perinatal and maternal mortality rates

worldwide.[17] Anemia prevalence is notably high, affecting 80-90 % of certain vulnerable populations. Over 20% of the global population is impacted by anemia, with 5 million cases in developed nations. The causes of anemia are primarily related to inadequate nutrient intake, which impairs global development.[18] It emphasizes the necessity of meeting the nutritional needs of adolescent girls to combat malnutrition and anemia. The National Family Health Survey (NFHS) 5 (2019-2021) reported a national anemia prevalence of 59% among adolescent girls and 31% among boys, with Tamil Nadu showing lower rates of 52.9% among girls and 24.6% among boys. The NFHS-4 indicated that 54.1% of teenage girls aged 15-19 in India were anemic. The NFHS-5 report shows an increase to 59.1%, reflecting a rise in anemia prevalence among adolescent girls within this demographic.[19, 20]

Table 1: Anemia Prevalence Across Different Groups and Regions

Survey/Study	Group	Prevalence (%)	Region	Remarks
Global Data	General Population	20%	Worldwide	Over 5 million cases in developed countries
NFHS-4 (2015-16)	Vulnerable Groups	80-90%	Worldwide	Includes pregnant women, children, and adolescents
	Adolescent Girls (15-19 years)	54.1%	India	Prevalence in adolescent girls increased in NFHS-5
NFHS-5 (2019-21)	Adolescent Girls (15-19 years)	59.1%	India	Rise in anemia prevalence from NFHS-4
	Adolescent Girls	59%	National Average	Higher prevalence compared to boys
	Adolescent Boys	31%	National Average	Lower prevalence than girls
	Adolescent Girls	52.9%	Tamil Nadu	Lower than the national average

Sources: Year of the National Family Health Survey (NFHS): 2015–16 (NFHS-4), 2019–21 (NFHS-5)

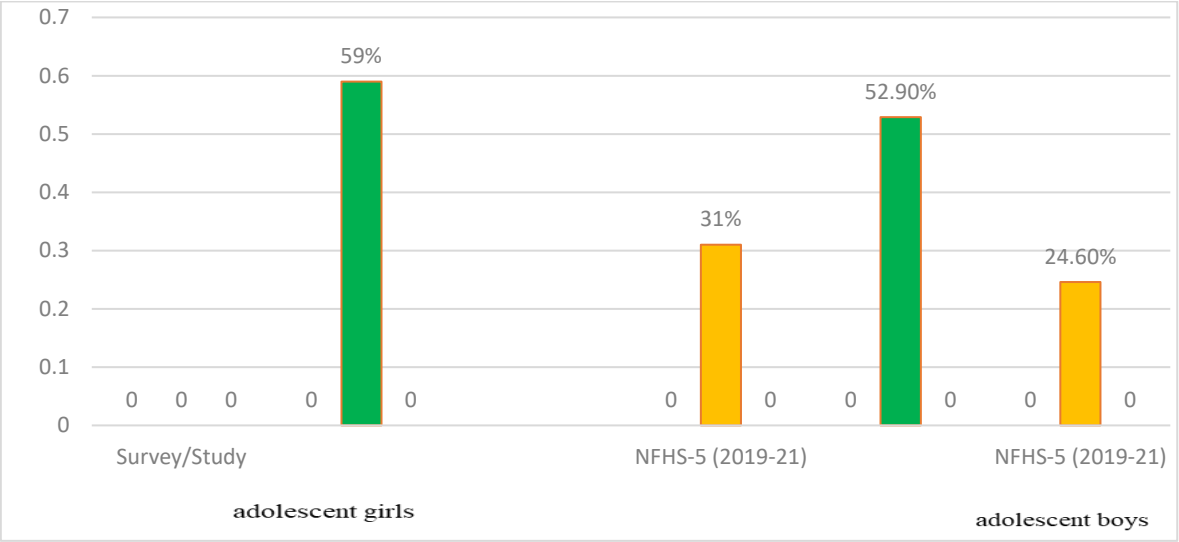

Figure 1: Comparison of Anemia Prevalence: Tamil Nadu vs. National Average

According to NFHS-5 (2019-21), the incidence of anemia among teenage girls at the national level is 59%, which is higher compared to adolescent boys, who have a prevalence of 0931%. In Tamil Nadu, the prevalence of anemia among teenage girls is 52.9%, while among adolescent boys, it is 24.6%, both of which are lower than the national average

2. Strategies to reduce anemia

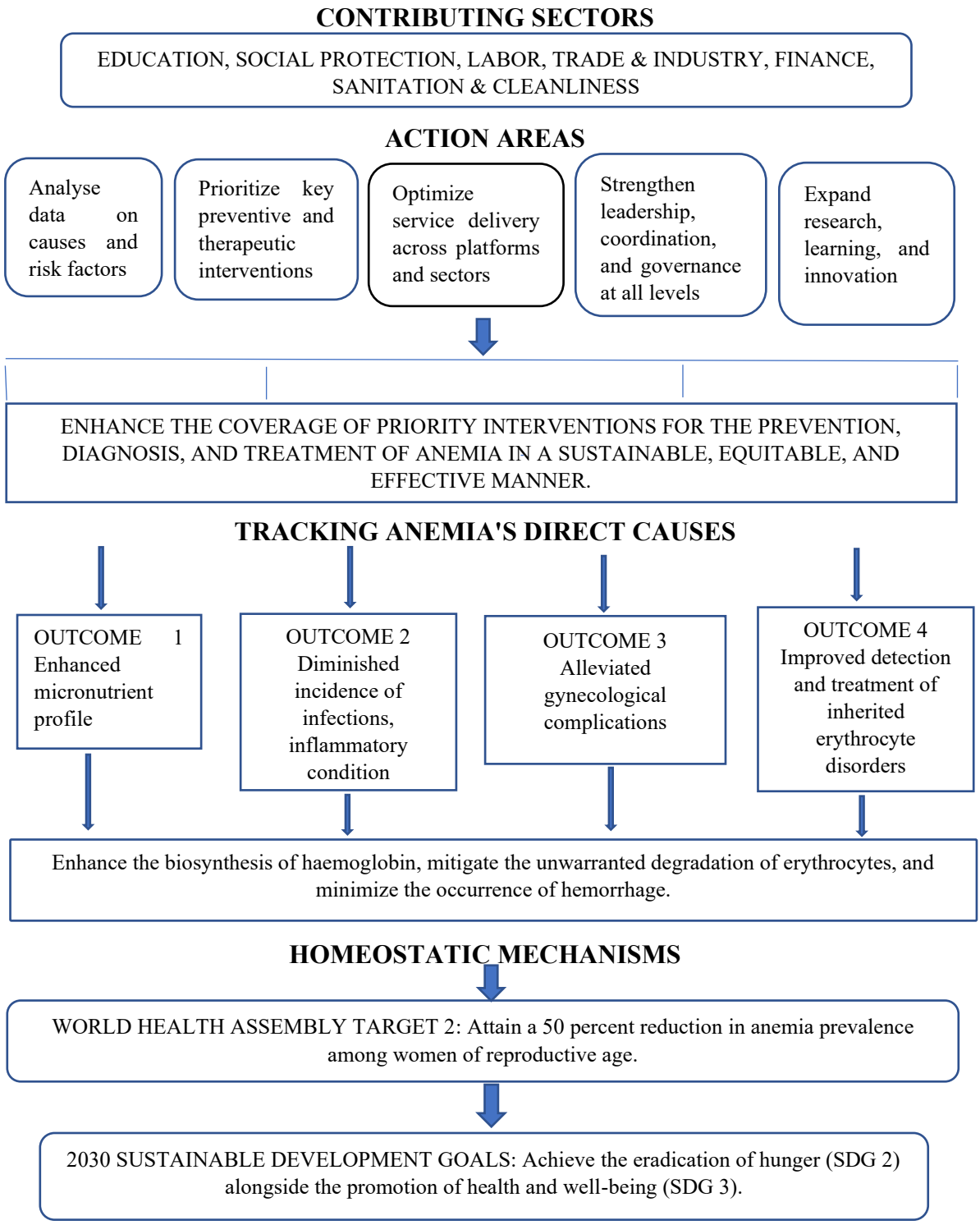

Figure 2: Sources: WHO 2023

This anemia reduction framework outlines the necessarily integrated strategy that unites various sectors and stakeholders. It defines five key action areas aimed at expanding the reach and effectiveness of interventions, leading to four primary outcomes. These outcomes, in turn, support enhanced physiological functions, contributing to a reduction in anemia and overall improvement in health and well-being.[21]

3. Rationale for an integrated framework to drive anemia reduction

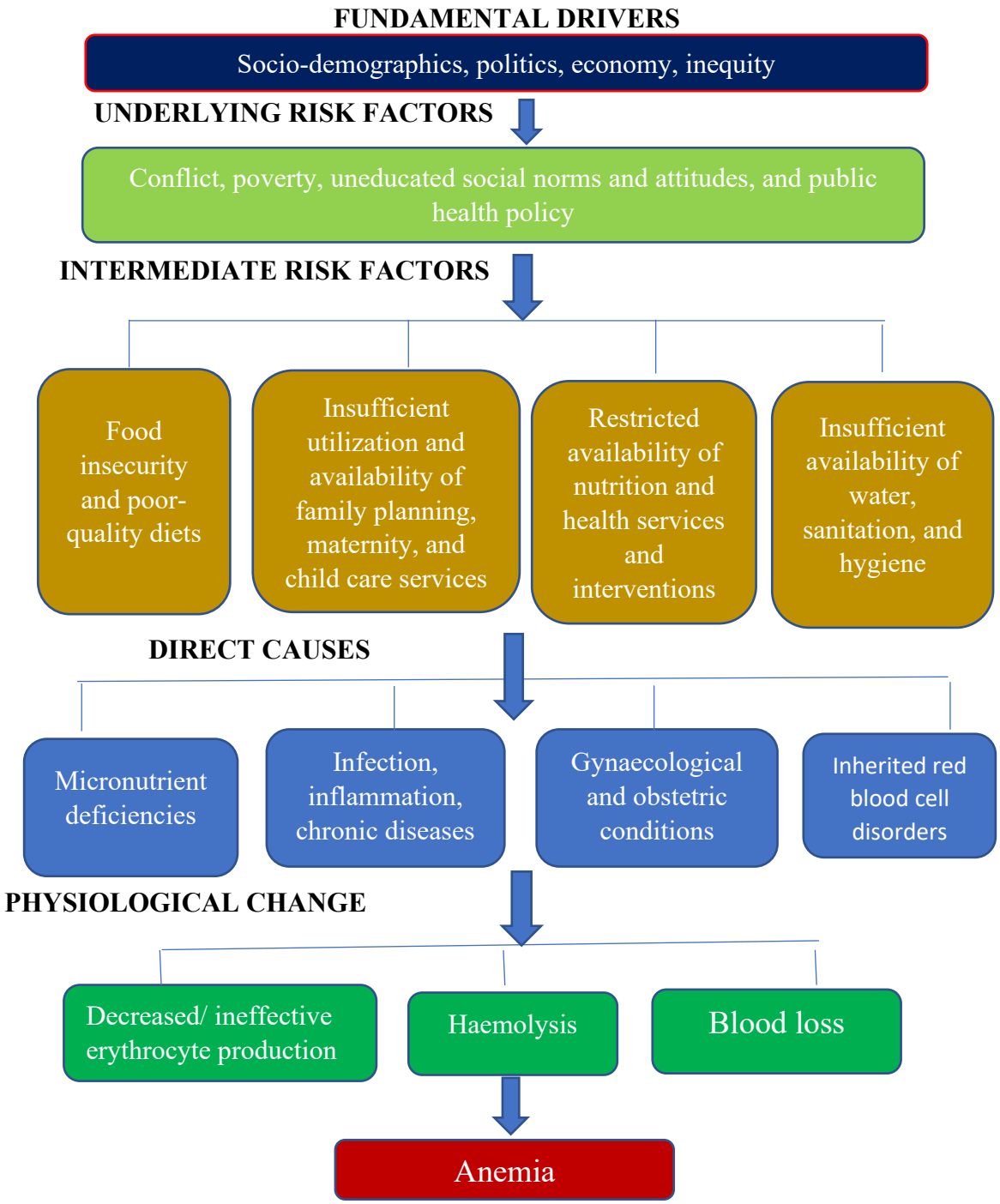

Figure 3: Conceptual framework of anemia aetiology (Sources: adapted from. [6, 22])

Iron deficiency remains the most commonly identified cause, accounting for an estimated 10% to over 60% of cases, depending on the specific population and context. Historically, efforts to combat anemia have primarily focused on preventing and treating iron deficiency. Nevertheless, other major factors of nutritional deficiencies, diseases like malaria and parasitic infections, chronic conditions, inflammatory conditions, obstetric and gynaecological disorders, and inherited disorders that influence erythrocytes. All these factors collectively play crucial roles in determining anemia rates in different groups. [22,23,24]

4. Types of Anemia

Anemia encompasses various forms and classifications. It can result from multiple red cell anomalies, such as impaired low-level (aplastic anemia), maturation issues (megaloblastic anemia), hemoglobin synthesis deficits (iron deficiency anemia), congenital disorders (thalassemia), or red cell loss (hemolytic anemias).[25]

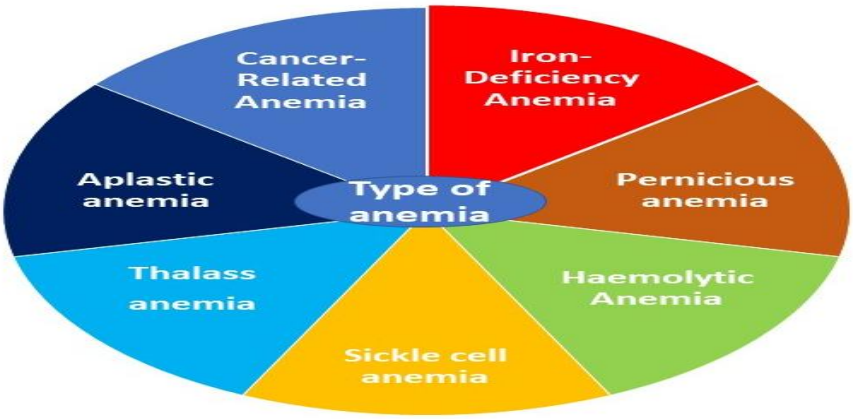

Figure 4: Types of Anemia

4.1 FeDA or sideropenic anemia

It is a condition resulting from insufficient iron in the bloodstream. Adolescents and premenopausal women exhibit a higher prevalence of this anemia. Factors such as excessive blood loss through donation, gastrointestinal bleeding, and heavy menstruation may intensify this condition. It includes pregnancy, childhood growth, heavy menstruation, impaired iron absorption, gastrointestinal haemorrhage, dietary inadequacies, certain medications, deficiencies in other vitamins, renal bleeding, bone marrow disorders, red blood cell abnormalities, and hookworm infestations. [26]

4.2 Pernicious anaemia

It plays a crucial role in sustaining human life and is essential for the production of new cells, especially erythrocytes. A deficiency in vitamin B12 can lead to anemia, additional complications. Typically, pernicious anemia manifests after the age of 50. Individuals with concurrent autoimmune disorders exhibit a higher susceptibility. Notable examples encompass anticonvulsants for epilepsy, metformin, colchicine, and neomycin.[27]

4.3 Haemolytic Anemia

Erythrocytes in hemolytic anemia are quickly extracted from the circulation and destroyed before they can reach their typical lifespan. People of various ages, genders, and ethnicities can develop hematolysis anemia. Along with conditions including hereditary spherocytosis, hereditary elliptocytosis, glucose-6 phosphate dehydrogenase (G6PD) deficiency, and pyruvate kinase deficiency, hemolytic anemia manifests as fatigue, malaise, palpitations, cardiac hypertrophy, and congestive heart failure. Additionally, hemolytic anemia may be brought on by certain illnesses and drugs.[28]

4.4 Sickle cell anemia

These cells contain abnormal haemoglobin, impeding blood flow in vessels. Consequences of this obstruction include organ damage, severe infections, and pain.

4.5 Thalassaemia

Thalassaemia is a genetic disorder characterized by reduced healthy red blood cells and haemoglobin. The primary variants are alpha-thalassemia and beta-thalassemia. Insufficient production of these protein chains impairs red blood cell development and oxygen transport. Gene regulation governs the synthesis of haemoglobin protein chains.[29]

4.6 Aplastic anemia

Aplastic anemia is a haematological disorder resulting from insufficient blood cell production by the bone marrow. This condition can lead to various health complications, including cardiac and infectious issues. Additionally, inherited genetic disorders may lead to aplastic anemia. Common manifestations include fatigue, respiratory distress, and pallor. Modalities encompass blood transfusions, stem cell transplants, and pharmacotherapy to alleviate symptoms. Stem cell transplantation serves as a potentially curative approach for the disorder.[30]

4.7 Cancer-Related Anemia

Cancer invasion is characterized by anemia resulting from malignancy. After Cancer (ASC), alongside cancer treatment modalities, including anemia induced by radiation. The encroachment of malignant cells into healthy tissues precipitates blood loss, marrow infiltration inhibits erythropoiesis, and the resultant inflammatory processes may induce functional iron deficiency, serving as the immediate causative factors of ASC. Myelosuppressive chemotherapy, commonly identified as CIA, has the potential to elicit anemia either as a monotherapy. A substantial proportion of elderly cancer patients are likely to exhibit CKD, which may arise as a consequence of chemotherapy, age-associated physiological decline, or renal dysfunction secondary to tumor infiltration. While it is plausible for patients to present with multiple contributory factors for anemia, the underlying etiology of CRA invariably pertains to the generation, destruction, or depletion of red blood cells (RBCs).[31,32]

5. Causes

A predominant contributor to iron deficiency anemia is chronic hemorrhage. In postmenopausal females, the origin of chronic hemorrhage is most frequently attributed to the gastrointestinal tract, necessitating comprehensive diagnostic evaluation to identify the source of the bleeding. In the majority of instances, the etiology of this haemorrhagic loss is benign (such as haemorrhoids); however, significant and potentially lethal causes of chronic blood loss include malignancies and vascular anomalies. Infection with hookworm can lead to additional mobility issues, including malnutrition. Hookworm infections predominantly impact pediatric populations.[33]

A significant correlation with iron deficiency anemia can be observed in cases of gastritis caused by Helicobacter pylori, necessitating further investigation or refutation. Post-gastrectomy conditions may also be linked to iron deficiency anemia, such as folic acid deficiency anemia. Iron malabsorption may also manifest with lesions affecting the duodenum, inflammatory bowel diseases, and celiac disease.[34, 35]

6. Risk factors of anemia among adolescent girls

In India, adolescent girls often experience significant anemia due to nutrient deficiencies. Such deficiencies during adolescence adversely impact reproductive health. Many teenage girls marry and bear children before reaching full physical maturity, increasing the risk. Nutritional deficiencies in these girls contribute to elevated maternal mortality, low infant birth weights, increased perinatal death rate, and increased fertility rates. The developmental stage is critical, as adequate iron status during adolescence can mitigate severe anemia in pregnant women. It also causes delays in the onset of menarche and impairs the immunological system, ultimately leading to infection. If an anemic adolescent girl becomes pregnant, it may raise fetal morbidity and mortality, perinatal risk.[36] This time is associated with recurrent menstrual blood loss during menarche, hormonal changes, low dietary iron intake, and accelerated anemia.[37]

7. Symptoms of anemia

Table 2: Symptoms of anemia

Symptom	Description
Fatigue	A state of exhaustion or diminished energy levels, distinct from sleepiness. Common in various medical conditions.
Weakness	Resolving from excessive fatigue, inadequate physical fitness, or post-exercise recovery.
Jaundice	Characterized by the yellowing of the skin, mucous membranes, or eyes due to bilirubin accumulation, indicating potential health issues.
Chest Discomfort	Manifest as a sharp pain or persistent ache, potentially radiating to the neck, jaw, back, or arms.
Cold Extremities	Indicate peripheral artery disease (PAD), especially in older adults or individuals over 50 with diabetes or a smoking history.
Headaches	The most common form of pain is often linked to tension, anxiety, depression, and stress, causing missed work or school.[38]

Sources: Patil, N., et al., 2018.[38]

8. Anemia and Its Effect on Other Conditions: A Review of Research

Table 3: Anemia and its impact on other diseases

S.no	Impact on Other Diseases	Author Year	Study design	Sample size	Anemia severity	Research Gap
1.	Immune system	Canny, S., et al., 2023.[39]	Experimental design	200	Inflammatory disease, RBC production, and clearance balance.	It provides valuable insights into inflammatory anemia mechanisms and highlights significant research gaps.
2.	Chronic liver disease	Gonzalez-Casas R, et al., 2009.[40]	Comprehensive studies	300	Hepatocellular dysfunction and coagulation abnormalities	The association between anemia and patient outcomes in CLD is underexplored, requiring further research to guide targeted treatment and improve clinical outcomes.
3.	Tuberculosis	Gelaw, Y., et al., 2021[41].	Observational studies	215,294	-	The research reveals a link between anemia and tuberculosis, necessitating more extensive studies. Furthermore, the lack of subgroup analyses constrains understanding of the regional, socioeconomic, and nutritional influences.
4.	Chronic kidney disease	Portolés, J., et al., 2021.[42]	Observational studies	300	CKD-related anemia worsens as kidney function declines, reducing EPO and iron levels and increasing inflammation.	The paper explores COVID-19's effect on anemia management in CKD patients, focusing on ESA and iron supplementation. It identifies a research gap in adjusting anemia management during pandemics.
5.	Atherosclerosis	Mark J. et al. 2002.[43]	Cross-sectional study	**Total - 14,410** men = 6,267; women =8,143	It lowers hemoglobin, strains the heart, and increases the risk of heart failure. ischemic heart disease	The study identified anemia as a CVD risk factor, but did not explore its biological mechanisms or the severity of the impact of anemia

6.	Asthma	Rhew, K., et al 2023.[44]	Retrospective cohort study	Total-3085 1354 --asthma patients 1731- healthy adults	Anti-inflammatory and inflammatory	The link between asthma and anemia remains unclear, requiring further research on the immunological and inflammatory pathways contributing to anemia in asthma patients.
7.	Alzheimer disease	Alexander Andreev et al., 2020.[45]	Observational study	Total -3,243 control group; 4,517 1,274 ADRD group.	Chronic inflammatory conditions like DM, obesity, aging, and CKD	The link between anemia subtypes, especially chronic inflammation anemia, and ADRD is underexplored, requiring further study to clarify causality and mechanisms.
8.	Dabetes	Kansal, A., et al., 2017.[46]	observational prospective study	Total -100 diabetic patients 53 males 47 females		The study highlights a significant link between anemia and diabetic retinopathy but does not delve into the mechanisms or nutritional deficits underlying anemia.
9.	Hypertension	Paul, B., et al., 2008.[47]	Observational study	187 patients	Normocytic anemia	While the study established a link between hypertension and lower hemoglobin concentration, the effect of anemia on morbidity and mortality in hypertensive patients requires more investigation.
10.	Bone marrow density	Ahmed, R. J., et al., 2024.[48]	Comparative cross-sectional design	Total -195 90 males and 105 females	Bone Mineralization, Backache, Oxidative Stress	Although previous research has connected anemia to lower bone mineral density, it remains unclear which lumbar vertebrae are most impacted by anemia.
11.	Celiac disease	Talarico, V., et al., 2021.[49]	longitudinal observational design	Total- 100	Total Iron Binding Capacity, Serum Ferritin, and Transferrin Saturation	Data on iron store recovery duration in celiac disease patients on a GFD, the effectiveness of alternative iron supplements versus ferrous sulfate, and the need for supplementation alongside GFD for treating iron deficiency anemia remains inconclusive.

9. Complications of anemia

Table 4: Complications of anemia

Complication	Description
Severe Fatigue	Advanced anemia leads to persistent exhaustion due to inadequate oxygen supply, significantly impacting daily activities and quality of life.[50]
High-Risk Pregnancy	Lack of iron, Premature birth, and low birth weight are two negative outcomes that are increased by anemia during pregnancy.[51]
Cardiac Dysfunction	Compensating for reduced oxygen levels, the heart undergoes an increased workload, potentially result in left ventricular hypertrophy and heart failure.[52]
Inherited Hemolytic Anemia	Genetic forms such as sickle cell anemia and thalassemia cause chronic hemolysis, severe complications, and increased mortality rates.[53]

10. Advances in Anaemia Treatment

Medical research teams successfully cloned the erythropoietin gene in 1988, after which the first recombinant drug became available for clinical use in 1990. Introduced for clinical use in 1990. Erythropoietin functions as standard medical treatment for anemic patients at present. Health experts deliver folic acid and intravenous iron treatment to homoanemic patients receiving dialytic renal care with standard erythropoietin therapy. Patients with functional iron deficiency should receive folic acid and intravenous iron therapy, yet chronic renal failure patients beyond the dialysis stage require only erythropoietin medication. Treatment for chronic renal failure patients who have not reached the dialysis stage mandates the exclusive use of erythropoietin pharmaceuticals. The National Institute for Health and Care Excellence sets guidelines that determine the proper erythropoietin for adult patients. Medical staff approve erythropoietin therapy based on specific haemoglobin thresholds for adult patients.

Erythropoietin is also recognized as beneficial in the treatment of:

- Cancer-related anemia in non-myeloid malignancies. [54]
- Anemia associated with myelodysplastic syndrome. [55]

While concerns regarding the elevated costs of erythropoietin exist, these must be weighed against the potential for improved clinical outcomes, reduced dependence on costly donor blood, and decreased hospital and nursing care requirements.[56]

11. Nutritional Management of Anemia

Supporting hemoglobin formulation is the primary aspect of anemia management. Anemia can be effectively treated by emphasizing foods that contain iron, copper, Galzin, folate, cobalamin, and protein. The benefits of ferrous with B complex have a complementary effect to treat anemia.

11.1. Cobalamin

Low vitamin B12 concentrations can cause pernicious anemia, which can be managed through vitamin B12 supplementation. These supplements can include fortified breakfast cereals, such as beef, liver, poultry, fish, eggs, and dairy products.

11.2. Pteroylglutamic Acid

Excellent sources of folic acid include fortified bread, pasta, rice, dark green leafy vegetables such as spinach, black-eyed peas, dried legumes, beef liver, eggs, and various fruits like bananas and oranges, and their juices.

11.3. Vitamin C

Vitamin C plays a role in enhancing iron absorption. It is abundant in many fruits and vegetables, particularly citrus fruits like oranges, grapefruits, and tangerines. Fresh and frozen fruits and vegetables typically have more vitamin C than canned. Other fruits that provide good sources of vitamin C include kiwi, strawberries, and cantaloupe. Numerous vegetables are also rich in vitamin C, including broccoli, peppers, Brussels sprouts, tomatoes, cabbage, potatoes, and leafy greens, such as spinach and turnip greens.

12. Dietary Recommendations for Anemia

Haemoglobin plays a vital role in transporting oxygen from the lungs to various tissues throughout the body. Haemoglobin levels are insufficient to deliver adequate oxygen, and anemia develops. Individuals with anemia may experience a range of symptoms, including persistent fatigue, insomnia, dizziness, pallor, shortness of breath, irregular menstrual cycles, and an unusually rapid heartbeat.

Table 5: Dietary recommendations

Category	Iron-Rich Sources	Benefits
Fruits	Apples, tomatoes, plums, bananas, lemons, grapes, raisins, oranges, figs, carrots	Provide high iron content, aiding in hemoglobin synthesis and oxygen transport.
Honey	Natural honey	Rich in iron, copper, and manganese, supporting hemoglobin production.
Vegetables	Spinach, lettuce, beets, broccoli, fenugreek, celery, kale	Contains iron, cobalamin, and folic acid, needed for anemia recovery and energy levels.
Beetroot Juice	Beetroot juice	As a tonic, it improves iron levels and reduces fatigue and lethargy.

Source: Soundarya, N., 2016.[57]

13. Anemia control in India

The National Nutritional Anemia Prophylaxis Program (NNAPP) was established in 1970, but was observed to have a minimal effect on addressing nutritional anemia. Modifications were instituted after the program's assessment to enhance its efficacy. Following the findings of the NFHS-3, which indicated a substantial prevalence of anemia among pregnant and lactating women, adolescent girls, adolescent boys, and children under five years of age, the Iron Plus initiative was established to encompass these demographics.

The National Anemia Control Programme (NACP), operational since 1991, has included a diagnostic and treatment strategy to address anemia in various settings. The Tenth Five-Year Plan highlighted the importance of universal anemia screening among pregnant women, along with providing appropriate interventions based on the severity of anemia and available treatments. The guidelines outlined in the National Iron Plus Initiative (NIPI) offer detailed instructions for implementing the program.[58]

The National Family Health Survey (NFHS) 2, conducted in 1998-99, marked the inaugural national survey to yield national and state-specific estimates of the prevalence and severity of anemia during pregnancy. Subsequently, NFHS 3 (2005-2006) disseminated national and state-specific prevalence estimates of anemia in pregnancy. The NFHS 4 (2015-2016) Fact Sheets furnish data concerning the prevalence of anemia across the nation and within all States and Union Territories (UTs). The NFHS surveys employed the HemoCue method, which includes hemoglobin (Hb) levels. DLHS 2 and 4, as AHS CAB, utilized the cyanmethemoglobin method for hemoglobin estimation.[59]

14. Anemia Mukt Bharat Strategic Interventions

Several interventions have been implemented in India to mitigate the prevalence of anemia as a component of the programme:

Prophylactic Iron and Folic Acid Supplementation: The daily administration of iron and folic acid supplements is conducted to compensate for the deficiency of these essential nutrients in the human body.

Deworming: Pharmaceutical medications such as anthelmintics are employed to eliminate parasitic infestations, including roundworms, flukes, and tapeworms.

Campaign to Practice Proper Behaviour: This encompasses initiatives aimed at enhancing adherence to the consumption of iron and folic acid supplements, as well as medications that facilitate deworming and

help sustain adequate iron levels in the body. Furthermore, workshops are held to educate caregivers on optimal feeding practices for infants and young children to encourage iron-rich foods in a varied diet. The program also requires that delayed umbilical cord clamping be practiced in all healthcare facilities after delivery.

Diagnosing and Treating Anemia: Advanced and digitized methodologies are employed for early diagnosis and treatment of anemia in vulnerable populations such as pregnant women and children.

Requiring the Availability of Iron and Folic Acid Fortified Foods The programme enforces the inclusion of iron and Folic acid in most public health initiatives that receive government funding.[60]

CONCLUSION

Anemia among adolescent females persists as a critical public health issue, carrying substantial ramifications for physical growth, cognitive advancement, reproductive health, and overall quality of life. The elevated incidence is predominantly due to nutritional inadequacies, particularly regarding iron, alongside socio-economic, cultural, and gender-related determinants that curtail access to sufficient nutrition and healthcare services. Effectively addressing anemia necessitates a comprehensive strategy that not only rectifies the deficiency but also confronts its underlying causes. Innovative and sustainable dietary interventions, including the formulation of iron-rich meal plans, the incorporation of fortified food products, the advocacy for locally sourced iron-rich constituents, and the provision of nutrition education, present viable solutions. These interventions must be culturally congruent, economically feasible, and bolstered by robust community engagement and policy frameworks. The sustainability of health outcomes for adolescent females is contingent upon a holistic and integrated model that amalgamates nutrition, educational initiatives, health services, and empowerment strategies. Emphasizing adolescent health in the present is essential for cultivating a healthier and more productive generation in the future.

Recommendations for further study

- Develop techniques for intense adult education.
- To improve the socioeconomic well-being of the community through poverty reduction programs.
- This must be complemented by programs that prevent anemia among adolescent girls through education and intervention prophylaxis.
- Prevention of worm infestation.
- Screening for anemia among the target group and referring anemic girls to an appropriate health facility.

Declaration by Authors

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