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Review of Nutritional Status and Anemia among Adolescent Girls Aged 10–19 Years in Rural India

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Abstract: *Adolescence is a critical period of rapid physical growth, sexual maturation, and increased nutritional requirements. Adolescent girls aged 10–19 years are particularly vulnerable to nutritional deficiencies because of increased requirements for iron and other micronutrients, menstrual blood loss, inadequate dietary intake, infections, and limited access to health and nutrition services. In rural India, these challenges are often intensified by poverty, food insecurity, low dietary diversity, poor sanitation, limited nutrition awareness, and gender-related inequalities in food distribution and healthcare access.*

Anaemia is one of the most important nutritional problems affecting adolescent girls and can negatively influence physical growth, cognitive performance, educational participation, immunity, and future maternal health. Nationally representative evidence from the Comprehensive National Nutrition Survey reported anaemia in approximately 40% of Indian adolescent girls aged 10–19 years, while a systematic review and meta-analysis of community-based studies estimated a substantially higher pooled prevalence of 65.7%, demonstrating considerable variation between populations and regions. Rural studies have also documented very high levels of anaemia; for example, research among adolescent girls in rural Maharashtra reported substantial iron-deficiency anaemia.

Keywords: Adolescent girls, nutritional status, anaemia, iron deficiency, rural India, micronutrients, dietary intake, menstrual health, nutrition intervention.

I. INTRODUCTION

Adolescence, generally defined as 10–19 years, represents a transition between childhood and adulthood and is characterized by accelerated growth and profound physiological changes. Nutritional requirements increase considerably during this period because adolescents experience rapid increases in body size, blood volume, muscle mass, and reproductive development. For girls, the onset of menstruation further increases iron requirements because of regular blood loss. The World Health Organization identifies adolescents aged 10–19 years as an important population for anaemia monitoring and emphasizes that menstruating adolescents are at increased risk because of repeated blood loss. In India, nutritional inadequacy during adolescence is particularly concerning in rural communities where household poverty, limited food diversity, dependence on cereal-based diets, inadequate intake of animal-source foods, poor sanitation, and restricted healthcare access may coexist. Anaemia consequently represents not only a biomedical problem but also a broader nutritional, socioeconomic, educational, and public-health concern.

II. NUTRITIONAL STATUS OF ADOLESCENT GIRLS IN RURAL INDIA

The nutritional status of adolescent girls is influenced by dietary intake, socioeconomic conditions, family food practices, physical activity, infections, reproductive health, and access to health services. Rural adolescent girls may consume diets dominated by cereals with comparatively inadequate quantities of pulses, green leafy vegetables, fruits, milk, eggs, and meat. Such dietary patterns can result in inadequate intake of iron, folate, vitamin B12, vitamin A, zinc, and high-quality protein. The problem can be further aggravated when iron-rich foods are unavailable or unaffordable. Nutritional status is also influenced by intrahousehold food allocation, with girls sometimes receiving less nutritious

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food than other household members. In addition, early marriage and pregnancy among adolescents can further increase nutritional demands.

Evidence from the CNNS provides important national-level information because it simultaneously examined haemoglobin, micronutrient biomarkers, diet, and social factors among adolescents. The survey found anaemia in 39.6% of adolescent girls, compared with 17.6% of boys, and reported that iron deficiency was the strongest predictor of anaemia. Vitamin A deficiency, zinc deficiency, and haemoglobinopathies were also associated with anaemia. These findings demonstrate that adolescent nutritional status should be assessed through a multidimensional approach rather than focusing only on haemoglobin concentration.

III. BURDEN OF ANAEMIA AMONG ADOLESCENT GIRLS

Anaemia is characterized by an insufficient haemoglobin concentration to meet physiological requirements. Among adolescent girls, iron deficiency is particularly important because rapid growth and menstruation increase iron requirements. The magnitude of the problem varies substantially according to geographic location, socioeconomic status, dietary practices, study methodology, and the population studied.

A systematic review and meta-analysis of 35 community-based studies involving 152,640 adolescent girls estimated the pooled prevalence of anaemia in Indian adolescent girls at 65.7%, with very high heterogeneity between studies. More recent regional evidence similarly demonstrates a high burden: a 2025 systematic review and meta-analysis of 32 studies involving 14,053 adolescent girls estimated pooled anaemia prevalence at approximately 65%, with regional prevalence ranging from about 52% in South India to 81% in East India. Such differences indicate that national averages can conceal substantial local and regional inequalities.

Among adolescents aged 15–19 years, analysis of NFHS-4 and NFHS-5 data found that anaemia prevalence increased from 54.0% to 59.2%, with rural residence emerging as a significant predictor in NFHS-5. These findings highlight the continuing importance of rural adolescent girls as a priority population for anaemia prevention.

IV. MAJOR DETERMINANTS OF ANAEMIA

Several interacting factors contribute to anaemia among adolescent girls in rural India. Inadequate dietary iron intake is one of the major contributors, particularly when diets contain limited haem-iron sources such as meat, fish, and eggs. Even when plant-based iron is consumed, absorption may be limited by dietary inhibitors such as phytates, while vitamin C-rich foods can improve non-haem iron absorption.

Menstrual blood loss is another important determinant. Girls with heavy or prolonged menstruation may lose considerable amounts of iron and may not compensate through dietary intake. Lack of menstrual-health knowledge and social restrictions surrounding menstruation can also delay healthcare seeking.

Micronutrient deficiencies beyond iron may contribute to anaemia. CNNS evidence identified iron deficiency as the strongest predictor but also found associations with haemoglobinopathies, vitamin A deficiency, and zinc deficiency. Infections and poor sanitation may also contribute through inflammation, parasitic infections, and impaired nutrient absorption. Socioeconomic conditions, parental education, household food security, access to health services, and adherence to iron-folic acid supplementation further influence risk.

Table 1. Major Determinants of Nutritional Anaemia among Rural Adolescent Girls

Determinant	Possible Influence on Anaemia
Inadequate iron intake	Reduces iron available for haemoglobin synthesis
Low dietary diversity	Increases risk of multiple micronutrient deficiencies
Menstrual blood loss	Increases regular iron requirements
Vitamin A deficiency	May interfere with normal erythropoiesis and iron metabolism
Vitamin B12/folate deficiency	Can impair red blood cell formation
Zinc deficiency	Associated with poor nutritional status and anaemia risk
Parasitic infections	May cause blood loss and impaired nutrient utilization

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Poor sanitation	Increases risk of infections and intestinal disorders
Poverty/food insecurity	Limits access to diverse and nutrient-rich foods
Low nutrition awareness	May contribute to inappropriate dietary practices
Poor IFA adherence	Reduces effectiveness of supplementation programmes
Early pregnancy	Increases nutritional and iron requirements

V. RURALITY, SOCIOECONOMIC CONDITIONS AND DIETARY PRACTICES

Rural residence is important because nutritional outcomes are closely connected with socioeconomic and environmental conditions. Families with limited financial resources may prioritize inexpensive staple foods rather than nutrient-dense foods. Girls may therefore consume sufficient calories but remain deficient in essential micronutrients, producing a form of "hidden hunger." Rural areas may also experience shortages of adolescent-friendly health services, limited screening facilities, transportation difficulties, and lower health literacy.

The evidence also indicates that anaemia varies considerably across Indian regions. The national CNNS analysis found prevalence among girls ranging from approximately 29% to 46% across broad regions, with particularly high state-level estimates in some eastern states. This regional variation suggests that interventions should be adapted to local dietary patterns, disease burdens, cultural practices, and health-system capacity rather than applying an identical strategy everywhere.

VI. HEALTH AND DEVELOPMENTAL CONSEQUENCES

Anaemia during adolescence can have immediate and long-term consequences. Girls with anaemia may experience fatigue, weakness, reduced physical capacity, headaches, poor concentration, and reduced participation in educational and social activities. Severe or persistent anaemia can affect cognitive functioning and physical development. Because adolescence represents a foundation for future reproductive health, unresolved nutritional deficiencies may continue into adulthood and pregnancy.

The consequences extend beyond individual health. Poor nutritional status can influence educational attainment, work capacity, productivity, and quality of life. Anaemia among adolescent girls is therefore relevant to human-capital development and intergenerational health. Improving adolescent nutrition can provide benefits not only during adolescence but also during future pregnancy and motherhood.

VII. EXISTING NUTRITIONAL AND ANAEMIA-CONTROL STRATEGIES

India has implemented several strategies to reduce adolescent anaemia. The Weekly Iron and Folic Acid Supplementation programme was developed to provide iron-folic acid supplementation to adolescent girls, accompanied by nutrition education and deworming. The national Anaemia Mukt Bharat strategy subsequently expanded the approach toward prevention, screening, treatment, and addressing multiple causes of anaemia. The CNNS evidence notes the evolution of India's adolescent anaemia programme from earlier WIFS interventions toward a broader "test and treat" approach under Anaemia Mukt Bharat.

However, implementation remains challenging. A recent systematic review of school-going adolescent girls found that inadequate dietary iron, menstrual blood loss, poor sanitation, helminthic infections, and suboptimal adherence to iron-folic acid supplementation are important factors associated with anaemia. Therefore, supplementation programmes need to be supported by education, monitoring, counselling, screening, and improved access to health services.

Table 2. Review of Major Evidence on Anaemia among Indian Adolescent Girls

Study/Source	Population/Sample	Major Finding	Relevance to Rural India
Scott et al. (2022)	14,673 adolescents aged 10–19 years	Anaemia was 39.6% among girls; iron deficiency was the strongest predictor	Demonstrates importance of micronutrient assessment
Daniel et al.	35 studies; 152,640 girls	Pooled anaemia prevalence was 65.7%	Shows substantial national

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(2023)			burden and heterogeneity
Ahankari et al. (2016)	1,010 rural girls in Maharashtra	High burden of iron-deficiency anaemia in rural adolescent girls	Direct evidence from a rural population
NFHS-4/NFHS-5 analysis	237,446 adolescents aged 15–19 years	Anaemia increased from 54.0% to 59.2%; rural residence was a significant predictor in NFHS-5	Highlights continuing rural vulnerability
Regional meta-analysis (2025)	32 studies; 14,053 girls	Pooled prevalence about 65%; substantial regional variation	Supports region-specific interventions
Duggirala et al. (2026)	Systematic review of school-going girls	Anaemia commonly linked with inadequate iron intake, menstrual loss, sanitation and poor IFA adherence	Highlights implementation gaps

VIII. RECOMMENDATIONS FOR IMPROVING NUTRITIONAL STATUS

Improving nutritional status among rural adolescent girls requires a coordinated and life-course approach. First, households and schools should promote dietary diversity through locally available iron-rich foods, pulses, green leafy vegetables, millets, eggs, dairy products, and other nutrient-dense foods. Vitamin C-rich foods should be encouraged with plant-based iron sources to improve absorption. Second, regular iron-folic acid supplementation should be accompanied by adherence monitoring and counselling rather than relying solely on tablet distribution.

Third, adolescent-friendly screening should be strengthened so that anaemia can be identified early and appropriately treated. Menstrual-health education should address heavy menstrual bleeding, menstrual hygiene, myths, and when to seek medical care. Fourth, sanitation and infection-control measures should be strengthened, particularly where parasitic infections are prevalent. Finally, community health workers, teachers, parents, and adolescent girls themselves should be involved in nutrition education and monitoring.

IX. CONCLUSION

The reviewed evidence establishes that poor nutritional status and anaemia remain major health concerns among adolescent girls aged 10–19 years in India, with rural girls representing an especially important vulnerable population. Anaemia is influenced by multiple interconnected factors, including inadequate dietary iron, low dietary diversity, menstrual blood loss, micronutrient deficiencies, infections, poor sanitation, poverty, limited nutrition awareness, and inadequate adherence to supplementation. National and systematic-review evidence demonstrates a substantial burden, although prevalence varies widely according to region and study population.

The persistence of anaemia despite national programmes indicates that supplementation alone is insufficient. Future interventions should integrate nutrition-sensitive and nutrition-specific measures, including dietary diversification, iron-folic acid supplementation, screening and treatment, deworming where appropriate, menstrual-health education, sanitation improvement, community participation, and stronger programme monitoring. Particular attention should be given to rural, economically disadvantaged, and geographically high-burden communities. A comprehensive strategy during adolescence can improve immediate health and educational outcomes while also reducing the risk of poor maternal and intergenerational health in later life.

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