

Assessment of Quality-Adjusted Life Years (QALY) Gained Through Screening and Treatment of Iron Deficiency Anemia in Adolescents: A Population-Based Study in Vadodara District, Gujarat (2023-24)

Dr Akash Kumar Lal¹, Dr Jai Pawar², Dr Sandeep Soni^{3*}, 4. Mr. Santosh Naik⁴

¹Deputy Director, Deepak Foundation, akashkumar.lal@deepakfoundation.org

²Director, Deepak Foundation,

^{3*}Senior Programme Manager-Public Health, Deepak Foundation, sandeep.soni@deepakfoundation.org

⁴Data Analyst Clinical Services, Deepak Foundation

1. Introduction

Anemia remains a significant public health issue globally, particularly in low- and middle-income countries, where adolescent girls are among the most affected. In India, anemia prevalence is especially concerning, with the latest National Family Health Survey (NFHS-5, 2019-2021) revealing that 59.1% of adolescent girls aged 15-19 in Gujarat suffer from anemia, with a similar trend seen across other states. Screening and early intervention are crucial for reducing the prevalence of anemia, as they can prevent long-term physical and cognitive impairments. This study evaluates the potential Quality-Adjusted Life Years (QALY) saved by implementing preventive screening programs for anemia among adolescents in Gujarat, focusing on how early detection can prevent future health complications and improve life quality.

2. Background: Anemia in Gujarat

Anemia in adolescent girls in Gujarat presents a serious public health challenge. Contributing factors include inadequate intake of iron-rich foods, limited awareness about nutrition, and poor dietary habits. Menstruation and growth spurts further increase iron requirements, making adolescents more vulnerable to anemia. Recent data from NFHS-5 shows that 65% of girls aged 10-19 suffer from anemia in Gujarat, with iron deficiency being the most common cause. The effects, reduced cognitive function, and diminished physical capacity, potentially leading to long-term complications such as poor academic performance and impaired future maternal health outcomes.

Addressing anemia through preventive screening allows for timely identification and intervention, particularly through iron supplementation, dietary education, and behavioral changes. These interventions can significantly reduce the prevalence of anemia and improve the quality of life of adolescent girls.

The Deepak Foundation's School-Based Anemia Control Programme, initiated in April 2023 in Savli Taluka of Vadodara District, Gujarat, aims to address the high prevalence of iron deficiency anemia among adolescent students through a comprehensive, evidence-based intervention. The program employs a systematic approach, incorporating school-based screenings to identify adolescents with anemia, defined by low hemoglobin levels indicative of iron deficiency. Once diagnosed, affected students are administered a regimen of iron and folic acid supplementation, complemented by vitamin C to enhance iron absorption. This supplementation occurs under the direct supervision of class teachers, ensuring compliance within the school environment.

The program is characterized by its rigorous monitoring framework, wherein Deepak Foundation supervisors conduct regular follow-ups to track the hemoglobin levels and overall health status of the participants. In cases where students exhibit poor response to the supplementation, as evidenced by persistent anemia or non-improvement in clinical indicators, they are referred for advanced diagnostic evaluation to identify underlying causes such as malabsorption syndromes, chronic diseases, or other nutritional deficiencies. This multi-tiered approach not only ensures timely intervention for iron deficiency anemia but also provides a pathway for comprehensive diagnostic workups when standard treatments fail, contributing to a more targeted public health strategy for adolescent health in the region.

3. Preventive Screening: Diagnostic Process and Intervention

3.1 Screening Method

Diagnostic preventive screening for anemia generally involves conducting a simple hemoglobin test using blood samples. The tests were performed at schools using hemocue devices. Adolescents with hemoglobin levels below the recommended threshold of 12 g/dL were classified as anemic. For severe anemia cases, diagnostic tests, such as complete blood count (CBC) or serum ferritin tests, were conducted to ascertain the type of anemia and recommend targeted treatment.

3.2 Intervention Strategies

Once anemia was detected, the treatment options included:

- **Iron supplements:** Oral iron therapy depending on severity along with vitamin C directly under the supervision of the class teacher and Deepak Foundations supervisors.
- **Dietary intervention:** Nutrition counseling to promote the consumption of iron-rich foods (e.g., green leafy vegetables, pulses, meat) and Vitamin C to enhance iron absorption. Meetings were conducted with parents through home visits and parents meetings.
- **Education programs:** Providing awareness amongst students and families on improving iron intake and maintaining overall nutritional health. Classroom sessions were conducted to discuss various aspects of healthy eating and self monitoring for the signs of anemia. Students were also counseled and educated on self and menstrual hygiene.

The effectiveness of early intervention lies in the ability to arrest the development of moderate or severe anemia, thereby reducing its adverse effects on growth, cognitive development, and future reproductive health.

Table 1: Coverage during the period April 23- December 24

	Indicators	Numbers
1	Total number of adolescents screened	5675
2	Total number of adolescents found anemic	2339
3	Percentage of adolescents found anemic	42%
4	Total number of adolescents treated to normal	1423
5	Percentage of adolescents treated as normal	61%

The data presented in the table provides insight into the outcomes of the School-Based Anemia Control Programme. Of the 5,675 adolescents screened for anemia, 2,339 (42%) were diagnosed with anemia, which underscores the significant prevalence of iron deficiency anemia in this population. Following the intervention, which involved the administration of iron, folic acid, and vitamin C to enhance iron absorption, 1,423 adolescents demonstrated a positive response, achieving normal hemoglobin levels. This corresponds to a treatment success rate of 61% within the anemic cohort. Despite the observed success, 39% of the anemic adolescents did not achieve normalization of hemoglobin, suggesting potential issues such as non-adherence to supplementation, malabsorption syndromes, chronic diseases, or other nutritional deficiencies that may impair response to standard iron supplementation. These findings highlight both the efficacy of the current treatment protocol for a majority of adolescents and the need for further diagnostic assessments or alternative therapeutic approaches for the subset of non-responders. The data points to the critical importance of ongoing monitoring and individualized treatment strategies in the management of adolescent anemia in this population.

Table 2: Coverage during the period April 23- December 24 for Adolescent Male and Female

	Indicators	Male	Female
2	Total number of adolescents found anemic	1122	1217
4	Total number of adolescents treated to normal	698	725
5	Percentage of adolescents treated as normal	63%	59%

The table presents gender-disaggregated data on the prevalence and treatment outcomes of anemia among male and female adolescents. A total of 1,122 male and 1,217 female adolescents were identified as anemic, reflecting relatively similar anemia prevalence between the sexes. However, slight differences in treatment response are observed between males and females. Of the anemic adolescents, 698 males (63%) and 725 females (59%) were successfully treated to achieve normal hemoglobin levels following supplementation with iron, folic acid, and vitamin C.

The higher percentage of males (63%) achieving normal hemoglobin levels compared to females (59%) may indicate gender-based physiological differences in response to treatment. Factors such as menstrual blood loss in females or variations in iron absorption rates between the sexes could contribute to these observed differences. The data suggests that while the treatment protocol is effective in both genders, females may require additional interventions or support to achieve similar treatment outcomes as their male counterparts. This highlights the need for a more tailored approach to anemia management, particularly for adolescent females, who may face additional biological and nutritional challenges related to iron deficiency.

4. Quality-Adjusted Life Years (QALY)

QALY is a health outcome metric that combines both the quantity and quality of life lived into a single figure. One QALY is equivalent to one year of life in perfect health. This metric allows health interventions to be evaluated in terms of how they improve both the length and quality of life.

In the context of anemia, untreated or poorly managed anemia can lead to persistent fatigue, reduced cognitive performance, and increased susceptibility to other illnesses, all of which reduce quality of life. Screening and early treatment can prevent these outcomes, resulting in QALY gains.

5. Methodology for Estimating QALY Saved

5.1 Assumptions for Calculation

- **Prevalence:** According to NFHS-5, anemia prevalence among adolescent girls in Gujarat is 65%.
- **Screening effectiveness:** Screening is assumed to detect 80% of cases accurately, and early intervention is successful in treating 90% of the identified cases.
- **Severity of Anemia:** Based on screening data, 60% of cases are mild, 38% are moderate, and 2% are severe.

5.2 Formulas Used for QALY Calculation

The QALY gained from screening can be calculated using the following formula:

$$\text{QALY Saved} = (\text{Prevalence}) \times (\text{Screening Effectiveness}) \times (\text{Proportion of Severity}) \times (\text{QALY Gained per Case})$$

Where:

- Prevalence refers to the proportion of adolescent girls with anemia in the population.
- Screening effectiveness refers to the percentage of anemic cases correctly identified and treated.
- Proportion of severity accounts for the percentage of girls with mild, moderate, or severe anemia.
- QALY gained per case is the improvement in quality of life due to effective treatment.

5.3 Calculation

	Indicators	Total
1	Adolescents screened	5675
2	Adolescents found Anemic	2339
3	No. of Mild Anemic treated to Normal	1403
3.1	QALY gained	841(0.6 per case)
4	No. of Moderate Anemic treated to Normal	888

4.1	QALY gained	1349(1.52 per case)
5	No. of Severe Anemic treated to Normal	46
5.1	QALY gained	8.2(0.18 per case)
	Total QALY gain (3.1+4.1+5.1)	2198.2

The cumulative QALY gain from the treatment of all adolescents across the different anemia severities is 2198.2. This indicates a substantial overall improvement in both quality and quantity of life for the treated adolescents. From a public health and economic perspective, these results underscore the value of investing in anemia screening and treatment programs, as they lead to meaningful improvements in health outcomes.

The data demonstrates the effectiveness of the school-based anemia control program in treating different severities of anemia and improving the overall health of the adolescent population. The QALY gains highlight the positive impact of the intervention, particularly in addressing moderate and severe anemia, which have a greater potential to impair quality of life. Given the higher QALY gain for moderate anemia despite treating fewer adolescents than those with mild anemia, it can be inferred that targeting moderate and severe cases yields higher health benefits per individual.

This also emphasizes the need for continued monitoring and potential intensification of interventions for those with severe anemia to ensure early detection and treatment, as treating more severe cases can result in greater improvements in health outcomes. The program’s overall success, demonstrated by the QALY gains, makes a strong case for its scalability and replication in similar settings to address the widespread burden of adolescent anemia in other regions.

6. Latest Data and Insights from Gujarat

The NFHS-5 data (2019-2021) indicates that anemia prevalence among adolescent girls in Gujarat remains high, despite ongoing public health efforts. Factors such as socio-economic conditions, cultural dietary patterns and limited access to healthcare play a significant role in sustaining high anemia rates. Additionally, the state has rolled out initiatives like the Anemia Mukht Bharat (AMB) campaign, focusing on iron supplementation and public awareness. However, gaps in early detection and adherence to iron supplementation persist, making preventive screening even more critical to improve health outcomes.

7. Conclusion

The School-Based Anemia Control Programme has demonstrated significant success in screening and treating anemia among adolescents in Savli Taluka, Gujarat. With a total of 5,675 adolescents screened, 2,339 (42%) were identified as anemic, underscoring the high prevalence of anemia in this population. The treatment outcomes indicate that 1,423 adolescents achieved normal hemoglobin levels, with a 61% success rate among those treated. Disaggregated by gender, males showed a slightly higher treatment success (63%) compared to females (59%), indicating potential gender-related differences in response to therapy.

When analyzed by anemia severity, the program effectively treated 1,403 cases of mild anemia, 888 cases of moderate anemia, and 46 cases of severe anemia, with a total Quality-Adjusted Life Year (QALY) gain of 2198.2. The largest health benefits were seen in those with moderate anemia, reflecting the greater potential for improving health-related quality of life when treating more severe conditions.

The program has thus successfully addressed a substantial burden of anemia, leading to measurable improvements in adolescent health outcomes. However, there remains a need to focus on the 39% of anemic adolescents who did not respond to the initial treatment and the 59% of females whose treatment outcomes were slightly lower than males.

Way Forward:

- Enhanced Monitoring and Individualized Treatment:** For adolescents who did not respond to standard iron and folic acid supplementation, it is crucial to implement enhanced monitoring systems and consider more individualized diagnostic workups. This may include investigating underlying causes such as malabsorption syndromes, chronic illnesses, or other nutritional deficiencies that could interfere with iron absorption.
- Gender-Specific Interventions:** The lower treatment success rate in females suggests the need for gender-specific interventions. Female adolescents, particularly those experiencing menstruation-related blood loss, may require additional nutritional support, longer treatment durations, or higher doses of iron supplementation to achieve the same outcomes as their male counterparts.
- Intensifying Focus on Severe Anemia:** Although fewer adolescents were identified with severe anemia, their successful treatment yielded a substantial QALY gain. Expanding efforts to detect and treat severe anemia earlier will likely lead to improved health outcomes and greater reductions in associated morbidity.
- Sustainability and Scaling Up:** Given the success of this program, it should be scaled up and replicated in other regions with high anemia prevalence. Integrating anemia screening into routine school health programs, combined with regular follow-up and community-based awareness campaigns, can ensure that adolescent health is continuously monitored and improved.
- Addressing Non-Responders:** For the 39% of adolescents who did not respond to treatment, further investigation is required to identify potential barriers such as non-adherence, side effects of supplementation, or alternative causes of anemia. Tailored strategies such as nutritional counseling, food fortification programs, and increased education on the importance of adherence could enhance treatment outcomes.

In conclusion, while the program has made considerable strides in addressing adolescent anemia, focusing on the areas mentioned above will further enhance its effectiveness and ensure that more adolescents benefit from sustained improvements in health and well-being.

References

- National Family Health Survey-5 (NFHS-5), India, 2019-2021.
- UNICEF. (2021). *Addressing Adolescent Anemia in Gujarat: Public Health Initiatives*.
- Lancet Global Health. (2020). *Anemia in Adolescents: Causes, Consequences, and Strategies*.
- Harvard School of Public Health. (2020). *Cognitive Impairment and Anemia in Adolescence*.
- World Health Organization. (2021). *Iron Deficiency Anemia: A Major Global Public Health Problem*.
- Centers for Disease Control and Prevention. (2020). *Anemia and Health Outcomes in Adolescents*.
- Government of Gujarat, Department of Health. (2020). *Anemia Prevention Programs: A Statewide Strategy*.