"Prevalence of Anemia in Tribal Populations: A Regional Study from Peth Region"

Niranjan Ramesh Giri

M. J. M. A. ACS. College Karanjali. Tal.Peth. Dist. Nashik. Maharashtra Savitribai Phule Pune University Pune, Maharashtra

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Anemia remains a major public-health challenge in India, particularly among tribal adolescents who face nutritional, social, and cultural disadvantages. This cross-sectional study assessed the prevalence and determinants of anemia among 200 adolescents (10–19 years) from a remote tribal area of the Peth region, Nashik District, Maharashtra. Hemoglobin levels were estimated using the cyanmethemoglobin method, and socio-dietary data were obtained through structured questionnaires. Results revealed that 68 % of girls and 54 % of boys were anemic, mostly of moderate severity. Inadequate dietary diversity, early menarche, poor sanitation, and limited healthcare access were key contributing factors. Compared with national data from NFHS-5 (2019–21), anemia prevalence in this tribal cohort was markedly higher. Gender-based disparities and cultural taboos restricting food intake during menstruation further worsened the problem. The findings underscore the need for targeted school-based iron supplementation, nutrition education, and culturally sensitive interventions. Addressing anemia in tribal adolescents is vital for improving health equity, educational outcomes, and future socioeconomic development.

Keywords: Adolescents, anemia, hemoglobin, tribal health, malnutrition, gender disparity

INTRODUCTION

Background and Significance

Anemia remains one of the most persistent public-health challenges in India and worldwide. According to the World Health Organization (WHO, 2023), nearly 1.8 billion people—approximately one-quarter of the global population—suffer from anemia, with the heaviest burden in South Asia and Sub-Saharan Africa. In India, the National Family Health Survey-5 (2019–21) reports that 57 % of women aged 15–49 years and 25 % of men are anemic. The prevalence is even higher among children and adolescents, particularly within tribal and rural populations where poverty, dietary monotony, and limited access to healthcare persist.

The Tribal Health Context in India

Tribal communities constitute about 8.6 % of India's population, representing a remarkable diversity of culture, language, and ecology. However, most tribal groups live in geographically isolated areas with restricted healthcare facilities, poor sanitation, and inadequate infrastructure. These conditions foster a vicious cycle of malnutrition and infection that contributes significantly to anemia. Several reports from Maharashtra, Madhya Pradesh, Odisha, and Jharkhand show higher anemia rates among tribal adolescents than among non-tribal peers (Colah et al., 2017; Pasricha, 2021). Despite national initiatives such as Anemia Mukt Bharat (AMB), coverage in remote tribal zones remains suboptimal because of logistic difficulties, poor compliance, and cultural barriers.

Why Adolescence Matters

Adolescence (10–19 years) is a critical developmental period marked by rapid growth and increased nutritional demands. Iron requirements peak due to accelerated muscle development, red-blood-cell production, and—in girls—the onset of menstruation. Iron deficiency during adolescence has lasting effects: it impairs cognitive and physical performance, increases susceptibility to infection, and, in females, raises risks of obstetric

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complications later in life. In tribal regions, these biological vulnerabilities intersect with socioeconomic deprivation. Diets dominated by cereals and millets, low intake of fruits and animal protein, and limited health awareness exacerbate iron deficiency. Cultural taboos—such as restrictions on specific foods during menstruation—further elevate risk among girls.

Existing Knowledge and Research Gaps

While numerous studies have examined anemia among pregnant women and children, comparatively few focus on **tribal adolescents**, a group that bridges the transition from childhood to adulthood. Data from the NFHS-5 emphasize adolescent vulnerability but often aggregate tribal and non-tribal populations, masking regional differences. Localized field studies are therefore crucial to understand community-specific determinants such as food practices, sanitation behaviors, education levels, and gender norms. Moreover, prior research has frequently emphasized biological measures while neglecting social and cultural dimensions that shape nutritional outcomes. An integrated, interdisciplinary perspective combining biomedical data with sociocultural insights can provide a more complete understanding.

Regional Context: Peth Region, Nashik District

The Peth taluka of Nashik District in northern Maharashtra is predominantly inhabited by the **Kokana** and **Warli** tribes, who depend largely on subsistence agriculture and seasonal labor. The terrain is hilly, rainfall-dependent, and often cut off from urban centers during monsoon months. Access to healthcare is limited to a few primary health sub-centers with irregular outreach. Nutritional programs such as school mid-day meals and iron supplementation often face logistical gaps, irregular supply, and cultural resistance. Preliminary observations from local health workers indicate widespread fatigue, pallor, and poor scholastic performance among adolescents—symptoms suggestive of chronic anemia. However, systematic documentation for this area has been lacking.

Policy Deficiencies and Implementation Barriers

The **Anemia Mukt Bharat** (AMB) strategy launched in 2018 by the Ministry of Health and Family Welfare aims to reduce anemia prevalence among children, adolescents, and women by 3 percentage points per year through a six-pronged approach: (1) prophylactic iron–folic acid supplementation, (2) testing and treatment, (3) deworming, (4) behavioral change communication, (5) strengthening of institutional delivery mechanisms, and (6) inter-sectoral convergence. Despite these measures, NFHS-5 data show limited progress in tribal belts. Gaps in health education, mistrust of biomedical interventions, and logistical hurdles (e.g., irregular supplement supply, lack of trained staff) continue to constrain program effectiveness.

The Need for a Focused Regional Study

Given the interplay of biological, social, and environmental factors, anemia among tribal adolescents in Peth region demands detailed investigation. A community-based, mixed-methods approach can elucidate not only the **prevalence** but also the **determinants** of anemia—dietary inadequacies, cultural restrictions, gender norms, and health-service barriers. Understanding these local dynamics will provide evidence to refine existing public-health strategies and guide culturally responsive interventions. Furthermore, regional data can feed into national monitoring frameworks to ensure that tribal voices are represented in policy formulation.

Research Objectives

The present study aims to:

Assess the prevalence and severity of anemia among tribal adolescents aged 10–19 years in the Peth region of Nashik District, Maharashtra.

Identify key socio-demographic, nutritional, and cultural factors associated with anemia.

Compare local prevalence with national and state-level trends (NFHS-5).

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Recommend targeted, gender-sensitive, and culturally acceptable interventions for effective anemia control.

Conceptual Framework

The study is grounded in a biopsychosocial model that recognizes anemia as a product of interacting determinants—biological (iron deficiency, infections), behavioral (dietary habits, hygiene), and structural (poverty, education, healthcare access). Such a framework moves beyond purely medical explanations and emphasizes the importance of social context in shaping health outcomes.

CONCLUSION OF INTRODUCTION

Anemia among tribal adolescents is more than a medical condition—it reflects deep-rooted inequities in nutrition, education, and opportunity. By documenting prevalence and underlying causes in one of Maharashtra's remote tribal belts, this study contributes valuable evidence toward national efforts such as **Anemia Mukt Bharat** and the **National Nutrition Mission**. The findings are expected to inform both local-level interventions and broader policy deliberations aimed at reducing anemia-related disparities.

Materials and Methods

Study Design

A **cross-sectional, community-based study** was conducted to assess the prevalence and determinants of anemia among tribal adolescents residing in the Peth region of Nashik District, Maharashtra. The design combined biomedical assessment with socio-demographic and dietary surveys, providing both quantitative and qualitative insights.

Study Area and Population

Peth taluka lies in the northern tribal belt of Maharashtra and is primarily inhabited by the **Kokana** and **Warli** tribes. The region is characterized by hilly terrain, seasonal agriculture, limited healthcare access, and dependence on government welfare schemes. The adolescent population (10–19 years) forms nearly 18 % of the total community.

The study focused on three purposively selected villages—**Karanjali**, **Dongarpada**, and **Ambegaon**—chosen for their accessibility and representation of typical tribal living conditions.

Study Sample and Justification

A total of **200 adolescents (100 boys and 100 girls)** were enrolled using **stratified random sampling** to ensure proportional representation of both genders and different age groups (10–14 years and 15–19 years).

Sample size estimation was based on the formula:

n=Z2×P(1−P)/d2n = Z^2 \times P(1 - P) / d^2n=Z2×P(1−P)/d2

where Z = 1.96 (95 % confidence), P = expected prevalence = 0.60 (60 %, from NFHS-5 rural Maharashtra data), and d = 0.07 (7 % margin of error).
The calculated minimum sample was **189**, which was rounded to **200** to compensate for potential non-response. This sample size ensures adequate statistical power for subgroup comparisons.

Inclusion and Exclusion Criteria

INCLUSION

Adolescents aged **10–19 years** residing in the selected villages for at least one year.

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Participants who provided informed consent (and assent for those <18 years) along with parental approval.

Exclusion:

Individuals with known chronic diseases (renal, hepatic, hematologic disorders).

Those under medication that could affect hemoglobin levels (iron therapy, steroids, etc.).

Pregnant girls were excluded to avoid confounding due to gestational anemia.

Data Collection Tools and Techniques

Data collection was carried out between **January and March 2025** through household and school visits.

(a) Hemoglobin Estimation

Capillary blood samples (20 µL) were obtained under aseptic precautions using sterile lancets. Hemoglobin concentration was measured using the **cyanmethemoglobin method** with a portable photo-colorimeter, following WHO (2011) standards.

Anemia was classified according to WHO cut-offs for adolescents:

Mild: 11.0–11.9 g/dL

Moderate: 8.0–10.9 g/dL

Severe: < 8.0 g/dL

Dietary Assessment

A **24-hour dietary recall** and **food-frequency questionnaire** were administered to estimate iron-rich food intake, dietary diversity, and consumption of inhibitors (tea, phytates). Respondents were also asked about deworming frequency and supplementation compliance.

Socio-Demographic and Cultural Survey

Structured questionnaires captured information on age, education, parental occupation, family income, sanitation, and menstrual practices among girls. Interviews were conducted in the local Marathi and Kokana dialects by trained field investigators to ensure accurate responses.

Data Analysis

Data were compiled and analyzed using SPSS v.26**.**

Descriptive statistics (mean, SD, percentages) summarized demographic variables.

The **Chi-square test** examined associations between categorical variables (gender, anemia severity, dietary habits).

t-tests compared mean hemoglobin between subgroups.

Statistical significance was considered at $p < 0.05$.

Ethical Considerations

Ethical clearance was obtained from the **Institutional Ethics Committee of M.J.M. Arts, Commerce & Science College, Karanjali**. Informed consent was obtained from all participants or their guardians. Privacy

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and confidentiality were maintained throughout the study. Participants identified as severely anemic were referred to the nearest Primary Health Centre for medical management.

Quality Control

All equipment was calibrated daily, and 10 % of samples were cross-checked at the PHC laboratory for validation. Questionnaires were pre-tested in a pilot group of 20 adolescents to refine language and cultural appropriateness.

RESULTS

Demographic Profile

A total of **200 tribal adolescents** (100 boys and 100 girls) from three villages—Karanjali, Dongarpada, and Ambegaon—participated in the study.
The **mean age** of respondents was **14.8 ± 2.6 years**.

Most belonged to nuclear families (63 %) and relied on agriculture or daily wage labor as their primary livelihood.

Nearly **78 %** of parents had not completed secondary education, and **69 %** of households reported monthly incomes below ₹8,000.

Access to safe drinking water was limited (58 %), and only **46 %** had sanitary latrines.

Prevalence and Severity of Anemia

Out of 200 participants, **122 (61 %)** were found to be anemic according to WHO criteria. Gender-wise prevalence showed that **68 % of girls** and **54 % of boys** were anemic. Moderate anemia was the most common category in both sexes (girls 42 %; boys 38 %), followed by mild anemia (girls 21 %; boys 13 %).

Severe anemia was observed in **5 %** of girls and **3 %** of boys.
The difference in prevalence between genders was statistically significant ($\chi^2 = 4.72$; $p < 0.05$).

Table 1. Prevalence and Severity of Anemia by Gender

Gender	Mild (%)	Moderate (%)	Severe (%)	Total (%)
Boys (n = 100)	13	38	3	54
Girls (n = 100)	21	42	5	68

Nutritional and Dietary Patterns

Dietary assessment revealed that **87 %** of adolescents consumed cereal-based meals three times a day, but intake of iron-rich foods such as green leafy vegetables (29 %), pulses (46 %), and animal protein (18 %) was low.
Consumption of tea immediately after meals—known to inhibit iron absorption—was reported by **72 %** of respondents.
Only **22 %** had ever received iron–folic acid (IFA) tablets through school programs.

Figure 1**.** Dietary diversity score among tribal adolescents (Bar chart)

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Socio-Cultural Determinants

Among girls, **63 %** reported food restrictions during menstruation, mainly avoidance of leafy vegetables and eggs.
Low parental literacy and poor sanitation were significantly associated with higher anemia prevalence ($p < 0.05$).
Adolescents who had deworming in the past six months showed higher mean hemoglobin levels (11.6 ± 1.2 g/dL) compared with those who had not (10.8 ± 1.4 g/dL).

Comparison with National Data

The overall anemia prevalence of **61 %** in this tribal cohort exceeds the national adolescent average of **41 % (NFHS-5, 2019–21)**.

This disparity underscores the disproportionate burden faced by marginalized tribal populations despite ongoing interventions under the **Anemia Mukt Bharat** programme.

Summary of Key Findings

Anemia is **highly prevalent (61 %)**, particularly among girls.

Dietary monotony, poor hygiene, and low education levels are major contributors.

Gender-specific socio-cultural taboos further increase female vulnerability.

Program coverage (IFA supplementation, deworming) remains inadequate in remote tribal regions.

DISCUSSION

Overview of Findings

The present study reveals a **high prevalence of anemia (61%)** among tribal adolescents in the Peth region of Nashik District, Maharashtra. The burden is notably greater among girls (68%) than boys (54%), consistent with patterns observed across tribal and rural populations in India. These results emphasize that despite national programs such as Anemia Mukt Bharat (AMB), anemia remains a deeply rooted public-health issue influenced by nutritional, cultural, and socio-economic determinants.

Comparison with National and Regional Data

The overall prevalence recorded in this study is **substantially higher than the national average** for adolescents reported in the **NFHS-5 (2019–21)**, which indicated 59.1% among girls and 31% among boys. Regional studies from tribal belts of **Odisha (60%)**, **Jharkhand (64%)**, and **Madhya Pradesh (57%)** (Pasricha, 2021; Colah et al., 2017) also echo similar trends, confirming that tribal adolescents continue to experience disproportionate vulnerability.
Such findings highlight persistent regional inequities and suggest that program reach and compliance in remote tribal areas remain limited. Moreover, the higher prevalence among girls reinforces the intersection of **gender and culture** in shaping nutritional outcomes.

Nutritional Determinants and Dietary Patterns

Dietary assessment identified **poor diversity** and **low consumption of iron-rich foods** as major contributing factors. Most adolescents relied on cereal-based diets with minimal fruits, pulses, and animal protein—patterns similar to those observed in rural Maharashtra and Madhya Pradesh (Balasubramanian et al., 2023). The widespread consumption of **tea after meals (72%)**, which inhibits iron absorption due to tannins, further exacerbates the problem. This pattern reflects both habit and lack of nutrition education.

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Iron deficiency is the dominant cause of anemia globally, accounting for nearly 50% of cases (WHO, 2020), but in tribal populations, **multifactorial etiologies** are evident—dietary insufficiency combined with chronic parasitic infections, repeated malaria, and poor hygiene practices. These determinants collectively reduce iron bioavailability and increase loss through intestinal bleeding.

Gender Disparities and Cultural Taboos

The significant difference between boys and girls ($p < 0.05$) is biologically and culturally mediated. Menstrual blood loss, when compounded by low dietary intake and early menarche, leads to higher susceptibility among girls.

In this study, **63% of girls reported dietary restrictions during menstruation**, mainly avoidance of leafy vegetables and eggs—foods rich in iron and folate. Similar findings were reported in tribal studies from **Dahanu (Maharashtra)** and **Sundargarh (Odisha)**, where cultural taboos limited girls' nutritional intake during menstruation (Kalaivani, 2009).

Such practices, rooted in traditional beliefs about impurity, perpetuate nutritional deprivation and reinforce gender inequity. Addressing these barriers requires culturally sensitive communication and the involvement of community elders, women's groups, and schoolteachers.

Socio-Economic and Environmental Factors

The study establishes a clear link between **parental education, household income, and anemia prevalence.** Over two-thirds of participants belonged to families earning less than ₹8,000 per month, and 78% of parents lacked secondary education.

Low literacy reduces understanding of dietary needs and healthcare utilization. Moreover, **poor sanitation** and **limited access to clean water** facilitate parasitic infections, further aggravating anemia.

These findings are consistent with reports from NFHS-5, which show that districts with lower education and sanitation coverage have higher anemia rates. This multidimensional interplay of poverty, hygiene, and awareness aligns with the **social determinants of health** model.

Comparison with Global Evidence

Globally, South Asia continues to bear the highest anemia burden, with prevalence rates of 45–60% among adolescents (Stevens et al., 2013). Studies in Bangladesh and Nepal report similar figures and highlight dietary inadequacies as central causes.

However, the **tribal context of India adds an additional layer of cultural complexity**. In African and Latin American regions, community-driven health promotion and food fortification programs have demonstrated success (WHO, 2014). India can draw lessons from these examples to tailor interventions that combine biomedical and cultural approaches.

Effectiveness of Current Programs

The Government of India's Anemia Mukt Bharat (AMB) initiative aims to reduce anemia prevalence by 3 percentage points annually through six interventions, including iron–folic acid supplementation, deworming, and behavioral change communication.

However, the present study reveals **low program penetration**—only 22% of adolescents had ever received IFA tablets. Implementation barriers such as irregular supply, limited school outreach, and lack of local awareness restrict impact. Moreover, community skepticism about "western medicine" and supplement side effects reduces compliance.

Therefore, health strategies must move beyond distribution to **community engagement and ownership**, incorporating tribal traditions and indigenous foods.

Role of Education and Schools

Schools can act as **critical platforms for anemia control**. Teachers can monitor IFA consumption, organize nutrition awareness sessions, and dispel myths surrounding menstruation and diet. Integrating health education into school curricula has shown positive outcomes in similar rural settings (Horton & Ross, 2003).

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In tribal regions like Peth, schools often serve as the only formal institution accessible to adolescents, making them ideal centers for integrated health programs, periodic screening, and referral linkages with primary health centers.

Emerging Solutions and Innovations

Advances in **nanotechnology-based iron formulations** and **fortified staple foods** offer promising alternatives to improve iron absorption and reduce gastrointestinal side effects (Beard et al., 2021). Community-level **food fortification (iron-fortified salt or rice)** could provide sustained, population-wide benefits, especially where dietary change is slow.

Combining these innovations with **traditional practices**, such as promoting iron-rich indigenous foods (e.g., nachni, drumstick leaves, black gram), could improve local acceptability.

Limitations of the Study

While this study provides valuable insights, certain limitations should be acknowledged. First, its **cross-sectional design** limits causal inference between anemia and contributing factors. Second, **biochemical parameters** other than hemoglobin (e.g., ferritin, folate, vitamin B12) were not measured due to logistical constraints.
Third, findings are specific to three villages in Peth region and may not be generalizable to all tribal groups. Nevertheless, the inclusion of both biomedical and socio-cultural dimensions offers a holistic understanding and a strong base for further longitudinal and intervention-based research.

Policy and Public-Health Implications

Findings underscore the need for **multi-sectoral approaches** integrating nutrition, education, sanitation, and gender empowerment.
Recommendations include:

Strengthening **school-based IFA distribution and deworming** with active teacher participation.

Implementing **nutrition education sessions** using local language and culturally relatable visuals.

Training **Anganwadi and ASHA workers** to counsel adolescent girls and parents on dietary diversification.

Encouraging **community participation** through local leaders and tribal healers to dispel myths about menstruation and food restrictions.

Expanding **food fortification programs** using locally consumed staples to ensure sustainability.

Future Research Directions

Future studies should incorporate biochemical profiling (serum ferritin, folate, B12) to distinguish iron deficiency from other causes of anemia. Qualitative methods such as focus-group discussions could further explore gender norms and cultural beliefs. Longitudinal intervention trials in collaboration with local schools and primary health centers can evaluate the effectiveness of community-based anemia control models.

CONCLUDING REMARKS OF DISCUSSION

The persistence of anemia among tribal adolescents reflects a convergence of nutritional deficits, cultural practices, and socio-economic inequality. Addressing it requires both scientific rigor and cultural sensitivity. Biomedical interventions alone will not suffice; sustainable change will arise from empowering communities, respecting traditions, and integrating indigenous knowledge with modern health programs.

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CONCLUSION

This study demonstrates that anemia among tribal adolescents in the Peth region of Nashik District remains a **serious and multifactorial public-health challenge**. With an overall prevalence of **61 %**, the problem is significantly higher than national averages, underscoring persistent inequities in nutrition and healthcare access. Girls are particularly vulnerable because of menstrual blood loss, dietary restrictions, and entrenched cultural taboos that limit their consumption of nutrient-rich foods.

The findings reveal that poor dietary diversity, low parental literacy, inadequate sanitation, and limited awareness form a complex web of risk factors. Despite the existence of national programs such as Anemia Mukt Bharat, field implementation remains weak in remote tribal areas. Effective control of anemia requires a paradigm shift—from isolated biomedical interventions to **community-anchored, culturally informed strategies**.

Key recommendations include:

Strengthening school-based programs for regular iron–folic acid supplementation, deworming, and hemoglobin screening.

Integrating nutrition and health education into school curricula and community meetings, emphasizing locally available iron-rich foods such as nachni, drumstick leaves, and pulses.

Empowering adolescent girls and mothers through culturally sensitive counseling that addresses menstruation-related myths and encourages equitable food distribution.

Collaborating with tribal leaders, teachers, and ASHA workers to improve trust, compliance, and local ownership of health initiatives.

Expanding food-fortification schemes using regionally consumed staples for sustained impact.

Addressing anemia in tribal adolescents is not only a biomedical necessity but also a **moral and developmental imperative**. Ensuring the nutritional well-being of these youth will strengthen educational attainment, economic productivity, and the overall health equity of India's tribal communities.

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