



Review Article

NUTRITION TRANSITION AND DETERMINANTS OF IRON DEFICIENCY ANAEMIA AMONG INDIAN TRIBAL COMMUNITIES

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ABSTRACT

Anaemia remains a major global public health problem, affecting approximately 24.8% of the population. The burden is disproportionately higher among socially and economically marginalized communities, particularly tribal populations in India. Traditionally, tribal diets were diverse and nutrient-rich, providing natural sources of essential micronutrients; however, ongoing dietary transitions and urbanization-driven changes have gradually altered these food patterns. **Objective:** To examine the association between urbanization-driven dietary transition and anaemia among tribal communities, and its role in iron deficiency. **Methods:** A narrative review and analytical synthesis were conducted using epidemiological studies, nutrition transition literature, and documented tribal dietary practices. **Results:** Anaemia prevalence among tribal populations ranges from 51% to over 70% in various regions. Urbanization has led to reduced consumption of iron-rich traditional foods such as millets, pulses, leafy greens, and forest products, alongside increased intake of refined cereals and processed foods with lower micronutrient density. Factors such as phytates, tannins, and reduced vitamin C intake further influence iron absorption. **Discussion:** Dietary transition plays a significant role in sustaining the high burden of anaemia among tribal populations by eroding indigenous food systems and thereby reducing the natural dietary protection against iron deficiency. Addressing this issue requires integrated strategies focusing on preservation of traditional diets, promotion of millets, strengthening of tribal agriculture, and culturally appropriate community-based interventions.

INTRODUCTION

Anaemia remains one of the most prevalent nutritional disorders worldwide and continues to pose a significant public health challenge, particularly in low- and middle-income countries. According to the World Health Organization (WHO), anaemia is defined as a reduction in haemoglobin concentration below 12g/dL in women and 13g/dL in men, resulting in diminished oxygen-carrying capacity of the blood and impaired physiological function.^[1] Globally, approximately 24.8% of the population- nearly 1.6 billion individuals- are affected, underscoring its magnitude and health consequences.^[2]

Tribal populations in India represent one of the most vulnerable groups with respect to anaemia, with multiple epidemiological studies consistently indicating a disproportionately high burden in these communities. This establishes anaemia as a significant public health concern among tribal populations. Women of reproductive age, the elderly, and individuals from lower socioeconomic backgrounds appear particularly susceptible.

The heightened burden among tribal populations is primarily driven by nutritional deficiencies and food insecurity, further compounded by recurrent infections, poverty, limited healthcare access, and socio-cultural marginalization. Traditional tribal diets were diverse, forest-based, and nutrient-dense, ensuring adequate intake and bioavailability of essential micronutrients. However, recent studies show that urbanization has shifted these patterns toward refined and processed foods, reducing dietary quality and micronutrient intake.

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This dietary transition has reduced iron density and absorption while promoting chronic inflammation and micronutrient deficiencies. Emerging evidence suggests that erosion of indigenous food systems may be a critical determinant of the persistent high prevalence of anaemia among tribal communities. Understanding the interaction between dietary transition and anaemia is therefore essential for designing culturally appropriate and sustainable public health interventions.

MATERIALS AND METHODS

Study Design

This study is a narrative review and analytical synthesis examining the association between urbanization-driven dietary transition and anaemia in tribal populations. It integrates epidemiological evidence, nutritional analysis, and socio-environmental determinants.

Data Sources and Literature Review

A structured literature search was conducted using PubMed, Google Scholar, WHO publications, and institutional repositories.

Inclusion Criteria

- Studies on anaemia in tribal populations in India.
- Research articles published in indexed journals on dietary patterns, nutrition transition, and indigenous food systems.

- WHO publications, NFHS reports, ICMR publications and government policy documents relevant to tribal health and nutrition.

Exclusion Criteria

- Articles lacking sufficient methodological details or full text availability.
- Non-scientific sources (except relevant policy documents).

Quality Appraisal

No formal tool was applied. However, preference was given to peer-reviewed studies, WHO guidelines, and methodologically sound research.

Analytical Framework

A conceptual model was used to explain pathways linking dietary transition to anaemia, including reduced iron intake, impaired absorption (phytates/tannins), low vitamin C intake, and inflammation-related poor iron utilization.

Ethical Considerations

This study used secondary data only; hence, ethical approval was not required

RESULTS

The synthesis of epidemiological evidence indicates that anaemia is highly prevalent among tribal populations across India, consistently exceeding public health thresholds.

Table 1: Anaemia Prevalence in Tribal Populations of India

Region/Tribe	Prevalence (%)
Paniya, Kurichiya, Kuruma, Adiya, Kattunayakan (Kerala tribal communities) ³	78.3%
Jenukuruba tribe (Mysuru, Karnataka) ⁴	77.1%
Koraga, Marathi naik (tribal women Udupi) ⁵	55.9%
Irular tribes (Tamil Nadu) ⁶	76%
Tribal population in Madhya Pradesh ⁷	76.7%
Ahom, Garo(Assam tribal populations) ⁸	59.82%
Gallong, Apatani, Miniyoung, Bokar, Tagin, Bori, Nishi, Ahom (Arunachal Pradesh tribal populations) ⁸	53.77%
Tripuri, Riyang, Adi, Jamatia, Chakma, Naotia, Debbarman (Tripura tribal populations) ⁸	57.45%
Bhuyan and Kharia (Orissa tribal population) ⁹	55.9%

Table 2: Nutrient Composition of Key Traditional Foods

Food	Iron (mg/100g)	Key Nutrients
Ragi (finger millet) ¹⁰	5.47	Calcium (264-365 mg), fibre
Kulthi (horse gram) ¹¹	8.76 ± 1.16	Protein (21.73±0.29), fibre
Mahua ladoo ¹²	4.05 ± 0.21	Energy-rich
Bamboo shoots (B.bamboos) ¹³	3.00	Vitamins (B6, A, E), amino acids
Green leafy vegetables	-	Iron, folate
Forest fruits	-	Vitamin C
Animal-source foods	-	Heme iron, B12

Traditional tribal diets were found to be nutritionally rich and diverse, providing essential micronutrients required for haemoglobin synthesis.

DISCUSSION

Traditional tribal diets and nutritional significance

Historically, tribal food systems were deeply rooted in ecological sustainability, biodiversity, and seasonal availability.^[14] Diets were composed of millets (e.g., ragi), pulses such as *Kulattha* (horse gram), green leafy vegetables, forest fruits, bamboo shoots, and locally sourced animal foods, which together provided a balanced supply of macro and micronutrients essential for haemoglobin synthesis. These foods were naturally rich in non-heme iron, protein, calcium, folate, and vitamin C, all of which are crucial for erythropoiesis.^[15] Moreover, traditional culinary practices such as fermentation, soaking, and zero-waste utilization of plant parts likely enhanced nutrient bioavailability and minimized anti-nutritional factors.^[16] Thus, indigenous dietary patterns functioned as an intrinsic protective system against micronutrient deficiencies, including iron deficiency anaemia.^[17]

Impact of urbanization and dietary transition

Historically, tribal communities followed physically active lifestyles and consumed diverse, minimally processed diets rich in millets, legumes, forest foods, and locally available seasonal product, which contributed to better dietary diversity and nutritional balance. However, rapid urbanization, deforestation, and increasing market penetration have led to significant disruption of these traditional food systems.^[18] The transition from diverse, coarse-grain-based diets to polished rice, refined wheat, and ultra-processed foods represents a fundamental shift not only in food composition but also in nutritional quality. These modern diets are typically energy-dense but micronutrient-poor, resulting in reduced dietary iron density despite adequate or even increased caloric intake.^[19] The displacement of millets and legumes, which are inherently rich in iron and fibre, by refined cereals has significantly lowered the overall micronutrient intake of tribal populations. The gradual dietary shift toward refined cereals resulted in reduced intake of dietary fibre and micronutrients, contributing to the rising burden of lifestyle disorders.^[20]

Changing food preferences and lifestyle patterns

Moreover, changing preferences over period of time, influenced by taste, texture, appearance, and availability have led to the gradual decline in acceptance of traditional foods. This dietary shift has been accompanied by increased consumption of energy-dense, processed, and commercially produced

foods. Simultaneously, lifestyle changes such as reduced physical activity, increasing dependence on market-based foods, reduced time devoted to traditional food preparation, changing occupational patterns, and declining household engagement in food cultivation and forest food collection have further altered dietary practices among tribal populations.^[21]

Socio-environmental determinants of dietary change

Socio-environmental factors further intensify vulnerability. Deforestation, biodiversity loss, and restricted access to forest resources have significantly reduced the availability of wild foods that were once central to tribal diets.^[22] Additionally, younger generations are increasingly adopting urban dietary preferences, leading to a gradual erosion of traditional knowledge systems.^[23] Women, in particular, are disproportionately affected due to higher physiological iron requirements, menstrual losses, and repeated pregnancies, compounded by socio-economic constraints that limit dietary diversity.^[24]

Role of women in nutritional sustainability and knowledge system

Women play a crucial role beyond household food management as custodians of traditional food knowledge and dietary practices, including recipes, preservation techniques, and the use of locally available nutrient-rich foods. Through intergenerational transmission of this knowledge, they sustain dietary diversity, nutritional adequacy, and cultural continuity. However, with changing livelihood patterns and increasing influence of modernization, this traditional knowledge system is gradually eroding, thereby disrupting household nutrition and contributing to the shift away from nutrient-rich indigenous diets.^[25] The declining role in traditional food procurement and preparation, due to changing livelihood patterns, further disrupts household nutrition.

Consequences on nutritional status and anaemia risk

These cumulative shifts in dietary patterns and socio-environmental conditions ultimately translate into compromised nutritional status, thereby increasing the susceptibility of tribal populations to anaemia and its associated health consequences such as impaired cognitive and physical development, decreased immune function, adverse maternal and reproductive outcomes.^[26]

Anaemia as a multifactorial public health problem

The present synthesis underscores that anaemia remains a severe and persistent public health concern among tribal populations, with prevalence rates frequently exceeding 50% across multiple

regions. Such consistently high levels indicate that anaemia in these communities is not merely a clinical condition but a reflection of complex nutritional, socio-economic, and ecological transitions. While conventional determinants such as poverty, recurrent infections, and limited healthcare access continue to play a role, the findings of this review highlight urbanization-driven dietary transition as a critical and often underappreciated contributor.

Mechanism of reduced intake and impaired iron absorption

In addition to reduced intake, impaired iron absorption plays a crucial role in the persistence of anaemia. The increased consumption of phytate-rich refined grains and tannin-containing beverages such as tea interferes with non-heme iron absorption.^[27,28] Simultaneously, reduced intake of vitamin C-rich foods, particularly forest fruits, further diminishes iron bioavailability.^[29] This dual effect i.e., lower intake and impaired absorption create a compounded nutritional deficit that perpetuates anaemia.

Effect of inflammation in iron metabolism

Another important dimension is the role of chronic inflammation in iron metabolism. Processed diets, coupled with ongoing exposure to infections and poor sanitation, may lead to a state of low-grade systemic inflammation.^[30] This condition stimulates hepatic production of hepcidin, a key regulator of iron homeostasis, which inhibits intestinal iron absorption and promotes iron sequestration within macrophages.^[31] As a result, even when dietary iron is present, its utilization becomes inefficient, contributing to anaemia of inflammation. Therefore, anaemia in tribal populations often reflects a dual burden of nutritional deficiency and inflammatory dysregulation, rather than simple iron deficiency alone.

Public health implications and strategies

The findings of this review emphasize that current public health approaches focusing primarily on iron supplementation may be insufficient if underlying dietary and ecological determinants are not addressed. While supplementation and fortification programs are essential, they should be complemented by food-based, culturally appropriate, and sustainable strategies. Protecting and revitalizing indigenous food systems, promoting climate-resilient crops such as millets, and strengthening local agricultural practices can play a pivotal role in improving nutritional outcomes. Community-based interventions, including decentralized anaemia screening and culturally sensitive nutrition education, are equally important for enhancing awareness and early detection.

Integrated approach

From a broader perspective, anaemia in tribal populations should be understood within the context of changing food environments, socio-cultural transformation, and ecological vulnerability rather than solely as a biomedical deficiency. Addressing this challenge requires an integrated approach that combines nutritional, environmental, and socio-cultural interventions, ensuring that tribal communities are empowered to preserve and reclaim their traditional dietary heritage while benefiting from modern healthcare advancements.

CONCLUSION

Anaemia among tribal populations remains a significant public health concern, with dietary transition emerging as a key contributing factor alongside socio-economic challenge. The shift from traditional, nutrient-rich diets to refined and processed foods has adversely affected micronutrient intake and iron utilization.

Addressing this issue requires moving beyond supplementation alone toward integrated, culturally appropriate, food-based strategies, including revitalization of indigenous food systems, promotion of millets, strengthening local agriculture, and community-based screening.

Limitation And Future Scope

There are very few studies that measured iron deficiency anemia specifically “before urbanization”, because older tribal nutrition data were not systematically recorded. However, several classic and comparative studies show that traditional tribal diets based on millets, forest foods, legumes, and locally available greens were nutritionally superior, and that anemia prevalence increased with dietary transition and modernization.

This study relied on secondary data and nutritional evaluation of traditional foods based on documented macro and micronutrient composition (iron, protein, calcium, fibre, and vitamin C), without direct biochemical or clinical assessment. Future research should focus on primary studies assessing dietary intake, nutrient bioavailability, and clinical outcomes, along with longitudinal evaluation of dietary transition and its impact on anaemia in diverse tribal populations.

Sustainable improvement will depend on restoring dietary diversity, preserving indigenous knowledge, and aligning interventions with local socio-cultural and ecological contexts

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