History of Medicine, 2022, 8(2): 910-917
DOI: 10.48047/HM.V8. I2.2022.910-917

Epidemiology and Etiological Spectrum of Anaemia in Adults: A Cross-Sectional Study from a Tertiary Care Center

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Abstract

Background: Anaemia continues to constitute one of the most pressing public-health challenges in India, with substantial impact across age, sex, and socioeconomic strata. Adult anaemia receives proportionately less attention than maternal or paediatric anaemia, despite its substantial contribution to morbidity, work-productivity loss, fatigue, impaired cognition, and adverse outcomes in chronic disease.

Objective: The present hospital-based cross-sectional investigation aimed to determine the prevalence of anaemia among adult patients (≥18 years) attending a major tertiary care hospital in South India, characterize the morphological and aetiological spectrum, and identify principal demographic, dietary, and clinical risk factors.

Methods: A cross-sectional analytical study was conducted from June 2020 to February 2021 at the Department of General Medicine. A total of 800 adult patients (excluding pregnant women) were enrolled through systematic sampling. Haemoglobin (cyanmethaemoglobin), red-cell indices, peripheral smear, serum ferritin (selected), serum vitamin B12 and folate (selected), and renal/hepatic function were assessed. Anaemia was classified per WHO criteria as mild, moderate, and severe. Sociodemographic, dietary, and clinical data were captured. Multivariate logistic regression identified independent predictors.

Results: Of 800 enrolled adults, 414 (51.7%) were anaemic — mild in 232 (29.0%), moderate in 142 (17.7%), and severe in 40 (5.0%). Female prevalence (62.4%) was significantly higher than male (40.5%). Microcytic-hypochromic morphology suggesting iron deficiency dominated (58.2%), followed by dimorphic (24.4%), macrocytic (10.6%), and normocytic-normochromic (6.8%). Aetiologies identified included iron-deficiency anaemia (58.2%), anaemia of chronic disease (16.4%), megaloblastic / mixed nutritional (15.7%), haemolytic (3.9%), and other (5.8%). Independent predictors included female sex (AOR 2.84), low socioeconomic status (AOR 2.46), vegetarian diet without iron-rich plant sources (AOR 1.94), chronic kidney disease (AOR 3.18), chronic infection / inflammation (AOR 2.62), menorrhagia in females (AOR 3.42), and family history of haemoglobinopathy (AOR 2.10).

Conclusion: More than half of adult patients attending this South India tertiary care hospital are anaemic, predominantly attributable to iron deficiency, with significant contributions from chronic disease and nutritional deficiency. Targeted screening, dietary diversification, supplementation, and management of underlying disease are essential.

Keywords

Anaemia; adults; iron deficiency; chronic disease; ferritin; haemoglobin; tertiary care; cross-sectional

1. Introduction

Anaemia, defined by the World Health Organization as a haemoglobin concentration below 13.0 g/dL in men, 12.0 g/dL in non-pregnant women, and 11.0 g/dL in pregnant women, remains one of the most pervasive global health concerns [1,2]. The WHO estimates that approximately 1.6 billion individuals worldwide are anaemic, with the highest prevalence in South Asia and Sub-Saharan Africa [3]. India bears a disproportionately large fraction of this burden, with NFHS-5 (2019–21) reporting anaemia prevalence of 57.0% among non-pregnant women and 25.0% among adult men [4].

Anaemia is not a disease but a syndrome; aetiology is multifactorial and includes iron deficiency (the predominant cause globally and in India), vitamin B12 and folate deficiencies, chronic disease and inflammation, chronic kidney disease, haemolytic disorders (haemoglobinopathies, autoimmune haemolytic anaemia), bone-marrow disorders, and chronic blood loss (gastrointestinal, gynaecological) [5,6]. Indian dietary patterns, characterized by predominantly vegetarian intake with high phytate and low haem-iron content, contribute substantially to iron-deficiency anaemia [7].

Adult anaemia, despite its substantial prevalence, has historically received less programmatic attention than maternal, paediatric, or adolescent anaemia, partly because severe morbidity is less immediately apparent [8]. Yet anaemia in adults contributes substantially to fatigue, reduced exercise tolerance, impaired cognition, decreased work productivity, increased susceptibility to infection, and worse outcomes in chronic conditions including heart failure, chronic kidney disease, cancer, and inflammatory diseases [9,10].

Tertiary care hospital populations are heterogeneous and frequently encompass patients with underlying chronic disease, complex comorbidities, and varying socioeconomic backgrounds, providing a rich data source for understanding adult anaemia patterns. The present cross-sectional investigation was therefore conducted at a major central Indian tertiary care institute to determine the prevalence, morphological-aetiological profile, and principal risk factors of anaemia among adults.

2. Materials and Methods

2.1 Study Setting

This hospital-based cross-sectional analytical study was conducted at the Department of General Medicine, Sri Lakshmi Narayana Institute of Medical Sciences— a 1,500-bedded tertiary care teaching institution. The study extended from June 2020 to February 2021.

2.2 Participants

Adults (≥18 years) attending the medicine outpatient department or admitted to medical wards during the recruitment period were eligible. Exclusion criteria included pregnancy, recent blood transfusion within 4 weeks, known terminal malignancy on active chemotherapy, severe acute haemorrhage, and refusal of consent. Sample size was calculated assuming 50% expected prevalence, 95% confidence, 4% absolute precision, and 10% non-response, yielding 728; 800 were enrolled.

2.3 Investigations and Definitions

Haemoglobin estimation was performed using the cyanmethaemoglobin method on automated haematology analyzers (Sysmex XN-1000); red-cell indices (MCV, MCH, MCHC, RDW), reticulocyte count, and peripheral smear morphology were obtained. Anaemia was classified per WHO criteria as mild (Hb 11.0–11.9 g/dL women, 11.0–12.9 g/dL men), moderate (Hb 8.0–10.9 g/dL), and severe (Hb <8.0 g/dL) [11]. Morphological classification used MCV: microcytic-hypochromic (<80 fL), normocytic-normochromic (80–100 fL), macrocytic (>100 fL), and dimorphic (mixed). Selected patients with anaemia underwent further investigations: serum ferritin, serum iron, total iron-binding capacity, transferrin saturation, vitamin B12 and folate, renal and hepatic function, stool occult blood, and Hb electrophoresis where indicated. Sociodemographic, dietary, and clinical data were captured on a structured proforma.

2.4 Statistical Analysis

Data were analyzed in SPSS version 26. Categorical variables were compared with chi-square or Fisher's exact tests; continuous variables with t-tests. Multivariate binary logistic regression identified independent predictors of anaemia. A two-tailed $p < 0.05$ was considered statistically significant.

3. Results

Of 800 enrolled adults, 414 (51.7%) were anaemic by WHO criteria — mild in 232 (29.0%), moderate in 142 (17.7%), and severe in 40 (5.0%). Mean haemoglobin among anaemic adults was 9.6 ± 1.8 g/dL. Female anaemia prevalence (62.4%) was significantly higher than male (40.5%, $p < 0.001$). The age-stratified, sex-stratified prevalence is presented in Table 1.

Table 1. Prevalence of anaemia by age and sex (n = 800).

Stratum	Total (n)	Anaemic n (%)	p-value
Overall	800	414 (51.7)	—
Female	404	252 (62.4)	<0.001
Male	396	162 (40.9)	—
Age 18–30 years	176	82 (46.6)	—
Age 31–45 years	224	108 (48.2)	—
Age 46–60 years	208	112 (53.8)	—
Age >60 years	192	112 (58.3)	0.044
Lower SES	342	212 (62.0)	<0.001
Upper-middle / upper SES	458	202 (44.1)	—
Vegetarian diet	412	236 (57.3)	0.005
Mixed / non-vegetarian diet	388	178 (45.9)	—

Morphological and aetiological characterization revealed iron-deficiency anaemia as the dominant subtype, with microcytic-hypochromic morphology and confirmed low ferritin in the majority of those tested. Anaemia of chronic disease, nutritional megaloblastic anaemia, and mixed-deficiency anaemia constituted additional substantial fractions. The morphological and aetiological profile is presented in Table 2.

Table 2. Morphological and aetiological profile of anaemia (n = 414).

Category	Number (n)	Percentage (%)
Morphology – Microcytic-hypochromic	241	58.2
Morphology – Dimorphic	101	24.4
Morphology – Macrocytic	44	10.6
Morphology – Normocytic-normochromic	28	6.8
Aetiology – Iron-deficiency anaemia	241	58.2
Aetiology – Anaemia of chronic disease	68	16.4
Aetiology – Megaloblastic (B12/folate)	44	10.6
Aetiology – Mixed nutritional (Fe + B12/folate)	21	5.1
Aetiology – Haemolytic (incl. haemoglobinopathies)	16	3.9
Aetiology – Anaemia of CKD	14	3.4
Aetiology – Bone-marrow disorder / aplastic	4	1.0
Aetiology – Other / unclassified	6	1.4
Anaemia – Mild (Hb mild range)	232	56.0
Anaemia – Moderate	142	34.3
Anaemia – Severe	40	9.7

Multivariate logistic regression, adjusting for age, identified female sex, low socioeconomic status, vegetarian dietary pattern without iron-rich plant sources (legumes, dark green leafy vegetables,

fortified cereals), chronic kidney disease, chronic inflammatory or infectious illness, menorrhagia in females, and family history of haemoglobinopathy as independent predictors of anaemia. The independent predictors are presented in Table 3.

Table 3. Multivariate logistic regression for independent predictors of anaemia.

Predictor	Crude OR	Adjusted OR (95% CI)	Wald χ^2	p-value
Female sex	2.42	2.84 (2.10–3.84)	32.4	<0.001
Low socioeconomic status	2.04	2.46 (1.82–3.32)	27.6	<0.001
Vegetarian diet (poor iron sources)	1.58	1.94 (1.42–2.64)	16.4	<0.001
Chronic kidney disease	3.62	3.18 (1.72–5.86)	13.4	<0.001
Chronic inflammation / infection	2.84	2.62 (1.74–3.94)	20.8	<0.001
Menorrhagia (females)	3.84	3.42 (2.10–5.58)	23.8	<0.001
Family history of haemoglobinopathy	2.42	2.10 (1.18–3.74)	6.4	0.011
Age >60 years	1.62	1.42 (1.04–1.94)	4.6	0.032
Worm infestation history	1.74	1.46 (0.96–2.22)	3.1	0.077

4. Discussion

This hospital-based cross-sectional study from a major central Indian tertiary care institute documents an adult anaemia prevalence of 51.7%, with substantially higher female (62.4%) than male (40.9%) prevalence. These figures align with NFHS-5 (2019–21) estimates and the broader Indian and South Asian literature, which has repeatedly documented adult anaemia prevalences of 45–65% in tertiary-care and community settings [12,13]. The 5.0% rate of severe anaemia (Hb <8 g/dL) is concerning, given the substantial contribution of severe anaemia to acute admission, hospital morbidity, and transfusion demand.

Iron-deficiency anaemia dominated the morphological and aetiological spectrum (58.2%), reaffirming iron deficiency as the leading cause of anaemia in the Indian context. The contributors include dietary inadequacy (low haem iron, high phytate), poor bioavailability, chronic blood loss (menstrual in women, gastrointestinal in older adults), parasitic infestations, and increased demand (pregnancy, lactation) [14,15]. The substantial fraction with anaemia of chronic disease (16.4%) reflects the heterogeneous tertiary-care population with chronic infections, autoimmune disorders, and malignancies.

Megaloblastic anaemia (10.6%) and mixed nutritional deficiency (5.1%), predominantly attributable to vitamin B12 deficiency, are increasingly recognized in vegetarian Indian populations, where dietary B12 sources are limited [16]. The recent National Anaemia Mukt Bharat strategy correctly emphasizes addressing both iron and B12/folate deficiencies through routine supplementation [17].

The independent predictors identified in our multivariate model — female sex, low socioeconomic status, vegetarian dietary patterns lacking iron-rich plant sources, chronic kidney disease, chronic inflammation/infection, menorrhagia, and family history of haemoglobinopathy — recapitulate the well-established multifactorial epidemiology of adult anaemia [18,19]. Female preponderance reflects menstrual blood loss, repeated pregnancies, and historically poorer dietary access; the 3.42 adjusted odds ratio for menorrhagia underscores the importance of gynaecological evaluation and management. CKD-associated anaemia, mediated by erythropoietin deficiency and inflammation, deserves erythropoiesis-stimulating-agent therapy where indicated.

Implications for clinical and public-health practice are substantial. Routine haemoglobin screening of adults in primary-care, occupational-health, and chronic-disease clinic settings should be standard. Comprehensive evaluation of identified anaemia — including red-cell indices, peripheral smear, and selected confirmatory tests (ferritin, B12, folate, reticulocyte count) — is essential for aetiology-directed therapy [20]. Dietary diversification, food fortification (wheat flour, milk), supplementation, and management of underlying disease (CKD, chronic infection, autoimmune disorders) are core strategies. The Anaemia Mukt Bharat programme should be extended robustly to non-pregnant adults, particularly women of reproductive age and the elderly [21,22].

Strengths of the present study include large sample, robust laboratory methodology including red-cell indices and selected aetiological investigations, multivariate adjustment, and inclusion of both outpatient and inpatient populations. Limitations include single-centre setting, hospital-based recruitment which may overestimate community prevalence due to disease-related selection, exclusion of pregnant women (a particularly affected group), and lack of routine universal aetiological work-up in mild cases.

5. Conclusion

More than half of adult patients attending this South Indian tertiary care institute are anaemic, predominantly attributable to iron deficiency, with substantial contributions from chronic disease and nutritional deficiency. Female sex, low socioeconomic status, vegetarian dietary patterns, chronic kidney disease, chronic inflammation/infection, menorrhagia, and family history of haemoglobinopathy are independent predictors. Targeted screening, dietary diversification, supplementation, and management of underlying disease, alongside continued strengthening of Anaemia Mukt Bharat, are essential.

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