

Original Research Article

A comparative study of anemia prevalence and associated factors among rural and urban adults in Bangalore, India

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Received: 12 June 2026

Revised: 29 July 2026

Accepted: 30 July 2026

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ABSTRACT

Background: Anemia is a major public health concern, particularly among women of reproductive age, and is influenced by socioeconomic, dietary, and health-related factors. This study aimed to compare the prevalence of anemia and associated factors among rural and urban adult populations in Bangalore.

Methods: A community-based cross-sectional comparative study was conducted among 300 participants (150 urban and 150 rural residents). Sociodemographic characteristics, dietary practices, anemia awareness, iron supplementation, and hemoglobin levels were assessed using a structured questionnaire and a digital hemoglobinometer. Data were analysed using descriptive statistics and the chi-square test.

Results: The overall prevalence of anemia was 29.3%, with significantly higher prevalence among urban participants (42.0%) than rural participants (16.7%) ($p < 0.001$). Urban participants had higher educational attainment (80.0% vs. 2.0%), greater awareness of anemia (51.3% vs. 2.7%), and higher iron supplementation use (25.3% vs. 10.0%) compared to rural participants (all $p < 0.001$). Significant differences were also observed in green leafy vegetable consumption, fruit intake, vitamin C consumption, and healthcare utilization between the two groups.

Conclusions: Anemia prevalence differed significantly between urban and rural populations. Despite better awareness and healthcare access among urban participants, anemia burden remained higher, suggesting that complex nutritional, physiological, and lifestyle factors contribute to urban anemia. Targeted, context-specific interventions integrating regular screening, dietary improvement, and supplementation adherence are required.

Keywords: Anemia, Diet, Hemoglobin, Prevalence, Rural, Urban

INTRODUCTION

Anemia is a major public health problem affecting individuals across all age groups worldwide. The World Health Organization (WHO) defines anemia as a hemoglobin concentration below 13.0 g/dL in men, below 12.0 g/dL in non-pregnant women, and below 11.0 g/dL in pregnant women.¹ It is characterised by a reduced oxygen-carrying capacity of blood, resulting in tissue hypoxia and clinical manifestations such as fatigue, weakness, pallor, dizziness, and reduced physical performance. Iron deficiency is the most common cause

of anemia globally and remains one of the most prevalent micronutrient deficiencies, particularly among women and children in developing countries.² In addition to iron deficiency, inadequate intake of folate, vitamin B12, vitamin A, and vitamin C can impair hemoglobin synthesis and contribute to anemia development.³ Chronic infections, inflammatory conditions, parasitic infestations, and certain chronic diseases may also contribute through mechanisms unrelated to nutritional deficiency.⁴

Anemia has important consequences throughout the life cycle. In children, it is associated with impaired growth, reduced cognitive development, and poor academic

performance, whereas in adults it contributes to fatigue, diminished work capacity, and reduced quality of life.⁵ Among women of reproductive age, menstruation, pregnancy, and lactation substantially increase physiological iron requirements and vulnerability to anemia.⁶ Despite several national nutrition and health initiatives, anemia continues to be a significant public health challenge in India. Analysis of National Family Health Survey data revealed that anemia prevalence among women of reproductive age in India's Aspirational Districts increased from 58.7% to 61.1% between NFHS-4 and NFHS-5.⁷ Lower educational attainment, poor socioeconomic status, inadequate dietary diversity, and limited access to healthcare services have been identified as major determinants of anemia in the Indian population.⁸

The burden and determinants of anemia often differ between rural and urban settings. Rural populations frequently experience food insecurity, poor dietary diversity, recurrent infections, inadequate sanitation, and reduced access to healthcare services, increasing their susceptibility to anemia.⁹ In contrast, urban populations may have greater access to healthcare facilities but are increasingly exposed to dietary transitions characterised by the consumption of processed and micronutrient-poor foods. Women in both settings remain particularly vulnerable due to menstrual blood loss and increased physiological iron requirements.¹⁰

Dietary practices and nutrition awareness play a crucial role in anemia prevention and management. Regular consumption of iron-rich foods alongside vitamin C-rich foods enhances iron absorption and improves hemoglobin levels.¹¹ Community-based nutrition education and counselling interventions have been shown to improve adherence to anemia prevention strategies.¹² Although several studies have investigated anemia prevalence and its determinants in different populations, limited evidence is available comparing rural and urban anemia prevalence and associated factors within Bangalore. The present study was therefore undertaken to compare anemia prevalence among rural and urban adults in Bangalore and to examine the socioeconomic, dietary, health-related, and awareness factors associated with anemia in these settings.

METHODS

Study design and setting

A community-based cross-sectional comparative study was conducted among adults residing in selected rural and urban areas of Bangalore, Karnataka, India over a two-month period from September 2025 to October 2025.

Participants

A total of 300 participants (150 urban and 150 rural) were enrolled in the study. Participants were selected using a

simple random sampling technique from the study population to minimize selection bias and ensure representative sampling of both rural and urban communities. Participation was voluntary and informed consent was obtained from all participants prior to enrolment.

Inclusion criteria

Individuals aged 20-50 years of age, both male and female participants.

Exclusion criteria

Individuals below 20 years of age.

Data collection

Data were collected using a pre-structured questionnaire capturing sociodemographic characteristics, household and environmental conditions, health status, anemia awareness, medical history, menstrual history, dietary habits, nutritional knowledge, lifestyle factors, and exposure to health education programmes. Participants were selected from both urban and rural areas of Bangalore. Adults aged 20–50 years, irrespective of their anemia status, were considered eligible for participation.

Hemoglobin estimation

Hemoglobin was measured using a validated digital hemoglobinometer following standard aseptic procedures. Anemia was classified according to WHO criteria: hemoglobin <12 g/dL in non-pregnant women, <13 g/dL in men, and <11 g/dL in pregnant women.¹⁷

Ethical considerations

Ethical approval was obtained from the Institutional Ethics Committee of Padmashree Institute of Management and Sciences. Informed written consent was obtained from all participants. All data were treated confidentially.

Statistical analysis

Data were analysed using SPSS version 22.0 and R version 3.2.2. Categorical variables were expressed as frequencies and percentages. The chi-square test was used to assess associations between categorical variables; Fisher's exact test was applied where expected cell frequency was less than five. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 300 participants were included (150 urban, 150 rural).

Sociodemographic characteristics

Significant differences were observed between rural and urban participants in educational status, occupation, and

annual income ($p < 0.001$) (Table 1). Urban participants had higher educational attainment and annual income. Gender distribution was identical between groups.

Table 1: Sociodemographic characteristics of rural and urban participants.

Variables	Urban (n=150), N (%)	Rural (n=150), N (%)	Total (n=300), N (%)	P value
Age in years				
20-30	63 (42.0)	48 (32.0)	111 (37.0)	<0.001**
31-40	27 (18.0)	45 (30.0)	72 (24.0)	
41-50	60 (40.0)	38 (25.3)	98 (32.7)	
>50	0 (0.0)	19 (12.7)	19 (6.3)	
Gender				
Female	131 (87.3)	131 (87.3)	262 (87.3)	1.000
Male	19 (12.7)	19 (12.7)	38 (12.7)	
Occupation				
Skilled	92 (61.3)	13 (8.7)	105 (35.0)	<0.001**
Unskilled	12 (8.0)	21 (14.0)	33 (11.0)	
Housewife	46 (30.7)	116 (77.3)	162 (54.0)	
Education level				
Primary	16 (10.7)	78 (52.0)	94 (31.3)	<0.001**
Secondary	14 (9.3)	60 (40.0)	74 (24.7)	
Higher	120 (80.0)	3 (2.0)	123 (41.0)	
No information	0 (0.0)	9 (6.0)	9 (3.0)	
Family size				
<5 members	107 (71.3)	114 (76.0)	221 (73.7)	0.432
5-10 members	43 (28.7)	36 (24.0)	79 (26.3)	
Annual income (INR)				
<1,00,000	47 (31.3)	150 (100.0)	197 (65.7)	<0.001**
>1,00,000	93 (62.0)	0 (0.0)	93 (31.0)	
Not disclosed	10 (6.7)	0 (0.0)	10 (3.3)	

**Statistically significant

Prevalence of anemia

Overall anemia prevalence was 29.3%, significantly higher in urban participants (42.0%) than rural participants (16.7%) ($\chi^2=23.27$, $p < 0.001$), as shown in Figure 1. According to WHO classification, urban anemia prevalence constitutes a severe public health problem, while rural prevalence represents a mild public health problem.¹⁷

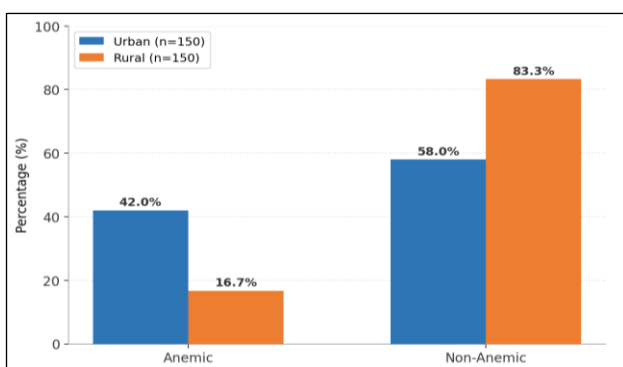


Figure 1: Prevalence of anemia among rural and urban participants ($\chi^2=23.27$, $p < 0.001$).

Awareness of anemia

A highly significant difference in anemia awareness was observed ($\chi^2=84.41$, $p < 0.001$) (Table 2). More than half of urban participants (51.3%) were aware of anemia versus only 2.7% of rural participants.

Knowledge of anemia causes, symptoms, and iron-rich foods was significantly higher among urban participants. Awareness of the causes of anemia was reported by 79.3% of urban participants compared with only 5.3% of rural participants ($\chi^2=137.56$, $p < 0.001$); blood loss was the most commonly identified cause by urban participants (71.3% vs. 2.7% rural), followed by nutrient deficiency (8.0% vs. 2.7%). Experience of anemia-related symptoms also differed significantly ($\chi^2=57.06$, $p < 0.001$): all rural participants denied experiencing anemia-related symptoms, while 31.3% of urban participants reported symptoms, with fatigue being most prevalent (11.3%), followed by dizziness, headache, and cold hands/feet (5.3% each), shortness of breath (2.7%), and pale skin or rapid heartbeat (0.7% each). Knowledge of iron-rich foods was significantly higher among urban participants (52.0% vs. 4.0% rural; $\chi^2=82.05$, $p < 0.001$). Knowledge of the role of vitamin C in enhancing iron absorption was

uniformly poor in both groups (2.7% urban vs. 1.3% rural; $\chi^2=0.68$, $p=0.409$).

Table 2: Awareness of anemia among rural and urban participants.

Variables	Urban (n=150), N (%)	Rural (n=150), N (%)	Total (n=300), N (%)	χ^2 value	P value
Unaware of anemia	73 (48.7%)	146 (97.3%)	219 (73.0%)	84.41	<0.001**
Aware of anemia	77 (51.3%)	4 (2.7%)	81 (27.0%)		

**Statistically significant

Dietary practices

Significant rural-urban differences were observed in all dietary indicators (Table 3). Urban participants consumed green leafy vegetables more frequently (16.0% daily, 66.7% weekly) than rural participants (0.7% daily, 34.7% weekly). Monthly consumption was more common

among rural participants (42.7% vs. 11.3%). Fruit consumption also differed significantly, with 75.3% of urban participants consuming fruit weekly compared to 43.3% of rural participants; 29.3% of rural participants reported only monthly fruit intake. Daily tea and coffee consumption was reported by all rural participants versus 74.7% of urban participants, a pattern relevant to non-heme iron absorption inhibition.

Table 3: Dietary practices among rural and urban participants (n=300).

Variables	Urban (n=150), N (%)	Rural (n=150), N (%)	Total (n=300), N (%)	P value
Frequency of green leafy vegetable consumption				
Daily	24 (16.0)	1 (0.7)	25 (8.3)	<0.001**
Weekly	100 (66.7)	52 (34.7)	152 (50.7)	
Once in 15 days	9 (6.0)	33 (22.0)	42 (14.0)	
Monthly	17 (11.3)	64 (42.7)	81 (27.0)	
Frequency of fruit consumption				
Daily	33 (22.0)	21 (14.0)	54 (18.0)	<0.001**
Weekly	113 (75.3)	65 (43.3)	178 (59.3)	
Once in 15 days	4 (2.7)	20 (13.3)	24 (8.0)	
Monthly	0 (0.0)	44 (29.3)	44 (14.7)	
Consumption of vitamin C-rich foods				
None	8 (5.3)	20 (13.3)	28 (9.3)	0.017*
Fruits only	78 (52.0)	92 (61.3)	170 (56.7)	
Vegetables only	52 (34.7)	31 (20.7)	83 (27.7)	
Both fruits and vegetables	12 (8.0)	7 (4.7)	19 (6.3)	
Frequency of tea/coffee consumption				
Daily	112 (74.7)	150 (100.0)	262 (87.3)	<0.001**
Weekly	24 (16.0)	0 (0.0)	24 (8.0)	
Monthly	2 (1.3)	0 (0.0)	2 (0.7)	
Never	12 (8.0)	0 (0.0)	12 (4.0)	

**Statistically significant

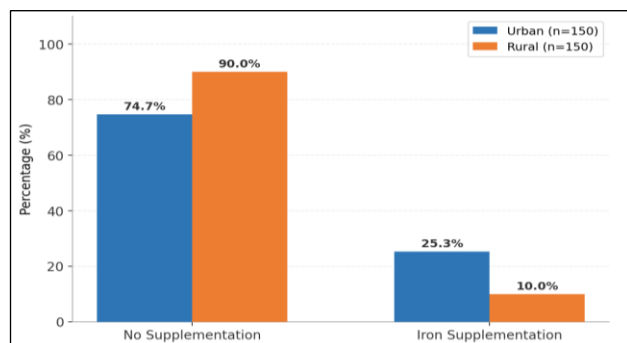


Figure 2: Iron supplementation among rural and urban participants ($p<0.001$).

Iron supplementation and health education

Iron supplementation was significantly more common among urban participants (25.3%) than rural participants (10.0%) ($p<0.001$) (Figure 2).

Health education regarding anemia was received by 65.4% of urban participants versus none of the rural participants ($p<0.001$) (Table 4). Healthcare professionals (33.3%) and ASHA workers (26.7%) were the primary information sources among urban participants.

Table 4: Exposure to health education regarding anemia among rural and urban participants.

Variables	Urban (n=150), N (%)	Rural (n=150), N (%)	Total (n=300), N (%)	P value
Received health education regarding anemia				
No	52 (34.7)	150 (100.0)	202 (67.3)	<0.001**
Yes	98 (65.4)	0 (0.0)	98 (32.7)	
Source of information				
Healthcare professionals	50 (33.3)	0 (0.0)	50 (16.7)	<0.001**
Community health workers (ASHA)	40 (26.7)	0 (0.0)	40 (13.3)	
Mahila groups	4 (2.7)	0 (0.0)	4 (1.3)	
Students	4 (2.7)	0 (0.0)	4 (1.3)	

**Statistically significant

DISCUSSION

The present study revealed an overall anemia prevalence of 29.3% among adults in Bangalore, with a significantly higher prevalence among urban participants (42.0%) compared to rural participants (16.7%). According to WHO classification, the urban prevalence constitutes a severe public health problem and the rural prevalence a mild public health problem.¹⁷ A notable finding was the higher anemia burden in urban participants despite their better educational attainment, greater disease awareness, higher iron supplementation rates, and greater exposure to health education. This contrasts with the conventional assumption that improved healthcare access necessarily results in lower anemia prevalence, and is consistent with observations by Yadav et al, who reported higher moderate anemia among urban adolescent girls.¹³

The higher urban anemia prevalence may reflect the multifactorial nature of the condition. A large urban Indian study of 4,775 anemic adults reported iron deficiency in 56.9% and vitamin B12 deficiency in 37.0%, indicating that urban anemia is not attributable solely to iron deficiency.¹⁵ Social, cultural, dietary, and malabsorptive factors contribute substantially. The near-universal daily tea and coffee consumption among rural participants, while potentially inhibiting non-heme iron absorption, did not translate into higher rural anemia, suggesting that other protective factors such as lower physiological demands, different menstrual patterns, or other dietary components may offset this risk in rural settings.

Knowledge of anemia, its causes, symptoms, and preventive measures was significantly greater among urban participants, who also had greater access to health education through healthcare professionals and community health workers. Despite this, awareness did not translate into effective preventive behaviour, supporting findings by Sharif et al, who noted that educational attainment and healthcare access alone are insufficient to reduce anemia if dietary quality and adherence to supplementation remain suboptimal.⁹

Dietary practices differed significantly between groups, with urban participants reporting more frequent consumption of green leafy vegetables and fruits. Vitamin C facilitates non-heme iron absorption and is important in anemia prevention.^{3,11} However, the persistence of higher urban anemia despite comparatively better dietary practices underscores the role of factors including chronic blood loss, inflammation, multiple micronutrient deficiencies, and bioavailability issues. Evaluation of the Anaemia Mukht Bharat programme has highlighted that, while iron and folic acid coverage has improved nationally, adherence and regular consumption remain suboptimal.¹⁶

Healthcare access patterns showed that a greater proportion of rural participants lived within 1 km of a health facility, yet this did not result in greater awareness or supplementation uptake, reinforcing that physical proximity must be accompanied by effective health communication and community outreach to achieve impact. Socioeconomic factors including low educational attainment, low income, and limited access to quality healthcare continue to be important risk factors for anemia in rural populations.¹⁴

Overall, these findings highlight that anemia remains a significant public health challenge in both urban and rural settings in Bangalore, with the higher urban burden challenging the assumption that anemia is primarily a rural problem. Comprehensive, context-specific strategies integrating nutritional screening, dietary diversification, food fortification, supplementation adherence support, and targeted health communication are essential.

CONCLUSION

This study identified significant rural-urban differences in anemia prevalence and related determinants among adults in Bangalore. Contrary to conventional expectations, anemia was more prevalent among urban participants despite better awareness, dietary practices, health education exposure, and iron supplementation uptake. These findings indicate that urban anemia is a complex interplay of nutritional, physiological, socioeconomic, and lifestyle factors that extend beyond knowledge and

healthcare access. Future public health interventions should adopt a comprehensive, context-specific approach integrating regular hemoglobin screening, dietary counselling, micronutrient supplementation adherence, and health literacy improvement to reduce the anemia burden across diverse population groups.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee, Padmashree Institute of Management and Sciences, Bangalore, India

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Cite this article as: Pandurangaiah S, Mathew AA, Shettigar G. A comparative study of anemia prevalence and associated factors among rural and urban adults in Bangalore, India. *Int J Community Med Public Health* 2026;13:5074-9.