International Journal of Community Medicine and Public Health
Indu M et al. Int J Community Med Public Health. 2025 Oct;12(10):4669-4674
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20253270

Original Research Article

Prevalence of anemia among women in reproductive age group employed in garment factories in Bengaluru urban: a cross-sectional study

Indu M.[1], Anil N. S.[2], Rana Sarvar[3]*, Sharath B. N.[1]

[1]Department of Community Medicine, ESIC MC and PGIMSR, Rajajinagar, Bengaluru, Karnataka, India
[2]Department of Community Medicine, ESIC MC and PGIMSR, Kalaburagi, Karnataka, India
[3]Department of Community Medicine, ESIC MC and Hospital, Sanathnagar, Hyderabad, Telangana, India

Received: 23 July 2025
Accepted: 06 September 2025

***Correspondence:**
Dr. Rana Sarvar,
E-mail: sarvar-rana26@gmail.com

ABSTRACT

Background: Anemia is a major global public health concern, particularly affecting women of reproductive age. Occupational settings like garment factories may pose additional risks due to poor working conditions, nutritional inadequacies, and workplace-related health hazards. India has the highest burden of anemic women globally, with over half of reproductive-age women affected.
Methods: A cross-sectional analytical study was conducted among women aged 15-49 years working in garment factories in Bengaluru Urban. Multi-stage cluster sampling was used to select participants. Data was collected through structured interviews, anthropometric measurements, and hemoglobin estimation using the digital hemoglobinometer method. Anemia was defined as hemoglobin levels <12.0 gm/dl according to WHO criteria. Statistical analysis included descriptive statistics and multivariable logistic regression to identify associated factors.
Results: The overall prevalence of anemia was found to be 71.3%, with 37.2% having mild anemia, 52.9% moderate anemia, and 9.8% severe anemia. Significant risk factors included low socioeconomic status, inadequate dietary intake, long working hours, and poor workplace conditions.
Conclusions: Anemia prevalence among female garment workers in Bengaluru urban area was substantial, indicating an urgent need for targeted interventions focusing on nutritional supplementation, improved workplace conditions, and comprehensive occupational health programs.

Keywords: Anemia, Bengaluru, Garment industry, Occupational health, Reproductive age, Women workers

INTRODUCTION

Anemia represents one of the most significant global public health challenges, affecting approximately 1.62 billion people worldwide, with women of reproductive age bearing a disproportionate burden.[1] The World Health Organization estimates that 30% of non-pregnant women and 37% of pregnant women aged 15-49 years globally are affected by anemia.[1] This condition not only compromises individual health and quality of life but also has far-reaching consequences for economic productivity, maternal and child health outcomes, and overall societal development.[2]

Women of reproductive age are particularly vulnerable to anemia due to physiological factors including menstrual blood loss, increased iron requirements during pregnancy and lactation, and often inadequate dietary iron intake.[2,3] In occupational settings, additional risk factors may exacerbate this vulnerability. The garment industry, which employs millions of women globally, presents unique challenges that may contribute to anemia

prevalence.[4,5] These include prolonged working hours, poor ventilation, exposure to dust and chemicals, inadequate rest periods, and limited access to nutritious meals during work hours.[6,7]

India bears the highest burden of anemia globally, with more than half (51%) of all women of reproductive age being anemic.[4] The National Family Health Survey-5 (2019-21) reported an anemia prevalence of 47.8% among women of reproductive age in Karnataka.[8] Urban areas like Bangalore, despite better healthcare access, continue to show significant anemia prevalence rates ranging from 33-44% among women.[9,10] The garment industry in Karnataka, particularly concentrated in Bangalore, employs over 1.4 million workers, with approximately 90-94% being women.[11] Studies from garment factories have reported varying anemia prevalence rates, with some showing rates as high as 29% in urban factories and 22% in rural settings.[4]

The industrial area in Bengaluru Urban houses numerous garment manufacturing units, employing thousands of women workers.[11,12] These workers, predominantly from lower socioeconomic backgrounds, face multiple health challenges including poor nutritional status, demanding work schedules, and limited access to healthcare services.[7,13] Despite the significant economic contribution of these workers to India's textile exports, their health status remains largely understudied. Understanding the prevalence and determinants of anemia in this vulnerable population is crucial for developing targeted interventions and informing occupational health policies.

Therefore, this study aimed to assess the prevalence of anemia and identify associated risk factors among women of reproductive age employed in garment factories in Bengaluru Urban.

METHODS

Study design and setting

A cross-sectional analytical study was conducted among women workers employed in garment in Bengaluru Urban, Karnataka, India. Bengaluru Urban is one of the major industrial hubs in Bangalore, housing numerous garment manufacturing units including both large-scale export houses and smaller fabrication units.[11] The study was conducted over a period of six months from January 2023 to June 2023.

Study population and eligibility criteria

The study population comprised women aged 15-49 years employed in garment factories for at least one year. Women who were pregnant, lactating, had known chronic illnesses (such as chronic kidney disease, liver disease, or malignancy), or were taking iron supplementation were excluded from the study.

Sample size calculation

Sample size was calculated using the formula for cross-sectional studies: $n=Z^2pq/d^2$, where Z=1.96 (95% confidence level), p = expected prevalence of anemia (45% based on Karnataka NFHS-5 data), q = 1-p, and d = desired precision (7%).[8] The calculated sample size was 204, which was increased to 286 to account for potential non-response.

Sampling method

Multi-stage cluster sampling was employed. In the first stage, garment factories in Rajajinagar and surrounding areas were listed and stratified by size (small: <100 workers, medium: 100-500 workers, large: >500 workers). In the second stage, factories were randomly selected from each stratum. In the final stage, eligible women workers were randomly selected from each chosen factory using systematic sampling.

Data collection

Data collection was conducted by trained research assistants using a pre-tested structured questionnaire. The questionnaire included:

Sociodemographic characteristics: age, education, marital status, family size, monthly income, and residence.

Occupational factors: duration of employment, working hours, job designation, overtime work, and workplace conditions.

Dietary assessment: dietary diversity, frequency of iron-rich food consumption, and meal patterns.

Health history: menstrual history, contraceptive use, past medical history, and symptoms of anemia.

Hemoglobin estimation

Hemoglobin levels were estimated using the digital hemoglobinometry method, which is considered the gold standard for hemoglobin estimation.[14] The HemoCue Hemoglobinometer System is based on the principle of transmission photometry. The ring finger of the subject was sterilized using a swab (spirit soaked) and a single deep prick is done using lancet. A drop of blood was applied to the self-filling microcuvette. The hemoglobin in the blood sample was converted to methemoglobin and then to azidemethemoglobin within the reagent-coated microcuvette, and dual-wavelength photometry (506 nm and 880 nm) was used to measure hemoglobin concentration while compensating for turbidity. This corresponds to the total hemoglobin present in blood. Quality control measures included daily calibration of instruments and use of control samples.

Anemia classification

Anemia was defined according to WHO criteria as hemoglobin levels <12.0 gm/dl for non-pregnant women.[1] Anemia severity was classified as: mild anemia: 11.0-11.9 gm/dl, moderate anemia: 8.0-10.9 gm/dl and severe anemia: <8.0 gm/dl.

Statistical analysis

Data was entered in EpiData version 3.1 and analyzed using SPSS version 25.0. Descriptive statistics including means, standard deviations for continuous variables, and frequencies with percentages for categorical variables were calculated. Chi-square test was used to assess associations between categorical variables. Multivariable logistic regression was performed to identify independent risk factors for anemia, with adjusted odds ratios (AOR) and 95% confidence intervals (CI) calculated. A p value <0.05 was considered statistically significant.

RESULTS

Demographic and occupational characteristics

A total of 486 women workers participated in the study. The mean age of participants was 35.37±9.5 years, with the majority (45.6%) aged between 25-40 years. Most participants (85.1%) were married, and 42.4% had completed secondary education. The median monthly income was ₹14,500 (IQR: ₹9,000-₹21,500). Regarding occupational characteristics, 68.2% worked as sewing operators, with a mean work experience of 4.8±3.6 years. The majority (76.9%) worked 8-9 hours per day, and 34.5% regularly worked overtime.

Table 1: Prevalence of anemia by severity.

Anemia grade	Hemoglobin level (gm/dl)	Frequency	Percentage
Normal	≥12.0	82	28.7
Mild	11.0-11.9	76	26.6
Moderate	8.0-10.9	108	37.7
Severe	<8.0	20	7.0
Total		286	100.0

Prevalence of anemia

The overall prevalence of anemia was 71.3%. Among anemic participants, 26.6 % had mild anemia, 37.7% had moderate anemia, and 7 % had severe anemia. The mean hemoglobin level was 10.92±1.7 gm/dl.

Factors associated with anemia

Sociodemographic factors

Anemia prevalence was significantly higher among participants aged 15-25 years (58.7%) compared to those aged 35-49 years (44.2%) (p=0.032). Women with no formal education had higher anemia prevalence (61.8%) compared to those with higher secondary education (43.6%) (p=0.018). Low socioeconomic status (monthly income <₹12,000) was significantly associated with anemia (OR: 2.1, 95% CI: 1.4-3.2).

Occupational factors

Workers with longer work experience (>5 years) had lower anemia prevalence (47.3%) compared to those with <2 years' experience (59.4%) (p=0.024). Daily working hours >9 hours was associated with increased anemia risk (OR: 1.6, 95% CI: 1.1-2.4). Regular overtime work was significantly associated with anemia (58.6% versus 49.1%, p=0.041).

Dietary factors

Inadequate consumption of green leafy vegetables (<3 times/week) was strongly associated with anemia (OR: 2.8, 95% CI: 1.8-4.3). Women who skipped breakfast regularly had higher anemia prevalence (63.2% versus 47.8%, p=0.003). Poor dietary diversity score was significantly associated with anemia (p<0.001).

Reproductive health factors

Women with heavy menstrual bleeding had significantly higher anemia prevalence (68.4% versus 47.2%, p<0.001). Short birth intervals (<24 months) and higher parity (>2 children) were associated with increased anemia risk.

Table 2: Factors independently associated with anemia (multivariable logistic regression).

Variable	Adjusted OR	95% CI	P value
Age 15-25 years (ref: 35-49 years)	1.8	1.1-2.9	0.018
No formal education (ref: >secondary)	2.2	1.2-4.1	0.012
Monthly income <₹8,000 (ref: >₹10,000)	1.9	1.2-3.0	0.006
Working hours >10/day (ref: ≤8 hours)	1.7	1.1-2.6	0.021
Inadequate green leafy vegetables	2.5	1.6-3.9	<0.001
Heavy menstrual bleeding	2.1	1.3-3.4	0.002
Poor workplace conditions	1.5	1.0-2.3	0.048

DISCUSSION

Main findings

This study revealed a substantial prevalence of anemia (71.3%) among women garment workers in Bengaluru Urban, which is considerably higher than the general urban female population in Karnataka (44%).[8] The presence of mild anemia (37.2% of anemic cases) suggests that early intervention strategies could be highly effective in this population. The predominance of moderated anemia (52.9 % of anemic cases) underscores regular screening and treatment of such cases.

The observed prevalence is consistent with studies from other garment manufacturing regions. A study among garment workers in Bangladesh reported anemia prevalence of 77-80%, while research from Shahi Exports in India found 29% prevalence in urban factories.[4,15] The variation in prevalence rates across studies may be attributed to differences in study populations, diagnostic criteria, and regional factors.

Risk factors analysis

Our findings identified several modifiable and non-modifiable risk factors for anemia. Younger age emerged as a significant risk factor, which is consistent with global literature showing higher anemia vulnerability among adolescents and young women due to rapid growth, menstruation onset, and often inadequate dietary practices.[2] Educational status showed a strong inverse relationship with anemia, reflecting the importance of health literacy in nutritional choices and healthcare-seeking behavior.[16]

Socioeconomic factors played a crucial role, with women earning less than ₹8,000 monthly showing nearly twice the odds of anemia. This finding underscores the economic barriers to accessing iron-rich foods and healthcare services, consistent with research showing poverty as a fundamental determinant of anemia.[16,17]

Occupational health implications

The study revealed concerning associations between working conditions and anemia risk. Extended working hours (>10 hours daily) and regular overtime work were independently associated with anemia, possibly due to irregular meal patterns, fatigue, and limited time for adequate nutrition and rest.[7] These findings align with research documenting poor working conditions in garment factories, including inadequate rest periods and excessive work demands.[5,18]

Poor workplace conditions, including inadequate ventilation, dust exposure, and limited access to clean drinking water, contributed to anemia risk.[7] The garment industry's demanding work environment, characterized by prolonged sitting, repetitive tasks, and high production targets, may exacerbate nutritional deficiencies and compromise workers' health.[6,19]

Dietary and reproductive health factors

Inadequate consumption of green leafy vegetables emerged as the strongest dietary risk factor (AOR: 2.5), highlighting the critical role of iron-rich foods in anemia prevention.[10,16] The finding that women who regularly skipped breakfast had higher anemia rates emphasizes the importance of regular meal patterns for maintaining iron stores.

Heavy menstrual bleeding significantly increased anemia risk, consistent with physiological understanding of iron loss during menstruation.[3] This finding suggests the need for reproductive health counselling and menstrual hygiene management programs in workplace settings.

Comparison with previous studies

The prevalence observed in our study (71.3%) falls within the range reported by other Indian studies. Research in Tamil Nadu reported 64.8% anemia prevalence among rural reproductive-age women,10 while studies in urban Bangalore showed prevalence rates of 30-34% in pregnant women.[9] The higher rates in our study population may reflect the occupational hazards and socioeconomic vulnerabilities specific to garment workers.

Compared to international studies, our findings align with research from Bangladesh garment factories reporting high anemia prevalence, though their rates were higher (77-80%).[15] This suggests that occupational factors in garment manufacturing consistently contribute to anemia risk across different settings.

Public health implications

The high anemia prevalence in this economically productive population has significant implications for both individual and societal well-being. Anemia reduces work productivity, increases absenteeism, and compromises quality of life.[20] From a public health perspective, addressing anemia in garment workers requires multi-sectoral interventions including:

Workplace interventions: implementation of iron-fortified meal programs, improved rest facilities, and regular health screening.

Policy measures: enforcement of labor laws regarding working hours and workplace conditions.

Health system strengthening: integration of occupational health services with primary healthcare.

Nutritional interventions: targeted iron supplementation and nutrition education programs.

Several limitations should be acknowledged. The cross-sectional design precludes causal inferences. The study was limited to Bengaluru urban area, which may limit generalizability to other industrial areas. Dietary assessment relied on recall methods, which may introduce bias. Additionally, we did not assess other potential causes of anemia such as parasitic infections or inherited hemoglobinopathies.

CONCLUSION

This study demonstrates a high prevalence of anemia among women garment workers in Bengaluru Urban, with over half of the workforce affected. The identified risk factors- including young age, low education, poor socioeconomic status, extended working hours, inadequate dietary intake, and heavy menstrual bleeding- provide clear targets for intervention. The findings highlight the urgent need for comprehensive occupational health programs that address both workplace conditions and individual health needs.

Recommendations include implementing workplace nutrition programs, enforcing labor regulations regarding working hours, providing health education on anemia prevention, and establishing regular health screening services. Multi-stakeholder collaboration involving factory management, government agencies, and healthcare providers is essential to address this significant public health challenge and protect the health of women workers who contribute substantially to India's textile industry.

ACKNOWLEDGEMENTS

The authors sincerely thank the garment factory workers for their participation and the factory management for their cooperation in facilitating the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Indu M, Anil NS, Sarvar R, Sharath BN. Prevalence of anemia among women in reproductive age group employed in garment factories in Bengaluru urban: a cross-sectional study. Int J Community Med Public Health 2025;12:4669-74.