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Article

Anemia prevalence among illiterate pregnant women attending a tertiary hospital in Bangladesh

Barsha Sarker Nipa[1], Rahul Dev Bairagi[2*], Fouzia Akter[1], Partha Chandra Debnathe[3], Raiyan Rahman Reon[2], Anike Chakrabarty[4], Shuvra Chakrabarty[5] and Md. Mustafizur Rahman[2]

[1]Department of Nutrition and Food Engineering, Daffodil International University, Dhaka-1207, Bangladesh
[2]Pharmacy Discipline, School of Life Sciences, Khulna University, Khulna-9208, Bangladesh
[3]Department of Pharmacy, Noakhali Science and Technology University, Noakhali-3814, Noakhali, Bangladesh
[4]Khulna Medical College Hospital, Khulna-9000, Bangladesh
[5]Department of Pharmacy, State University of Bangladesh, Dhaka-1461, Bangladesh

[*]Corresponding author: Rahul Dev Bairagi, Pharmacy Discipline, School of Life Sciences, Khulna University, Khulna-9208, Bangladesh. E-mail: rahuldev131133@gmail.com

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Abstract: Anemia remains one of the most widespread nutritional disorders globally and poses a substantial public health challenge, particularly among pregnant women in low- and middle-income countries. During pregnancy, the body's demand for iron increases to support fetal growth and maternal blood volume expansion; failure to meet this demand often results in maternal anemia, adversely affecting both maternal and neonatal outcomes. This study aimed to assess the prevalence of anemia among illiterate pregnant women in Bangladesh and examine its association with educational, socioeconomic, and dietary factors. A cross-sectional study was conducted at the Maternal and Child Health Training Institute (MCHTI), where 100 randomly selected pregnant women receiving antenatal care (ANC) participated. Data were analyzed using descriptive statistics, and chi-square tests were applied to identify associations between anemia and socioeconomic variables. The overall prevalence of anemia was 71%, with significantly higher rates among illiterate women (95.84%) compared to literate women (48.1%). Among illiterate pregnant women, mild anemia was found in 60.4%, moderate anemia in 27.1%, and severe anemia in 8.3% of cases. Anemia was more prevalent (65.22%) during the second trimester, and 89.58% of illiterate women came from low-income families. The findings suggest that insufficient education, limited dietary diversity, inadequate medical examinations, and insufficient iron supplementation contribute to the elevated prevalence of anemia. The study concludes that anemia remains a serious public health issue among pregnant women in Bangladesh. The findings imply that improving educational attainment, promoting nutrition awareness, and providing socioeconomic and antenatal support are essential to reducing anemia and improving maternal and fetal health outcomes.

Keywords: maternal health; iron deficiency; antenatal care; nutritional status; socioeconomic factors

1. Introduction

Anemia is a hematological disorder characterized by a reduction in erythrocyte count or a subnormal concentration of hemoglobin, compromising the blood's oxygen-carrying capacity. This condition disproportionately affects biologically vulnerable groups, particularly women of reproductive age, during pregnancy and young children (Karami *et al*., 2022; Alem *et al*., 2023; Zhang *et al*., 2024). In Bangladesh,

anemia remains a critical nutritional disorder, with iron-deficiency anemia being the most common form (Kabir *et al*., 2022). The condition arises from multiple etiologies, including chronic blood loss due to heavy menstruation, inadequate dietary iron intake, parasitic infections, and complications such as miscarriage and frequent pregnancies (Azhar *et al*., 2021). Hemoglobin is crucial in transporting oxygen to cells, enabling energy production (Drvenica *et al*., 2022). Reduced hemoglobin levels hinder oxygen transport to cells, potentially affecting vital organs within the body. Consequently, the decrease in hemoglobin concentration is correlated with low birth weight, maternal mortality, and preterm delivery of the infant (Young *et al*., 2023).

During pregnancy, the physiological demand for iron increases significantly to support fetal development and maternal blood volume expansion, rendering expectant mothers particularly susceptible. Left unaddressed, maternal anemia can lead to adverse outcomes, including preterm birth, low birth weight, and increased maternal morbidity and mortality (Ding *et al*., 2019). Anemia significantly influences both the mother and the baby, elevating the risk of maternal mortality, fetal mortality, low birth weight, and other adverse outcomes. According to a study, the normal hemoglobin concentration during pregnancy is 11.5 g/dl (Wang *et al*., 2025). A study using data from 2,259 pregnant women in the 2011 Bangladesh Demographic and Health Survey found a 44% prevalence of anemia. Mixed-effect multilevel logistic revealed that anemic women had higher odds of pregnancy complications (AOR 1.39), preterm birth (AOR 2.03), early neonatal death (AOR 1.87), and perinatal mortality (AOR 1.54), but lower odds of menstrual irregularities (AOR 0.79), diabetes (AOR 0.78), and hypertension (AOR 0.79) compared to non-anemic women (Kabir *et al*., 2022). Pregnant women often have limited awareness of anemia symptoms due to insufficient monitoring and screening. Pregnancy requires increased intake of nutrients, particularly iron and folic acid, to support fetal and placental development and the expansion of maternal blood volume. In many developing countries, women enter pregnancy with inadequate nutritional reserves, increasing their susceptibility to anemia. Common clinical manifestations include fatigue, pallor, cold extremities, and tachycardia (Temitope *et al*., 2022).

Anemia is commonly classified into three categories based on hemoglobin concentration: mild (10.0–10.9 g/dL), moderate (7.0–9.9 g/dL), and severe (<7.0 g/dL). Although mild anemia is frequently observed during pregnancy and is often considered less immediately harmful to the fetus, inadequate management can lead to progression to more severe forms with potentially adverse maternal and fetal outcomes (Gómez *et al*., 2025). Pregnant women who maintain a nutritious diet are more likely to give birth to a healthy baby (Keats *et al*., 2021) .

Unfortunately, a significant proportion of Bangladesh's population lives in poverty, with illiterate women, often from socioeconomically disadvantaged backgrounds, facing acute challenges in affording nutritious diets and accessing antenatal care (ANC). Consequently, pregnant women in Bangladesh constitute a highly vulnerable cohort, burdened by persistently elevated maternal mortality rates, systemic healthcare deficiencies, and pervasive malnutrition, all predominantly attributable to preventable factors (Ahmed *et al*., 2024). The Bangladesh government has implemented several programs to control anemia, including the National Nutrition Program (NNP), which distributes iron-folic acid supplements to pregnant women, and the Community-based Health Care Program, focusing on maternal and child health. Additionally, the Vitamin A and Iron Supplementation Program aims to reduce anemia and improve overall nutritional status (Campbell *et al*., 2020; Engle-Stone and Adams, 2022).

Despite the implementation of national nutrition and maternal health programs, anemia continues to pose a major public health challenge among illiterate pregnant women in Bangladesh, indicating gaps in program reach, utilization, and effectiveness. However, limited empirical evidence exists that simultaneously examines the socioeconomic, antenatal, and dietary determinants of anemia within this particularly vulnerable group. Therefore, the central research question of this study is, what socioeconomic, demographic, ANC, and nutritional factors contribute to the high prevalence and severity of anemia among illiterate pregnant women in Bangladesh? Based on existing literature and contextual evidence, this study hypothesized that illiterate pregnant women with lower household income, inadequate dietary diversity, irregular ANC attendance, and poor adherence to iron supplementation are significantly more likely to develop anemia compared to their counterparts with better socioeconomic conditions, dietary practices, and healthcare utilization. Accordingly, this study aimed to assess the prevalence and severity of anemia among illiterate pregnant women in Bangladesh, examine its association with key demographic and socioeconomic variables, evaluate the impact of dietary practices and iron supplementation adherence, and identify modifiable risk factors to inform targeted public health interventions. This study provides evidence to inform targeted maternal health policies and interventions by highlighting the critical roles of socioeconomic status, dietary practices, ANC utilization, and iron supplementation adherence in reducing anemia among illiterate pregnant women in Bangladesh.

2. Materials and Methods

2.1. Ethical approval and informed consent

No ethical approval was required to conduct the research. All participants were fully informed about the study's purpose and procedures, and written informed consent was obtained from each individual prior to data collection. Participation was entirely voluntary, and strict confidentiality of all personal information was maintained throughout the study.

2.2. Study area, periods and design

A hospital-based cross-sectional survey was conducted at the outpatient department of the Maternal and Child Health Training Institute (MCHTI) in Dhaka, Bangladesh (Figure 1). The institute provides ANC services to pregnant women residing in the southern peripheral areas of Dhaka city, including Kamrangirchor, Puran Dhaka, Babubazar, Mirpur, Jigatola, Azimpur, and surrounding localities. Data were collected from consenting participants over a three-month period, from September to November 2018.

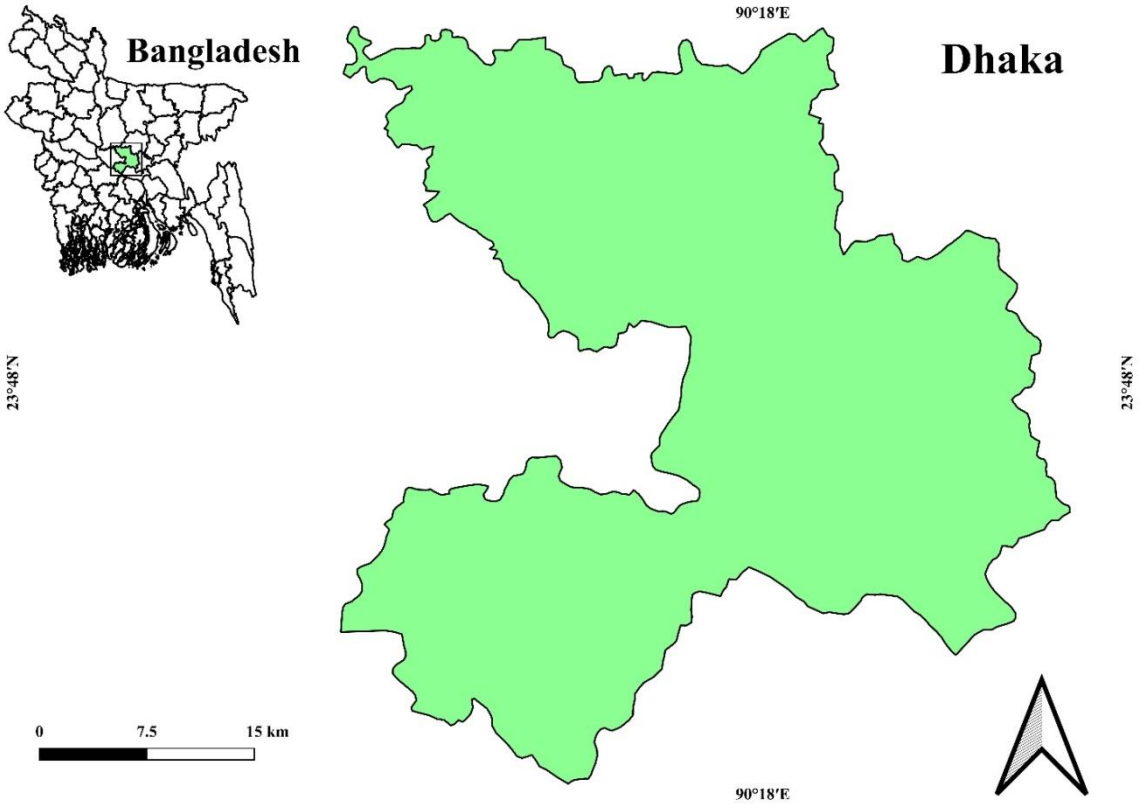

Figure 1. Location of the study area in different parts of Dhaka, Bangladesh.

2.3. Study population and size

Data were collected from pregnant women aged 18–34 years, an age range widely regarded as the peak reproductive period, thereby minimizing potential confounding obstetric risks associated with teenage and advanced maternal age pregnancies (Fritz *et al*., 2018). A total of 100 pregnant women participated in the study, including 52 literate and 48 illiterate individuals. The sample size was determined by logistical feasibility and the predefined three-month data collection period rather than by a formal sample size calculation.

2.4. Inclusion and exclusion criteria

Pregnant women aged 18–34 years who attended ANC services at the MCHTI during the study period and provided informed consent were included in the study. Pregnant women who were critically ill, had diagnosed mental health disorders, or were unable to participate in the interview process were excluded from the study.

2.5. Sampling method

Simple random sampling was employed to minimize selection bias. Each day, a complete list of eligible pregnant women attending the ANC clinic was prepared, and participants were randomly selected using a

random number generator. Literacy status was assessed by reviewing participants' educational backgrounds. Individuals were classified as illiterate if they had not completed any formal education or were unable to read or write a simple sentence in Bangla. This classification was verified through verbal assessment during interviews, as well as through self-reporting and interviewer observation (Ali *et al*., 2024).

2.6. Data collection

Data were collected using structured questionnaires administered through face-to-face interviews. The questionnaire was developed by the researchers based on a review of relevant literature, and its content validity was evaluated by two public health experts. A pilot test involving 10 participants (excluded from the final analysis) was conducted to assess clarity and internal consistency, with reliability confirmed via Cronbach's alpha. The questionnaire captured information on socioeconomic factors (e.g., education, occupation, husband's occupation, family income), reproductive history (e.g., marital status, number of children, contraceptive use), ANC (e.g., gestational age, ANC visits, inter-pregnancy interval), and dietary patterns. Hemoglobin levels were obtained from the pathology laboratory of MCHTI, and anemia was classified according to WHO criteria, using a hemoglobin threshold of <11 g/dL for pregnant women (Tabrizi and Barjasteh, 2015). Trimester-specific variations in hemoglobin thresholds were not applied in this study.

2.7. Poverty measurement

Socioeconomic status was evaluated based on monthly household income, with participants categorized into three income groups: <10,000 BDT, 10,000–20,000 BDT, and >20,000 BDT to facilitate analysis. Additional indicators, including the husband's occupation and the number of income-earning household members, were also recorded to provide a more comprehensive assessment of each family's economic situation.

2.8. Statistical analysis

Statistical analyses were performed using SPSS version 25 (SPSS Inc., Chicago, IL) and Microsoft Excel (Microsoft Corporation, Redmond, WA). Descriptive statistics were employed to summarize socioeconomic characteristics, reproductive history, and ANC parameters (Nah *et al*., 2020). Associations between anemia and variables such as socio-demographic factors, gestational age, and iron supplementation were evaluated using the chi-square test. Statistical significance was determined at a 95% confidence level, with a P-value ≤ 0.05 considered significant.

3. Results

3.1. The socioeconomic status of pregnant illiterate women

The study included 100 pregnant women, of whom 48 were classified as illiterate. Among these illiterate participants, 37.50% were aged 18–24 years, while 35.40% were younger than 18 years. Most participants relied on their husbands as the primary source of household income, with 66.70% reporting a monthly income between 10,000 and 20,000 BDT. Additionally, 62.50% of the participants lived in households with 4–6 family members. Regarding health information access, 64.60% of the women did not watch any health or nutrition-related television programs, indicating limited exposure to health education (Table 1).

Table 1. Socio-economic parameters and demographic distribution of illiterate women attending ANC at MCHTI (n = 48).

Socioeconomic parameters	Sub-category	Number of individuals and percentage
Age group	Below 18 years	17 (35.40%)
	18-24 years	18 (37.50%)
	25-29 years	13 (27.10%)
Family income per month (BDT)	<10000	13 (27.10%)
	10000 to 20000	32 (66.70%)
	20000 to 30000	3 (6.30%)
Family members	1 to 2	18 (37.50%)
	4 to 6	30 (62.50%)
Do you watch various health nutritional program on television?	Yes	17 (35.40%)
	No	31 (64.60%)

Among the 48 illiterate participants, 45 (93.75%) reported a monthly family income of less than BDT 20,000, indicating that the majority of the study population belonged to low-income households (Table 2). A significant association was observed between family income and the severity of anemia ($P < 0.05$), with anemia prevalence being markedly higher among women from lower-income families compared to those from higher-income families. This difference was statistically significant at the 95% confidence level ($P = 0.000$), highlighting the influence of socioeconomic status on maternal anemia.

Table 2. Association between family income and severity of anemia among illiterate pregnant women (n = 48).

Family income per month (BDT)		Grading of severity of anemia				Total
		Mild anemia	Moderate anemia	Severe anemia	No anemia	
<10000	Count	8	5	0	0	13
	% within family income per month	61.50%	38.50%	0.0%	0.0%	100.0%
10000-20000	Count	21	8	3	0	32
	% within family income per month	65.60%	25.0%	9.40%	0.0%	100.0%
20000-30000	Count	0	0	1	2	3
	% within family income per month	0.0%	0.0%	33.30%	66.7%	100.0%

Out of the total sample of 100 pregnant women, 48 were illiterate and 52 were literate. Among the illiterate participants, 46 (95.80%) were diagnosed with anemia, while only two were not anemic. Of the anemic women, 29 (60.40%) had mild anemia, 13 (27.10%) had moderate anemia, and four (8.30%) had severe anemia (Figure 2).

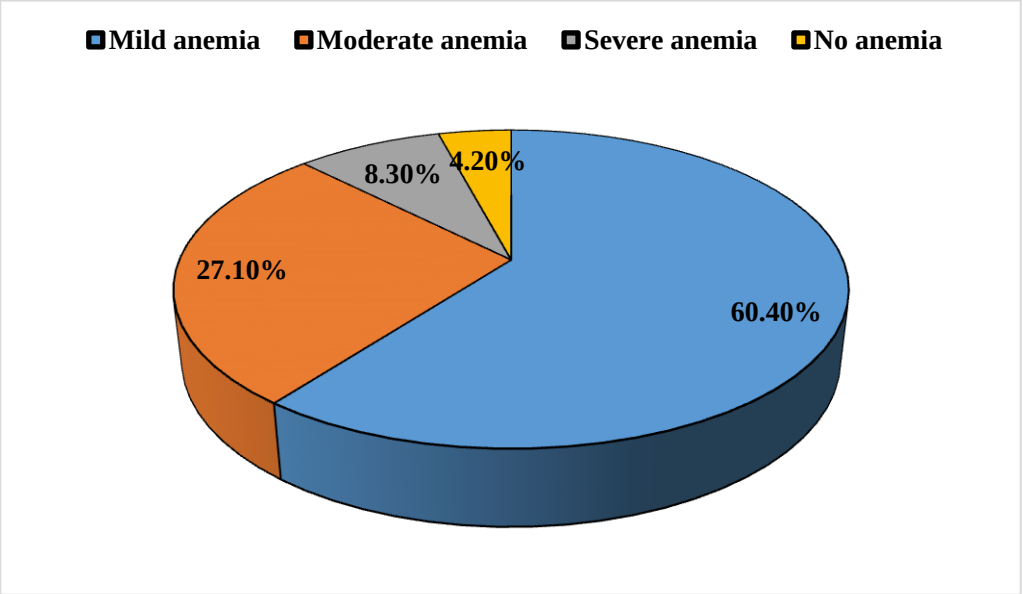

Figure 2. Distribution of severity of anemia among illiterate women attending ANC at MCHTI.

3.2. Clinical history and reproductive background of illiterate pregnant women

Among the 48 pregnant illiterate women, 26 (54.20%) were experiencing their first childbirth, indicating that a substantial proportion of illiterate women were first-time mothers. Additionally, 27.10% had two children, and 18.80% had one child. About 16% of participants reported a history of miscarriage, while 37 women (77.10%) were not using any form of contraception (Figure 3).

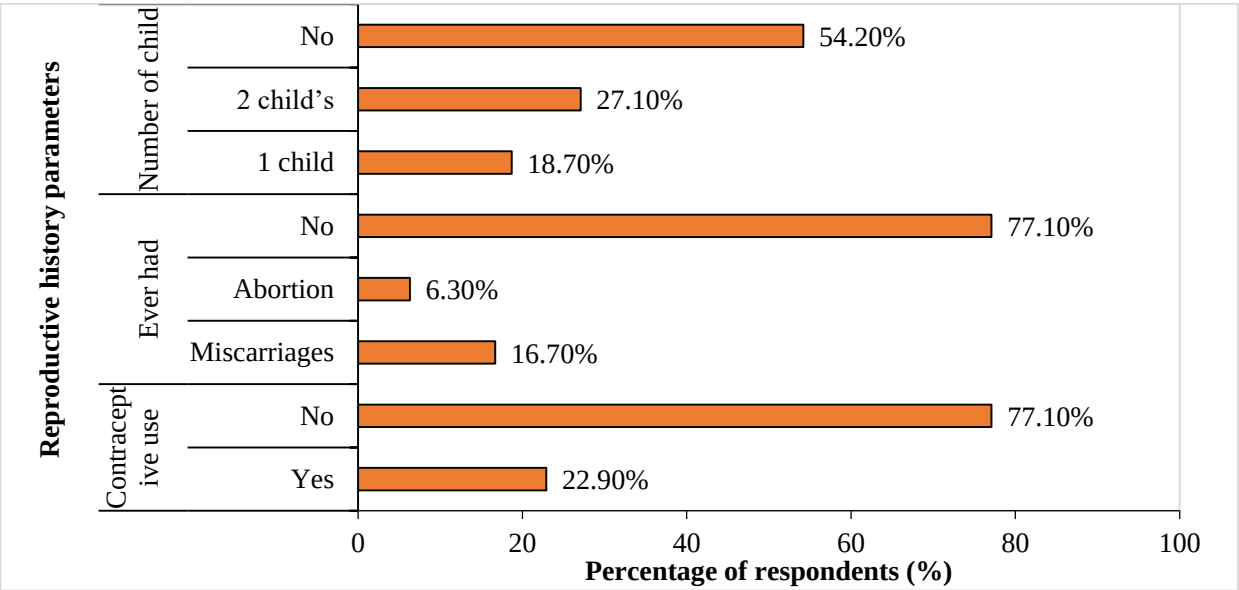

Figure 3. Reproductive history distribution among illiterate pregnant women attending attended antenatal care (ANC) at MCHTI (n = 48).

Among the 48 illiterate participants, 31 women (64.6%) were in their second trimester of pregnancy. A total of 41 women (85.40%) attended ANC during their current pregnancy. Prior to pregnancy, 34 women (70.80%) did not exhibit signs of anemia. The severity of anemia was significantly associated with ANC attendance during the current pregnancy ($P = 0.004$), suggesting that regular prenatal checkups may influence anemia status (Table 3).

Table 3. The antenatal condition of the participants attending the antenatal care (ANC) at MCHTI.

Parameters	Category	No. of individuals	Percentage (%)
Anemia prior to being pregnant	Yes	14	29.20
	No	34	70.80
Gestational age	1st trimester	11	22.90
	2nd trimester	31	64.60
	3rd trimester	6	12.50
ANC during pregnancy	Yes	41	85.40
	No	7	14.60
Heavy period	Yes	21	43.80
	No	27	56.30

In the first trimester, 81.80% of women had mild anemia, 9.10% had severe anemia, and 9.10% had no anemia. In the second trimester, the majority (54.80%) had mild anemia, 35.50% had moderate anemia, 6.50% had severe anemia, and 3.20% were not anemic. During the third trimester, 50% of participants had mild anemia, 33.30% had moderate anemia, and 16.70% had severe anemia (Table 4).

Table 4. Association between gestational age and severity of anemia among illiterate pregnant women (n = 48).

Gestational age		Grading of severity of anemia				Total
		Mild anemia	Moderate anemia	Severe anemia	No anemia	
1st trimester	Count	9	0	1	1	11
	% within gestational age	81.80%	0.0%	9.10%	9.10%	100.0%
2nd trimester	Count	17	11	2	1	31
	% within gestational age	54.80%	35.50%	6.50%	3.20%	100.0%
3rd trimester	Count	3	2	1	0	6
	% within gestational age	50.0%	33.30%	16.70%	0.0%	100.0%

3.3. Dietary practices of illiterate mothers during pregnancy

Among the 48 illiterate pregnant women, a majority (28, 58.30%) had a normal body mass index (BMI). Regarding dietary patterns, 33 women consumed three meals per day, while 15 reported having more than three meals daily. Notably, 81.30% of the participants did not adhere to the recommended iron supplementation regimen (Figure 4). Statistical analysis revealed a significant association between iron supplementation and anemia severity ($P < 0.05$), indicating that women who did not take iron supplements experienced markedly higher levels of anemia. This difference was highly significant at the 95% confidence level ($P = 0.000$), underscoring the critical role of iron supplementation in mitigating anemia during pregnancy. Frequent consumption of certain foods—red meat, lentils, sweet potatoes, spinach, green leafy vegetables, bananas, and taro stems—was associated with reduced anemia severity among participants. Most of these associations were statistically significant, with p-values ranging from 0.000 to 0.029.

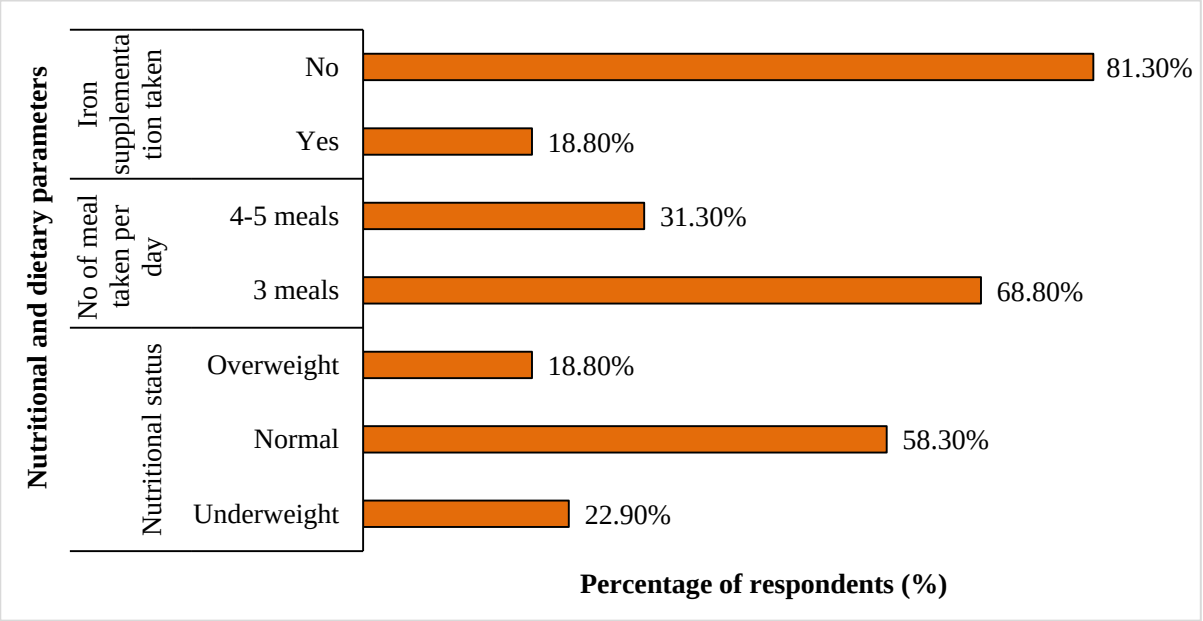

Figure 4. Nutritional status and iron supplementation practices among illiterate pregnant women at MCHTI (n = 48).

3.4. Predicting factors of anemia among illiterate pregnant women

The bivariate analysis identified several significant predictors of anemia among illiterate pregnant women. Higher anemia prevalence was observed among participants from lower-income households (<20,000 BDT), those in their second trimester, women who did not take iron supplements, and those consuming fewer than three meals per day. Additionally, lack of ANC follow-up, limited awareness about anemia, and infrequent consumption of iron-rich or nutrient-dense foods were associated with increased anemia risk. Some factors, including heavy menstrual history, BMI category, and reproductive history, were also evaluated, but statistical significance was either not reported or not clearly defined (Table 5).

Table 5. Predictive factors associated with anemia among illiterate pregnant women (n = 48).

Predictive factor	Category compared	Higher anemia prevalence in	Statistical test used	*P*-value
Family monthly income	<20,000 vs ≥20,000 BDT	<20,000 BDT	Z-test for proportions	0.000
Gestational age	1st, 2nd, 3rd trimester	2nd trimester	One-way ANOVA	0.004
Iron supplementation	Yes vs No	No	Z-test for proportions	0.000
Dietary frequency	<3 vs ≥3 meals/day	<3 meals/day	Z-test for proportions	0.012
ANC Follow-up	Yes vs No	No	Z-test for proportions	0.007
Awareness about Anemia	Aware vs Not aware	Not aware	Z-test for proportions	0.018

Table 5. Contd.

Predictive factor	Category compared	Higher anemia prevalence in	Statistical test used	*P*-value
Food group consumption	Regular vs Rare consumption	Rare consumers	Fisher's Exact Test / ANOVA	0.000–0.029
Heavy menstrual history	Yes vs No	Yes	Z-test for proportions	Not given
BMI Category	Underweight vs Normal/Overweight	Not stated	One-way ANOVA (assumed)	Not given
Reproductive history	1st-time vs multiparous mothers	Not clearly stated	Fisher's Exact Test (assumed)	Not given

4. Discussion

This study demonstrates a high prevalence of anemia among pregnant women attending ANC at MCHTI, with a particularly notable burden among those with limited literacy. Anemia was defined using the World Health Organization (WHO) threshold of hemoglobin <11 g/dL for pregnant women (Smith *et al*., 2025). Among illiterate women (n = 48), 95.83% were anemic, with 60.40% experiencing mild anemia, 27.10% moderate anemia, and 8.30% severe anemia. However, the assertion that literacy status is a principal factor should be nuanced: a substantial proportion of literate women (48.10%) were also anemic, indicating that anemia is a multifactorial issue not solely attributable to literacy level. Thus, while literacy may play a contributory role, other determinants such as socioeconomic status, gestational age, iron supplementation, dietary frequency, and ANC attendance are also significant. Contrary to prior claims, our data did not establish a direct statistical correlation between literacy level and anemia prevalence. Although Lokare *et al*. (2012) reported such a correlation, our results suggest that multiple variables, rather than literacy alone, contribute to anemia. The use of terms such as "low literate" or statements regarding incidence rather than prevalence has been revised for clarity and accuracy.

A statistically significant association (Chi-square test, $P < 0.001$) was observed between lower family income (<20,000 BDT) and higher anemia prevalence. Most participants (66.70%) belonged to families earning 10,000–20,000 BDT, and 62.50% had 4–6 household members, suggesting that resource limitations may affect both nutritional intake and healthcare access. This aligns with previous study of Mangla and Singla (2016), which also noted socioeconomic disadvantage as a key contributor to anemia.

Gestational age was significantly associated with anemia severity (Chi-square test, $P = 0.004$). Anemia was most prevalent in the second trimester, with 65.22% of anemic cases occurring during this period. This finding is consistent with research from Southern Ethiopia, which reported higher anemia rates during the second and third trimesters (Gebre and Mulugeta, 2015).

Similarly, our study identified a significant association between dietary frequency and anemia (Chi-square test, $P = 0.012$), with higher anemia prevalence among women consuming fewer than three meals per day. This finding highlights the critical role of adequate meal frequency and dietary diversity during pregnancy. Regular consumption of iron-rich foods, including red meat, lentils, bananas, and green leafy vegetables, was associated with lower anemia severity, with statistically significant P-values ranging from 0.000 to 0.029. These results are consistent with evidence from studies conducted in Pakistan and Turkey, which similarly reported a protective effect of diversified diets against anemia (Karaoglu *et al*., 2010; Gibore *et al*., 2021). Nutritional deficiencies resulting from poverty and lack of knowledge likely exacerbate anemia, emphasizing the need for targeted nutritional interventions.

Adherence to iron supplementation was notably low, with 81.30% of illiterate women reporting that they did not take iron supplements during pregnancy, despite free provision by MCHTI. This poor compliance was significantly associated with a higher prevalence of anemia (Chi-square test, $P < 0.001$). While some women cited forgetfulness or gastrointestinal discomfort, others lacked awareness of the importance of iron intake. This is consistent with prior study of Zhang *et al*. (2022) that identified poor iron adherence as a major contributor to anemia.

While 85.40% of the illiterate women attended ANC services, the association between ANC follow-up and anemia was still significant (Chi-square test, $P = 0.007$), implying that ANC alone may not be sufficient without quality counseling and follow-through. The claim in earlier versions of the discussion that illiteracy leads to poor healthcare utilization is inconsistent with this finding and has thus been corrected.

This study highlights the high prevalence of anemia among pregnant women, particularly those from lower socioeconomic backgrounds. Key predictors include low income, poor dietary frequency, non-adherence to iron

supplementation, and gestational age. While literacy may influence health behaviors, it is not the sole determinant. Interventions must focus on improving nutritional education, promoting dietary diversity, and ensuring iron supplementation compliance during ANC visits. Future research should explore the qualitative reasons behind poor iron adherence and examine longitudinal trends to better understand causality. Additionally, a clearer definition of literacy levels and standardized measurement of anemia prevalence will enhance future investigations.

5. Conclusions

This study demonstrates that anemia remains a significant public health challenge among illiterate pregnant women in Bangladesh. Limited education contributes to poor nutritional awareness, low intake of iron-rich foods, and suboptimal use of antenatal care (ANC) services, thereby increasing anemia risk. The findings emphasize the need for integrated maternal health strategies that combine literacy improvement, nutrition education, and improved access to prenatal care and iron supplementation. Targeted community-based interventions, supported by future longitudinal research, are essential for developing sustainable approaches to anemia prevention in resource-limited settings.

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Data availability

All data supporting the findings of this study are included within the manuscript.

Conflict of interest

None to declare.

Authors' contribution

Barsha Sarker Nipa: conceptualization, research design, data curation, data acquisition, formal analysis, investigation, methodology, visualization, writing first draft of the manuscript, review and revision of the manuscript; Rahul Dev Bairagi: data curation, formal analysis, investigation, resources, software, writing first draft of the manuscript, review and revision of the manuscript; Fouzia Akter: conceptualization, methodology, project administration, supervision, visualization, review and revision of the manuscript; Partha Chandra Debnathe: formal analysis, review and revision of the manuscript; Raiyan Rahman Reon: formal analysis, review and revision of the manuscript; Anike Chakrabarty: data analysis, review and revision of the manuscript; Shuvra Chakrabarty: formal analysis, review and revision of the manuscript; Md. Mustafizur Rahman: formal analysis, validation, resources, review and revision of the manuscript. All authors have read and approved the final manuscript.

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