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Prevalence of Anemia and Hemoglobinopathies among Newborns and their Mothers at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia

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ABSTRACT

Background: Neonatal and maternal anemia are an important public health concerns, particularly in low-and middle-income countries such as Ethiopia. Early screening for anemia and hemoglobinopathies, including sickle cell disease, can facilitate timely diagnosis and interventions. However, evidence on newborn screening for anemia and sickle cell disease is limited. This study aimed to determine the prevalence of anemia among newborns and their mothers and to assess the prevalence of hemoglobinopathies, including sickle cell disease, among newborns.

Methods: A hospital-based cross-sectional study was conducted from September 2025 to January 2026. A total of 583 mother–newborn pairs were screened for anemia, and 1,000 newborns were screened for hemoglobinopathies. Participants were recruited using a convenience sampling technique. Socio-demographic, clinical, nutritional, and behavioral data were collected using a structured questionnaire. Maternal nutritional status was assessed using mid-upper arm circumference (MUAC). Cord blood and maternal capillary blood samples were collected to determine hemoglobin levels using the HemoSmart Gold Hemoglobin Screening Meter. Hemoglobinopathies were assessed in newborns using standard screening procedures. Descriptive statistics were used to summarize the data and bivariable and multivariable binary logistic regression analyses were performed to identify factors associated with anemia. Statistical significance was set at $p < 0.05$.

Results: The prevalence of anemia among newborns was 18.9%, with a slightly higher prevalence (21.1%) among those with low-birth-weight. Overall, 14.4% of newborns had abnormal hemoglobin patterns suggestive of hemoglobinopathies or thalassemia or other hemoglobinopathies associated with thalassemia; however, neither sickle cell disease nor sickle cell trait was detected. Neonatal anemia was independently associated with a lack of maternal folic acid or vitamin B supplementation ($p < 0.001$), maternal use of traditional medicine during pregnancy ($p = 0.015$), and severe acute maternal malnutrition ($p = 0.004$). Among the mothers who delivered, the prevalence of anemia was 54.7%, while 8.3% were malnourished. Maternal anemia was significantly associated with occupation ($p = 0.030$), history of traditional medicine use ($p = 0.012$), and the mode of delivery ($p = 0.026$).

Conclusion: Maternal anemia remains a severe public health problem, whereas neonatal anemia represents a moderate public health burden in the study setting. Although sickle cell disease and sickle cell traits were not detected, the relatively high prevalence of other hemoglobinopathies warrants further investigation. Routine screening of newborns and mothers for anemia and hemoglobinopathies should be considered to enable early detection and appropriate management, particularly in high-burden settings.

Keywords: Anemia, hemoglobinopathies, newborns, Delivery mothers

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INTRODUCTION

Anemia is defined by the World Health Organization (WHO) as a reduction in the amount of red blood cells or the concentration of hemoglobin below the normal reference values for an individual's age, sex, physiological status, and geographical location (1). It remains one of the most common public health problems worldwide, disproportionately affecting women of reproductive age and young children (2). During pregnancy, maternal anemia is associated with adverse maternal and neonatal outcomes, including preterm birth, low birth weight, impaired fetal growth, increased perinatal morbidity, and mortality (3, 4). Because fetal erythropoiesis depends largely on maternal iron stores and placental iron stores at birth (5).

Neonatal anemia is a multifactorial condition resulting from nutritional deficiencies, hemorrhage, hemolysis, impaired red blood cell production, maternal and neonatal infections, and inherited hemoglobin disorders (6, 7). In sub-Saharan Africa, neonatal anemia is frequently associated with maternal anemia, poor maternal nutritional status, and infectious diseases such as malaria (8, 9). If left untreated, neonatal anemia can impair oxygen delivery to tissues, disrupt brain growth and neurodevelopment, cause growth retardation, and result in long-term cognitive and developmental deficits (10, 11).

Inherited hemoglobin disorders (hemoglobinopathies) are among the most common monogenic disorders worldwide (12). These disorders, including sickle cell disease and thalassemias, arise from structural abnormalities or reduced synthesis of hemoglobin (13). They contribute substantially to neonatal and childhood morbidity and mortality, particularly in low- and middle-income countries where routine newborn screening programs are limited or absent. Early identification through newborn screening enables timely clinical management, parental counseling, and implementation of preventive interventions that improve survival and quality of life (14-16).

According to the WHO, approximately 36.5% of pregnant women worldwide were affected by anemia in 2019, with the highest prevalence reported in Sub-Saharan Africa (46.2%) (17). In Ethiopia, the pooled prevalence of anemia among pregnant women has been estimated at 26.4%, indicating that maternal anemia remains a significant public health challenge (18). Maternal anemia has consistently been associated with adverse pregnancy outcomes, including preterm delivery, low birth weight, postpartum hemorrhage, and increased maternal and neonatal mortality (19).

Despite the substantial burden of maternal anemia in Ethiopia, evidence on anemia and hemoglobinopathies among newborns at birth remains limited. Even though a few studies revealed that the prevalence of anemia among newborns range from 23.2 - 26.4% (20-23), most available studies have focused on maternal anemia or anemia among older infants and children, while data on neonatal anemia and inherited hemoglobin disorders are scarce. In addition, newborn screening for hemoglobinopathies is not routinely implemented in Ethiopia, resulting in limited information on the epidemiology of these disorders and missed opportunities for early diagnosis and intervention.

Generating local evidence on the prevalence of anemia and hemoglobinopathies among delivery mothers and their newborns is essential to inform maternal and neonatal health policies, support the establishment of newborn screening programs, and guide interventions aimed at reducing hematological disorders and improving neonatal outcomes. Therefore, this study aimed to determine the prevalence of anemia among newborns and delivery mothers and to assess the prevalence of hemoglobinopathies among newborns at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia.

METHODS

Study setting

This study was conducted at the University of Gondar Comprehensive Specialized Hospital (UoGCSH), a tertiary teaching and referral hospital located in Gondar City, Northwest Ethiopia. The University of Gondar was established in 1954, and it's College of Medicine and Health Sciences is one of the country's leading institutions for medical education, research, and clinical services. The hospital serves an estimated population of more than seven million people in the Amhara National Regional State and neighboring regions and conducts approximately 13,200 deliveries annually.

Study design, period, and participants

A hospital-based cross-sectional study was conducted from September 2025 to January 2026. Delivery mothers and their newborns who gave birth at UoGCSH during the study period

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were included. Newborns with intra-urine transfusion and placental abruption, traumatic cord venipuncture were excluded from the study. A total of 583 mother–newborn pairs were screened for anemia, and maternal nutritional status was assessed among all participating mothers. In addition, 1,000 newborns were screened for sickle cell hemoglobin and other hemoglobinopathies.

Study variables

The dependent variables were neonatal anemia, maternal anemia, and the presence of hemoglobinopathies among newborns. The independent variables included maternal age, educational status, occupation, nutritional status (MUAC), folic acid or vitamin B supplementation, fruit and vegetable consumption, history of traditional medicine use, family history of congenital anomalies, gravidity, history of stillbirth, gestational age, birth weight, neonatal age at assessment, and maternal hemoglobin level.

Data collection

Socio-demographic, clinical, nutritional, obstetric, and behavioral data were collected using a structured, pretested questionnaire administered by trained midwives.

Maternal socio-demographic variables included age, residence, educational status, religion, marital status, and occupation. Newborn characteristics included sex, age at assessment, gestational age, and birth weight.

Clinical information included maternal history of chronic illness, medication use during pregnancy, obstetric history, pregnancy complications, and family history of congenital anomalies.

Maternal nutritional status was assessed using mid-upper arm circumference (MUAC). A MUAC of <23 cm was used to identify undernutrition, while a MUAC of <21 cm indicated severe acute malnutrition. Information on folic acid or multivitamin supplementation, frequency of fruit and vegetable consumption, alcohol intake, khat chewing, and traditional medicine use during pregnancy was also collected.

Blood sample collection and laboratory analysis

Approximately 3 mL of umbilical cord blood was collected immediately after delivery into EDTA anticoagulated tubes. Samples were gently mixed and used for hemoglobin determination and screening for hemoglobinopathies.

Capillary blood samples were collected from delivery mothers for hemoglobin measurement. Newborns with cord blood hemoglobin levels <14 g/dL underwent repeat hemoglobin testing using heel-prick blood samples approximately 8 hours after birth to confirm anemia.

Hemoglobin concentration was measured using the HemoSmart Gold Hemoglobin Screening Meter (APEXBIO), a portable electrochemical biosensor designed for quantitative measurement of hemoglobin in fresh whole blood, with a measurement range of 4–24 g/dL and a turnaround time of approximately five seconds. Blood samples were collected by trained midwives and analyzed by laboratory technologists following the manufacturer's instructions.

Screening for hemoglobinopathies

Newborns were screened for sickle cell hemoglobin and other hemoglobinopathies using the SICKLECHECK™ rapid diagnostic test. This immunochromatographic assay simultaneously detects hemoglobin A (HbA) and hemoglobin S (HbS) using antibody-based competitive immunoassay technology with gold nanoparticle detection. Test results were interpreted according to the manufacturer's instructions. The absence of color bands at the test regions (S & A) indicates the presence of respective antigen (Hb S / Hb A) in the test specimen. The presence of colored band at the test regions (S & A) indicate the absence of the respective antigens (Hb S / Hb A) in the specimen (other hemoglobinopathies or thalassemia or others hemoglobinopathies associated with Thalassemia). Newborns were classified as having sickle cell disease when both the control (C) and sickle cell (S) bands were present.

Definition of anemia

Maternal anemia was defined as hemoglobin concentration <12.0 g/dL. Mild, moderate, and severe anemia were defined as hemoglobin concentrations of 11.0–11.9 g/dL, 8.0–10.9 g/dL, and <8.0 g/dL, respectively (24). Neonatal anemia was defined as a cord blood hemoglobin concentration <14.0 g/dL. Severity was classified as mild (10.0–13.9 g/dL), moderate (7.0–9.9 g/dL), and severe (<7.0 g/dL) according to published recommendations (25).

Data analysis

Data were entered and analyzed using IBM SPSS Statistics version 27. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize participant characteristics.

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Normality of continuous variables was assessed using the Shapiro–Wilk test. The goodness-of-fit of the logistic regression model was evaluated using the Hosmer–Lemeshow test, with a p-value >0.05 indicating adequate model fit.

Bivariable logistic regression analysis was initially performed to identify candidate variables associated with neonatal and maternal anemia. Variables with a p-value <0.25 were included in the multivariable logistic regression model. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated, and statistical significance was declared at p<0.05.

Quality assurance mechanisms

The questionnaire was developed in English, translated into Amharic, and back-translated into English to ensure consistency. Data collectors and supervisors received appropriate training before data collection.

All laboratory procedures were performed according to standard operating procedures. Reagents and test kits were checked before use to ensure they were within their expiration dates. Data collection was closely supervised by the investigators, and completed questionnaires were reviewed daily for completeness and consistency before data entry.

Ethical consideration

Ethical approval for this study was obtained from the Institutional Research Ethics Review Committee (IRERC) of the College of Medicine and Health Sciences, University of Gondar on the 3rd of April 2024 with a letter number CMHSH-UOG IRERC/25/4/2024. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Before enrollment, the purpose, procedures, potential benefits, and possible risks of the study were explained to all participating mothers. Written informed consent was obtained from each mother for her participation and on behalf of her newborn before data and blood sample collection. Participation was entirely voluntary, and participants were informed of their right to refuse or withdraw from the study at any time without affecting the healthcare services they received.

Umbilical cord blood samples were collected only after delivery from the detached umbilical cord, posing no additional risk to the mother or newborn. Mothers were informed about the blood collection procedures before providing consent.

To protect participants' privacy, all collected data were coded and kept strictly confidential. Personal identifiers were removed from the dataset, and access to the data was restricted to the research team. Newborns identified with anemia or abnormal newborn screening results were referred to the appropriate pediatric clinics at the University of Gondar Comprehensive Specialized Hospital for further diagnostic evaluation, treatment, and follow-up in accordance with national and WHO recommendations.

RESULTS

Socio-demographic characteristics of delivery mothers

A total of 583 delivery mothers participated in the study. Most mothers (62.8%) were aged 21–30 years, and 90.0% resided in urban areas. Regarding educational status, 43.4% had completed secondary school. By occupation, 65.4% were housewives, while 11.1% were government employees (Table 1).

Clinical, nutritional, and behavioral characteristics of delivery mothers

Among the participating mothers, 64.8% (378/583) were multigravida, 14.9% (87/583) had a history of miscarriage, and 3.8% (22/583) reported a previous stillbirth. Twin deliveries accounted for 5.5% (32/583) of all births.

More than half of the mothers (58.0%) reported consuming fruits and vegetables only occasionally, while 11.8% had used traditional medicine during pregnancy. Pregnancy-related complications were reported by 20.1% (152/583) of participants, with pre-eclampsia (45.4%; 69/152) and oligohydramnios (17.8%; 27/152) being the most common complications.

The overall prevalence of maternal malnutrition, assessed using MUAC, was 8.3% (48/583). Moderate acute malnutrition and severe acute malnutrition were identified in 5.0% (29/583) and 3.3% (19/583) of mothers, respectively (Table 2).

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Table 1: Socio-demographic characteristics of delivery mothers at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, September 2025–January 2026 (n = 583).

Category	Frequency	Percent
Age		
<20	68	11.7
21-30	366	62.8
31-40	149	25.5
>41		
Residence		
Urban	529	90.7
Rural	54	9.3
Education		
No formal education	40	6.9
Elementary School	133	22.8
Secondary school	253	43.4
College and above	157	26.9
Religion		
Orthodox	542	93.0
Muslim	39	6.7
Protestant	2	0.3
Marital status		
Single	14	2.4
Married	561	96.2
Divorced	8	1.4
Occupation		
Farmer	17	2.9
Student	12	2.1
House wife	381	65.4
Government employee	65	11.1
Merchant	38	6.5
Non-Government employee	13	2.2
Daily Laborer	1	0.2
Others	56	9.6

Table 2: Clinical, nutritional, and behavioral characteristics of delivery mothers at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, September 2025–January 2026 (n = 583).

Variables	Frequency	%
Obstetric related data		
Primigravida	205	35.2
Multigravida	378	64.8
History of Miscarriage		
Yes	87	14.9
NO	496	85.1
Multiple Pregnancy		
Yes	536	91.9
NO	47	8.1
History of still birth		
Yes	22	3.8
NO	561	96.2
Family History of congenital anomalies		
Yes	5	0.9
NO	578	99.1
History of Newborns with congenital malformations		
Yes	1	0.2
NO	582	99.8
Consumption of vegetables and fruits per week		
Some times	338	58.0
Daily	92	15.8
Rarely	129	22.1
Not at all	24	4.1
Behavior factors		
History of alcohol intake		
Yes	28	4.8
NO	555	95.2
History of Khat chewing		
Yes	1	0.2
NO	582	99.8
History of traditional medicine		
Yes	69	11.8
NO	514	88.2
Nutritional status		
Normal	535	91.8
Moderate acute malnutrition	29	5
Severe acute malnutrition	19	3.3

Demographic and clinical characteristics of newborns

Of the 583 newborns included in the anemia screening, 50.4% were male. Regarding gestational age, 44.4% (259/583) were born at full term, whereas 12.0% (70/583) were preterm. At the time of assessment, 72.7% (424/583) of newborns were within the first hour of life (golden hour), while 18.4% (107/583) were in the first period of reactivity.

Most newborns (85.8%; 500/583) had normal birth weight. Low birth weight was observed in 12.2% (71/583), while only three newborns had very low birth weight (Table 3).

Table 3: Demographic and clinical characteristics of newborns at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, September 2025–January 2026 (n = 583).

Category	Frequency	Percent
Sex		
Male	294	50.4
Female	289	49.4
Age of infants in minutes		
≤ 60 minutes	424	72.7
60-120 minutes	107	18.4
120-180 minutes	32	5.5
180-240 minutes	20	3.4
Gestational age		
Preterm (before 37 weeks)		
Late Preterm (34 to 36 weeks)	51	8.7
Moderately Preterm (29 to 33 weeks)	16	2.7
Extremely Preterm (Below 29 weeks)	3	0.5
Term (37-41 weeks)		
Early Term: 37 weeks (0 days to 38 weeks)	164	28.1
Full Term: 39 weeks (0 days to 40 weeks)	259	44.4
Late Term: 41 weeks (0 days to 41 weeks)	67	11.5
Post-term (after 42 weeks)		
Birth weight		
Normal birth weight (2500-400 gram)	500	85.8
Low birth weight (<2500 gram)	71	12.2
Very low birth weight (<1500 gram)	3	0.5
High birth weight (>4001 gram)	9	1.5

Prevalence of maternal anemia

The overall prevalence of anemia among delivery mothers was 54.7% (319/583). Mild, moderate, and severe anemia were identified in 22.8% (133/583), 26.2% (153/583), and 2.4% (14/583) of mothers, respectively.

Prevalence of neonatal anemia

The overall prevalence of neonatal anemia was 18.9% (110/583; 95% CI: 16.0%–22.1%) (Figure 1). The prevalence of anemia was 13.5% among full-term newborns and 24.4% among early-term newborns. According to birth weight, anemia was observed in 18.2% of newborns with normal birth weight, 21.1% (15/71) of low-birth-weight newborns, 66.7% of very-low-birth-weight newborns, and 22.2% of high-birth-weight newborns (Figure 2).

Among the 94 newborns with cord blood hemoglobin levels <14.0 g/dL, repeat heel-prick testing performed approximately eight hours after birth confirmed anemia in six (6.4%) newborns. Twelve newborns (12.8%) required admission to the neonatal intensive care unit (NICU). Of these, two received iron supplementation, one underwent blood transfusion, two died during follow-up, and the remaining 92 newborns were discharged with improved clinical conditions.

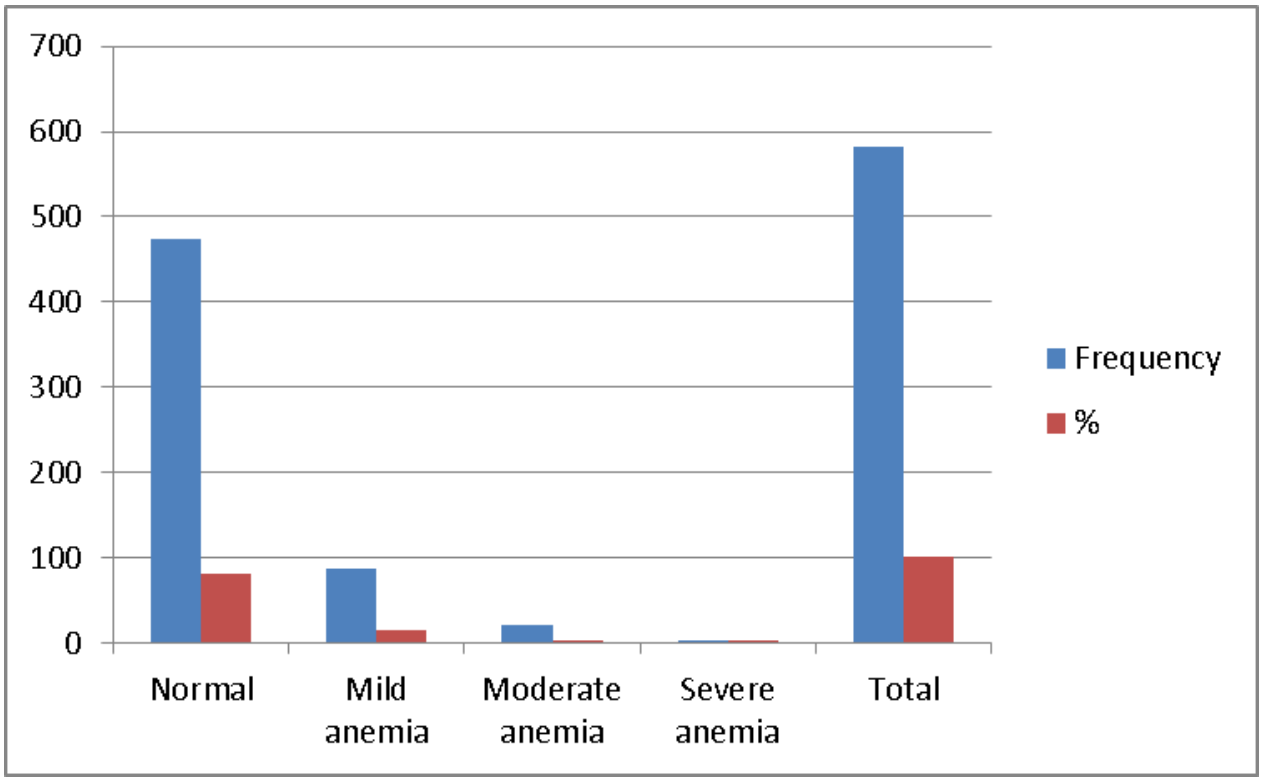

Figure 1: *Overall prevalence of neonatal anemia among newborns at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, September 2025–January 2026 (n = 583).*

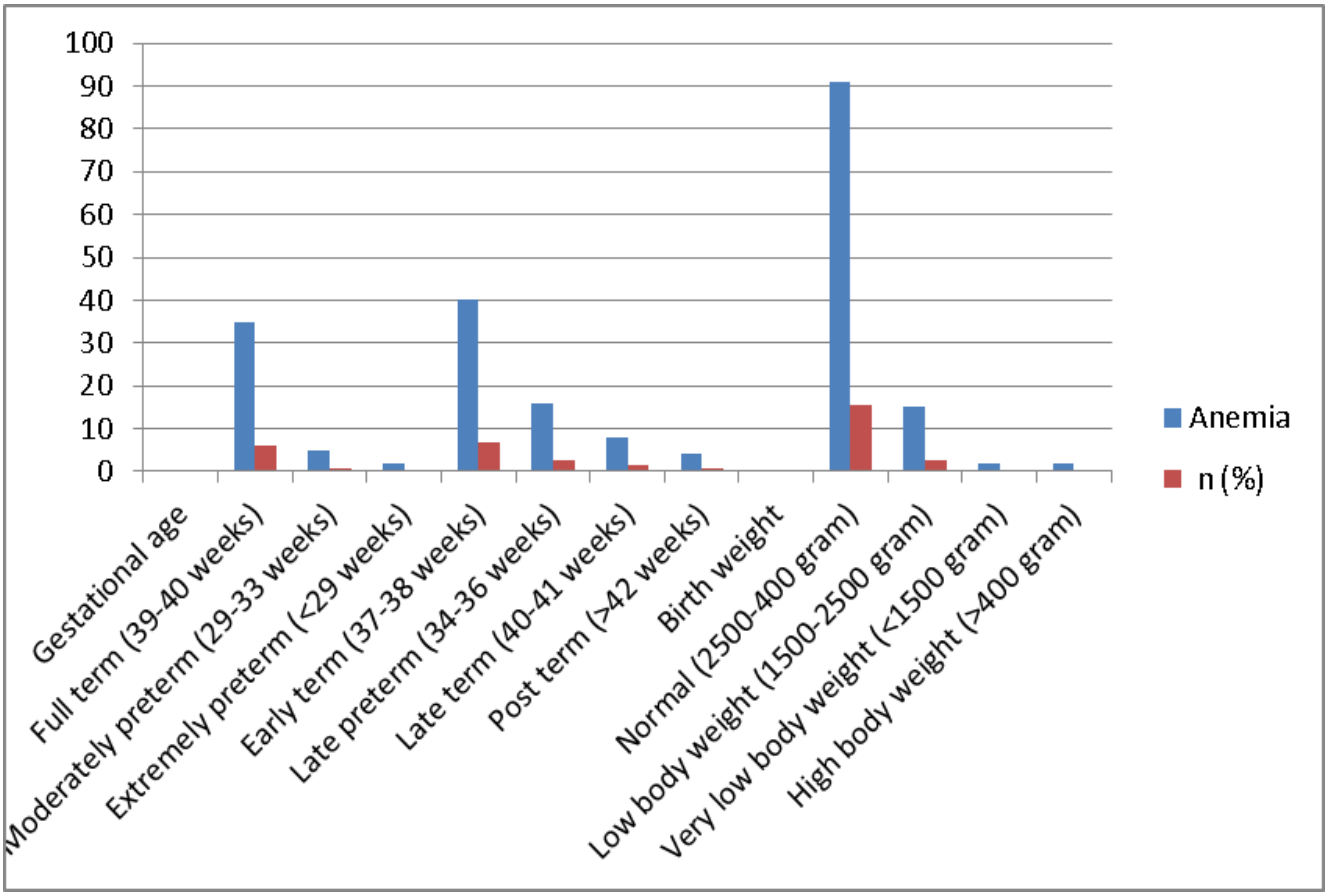

Figure 2: *Prevalence of neonatal anemia according to gestational age and birth weight at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, September 2025–January 2026.*

Prevalence of hemoglobinopathies among newborns

Among the 1,000 newborns screened, 856 (85.6%) demonstrated a normal hemoglobin pattern. The remaining 144 (14.4%) showed abnormal hemoglobin patterns suggestive other hemoglobinopathies or thalassemia or other hemoglobinopathies associated with thalassemia. However, none of the screened newborns tested positive for sickle cell disease or sickle cell trait.

Factors associated with neonatal anemia

In the multivariable logistic regression analysis, neonatal anemia was independently associated with lack of maternal folic acid or vitamin B supplementation (AOR not reported; COR=5.89, 6.44, 95% CI: 3.37–10.33), maternal use of traditional medicine during pregnancy (AOR=2.24, 95% CI: 1.17–4.30).), severe acute maternal malnutrition (AOR=4.03, 95% CI: 1.58–10.30), neonatal age at assessment during the period of decreased activity (AOR=2.56, 95% CI: 1.03–6.37) and the second period of reactivity (AOR=4.19, 95% CI: 1.41–12.43), and gestational age (early-term (AOR=2.47, 95% CI: 1.36–4.49) and late-term (AOR=2.65, 95% CI: 1.12–6.25) (Table 4).

Factors associated with maternal anemia

Multivariable logistic regression analysis identified occupation (housewives (AOR=2.45, 95% CI: 1.23–4.88, farmers (AOR=7.38, 95% CI: 1.21–44.99), traditional medicine uses during pregnancy (AOR=2.25, 95% CI: 1.19–4.23), and mode of delivery (cesarean section (AOR=1.51, 95% CI: 1.05–2.16) as independent predictors of maternal anemia (Table 5).

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Table 4: Multivariable logistic regression analysis of factors associated with neonatal anemia among newborns at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, September 2025–January 2026

Variables		Anemia		COR (95% CI)	AOR (95% CI)	P-value
		Yes n (%)	No n (%)			
Education of mother	No formal education	12(2.1)	28(4.8)	1.44 (0.66-3.12)	1.53 (0.51-4.61)	0.45
	Elementary School	21(3.6)	112(19.2)	0.63(0.35-1.14)	0.77(0.34-1.73)	0.530
	Secondary School	41(7.0)	212(36.4)	0.65(0.39-1.07)	0.67(0.034-1.30)	0.235
	College and Above	36(6.2)	121(20.7)	1	1	
Occupation	Government employee	11(1.9)	54(9.3)	1	1	
	Housewife	62(10.6)	319(54.7)	0.95(0.47-1.93)	1.32(0.52-3.35)	0.56
	Farmer	5(0.9)	12(2.1)	2.05(0.59-6.99)	1.17(0.22-6.11)	0.85
	Merchant	8(1.4)	30(5.1)	1.31(0.48-3.61)	1.25(0.38-4.12)	0.72
	Non-Government employee	6(1.0)	7(1.2)	4.21(1.18-14.96)	2.455(0.54-11.14)	0.24
	Others	18(3.1)	51(8.7)	1.73(0.75-4.02)	1.23(0.44-3.43)	0.69
Family history of congenital anomalies	Yes	3(0.5)	2(0.3)	6.60(1.09-40.00)	8.02(0.99-64.73)	0.05
	No	107(18.4)	471(80.8)	1	1	
Folic acid or vitamin B intake of the mother	Yes	26(4.5)	315(54.0)	1	1	
	No	84(14.4)	158(27.1)	6.44 (3.99-10.41)	5.90 (3.36- -10.33)	0.001*
Vegetable and fruit consumption per week	Daily	17(2.9)	75(12.9)	1	1	
	Sometimes	60(10.3)	278(47.7)	0.95(0.53-1.73)	1.28(0.62-2.64)	0.49
	Rarely	26(4.5)	103(17.6)	1.11(0.56-2.19)	1.029(0.05-2.37)	0.94
	Not at all	7(1.2)	17(2.9)	1.82(0.651-5.07)	0.74 (0.20-2.71)	0.64
History of traditional medicine usage	Yes	28(4.8)	41(7.0)	3.6(2.11-6.15)	2.24(1.170-4.30)	0.015*
	No	82(14.1)	432(74.1)	1	1	
MUAC	Normal	95(16.3)	440(75.5)	1	1	
	Moderate Acute malnutrition (MAM)	11(1.9)	18(3.1)	2.83(1.3-6.19)	4.03(1.58-10.30)	0.004**
	Severe Acute malnutrition (SAM)	4(0.7)	15(2.5)	1.24(0.40 -3.80)	0.93(0.27-3.17)	0.909
Hemoglobin level of mothers	Normal	39(6.7)	225(38.6)	1	1	
	Anemia	71(12.2)	248(42.5)	1.65(1.07-2.54)	1.32(0.78-2.24)	0.30
History of still birth	Yes	7(1.2)	15(2.6)	2.08(0.825-5.22)	1.26 (0.40-3.95)	0.69
	No	103(17.7)	458(78.5)	1	1	
Gravidity	Primigravida	31(5.3)	174(29.8)	1	1	
	Multigravida	79(13.6)	299(51.8)	1.48 (0.94-2.34)	1.31(0.77-2.24)	0.32
Age of infants in minutes	<60	68(11.7)	356(61.1)	1	1	
	60-120	20(3.4)	87(14.9)	1.20 (0.69-2.09)	1.42(0.74-2.70)	0.29
	120-180	12(2.1)	20(3.4)	3.14(1.47-6.73)	2.56 (1.03-6.37)	0.043*
	180-240	10(1.7)	10(1.7)	5.24(2.1-13.06)	4.19(1.41-12.43)	0.010*
Gestational Age	Full term (39-40 weeks)	35(6.0)	224(38.4)	1	1	
	Moderately preterm (29-33 weeks)	5(0.9)	11(1.9)	2.91(0.95-8.88)	4.52(0.98-20.84)	0.053
	Extremely preterm (<29 weeks)	2(0.3)	1(0.2)	12.80(1.13-144.92)	9.64(0.18-528.24)	0.267
	Early term (37-38 weeks)	40(6.8)	124(21.3)	2.07(1.25-3.42)	2.47(1.36-4.49)	0.003**
	Late preterm (34-36 weeks)	16(2.7)	35(6.0)	2.93(1.47-5.84)	2.65(1.12-6.25)	0.026**
	Late term (40-41 weeks)	8(1.4)	59(10.1)	0.87(.38-1.97)	0.85(0.34-2.11)	0.724
	Post term (>42 weeks)	4(0.7)	19(3.3)	1.35(0.43-4.19)	1.45(0.38-5.57)	0.589
Birth weight of Newborns	Normal (2500-4000 gram)	91(15.6)	409(70.2)	1	1	
	Low (1500-2500 gram)	15(2.6)	56(9.6)	1.2(0.65-2.22)	0.84(0.37-1.86)	0.659
	Very low (<1500 gram	2(0.3)	1(0.2)	8.99(0.81-100.20)	4.34(0.08-237.69)	0.473
	High (>4001 gram)	2(0.3)	7(1.2)	1.28(0.26-6.28)	2.25(0.37-13.65)	0.378

Table 5: Multivariable logistic regression analysis of factors associated with maternal anemia among delivery mothers at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, September 2025–January 2026.

Variables		Anemia		COR (95% CI)	AOR (95% CI)	P-value
		Yes n (%)	No n (%)			
Residence of mother	Urban	279(47.9)	250 (42.9)	1	1	
	Rural	40 (6.8)	14 (2.4)	2.56(1.36-4.82)	1.39(0.65-2.96)	0.399
Education of mother	No formal education	24 (4.1)	16 (2.7)	1.41(0.70-2.85)	0.61(0.25-1.49)	0.274
	Elementary School	84 (14.4)	49 (8.4)	1.61(1.00-2.58)	1.07(0.58-1.66)	0.839
	Secondary School	130(22.3)	123(21.1)	0.99(0.97-1.48)	0.77(0.46-1.30)	0.331
	College and Above	81(13.9)	76(13.1)	1	1	
Religion	Muslim	16(2.7)	23(3.9)	1	1	
	Orthodox	301(51.7)	241(41.4)	1.80(0.93-3.47)	1.60(0.78-3.27)	0.198
Occupation	Government employee	25(4.3)	40(6.8)	1	1	
	Student	4(0.7)	8(1.4)	0.80(0.22-2.94)	1.14(0.28-4.65)	0.861
	Housewife	214(36.7)	167(28.6)	2.05(1.20-3.52)	2.45(1.23-4.88)	0.011*
	Farmer	15(2.6)	2(0.3)	12.00(2.53-56.98)	7.38(1.21-44.99)	0.030*
	Merchant	19(3.3)	19(3.3)	1.60(0.71-3.59)	1.7400.71-4.25)	0.224
	Non-Government employee	9(1.5)	4(0.7)	3.60(1.00-12.94)	2.99(0.72-12.31)	0.130
	Others	32(5.5)	24(4.1)	2.13(1.03-4.42)	1.90(0.83-4.37)	0.131
Family history of congenital anomalies	Yes	1(0.2)	4(0.7)	0.20(0.02-1.84)	0.171(0.02-1.96)	0.156
	No	318(54.5)	260(44.6)	1	1	
Folic acid or vitamin intake of the mother	Yes	146(25.0)	96(16.5)	0.67(0.489-0.95)	0.77 (0.51-1.15)	0.199
	No	173(29.7)	168(28.8)	1	1	
Vegetable and fruit consumption per week	Daily	165(28.3)	173(29.7)	1	1	
	Sometimes	47(8.1)	45(7.7)	0.91(0.576-1.45)	0.87(0.53-1.43)	0.590
	Rarely	86(14.7)	43(7.4)	1.92(1.11-3.32)	1.56(0.85-2.85)	0.151
	Not at all	21(3.6)	3(0.5)	6.702(1.869-24.031)	3.92(0.97-15.85)	0.055
History of traditional medicine usage	Yes	51(8.7)	18(3.1)	2.601(1.479-4.574)	2.25(1.1933-4.23)	0.012*
	No	268(46.0)	246(42.2)	1	1	
MUAC	Normal	293(50.2)	242(41.5)	1	1	
	Moderate Acute malnutrition (MAM)	14(2.4)	15(2.6)	0.77(0.37-1.63)	0.148(0.19-1.97)	0.116
	Severe Acute malnutrition (SAM)	12(2.1)	7(1.2)	1.42(0.55-3.65)	0.98(0.34-2.78)	0.964
History of excess menstrual bleeding	Yes	3(0.5)	4(0.7)	0.62(0.14-2.78)	0.52(0.10-2.63)	0.429
	No	316(54.2)	260(44.6)	1	1	
Heavy vaginal bleeding during delivery	Yes	10(1.7)	6(1.0)	1.39(0.50-3.88)	1.56(0.47-5.19)	0.472
	No	309(53.0)	258(44.3)	1	1	
Heavy vaginal bleeding after delivery	Yes	5(0.9)	2(0.3)	2.09 (0.40-10.84)	2.04(0.29-14.40)	0.474
	No	314(53.9)	262(44.9)	1	1	
Mode of delivery	Vaginal	150(25.7)	157(26.9)	1	1	
	Vacuum	4(0.7)	3(0.5)	1.40 (0.31-6.34)	0.61 (0.11-3.26)	0.561
	Cesarean	165(28.3)	104(17.9)	1.66(1.19-2.32)	1.51(1.05-2.16)	0.026*

DISCUSSION

This study assessed the prevalence of anemia among newborns and delivery mothers and screened newborns for sickle cell disease and other hemoglobin abnormalities at the University of Gondar Comprehensive Specialized Hospital. The findings demonstrated that neonatal anemia (18.9%) and maternal anemia (54.7%) remain important public health concerns in the study setting. Maternal nutritional status, folic acid or vitamin supplementation, traditional medicine use, occupation, and mode of delivery were identified as important factors associated with anemia.

Anemia among newborns is a critical public health issue that affects approximately 30.52% of newborns in Africa (25). The prevalence of neonatal anemia in the present study was 18.9% (95% CI: 16.0–22.1%). Although lower than previous reports from Jimma Medical Center (26.4%), Tibebe Ghion Specialized Hospital (23.2%), and the University of Gondar Comprehensive Specialized Hospital (25.0%) (20-22), nearly one in five newborns was anemic, indicating that neonatal anemia remains a substantial health problem. Differences between studies may be explained by variations in study populations, maternal nutritional status, socioeconomic conditions, timing of hemoglobin measurement, and differences in the operational definition of neonatal anemia.

Gestational age was independently associated with neonatal anemia (21). Compared with full-term newborns, those born at early term (37–38 weeks) and late preterm (34–36 weeks) had significantly higher odds of anemia. Similar findings have been reported in previous Ethiopian studies (22, 26). This association is biologically plausible because fetal iron transfer from the mother occurs predominantly during the third trimester of pregnancy. Consequently, newborns delivered before complete fetal iron accumulation have lower iron stores and a reduced capacity for hemoglobin synthesis. In addition, immature erythropoietin production, shorter erythrocyte survival, rapid postnatal growth, and increased iron requirements contribute to the development of neonatal anemia among preterm infants (27, 28).

The prevalence of anemia was slightly higher among low-birth-weight newborns than among those with normal birth weight. Although anemia was also observed among newborns with high birth weight, the number of newborns in this category was small, limiting meaningful comparison (23, 29). Repeat hemoglobin testing performed approximately eight hours after birth confirmed anemia in only a small proportion of newborns with initially low cord blood hemoglobin concentrations. This finding suggests that some low cord blood hemoglobin measurements may represent transient physiological variation or differences between cord and postnatal hemoglobin measurements (30).

No newborn screened positive for sickle cell disease or sickle cell trait. This finding is consistent with previous reports suggesting that sickle cell disease is relatively uncommon in northwestern Ethiopia compared with some other regions of the country (31, 32). Nevertheless, a proportion of newborns (14.4%) demonstrated abnormal hemoglobin screening results. Because confirmatory laboratory methods such as hemoglobin electrophoresis or high-performance liquid chromatography were not performed, the specific hemoglobin variants could not be identified. Therefore, further studies using confirmatory diagnostic techniques are required to characterize the spectrum of hemoglobin variants among Ethiopian newborns (33).

Maternal folic acid or vitamin supplementation, traditional medicine uses during pregnancy, and maternal nutritional status were independently associated with neonatal anemia. Newborns born to mothers who did not receive folic acid or vitamin supplementation had significantly higher odds of anemia. Adequate maternal micronutrient supplementation during pregnancy plays a critical role in fetal erythropoiesis and iron metabolism and has consistently been associated with improved neonatal hematological outcomes (34). Similarly, maternal use of traditional medicine was associated with increased odds of neonatal anemia. Although some herbal preparations are traditionally used during pregnancy, their composition, safety, and potential effects on fetal hematopoiesis remain poorly understood and warrant further investigation (35). In addition, maternal moderate acute malnutrition was independently associated with neonatal anemia, highlighting the importance of maternal nutritional status during pregnancy. Poor maternal nutrition can impair placental nutrient transfer and fetal iron stores, thereby increasing the risk of neonatal anemia (36, 37).

The prevalence of maternal anemia in this study was 54.7%, indicating a severe public health problem according to WHO

criteria for anemia among women (38, 39). This estimate is considerably higher than the national pooled prevalence reported among pregnant women in Ethiopia, suggesting that maternal anemia remains a substantial burden in the study area. Differences may reflect variations in socioeconomic conditions, nutritional status, healthcare access, and the timing of hemoglobin assessment.

Occupation, traditional medicine use, and mode of delivery were independently associated with maternal anemia. Housewives and farmers had significantly higher odds of anemia than government employees. Similar associations have been reported in previous Ethiopian studies, where lower socioeconomic status and limited access to diverse diets were associated with an increased risk of maternal anemia (40-42). Women involved primarily in household activities or subsistence farming may have reduced dietary diversity, limited purchasing power, and poorer access to health services, all of which contribute to inadequate nutritional status.

Traditional medicine use during pregnancy was also independently associated with maternal anemia. Although traditional remedies remain widely used in many Ethiopian communities, some herbal preparations may interfere with nutrient absorption, contribute to gastrointestinal blood loss, or delay timely utilization of antenatal care services (48). Further pharmacological and epidemiological studies are needed to evaluate the safety of these commonly used traditional medicines during pregnancy.

Women who delivered by cesarean section had significantly higher odds of anemia than those who delivered vaginally. This finding is consistent with previous studies reporting increased postpartum anemia following operative delivery (43, 44). The higher risk is likely attributable to greater intraoperative blood loss associated with cesarean section compared with uncomplicated vaginal delivery, resulting in reduced postpartum hemoglobin concentrations (45).

Strengths and limitations of the study

This study has several strengths. It simultaneously evaluated maternal anemia, neonatal anemia, maternal nutritional status, and newborn hemoglobin screening in a relatively large sample of mother–newborn pairs. However, several limitations should be considered. The cross-sectional design precludes causal inference, and the use of convenience sampling may limit the generalizability of the findings. In addition, abnormal hemoglobin screening results were not confirmed using electrophoresis, high-performance liquid chromatography, or molecular techniques. Therefore, the specific hemoglobin variants could not be identified.

Conclusions and recommendations

Neonatal anemia and maternal anemia remain important health problems among mother–newborn pairs attending the University of Gondar Comprehensive Specialized Hospital. Maternal folic acid or vitamin supplementation, maternal nutritional status, traditional medicine use, occupation, and mode of delivery were significantly associated with anemia. Although no cases of sickle cell disease or sickle cell trait were identified, additional studies using confirmatory diagnostic methods are needed to characterize abnormal hemoglobin variants among Ethiopian newborns. Strengthening maternal nutrition during pregnancy, promoting appropriate antenatal micronutrient supplementation, discouraging unverified traditional medicine use, and considering targeted screening of mothers and newborns may facilitate early detection and management of anemia.

Supplementary Information

List of abbreviations

NBS: Newborn screening

SCD: Sickle Cell Disease

SCT: Sickle Cell Trait

MUAC: Mid-upper arm Circumference

Hemoglobin S

Hemoglobin A

SPSS: Statistical Package for the Social Sciences

SAM: Sever acute malnutrition

Hgb: hemoglobin

WHO: World Health Organization

IPPA: immediate postpartum anemia

MUAC: Mid-upper arm circumference

CMHS: College of Medicine and Health Sciences

APGAR: Appearance (color), Pulse (heart rate), Grimace (reflex), Activity (muscle tone), and Respiration (breathing)

EDTA: Ethylenediaminetetraacetic acid

MAM: Moderate Acute malnutrition

NICU: Neonatal intensive care unit

AOR: adjusted odds ratio

COR: crude odds ratio

USA: United States of America

ANC: Antenatal care

RBC: Red blood cell

ICGEB: International Centre for Genetic Engineering and Biotechnology

UoG: University of Gondar

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Authors' contributions

BG conceptualized the study. BG, BW, YG, MA, HW, MS, SA, SB designed the study and implemented the study. BG registered the data, BG and BW analyzed the data. BG wrote the first draft of the manuscript and BW, YG, MA, HW, MS, SA, SB contributed to subsequent drafts of the manuscript. All authors have read and approved the final manuscript.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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