Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Determinants of Anemia Among Pregnant Women Attending Antenatal Care at Public Health Facilities in Gambella Town, Gambella, Southwest Ethiopia, 2025

Duol Olock Thiyang

duololock95@gmail.com

Gambella Regional Health Bureau

Mamo Nigatu Gebre

Jimma University

Bang Chuol Nyuot

Jimma University

Research Article

Keywords: Anemia, antenatal care, pregnant women, case–control study, dietary diversity, Gambella, Ethiopia

Posted Date: October 30th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11379118/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Anemia during pregnancy is a major public health concern associated with adverse health outcomes for both mothers and their newborns. Despite the availability of antenatal care (ANC) services in Ethiopia, anemia remains prevalent, and its determinants vary across settings. However, evidence on the factors associated with anemia among pregnant women in Gambella town is limited.

Objective

To identify determinants of anemia among pregnant women attending antenatal care at public health facilities in Gambella town, Gambella, southwest Ethiopia, in 2025.

Methods

An institution-based unmatched case–control study was conducted from May to July 2025 among 250 pregnant women attending ANC at public health facilities in Gambella town. The study included 125 cases, defined as pregnant women with hemoglobin concentrations below 11 g/dL, and 125 controls, defined as those with hemoglobin concentrations of 11 g/dL or higher. Data were collected using interviewer-administered questionnaires and laboratory investigations. Blood and stool samples were examined for malaria and parasitic infections, respectively, and hemoglobin concentrations were measured using the HemoCue Hb 301 + analyzer. Mid-upper arm circumference (MUAC) was measured to assess nutritional status. Data were entered using Epi Info version 7.2.2 and analyzed using SPSS version 27. Bivariate and multivariable logistic regression analyses were performed to identify factors associated with anemia. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated, and statistical significance was declared at $p < 0.05$.

Results

All 250 participants completed the study, yielding a 100% response rate. Rural residence (AOR = 3.65, 95% CI: 1.03–12.90), no formal education (AOR = 3.78, 95% CI: 1.72–8.33), a history of blood loss during pregnancy (AOR = 4.60, 95% CI: 1.16–18.04), a history of malaria (AOR = 4.04, 95% CI: 1.66–9.87), and chronic disease (AOR = 5.82, 95% CI: 1.81–18.74) were significantly associated with anemia. Compared with pregnant women with high dietary diversity, those with low dietary diversity (AOR = 7.10, 95% CI: 1.31–38.60) and medium dietary diversity (AOR = 2.52, 95% CI: 1.17–5.41) had higher odds of anemia.

Conclusion

Anemia among pregnant women attending ANC in Gambella town was associated with rural residence, lack of formal education, a history of blood loss during pregnancy, a history of malaria, chronic disease, and low or medium dietary diversity. Strengthening maternal health education, promoting dietary diversity, improving the prevention and management of malaria and chronic diseases, and ensuring appropriate clinical assessment of blood loss may help reduce the burden of anemia among pregnant women in this setting.

1. Background

Anemia in pregnancy remains one of the most serious public health challenges globally, with significant implications for both maternal and perinatal outcomes. It is defined by the World Health Organization (WHO) as a hemoglobin concentration of less than 11 g/dl in pregnant women (1). Anemia during pregnancy is associated with adverse consequences, including maternal mortality, preterm delivery, intrauterine growth restriction, low birth weight, and impaired physical and cognitive development of infants(2, 3).

Globally, anemia affects approximately 40% of pregnant women, with sub-Saharan Africa and South Asia bearing the highest burden (4). In Ethiopia, despite continued efforts such as iron and folic acid supplementation, deworming, malaria prevention, and nutrition education programs, anemia remains a major concern. According to the 2022 Ethiopian Demographic and Health Survey (EDHS), about 29% of pregnant women were found to be anemic(5, 6).

The occurrence of anemia during pregnancy is influenced by multiple and interrelated factors. Socioeconomic and demographic conditions, such as maternal education and household income, often determine access to adequate nutrition and health care(7, 8). Obstetric and gynecological characteristics, including birth intervals, contraceptive use, and history of blood loss, also play critical roles (9, 10). Furthermore, infectious diseases such as malaria, HIV, and helminth infections remain major contributors to anemia in endemic regions(11, 12). Lifestyle and dietary behaviors, such as poor dietary diversity, alcohol consumption, and tea/coffee intake immediately after meals, further exacerbate the problem(13, 14).

Gambella town, one of the largest urban centers in the Gambella region, Ethiopia, provides relatively better access to antenatal care (ANC) services compared to rural settings(15). However, anemia among pregnant women remains a common clinical problem. Despite the presence of several health facilities in the town, there is limited evidence on the determinants of anemia among pregnant women specific to this setting. Most previous studies have been descriptive or cross-sectional, limiting their ability to establish associations with multiple risk factors simultaneously(16).

To address this gap, a case-control study was conducted to identify determinants of anemia among pregnant women attending ANC at public health facilities in Gambella town. Findings from this study will provide context-specific evidence to guide local health planners, health care providers, and policymakers

in designing effective interventions to reduce the burden of anemia and improve maternal health outcomes.

2. Methodology

Study Area and Period

The study was conducted in Gambella town, located in the Gambella Regional State, Southwest Ethiopia, about 776 km from Addis Ababa. The town has one general hospital, one primary hospital, and two health centers, all providing maternal and child health services, including ANC. The study was carried out from May to July 2025.

Study Design

An institution-based unmatched case–control study design was conducted.

Population:

All pregnant women who attended ANC at the selected public health facilities during the study period and had their haemoglobin measured were included in the study. All pregnant women who had received a blood transfusion three months before the commencement of the study and all pregnant women who were critically ill and were not able to respond to the questionnaire were excluded from the study.

Sample Size Determination

The sample size was calculated using Epi Info version 7.2.2.5 by considering key exposure variables identified from previous studies, with a 95% confidence level, 80% power, and a control-to-cases ratio of 1:1. Adding a 10% non-response rate, the final sample size was 250 participants (125 cases and 125 controls).

Sampling Technique

A multistage sampling procedure was applied. First, public health facilities providing ANC services in Gambella town were identified. From these, two hospitals and three health centers were purposively selected. The total sample size was proportionally allocated to each facility based on average ANC attendance. Within each facility, consecutive cases were recruited as they were diagnosed, and for each case, two controls were selected from ANC attendees who were non-anemic, using systematic random sampling on the same day.

Variables

The dependent variable is anemia status. The independent variables are: socio-demographic and socioeconomic variables comprising age, residence, ethnicity, religion, maternal education level, occupational status, and monthly family income; obstetric and gynecological variables comprising

number of children, contraceptive use, menstrual days, history of blood loss, and birth interval; disease related variables comprising parasitic infection, HIV status, malaria, MUAC, and history of chronic disease (hypertension, diabetes mellitus, tuberculosis, cardiovascular disease); and behavioral and dietary related variables including dietary diversity score, tea/coffee consumption immediately after food, smoking, and alcohol consumption.

Data Collection Methods and Instruments

Data were collected using a structured interviewer-administered questionnaire developed after reviewing related literature. Hemoglobin concentration was measured by trained laboratory personnel using a portable HemoCue Hb 301 + device. Classification of anemia followed the WHO criteria. Stool examinations were performed to assess parasitic infections, and malaria diagnosis was confirmed by rapid diagnostic test or microscopy. Mid-upper arm circumference (MUAC) was measured to assess maternal nutritional status.

Data Quality Assurance

The questionnaire was prepared in English, translated into Nuer and Amharic, and back-translated to ensure accuracy. Data collectors and supervisors were trained for two days on the study objectives, ethical issues, and measurement techniques. A pre-test was conducted on 5% of the sample in a Gambella town primary hospital, and modifications were made accordingly. Daily supervision and cross-checking of questionnaires were conducted by supervisors. Laboratory equipment was calibrated regularly to maintain reliability.

Data Processing and Analysis

Data were coded and entered into Epi Info 7.2.2.5 and then exported to SPSS version 27 for analysis. Descriptive statistics such as means, proportions, and frequencies were used to summarize the data. Bivariate logistic regression was performed to examine the association between each independent variable and anemia. Variables with a p-value < 0.25 in bivariate analysis were included in the multivariable logistic regression model to identify independent determinants of anemia. Adjusted Odds Ratios (AOR) with 95% Confidence Intervals (CI) were reported, and statistical significance was declared at p-value < 0.05. Multicollinearity was checked using the variance inflation factor (VIF), and model fitness was assessed using the Hosmer-Lemeshow test.

Ethical Considerations

Ethical clearance was obtained from the Institutional Review Board (IRB) of Jimma University, Institute of Health. Permission was secured from the Gambella town health office and the management of selected health facilities. Written informed consent was obtained from each participant before data collection. Confidentiality was maintained by avoiding personal identifiers.

3. Results

3.1 Socioeconomic-demographic characteristics

The study enrolled 250 participants, with 125 cases and 125 controls, resulting in a 100% response rate. Among the respondents, 83 (33.2%) are aged 25-29, with 44 (53%) being cases and 39 (47%) controls. Most respondents live in urban areas, with 109 (87.2%) of cases and 120 (96%) of controls being residents. Regarding marital status, 120 (50.6%) of cases and 117 (49.4%) of controls were predominantly married or in a union. Regarding religion, 86 (68.8%) of cases and 75 (60%) of controls identify as Protestants. The dominant ethnicity is Nuer, with 57 (45.6%) of cases and 34 (27.2%) of controls belonging to this group. Regarding occupational status, 69 (55.2%) of cases and 44 (35.2%) of controls are housewives. In terms of educational status, 38 (30.4%) of cases and 35 (28%) of controls completed secondary school. Regarding family income, 50 (40%) of both cases and controls had an income between 9,000 and 15,000 birrs.

Table 1: Socio-demographic characteristics of pregnant mothers attending ANC in public health facilities of Gambella Town, May to July 2025**.**

Variables	Categories	Cases (n=125)	Controls(n=125)
		N (%)	N (%)
Age	15-19	8(6.4)	13(10.4)
	20-24	27(21.6)	28(22.4)
	25-29	44(35.2)	39(31.2)
	30-34	27(21.6)	33(26.4)
	>35	19(15.2)	12(9.6)
Residence	Urban	104(83.2)	119(95.2)
	Rural	21(16.8)	6(4.8)
Marital status	Married and in union	120(96.0)	117(93.6)
	Not union	5(4.0)	8(6.4)
Religion	Protestants	83(66.4)	78(62.4)
	Orthodox	26(20.8)	31(24.8)
	Others	16(12.8)	16(12.8)
Ethnicity	Nuer	57(45.6)	34(27.2)
	Anyuak	31(24.8)	29(23.2)
	Oromo	18(14.4)	34(27.2)
	Amhara	15(12.0)	15(12.0)
	Others specific	4(3.2%)	13(10.4%)
Occupational status	Housewife	54(43.2)	55(44.0)
	Students	31(24.8)	22(17.6)
	Government employee	28(22.4)	31(24.8)
	Unemployed	12(9.6)	17(13.1)
Educational status	No formal education	32(25.6)	12(9.6)
	1^{st} school completed	38(30.4)	35(28.0)
	2^{nd} school completed	23(18.4)	45(36.0)
	Diploma	27(21.6)	18(14.4)
	Degree and above	5(4.0)	15(12.0)
Family income	<3000-6000	19(15.2)	27(21.6)

6001-9000	47(37.6)	40(32.0)
9001-15000	50(40.0)	50(40.0)
>15000	9(7.2)	8(6.4)

Obstetrics and gynecological *diseases, behavioural and nutritional related* characteristics of participants.

Regarding first pregnancies, 85 (68%) of cases and 77 (61.6%) of controls have no previous history of pregnancy. The number of children, 65(52%) are cases and 57(45.6%) are controls. Contraceptive use: 69 (55.2%) of cases and 90 (72%) of controls do not use contraception. Among those who do, 30 (24%) of cases and 20 (16.8%) of controls use the pill. Regarding menstrual bleeding, 71 (56.8%) of cases and 81 (64.8%) of controls experienced no changes in their cycle, lasting 4-6 days. Regarding any blood loss, 71(56.8%) are cases, and 14(11.2%) are controls having a history of blood loss. The majority of both 115(92%) cases and 114(91.2%) controls have been screened for HIV. Regarding HIV status, 118(94.4%) cases and 109(87.2%) controls that were non-reactive respectively. Regarding malaria, 89(71.2%) are cases, and 104(83.2%) controls had a history of malaria. Concerning MUAC, 71(56.8%) cases, and 72(57.6%) controls did not have a MUAC greater than 23 cm. Regarding chronic illness, 87(69.6%) cases, and 118(94.4%) controls had no chronic illnesses. The most common chronic illness among 12 (30.8%) cases and 1(16.7%) control is tuberculosis. Regarding drinking tea and coffee, 115(92%) are cases and 107(85.6%) are controls, concerning consumption. In both cases, 81(64.8%) and controls 76(60.8%) do not consume tea/coffee after 30 minutes. Regarding alcohol consumption, 115 (92%) of cases and 107 (85.6%) of controls did not consume alcohol during pregnancy. During pregnancy, 104 (83.2%) of cases and 108 (86.4%) of controls did not smoke cigarettes.

Table 2: Obstetrics and gynecological disease, behavioral and nutritional related characteristics of pregnant mothers attending ANC in public health facilities of Gambella Town, May to July, 2025

Variables	Categories	Cases n = 125	Controls n = 125
		N (%)	N (%)
Your first pregnancy	Yes	40(32)	48(38.4)
	No	85(68)	77(61.6)
Number of children	1-3	65(52)	57(45.6)
	4-6	18(14.4)	22(17.6)
Contraceptive use	Yes	69(55.2)	90(72)
	No	56(44.8)	35(28)
Type of contraceptive use	Pilli	30(24)	20(16.8)
	Depo-Provera	16(12.8)	21(16.8)
	Implanon	9(7.2)	19(15.2)
	Injectable	13(10.4)	29(23.2)
Menstrual bleeding	<2-3 days	49(39.2)	44(35.2)
	>4-6 days	71(56.8)	81(64.8)
Any history of blood loss	Yes	71(56.8)	14(11.2)
	No	51(40.8)	111(88.8)
HIV screened	Yes	115(92)	114(91.2)
	No	10(8)	11(8.8)
HIV Status	Reactive	7(5.6)	16(12.8)
	Non-reactive	118(94.4)	109(87.2)
Malaria	Yes	109(87.2)	83(66.4)
	No	16(12.8)	42(33.6)
MUAC	<23 cm	54(43.2)	53(42.4)
	>23 cm	71(56.8)	72(57.6)
Chronic diseases	Yes	38(30.4)	7(5.6)
	No	87(69.6)	118(94.4)
Type of chronic illness diseases	HTN	5(12.8)	2(33.3)
	DM	3(7.7)	1(16.7)
	TB	12(30.8)	1(16.7)

	CVD	2(5.1)	0.0%
	Asthma	17(43.6)	2(33.3)
Drink tea/coffee	Yes	115(92)	107(85.6)
	No	10(8)	18(14.4)
Consumption of tea/coffee after 30 minutes	Yes	44(35.2)	49(39.2)
	No	81(64.8)	76(60.8)
Alcoholic consumption	Yes	10(8)	18(14.4)
	No	115(92)	107(85.6)
Smoke cigarettes	Yes	21(16.8)	17(13.6)
	No	104(83.2)	108(86.4)

Dietary diversity score characteristics

This dietary diversity refers to any meals consumed in the past 24 hours. Regarding starchy staples, 42(33.6%) of cases and 49(39.2%) of controls reported consumption. Vitamin A-rich foods were consumed in 90(72.0%) cases and 86(68.8%) of controls. Organ meat was eaten in 90(72.0%) of cases and 49(39.2%) controls, while flesh meat was consumed by 97(77.6%) of cases and 71(56.8%) of controls. The egg intake was 80(64.0%) among cases and 55(44.0%) among controls. Legumes and nuts were consumed by 115(92.0%) cases and 86(68.8%) of controls. Fruits and vegetables were reported by 114(91.2%) of cases and 110(88.0%) of controls. Both groups had equal intake of dark green leafy vegetables, 86(68.8%), and milk products, 111(88.8%). Overall dietary diversity, high diversity was found in 33(26.4%) of cases and 69(55.2%) of controls, while medium diversity was more common among cases, 83(66.4%), than controls, 51(40.8%). Low diversity was reported by 9(7.2%) of cases and 5(4.0%) of controls.

Table 3: Dietary diversity o**f** pregnant mothers attending ANC in public health facilities of Gambella Town, May to July 2025.

Food groups	Categories	Cases n = 125	Controls n = 125
		N (%)	N (%)
Starchy staple	No	83(66.4)	76(60.8)
	Yes	42(33.6)	49(39.2)
Vitamin A	No	35(28.0)	39(31.2)
	Yes	90(72.0)	86(68.8)
Organ meat	No	35(28.0)	76(60.8)
	Yes	90(72.0)	49(39.2)
Flesh meat	No	28(22.4)	54(43.2)
	Yes	97(77.6)	71(56.8)
Egg status	No	45(36.0)	70(56.0)
	Yes	80(64.0)	55(44.0)
Legume and Nut	No	10(8.0)	39(31.2)
	Yes	115(92.0)	86(68.8)
Fruit and vegetables	No	11(8.8)	15(12.0)
	Yes	114(91.2)	110(88.0)
Dark green leafy	No	39(31.2)	39(31.2)
	Yes	86(68.8)	86(68.8)
Milk product	No	14(11.2)	14(11.2)
	Yes	111(88.8)	111(88.8)
Dietary diversity score	Low	9(7.2)	5(4)
	Medium	83(66.4)	51(40.8)
	High	33(26.4)	69(55.2)

Determinants of anemia among pregnant women

In the bivariable analysis, variables with a p-value < 0.25 were selected for multivariable analysis. Accordingly, current residence, ethnicity, educational status, history of contraceptive use, history of blood loss, HIV test result, history of malaria, history of chronic disease, tea/coffee consumption, alcohol intake, and dietary diversity were selected as candidate variables for a multivariable binary logistic regression model. In multivariable analysis, residence, educational status, dietary diversity, history of malaria, history

of blood loss, and history of chronic disease were identified as the determinants of anemia among pregnant women attending antenatal care at public health facilities in Gambella town.

Pregnant women in rural areas were 3.65 times more likely to be anemic than those in urban areas (AOR = 3.65, 95% CI: 1.03–12.9). Women with no formal education were 3.78 **times more likely** to be anemic compared to those with a degree and above (AOR = 3.78, CI: (1.72,8.33). Women with a history of blood loss during pregnancy were 4.6 **times more likely** to develop anemia than those without such a history (AOR = 4.6, 95% CI: 1.16,18.04). Similarly, women who had a history of malaria were **4.04 times more likely** to be anaemic compared to those without malaria (AOR = 4.04, 95% CI: 1.66–9.87), and those with a history of chronic disease were 5.82 **times more likely** to be anemic than their counterparts (AOR = 5.82, 95% CI: 1.81,18.74). In addition, women with low dietary diversity were **7.10 times more likely** to be anemic (AOR = 7.10, 95% CI: 1.31–38.6), and those with medium dietary diversity were **2.52 times more likely** to be anemic compared to women with high dietary diversity (AOR = 2.52, 95% CI: 1.17–5.41).

Table 4: Multivariable and bivariate logistic regression analysis to identify the determinants of anemia among pregnant women attending antenatal care at public health facilities in Gambella town, 2025.

Variables	Category	Anemia		COR (95%CI)	AOR (95%CI)	P-value
		Cases	Controls			
Current residence	Urban	104(83.2)	119(95.2)	1	1	
	Rural	21(16.8)	6(4.8)	4.01(1.56,10.3)	3.65(1.03,12.9)	.045*
Ethnicity	Nuer	57(45.6)	34(27.2)	1	1	
	Anyuak	31(24.8)	29(23.2)	.638(.329,1.24)	.490(.151,1.59)	.236
	Oromo	18(14.4)	34(27.2)	.316(.155,.644)	.723(.195,2.68)	.627
	Amhara	15(12.0)	15(12.0)	.596(.260,1.38)	.861(.190,3.90)	.846
	Others	4(3.2)	13(10.4)	.184(.055,.608)	.329(.065,1.67)	.179
Educational status	No formal education	32(25.6)	12(9.6)	8.01(2.39,26.8)	3.78(1.72,8.33)	.001*
	Primary	38(30.4)	35(28.0)	3.26(1.08,9.89)	4.43(.936,20.9)	.061
	Secondary	23(18.4)	45(36.0)	1.54(.495,4.75)	2.11(.428,10.3)	.360
	Diploma	27(21.6)	18(14.4)	4.51(1.39,14.57)	2.09(.426,10.3)	.363
	Degree & above	5(4.0)	15(12.0)	1	1	
History of contraceptive use	Yes	69(55.2)	90(72.0)	2.09(1.23,3.53)	.454(.153,1.34)	.153
	No	56(44.8)	35(28.0)	1	1	
History of blood loss	Yes	72(57.6)	16(12.8)	9.26(4.92,17.44)	4.6(1.16,18.04)	.030*
	No	53(42.4)	109(87.2)	1	1	
HIV test result	Reactive	16(12.8)	7(5.6)	2.48(.981,6.24)	2.34(.515,10.6)	.272
	Non-reactive	109(87.2)	118(94.4)	1	1	
History of malaria	Yes	109(87.2)	83(66.4)	3.45(1.82,6.56)	4.04(1.66,9.87)	.002*
	No	16(12.8)	42(33.6)	1	1	
History of chronic disease	Yes	38(30.4)	7(5.6)	7.37(3.14,17.27)	5.82(1.81,18.74)	.003*
	No	87(69.6)	118(94.4)	1	1	
Tea/coffee consumption	Yes	107(85.6)	115(92.0)	.517(.228,1.171)	.793(.246,2.56)	.697
	No	8(14.4)	10(8.0)		1	
Alcohol intake	Yes	10(8.0)	18(14.4)	.517(.228,1.171)	.439(.115,1.68)	.229
	No	115(92.0)	107(85.6)		1	

Dietary diversity	Low	9(7.2)	5(4.0)	3.77(1.17,12.12)	7.10(1.31,38.6)	.023*
	Medium	83(66.4)	51(40.8)	3.41(1.98,5.86)	2.52(1.17,5.41)	.018*
	High	33(26.4)	69(55.2)		1	

**Indicates significance at 5% level, COR: Crude odds ratio, AOR: Adjusted odds ratio, `1: reference categories, CI: Confidence interval*

Discussion

This study identified several significant determinants of anemia among pregnant women attending antenatal care at public health facilities.

The findings of this study showed that pregnant women residing in rural areas were more likely to be anemic compared to their urban counterparts. This finding is consistent with studies conducted in Kacha Birra District, Southern Ethiopia, and Mekelle city public hospitals, which reported higher anemia prevalence in rural settings(17,18). This could be due to a lack of information about adequate nutrition during pregnancy, the remoteness of health-care facilities, and delayed ANC attendance in rural areas.

The current study showed that pregnant women with no formal education were more anemic compared to those with a degree or higher. Similar results were observed in a study done in Baghdad and Bench Maji, Keffa, and Sheka zones of public hospitals, Southwest, Ethiopia (19,20), which found that illiteracy was associated with poor knowledge about nutrition, limited access to health information, and lower socioeconomic status, all of which can contribute to anemia.

The finding also showed that pregnant women with a history of blood loss during the current pregnancy were more likely to be anemic. This finding was supported by studies done in West Shewa, Ethiopia, Kacha Birra District, Southern Ethiopia, and Northwest Ethiopia(16,17,21). This could be because blood loss leads to a direct reduction in hemoglobin and iron levels, which are essential for oxygen transport. During pregnancy, iron requirements are already elevated, and any additional blood loss, such as from vaginal bleeding or placental complications, can quickly deplete iron stores. In many cases, women may begin pregnancy with low iron reserves, and without adequate nutritional support or medical intervention, their bodies cannot replace lost red blood cells efficiently, resulting in anemia.

Pregnant women with a history of malaria were more likely to be anemic in this study. This is supported by A cross-sectional study in Burkina Faso and the General Hospital of Adare, southern Ethiopia, which demonstrated that anemia during pregnancy was caused by malaria(22,23). This could be since malaria infection, especially during pregnancy, leads to the destruction of red blood cells (hemolysis) and suppresses the production of new red blood cells in the bone marrow(24).

The malaria parasite invades and ruptures red blood cells, reducing hemoglobin levels and thereby contributing to anemia. Additionally, malaria can cause chronic inflammation, which interferes with iron metabolism and further impairs red blood cell formation (25).

The findings of the current study also showed that pregnant women with chronic disease were **more likely** to be anemic than their counterparts. This is supported by a study done in the *University Hospital Zurich Department of Obstetrics* and Arsi Shalla woreda, which reported that chronic disease during pregnancy is more likely to cause anemia(26,27). This could be due to the inflammatory effects of chronic illnesses such as HIV, tuberculosis, and renal disease, which disrupt iron metabolism and inhibit red blood cell production.

This study showed that women with low dietary diversity were more likely to be anemic than those with high dietary diversity. This finding is in line with studies done in Kacha Birra District and Horo Guduru Wollega Zone, which found that inadequate intake of iron-rich and micronutrient-dense foods compromises hemoglobin synthesis(17,28). The possible reason for this is that women with low dietary diversity are less likely to consume a wide range of nutrient-rich foods, particularly those high in bioavailable iron, folate, and other micronutrients essential for hemoglobin synthesis. Diets lacking in variety often rely heavily on starchy staples and may exclude important sources of iron, such as meat, legumes, and green leafy vegetables, as well as vitamin C-rich foods that enhance iron absorption. Additionally, nutritional inadequacy increases the risk of iron deficiency and ultimately leads to a higher likelihood of anemia(29).

This finding indicates that women with medium dietary diversity experienced anemia during pregnancy compared to those with high dietary diversity. A similar cross-sectional study conducted in Mekelle town also identified dietary diversity as a factor influencing anemia in pregnant women(30). This could be due to limited access to a variety of nutrient-rich foods, along with socioeconomic, cultural, and environmental challenges.

In contrast to the current study, variables like age, family size, and birth interval showed statistically significant associations with anemia among pregnant women in the previous studies conducted in Ethiopia(12). This difference might be because the determinants of anemia vary from one geographical area to another, because of the differences in nutritional, altitudinal, economic, and educational status of the study participants

Conclusion and recommendation

In conclusion, pregnant women who resided in rural areas, had no formal education, experienced blood loss during pregnancy, had a history of malaria or chronic disease, and consumed low-diversity diets were identified as the determinants of anemia among pregnant women attending antenatal care at public health facilities in Gambella town, Gambella, Ethiopia, 2025. It is recommended that public Health Facilities should strengthen routine screening and early management of anemia during antenatal care, especially for women from rural areas and those with a history of blood loss, malaria, or chronic illness.

Abbreviations

ANC Antenatal care

AOR Adjust odds ratio

CI Confidence Interval

DDS Dietary diversity score for women

EDHS Ethiopian Demographic Health Survey

EFETLP Ethiopia Field Epidemiology Training and Laboratory Program

HEWs Health extension workers

HG Haemoglobin

HIV: Human Immunodeficiency Virus

IRB Institutional Review Board

MUAC Mid Upper Arm Circumference

TB Tuberculosis

VIFVariance Inflation Factor

WHO World Health Organization.

Declarations

Author Contributions

Duol Olock Thiyang: Conceptualization, methodology, software, data accuracy investigation, formal analysis, writing – original draft. **Mamo Nigatu Gebre**: Writing – review and editing, supervision. **Bang Chuol Nyuot:** manuscript formatting, and critical review for clarity and scientific rigor

Acknowledgments

I would like to express my sincere gratitude to my academic Advisor, Mr. Mamo Nigatu, for his unreserved encouragement, constructive comments on my thesis, and guidance. I am also grateful to the instructors of Jimma University and the Department of Epidemiology for sharing their knowledge with us, which enabled me to carry out this work. I deeply appreciate the technical and Educational support provided by the Centers for Disease Control (CDC) and the Ethiopian Field Epidemiology Training Program (EFETP).

Ethics Statement

Ethical clearance for the study was obtained from the Jimma University Institutional Review Board (IRB), and support letters were obtained from the Gambella Regional Health Bureau. The study was conducted in

accordance with the **principles of the Declaration of Helsinki** and applicable ethical guidelines for research involving human participants. Informed consent was obtained from each participant before data collection. Participants were informed about the objectives and procedures of the study, their right to participate voluntarily and to withdraw at any time without consequences, and the measures taken to maintain the confidentiality and privacy of their information.

Consent

Informed consent was obtained from each participant before participation. Participants were assured that their information would be kept confidential and used solely for research purposes. For participants younger than 16 years, informed consent was obtained from a parent or legal guardian before enrollment. Individuals whose parent or legal guardian did not provide consent were not enrolled in the study.

Conflicts of Interest: The authors declare no conflicts of interest.

Funding: No funding was received from any organization or institution for the current study.

Transparency Statement

The corresponding author, Bang Chuol Nyuot and Mamo Nigatu Gebre, affirms that this manuscript provides an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned, and, where applicable, registered, have been appropriately explained.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. MN had full access to all data related to this study and assumes complete responsibility for the integrity of the data as well as the accuracy of the data analysis.

Consent for Publication: Not applicable. No identifying images or personal or clinical details of participants are presented in this manuscript.

Author detail:

Duol Olock Thiyang

Gambella Regional Health Bureau, Public Health Emergency Management

Email: duololock95@gmail.com

Mamo Nigatu Gebre

Jimma University, Department of Epidemiology and Biostatistics

Email: **mamo.nigatu@ju.edu.et**

Bang Chuol Nyuot

Jimma University, Department of Environmental Health

Email **: Bensonbang2016@gmail.com**

References

1. Shaduka E. An investigation into the aetiology of anaemia in pregnant women in Namibia. 2022.
2. James AH. Iron deficiency anemia in pregnancy. Obstet Gynecol. 2021;138(4):663–74.
3. Shander A, Goodnough LT. Management of anemia in patients who decline blood transfusion. Am J Hematol. 2018;93(9):1183–91.
4. Pacific W. World Health Organization WHO Regional websites. World. 2023.
5. Animut K, Berhanu G. Determinants of anemia status among pregnant women in ethiopia: using 2016 ethiopian demographic and health survey data; application of ordinal logistic regression models. BMC Pregnancy Childbirth. 2022;22(1):663.
6. Dufera T, Dheresa M, Dingeta T, Legesse M, Mesfin S, Balis B et al. Predictor of anemia among pregnant women attending antenatal clinics at Hiwot Fana Comprehensive Specialized Hospital, Eastern Ethiopia: a case-control study. Int Health. 2024;ihad118.
7. Mare KU, Aychiluhm SB, Sabo KG, Tadesse AW, Kase BF, Ebrahim OA, et al. Determinants of anemia level among reproductive-age women in 29 Sub-Saharan African countries: A multilevel mixed-effects modelling with ordered logistic regression analysis. PLoS ONE. 2023;18(11):e0294992.
8. Sunguya BF, Ge Y, Mlunde L, Mpembeni R, Leyna G, Huang J. High burden of anemia among pregnant women in Tanzania: a call to address its determinants. Nutr J. 2021;20:1–11.
9. Abay A, Yalew HW, Tariku A, Gebeye E. Determinants of prenatal anemia in Ethiopia. Arch Public Health. 2017;75(1):51.
10. Mukanga B, Mwila N, Nyirenda HT, Daka V. Perspectives on the side effects of hormonal contraceptives among women of reproductive age in Kitwe district of Zambia: a qualitative explorative study. BMC Women's Health. 2023;23(1):436.
11. Ssentongo P, Ba DM, Ssentongo AE, Ericson JE, Wang M, Liao D, et al. Associations of malaria, HIV, and coinfection, with anemia in pregnancy in sub-Saharan Africa: a population-based cross-sectional study. BMC Pregnancy Childbirth. 2020;20:1–11.
12. Weldekidan F, Kote M, Girma M, Boti N, Gultie T. Determinants of anemia among pregnant women attending antenatal clinic in public health facilities at Durame Town: unmatched case control study. Anemia. 2018;2018.
13. Mohammed FA, Woldegiorgs JL, Taye TA. The Prevalence of Anemia and Associated Factors among Pregnant Women Attending Antenatal Care Clinic at ALERT Hospital, Addis Ababa, Ethiopia, 2022. 2023.

14. Vanié SC, Edjème-Aké A, Kouassi KN, Gbogouri GA, Djaman AJ. Nutritional and obstetric determinant of Iron deficiency Anemia among pregnant women attending antenatal Care Services in Public Health Hospitals in Abidjan (Côte d'Ivoire): a cross-sectional study. Ecol Food Nutr. 2022;61(2):250–70.
15. Hassen HY, Ali JH, Gebreyesus SH, Endris BS, Temesgen AM. National incidence, prevalence and disability-adjusted life years (DALYs) of common micronutrient deficiencies in Ethiopia from 1990 to 2017: estimates from the global burden of diseases study. Global Health Action. 2020;13(1):1776507.
16. Hailu T, Kassa S, Abera B, Mulu W, Genanew A. Determinant factors of anaemia among pregnant women attending antenatal care clinic in Northwest Ethiopia. Tropical diseases, travel medicine and vaccines. 2019;5(1):13.
17. Teshome MS, Meskel DH, Wondafrash B. Determinants of Anemia Among Pregnant Women Attending Antenatal Care Clinic at Public Health Facilities in Kacha Birra District, Southern Ethiopia. J Multidisciplinary Healthc. 2020;13:1007–15.
18. Ebuy Y, Alemayehu M, Mitiku M, Goba GK. Determinants of severe anemia among laboring mothers in Mekelle city public hospitals, Tigray region, Ethiopia. PLoS ONE. 2017;12(11):e0186724.
19. Al-Sattam Z, Hassan S, Majeed B, Al-Attar Z. Knowledge about Anemia in Pregnancy among Females Attending Primary Health Care Centers in Baghdad. Open-Access Maced J Med Sci. 2022; 10 (B): 785–792. 2022.
20. Gudeta TA, Regassa TM, Belay AS. Magnitude and factors associated with anemia among pregnant women attending antenatal care in Bench Maji, Keffa and Sheka zones of public hospitals, Southwest, Ethiopia, 2018: A cross-sectional study. PLoS ONE. 2019;14(11):e0225148.
21. Deriba BS, Bala ET, Bulto GA, Geleta TA, Ayalew AF, Gebru AA, et al. Determinants of Anemia Among Pregnant Women at Public Hospitals in West Shewa, Central Ethiopia: A Case-Control Study. Anemia. 2020;2020(1):2865734.
22. Lingani M, Zango SH, Valéa I, Samadoulougou S, Sanou MA, Sorgho H et al. Prevalence and determinants of anaemia among pregnant women in a high malaria transmission setting: a cross-sectional study in rural Burkina Faso. Pan Afr Med J. 2024;47.
23. Kare AP, Gujo AB. Anemia among pregnant women attending ante natal care clinic in Adare General Hospital, southern Ethiopia: prevalence and associated factors. Health Serv insights. 2021;14:11786329211036303.
24. Koury MJ, Blanc L. Red blood cell production and kinetics. Rossi's principles Transfus Med. 2022;131–42.
25. Anaemia. and malaria | Malaria Journal [Internet]. [cited 2025 Jul 4]. Available from: https://link.springer.com/article/10.1186/S12936-018-2509-9
26. Amstad Bencaiova G, Krafft A, Zimmermann R, Burkhardt T. Treatment of anemia of chronic disease with true iron deficiency in pregnancy. J pregnancy. 2017;2017(1):4265091.
27. Weldemariam TB. Prevalence and factors associated with anemia among pregnant women attending antenatal care in Shalla Woreda, W/Arsi Zone, Oromia region. Int J Green Pharm. 2018;1:253–63.

28. Tulu BD, Atomssa EM, Mengist HM. Determinants of anemia among pregnant women attending antenatal care in Horo Guduru Wollega Zone, West Ethiopia: Unmatched case-control study. PLoS ONE. 2019;14(10):e0224514.
29. Inadequate dietary diversity during pregnancy. increases the risk of maternal anemia and low birth weight in Africa: A systematic review and meta-analysis - Seid – 2023 - Food Science & Nutrition - Wiley Online Library [Internet]. [cited 2025 Jul 5]. Available from: https://onlinelibrary.wiley.com/doi/full/10.1002/fsn3.3388
30. Abriha A, Yesuf ME, Wassie MM. Prevalence and associated factors of anemia among pregnant women of Mekelle town: a cross sectional study. BMC Res Notes. 2014;7(1):888.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- DuolOlockQuestionaire.docx