DETERMINANTS OF ANEMIA AMONG PREGNANT WOMEN ATTENDING ANTENATAL CARE

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ABSTRACT

Anemia during pregnancy remains a major maternal health problem because it increases the risk of adverse outcomes for mothers and infants. This study aimed to identify determinants of anemia among pregnant women attending antenatal care. This study used an analytical cross-sectional design based on aggregated maternal health data from 50 pregnant women in Sukamulya Village, Ciamis, Indonesia. The sample consisted of 25 pregnant women with anemia and 25 pregnant women without anemia. Anemia was defined as hemoglobin level below 11 g/dL. The variables analyzed were maternal age, education, occupation, gestational age, parity, mid-upper arm circumference, iron tablet adherence, number of antenatal care visits, and pregnancy interval. Data were analyzed using descriptive statistics, chi-square tests, and odds ratios for selected two-category variables. The results showed that maternal age and pregnancy interval were significantly associated with anemia. Education, occupation, gestational age, parity, nutritional status based on mid-upper arm circumference, iron tablet adherence, and antenatal care visits were not significantly associated with anemia in this dataset. Although low mid-upper arm circumference and non-adherence to iron tablets showed higher odds of anemia, these associations did not reach statistical significance. These findings indicate that maternal age and pregnancy interval should receive greater attention in antenatal anemia screening, while nutritional assessment and iron tablet counseling should continue as essential components of anemia prevention during pregnancy.

Keywords: anemia, antenatal care, pregnancy, maternal age, pregnancy interval

INTRODUCTION

Anemia during pregnancy remains a major global maternal health problem. The World Health Organization reported that 37% of pregnant women aged 15 to 49 years were affected by anemia in 2019. The Global Health Observatory also estimated that 35.5% of pregnant women worldwide experienced anemia in 2023 (World Health Organization [WHO], 2025a; WHO, 2025b). These figures show that anemia is not only a clinical problem, but also a public health concern that continues to affect maternal and child health across countries. Pregnant women are vulnerable to anemia because pregnancy increases iron requirements for maternal blood volume expansion, fetal growth, and placental development. When iron intake, nutritional reserves, and supplementation are inadequate, hemoglobin concentration may decrease and anemia may occur.

The severity of anemia as a public health problem can also be assessed from its prevalence. WHO classifies anemia in pregnant women as a severe public health problem when its prevalence reaches 40% or more. This classification is important because anemia in pregnancy has serious clinical and public health consequences for both the mother and the newborn. Azzam et al. (2025), in a systematic review and meta-analysis of 18 studies involving 14,548 pregnant women in Egypt, found that the pooled prevalence of anemia was 49% with a

95% confidence interval of 42% to 57%. This prevalence indicates a severe public health concern. The study also reported that anemia was significantly higher in the third trimester at 65% than in the second trimester at 47%. Among anemic pregnant women, most cases were mild and moderate anemia, each accounting for 47% of cases (Azzam et al., 2025).

In Indonesia, anemia during pregnancy remains a serious public health issue. The 2018 Basic Health Research reported that 48.9% of pregnant women in Indonesia experienced anemia (Kementerian Kesehatan Republik Indonesia, 2019). This prevalence indicates that almost one in two pregnant women in Indonesia had low hemoglobin levels during pregnancy. The problem is highly relevant for primary health care because most pregnant women receive early screening, nutrition education, and iron supplementation through antenatal care services. Therefore, local evidence is needed to identify which maternal, nutritional, obstetric, and antenatal care factors are most closely associated with anemia in specific community settings.

Anemia in pregnancy is commonly defined as hemoglobin concentration below 11 g/dL. This threshold is widely used in maternal health services to identify pregnant women who need further assessment, iron supplementation, nutritional counseling, and clinical monitoring. Anemia may occur due to iron deficiency, folate deficiency, vitamin B12 deficiency, infection, inflammation, poor dietary intake, or repeated pregnancies without adequate nutritional recovery. Iron deficiency remains one of the most common causes because pregnancy increases daily iron needs. Without adequate intake and supplementation, maternal iron stores may decline and hemoglobin production may be disrupted.

However, anemia during pregnancy should not be understood only as iron deficiency. The MINDI cohort study showed that anemia may reflect a broader nutritional and inflammatory condition. González-Fernández et al. (2024) reported that anemia in pregnant women was associated with lower ferritin, vitamin A, folate, and maternal nutritional indicators. Their findings suggest that anemia in pregnancy may involve iron deficiency, undernutrition, multiple micronutrient deficiencies, infection, inflammation, and impaired erythropoiesis. This evidence supports the view that anemia prevention should not depend only on iron tablets, but also on broader nutritional assessment, infection control, and adequate dietary intake.

The impact of anemia during pregnancy can affect both the mother and the fetus. For the mother, anemia may cause fatigue, reduced physical capacity, dizziness, decreased immunity, higher vulnerability to infection, and increased risk of complications during delivery. Severe anemia may increase the risk of maternal morbidity and may worsen outcomes when bleeding occurs during childbirth. For the fetus and newborn, maternal anemia has been associated with low birth weight, preterm birth, impaired fetal growth, and neonatal morbidity. Systematic reviews have shown that maternal anemia is associated with low birth weight and other adverse birth outcomes (Figueiredo et al., 2018; Rahmati et al., 2017). Azzam et al. (2025) also reported that infants born to anemic mothers had significantly lower Apgar scores, lower gestational ages, and lower birth weights, with birth weight being the most adversely affected neonatal outcome. These consequences show that anemia prevention should begin early and continue throughout pregnancy.

The determinants of anemia during pregnancy are complex. They include demographic, nutritional, obstetric, behavioral, infectious, socioeconomic, and health service factors. Maternal age may influence anemia risk because age is related to biological readiness, reproductive history, health behavior, and access to information. Educational level may influence how pregnant women understand nutrition, choose food, consume iron tablets, and follow antenatal recommendations. Occupation may reflect economic conditions, workload, and access to health information. Parity and pregnancy interval may affect maternal iron reserves because repeated pregnancy and childbirth can reduce nutritional recovery when food intake and supplementation are inadequate.

Recent evidence shows that the determinants of anemia vary across settings. Azzam et al. (2025) found that anemia among pregnant women was associated with maternal age over 30 years, rural residence, illiteracy, birth spacing of less than two years, lack of iron supplementation, intestinal parasites, antenatal visits of fewer than five times, multiparity, and low income. Dietary factors also played an important role, especially low intake of meat, vegetables, and fruits, as well as high tea consumption. Teshome et al. (2020) found that rural residence, previous heavy menstrual blood flow, maternal age, parasitic infection, food taboo, and drinking tea or coffee immediately after meals were significant predictors of anemia among pregnant women attending antenatal care in Southern Ethiopia. These findings indicate that anemia during pregnancy cannot be explained by a single cause. It should be viewed as the result of interaction among nutrition, infection, dietary behavior, culture, maternal knowledge, and access to health services.

Nutritional status is another important determinant of anemia during pregnancy. Mid-upper arm circumference is commonly used in antenatal care to identify chronic energy deficiency. A mid-upper arm circumference below 23.5 cm indicates poor maternal nutritional reserves. Pregnant women with low nutritional status may have limited energy and micronutrient reserves, including iron, folate, vitamin B12, vitamin A, and other nutrients needed for hemoglobin formation. This condition can increase vulnerability to anemia, especially when pregnancy increases physiological demand. Therefore, nutritional screening through mid-upper arm circumference is important because it is simple, low cost, and applicable in primary health care settings.

Evidence from maternal health studies supports the importance of nutritional assessment in anemia prevention. The MINDI cohort showed that undernutrition contributed to anemia through low maternal nutritional status, folate, vitamin A, and impaired erythropoiesis (González-Fernández et al., 2024). A study in Tana Toraja, Indonesia, also reported that diet, dietary restrictions, consumption of iron tablets, and supplementary food provision were associated with anemia among pregnant women attending a community health center (R. et al., 2024). These findings suggest that mid-upper arm circumference can be a practical entry point for identifying women who may require more intensive nutritional counseling and follow-up during antenatal care.

Antenatal care is a strategic entry point for anemia prevention and management. Through antenatal care, health workers can measure hemoglobin levels, assess nutritional status, distribute iron-folic acid tablets, monitor adherence, provide dietary counseling, and identify high-risk pregnancies. WHO recommends daily iron and folic acid supplementation during pregnancy as a public health intervention to reduce maternal anemia and improve pregnancy outcomes (WHO, 2012, 2024). However, the effectiveness of antenatal care depends not only on the number of visits, but also on the quality of screening, counseling, supplementation, and follow-up. A pregnant woman may attend antenatal care several times, but anemia may persist when counseling is limited, adherence is not monitored, or nutritional problems are not addressed.

Several studies support the role of antenatal care in anemia prevention, but they also show that the quality and timing of care matter. Azzam et al. (2025) found that fewer than five antenatal visits increased the odds of anemia among pregnant women. Sunguya et al. (2021), using data from 23,203 women of reproductive age and 2,194 pregnant women in Tanzania, reported that anemia remained highly prevalent among pregnant women at 57%. The study found that anemia was more likely among younger pregnant women, those living in larger households, those without formal education, those with food insecurity, those without health insurance, those who did not receive antimalarial medication during pregnancy, and those with low frequency of antenatal care attendance. Hoque et al. (2022) also showed that early antenatal booking was associated with lower anemia risk during pregnancy. These findings indicate that antenatal care must emphasize early booking, regular hemoglobin screening, nutritional counseling, and consistent follow-up.

Recent studies also show that maternal education and knowledge are central to anemia prevention. Wemakor (2019) found that 50.8% of pregnant women attending antenatal care at a tertiary referral hospital in Northern Ghana were anemic. The study reported that maternal knowledge of anemia and pregnancy trimester were independent determinants of anemia. Women with lower anemia knowledge had higher odds of anemia than women with better knowledge. This evidence shows that antenatal education should not be treated as a routine message only. It should be designed to improve maternal understanding of anemia causes, food sources of iron, correct use of iron-folic acid tablets, and the risks of anemia for both mother and baby.

Social and economic factors also influence anemia risk. Studies in several low and middle-income settings show that anemia is associated with poverty, low education, food insecurity, rural residence, household size, and limited access to quality health services. Sunguya et al. (2021) showed that food insecurity, lack of education, lack of health insurance, and low antenatal care attendance contributed to the high burden of anemia among pregnant women in Tanzania. Kavitha and Hilda Devi (2026) further highlighted gender-sensitive determinants in rural primary health settings, including low income, low education, non-adherence to iron-folic acid tablets, inadequate antenatal care, heavy workload, unequal food allocation, limited decision-making power, early marriage, and short birth spacing. These findings show that anemia during pregnancy is not only a biomedical condition. It is also shaped by the social environment in which pregnant women live.

Previous local research in Sukamulya Village described the characteristics of pregnant women with anemia. That study reported that most anemic pregnant women were aged 20 to 35 years, had elementary or junior high school education, were housewives, were in the second trimester, and had never given birth. However, the study only included pregnant women who experienced anemia. It did not include a comparison group of pregnant women without anemia. Therefore, the previous study could describe the profile of pregnant women with anemia, but it could not identify which factors were statistically associated with anemia.

This study addresses that gap by comparing pregnant women with anemia and pregnant women without anemia. The study analyzes maternal age, education, occupation, gestational age, parity, mid-upper arm circumference, iron tablet adherence, number of antenatal care visits, and pregnancy interval. This comparison provides stronger evidence than a purely descriptive profile because it allows the identification of factors associated with anemia status. The study also contributes local evidence for primary health care practice by showing which factors should receive more attention during antenatal screening and counseling.

The contribution of this article lies in its analytical focus. Unlike previous local evidence that only described anemic pregnant women, this study compares anemic and non-anemic pregnant women attending antenatal care. The findings may help midwives and maternal health workers prioritize early nutritional screening, hemoglobin examination, counseling for first-time pregnant women, monitoring of iron tablet consumption, and follow-up for pregnant women with low mid-upper arm circumference. The objective of this study was to identify determinants of anemia among pregnant women attending antenatal care in Sukamulya Village, Ciamis, Indonesia. The hypothesis of this study was that maternal age, education, parity, nutritional status, iron tablet adherence, antenatal care visits, and pregnancy interval are associated with anemia among pregnant women.

METHOD

Participant characteristics and research design

This study used an analytical cross-sectional design based on aggregated antenatal care data. The study was conducted in Sukamulya Village, Ciamis, Indonesia. The data were obtained from maternal health records of pregnant women who attended antenatal care services. The dataset included 50 pregnant women, consisting of 25 pregnant women with anemia and 25 pregnant women without anemia.

The unit of analysis was the group-level distribution of pregnant women based on anemia status and selected maternal health variables. The main outcome variable was anemia status. The independent variables were maternal age, education, occupation, gestational age, parity, mid-upper arm circumference, iron tablet adherence, number of antenatal care visits, and pregnancy interval.

This design was selected because the available data were recorded in aggregated frequency tables. The design allowed comparison between pregnant women with anemia and pregnant women without anemia. Therefore, the study could identify variables associated with anemia status, although it could not estimate independent predictors at the individual level.

Data sources

The data used in this study were secondary aggregated data from antenatal care records in Sukamulya Village, Ciamis. The data contained the frequency distribution of pregnant women according to anemia status and selected maternal, nutritional, obstetric, and antenatal care characteristics.

The anemia group included pregnant women whose hemoglobin levels were below 11 g/dL. The non-anemia group included pregnant women whose hemoglobin levels were 11 g/dL or higher. The aggregated data were organized into comparison tables between the anemia and non-anemia groups. No personal names, addresses, or individual identifiers were included in the analysis.

Eligibility and exclusion criteria

The inclusion criteria were pregnant women who attended antenatal care services, had hemoglobin status recorded, and had available information on the selected variables. These variables included maternal age, education, occupation, gestational age, parity, mid-upper arm circumference, iron tablet adherence, number of antenatal care visits, and pregnancy interval.

Pregnant women were excluded if their hemoglobin status was not available or if the key variables required for comparison were incomplete. Since this study used aggregated data, the exclusion process was applied at the level of data completeness in the available records.

Sampling procedures

The study used available antenatal care data from Sukamulya Village. The sample was grouped based on anemia status. The anemia group consisted of 25 pregnant women with hemoglobin levels below 11 g/dL. The non-anemia group consisted of 25 pregnant women with hemoglobin levels of 11 g/dL or higher..

The grouping was conducted to compare the distribution of maternal and obstetric characteristics between pregnant women with anemia and those without anemia. This comparison was necessary because previous descriptive data only described pregnant women with anemia and did not include a non-anemia comparison group.

Sample size, power, and precision

The final sample consisted of 50 pregnant women, with 25 pregnant women in the anemia group and 25 pregnant women in the non-anemia group. No prior sample size calculation or power analysis was conducted because this study used available aggregated antenatal care data.

The sample size was sufficient for descriptive analysis, chi-square testing, and odds ratio calculation for selected two-category variables. However, the relatively small sample size may have reduced the statistical power to detect associations for several clinically relevant variables, such as MUAC-based nutritional status, iron tablet adherence, parity, and antenatal care visits. In addition, the use of aggregated data limited the precision of individual-level risk estimation. For these reasons, the study did not conduct multivariable logistic regression.

Classification of anemia status

Anemia status was classified based on hemoglobin concentration. Pregnant women with hemoglobin levels below 11 g/dL were categorized as having anemia. Pregnant women with hemoglobin levels of 11 g/dL or higher were categorized as not having anemia.

In the anemia group, anemia severity was classified into three categories. Mild anemia was defined as hemoglobin level of 10.0 to 10.9 g/dL. Moderate anemia was defined as hemoglobin level of 7.0 to 9.9 g/dL. Severe anemia was defined as hemoglobin level below 7.0 g/dL. These categories were used to describe the severity profile among pregnant women with anemia.

Classification of nutritional status based on MUAC

Nutritional status was assessed using mid-upper arm circumference, also known as MUAC. In Indonesian maternal health services, this measure is commonly referred to as LILA. Pregnant women with MUAC below 23.5 cm were categorized as having low MUAC or chronic energy deficiency. Pregnant women with MUAC of 23.5 cm or higher were categorized as having normal nutritional status.

MUAC was included because it is a practical nutritional screening indicator during antenatal care. It can help identify pregnant women with poor nutritional reserves who may have a higher risk of anemia.

Measures and covariates

Anemia status was the dependent variable and was categorized into anemia and non-anemia. The independent variables included maternal age, education, occupation, gestational age, parity, MUAC-based nutritional status, iron tablet adherence, number of antenatal care visits, and pregnancy interval.

Maternal age was categorized into less than 20 years, 20 to 35 years, and more than 35 years. Education was categorized into elementary/junior high school, senior high/vocational school, and higher education. Occupation was categorized into civil servant, entrepreneur, farmer, private employee, and housewife. Gestational age was categorized into trimester I, trimester II, and trimester III. Parity was categorized into no previous childbirth, one to two childbirths, and more than two childbirths.

Iron tablet adherence was categorized into adherent and non-adherent based on the available antenatal care data. Antenatal care visits were categorized into adequate and inadequate. Pregnancy interval was categorized into first pregnancy, less than two years, and more than two years.

Data analysis

Data were analyzed using descriptive statistics, chi-square tests, and odds ratios. Descriptive statistics were used to present the frequency and percentage of each variable in the anemia and non-anemia groups.

The chi-square test was used to examine the association between each categorical independent variable and anemia status. This test was selected because both the outcome variable and the independent variables were categorical. The variables tested using chi-square included maternal age, education, occupation, gestational age, parity, MUAC-based nutritional status, iron tablet adherence, antenatal care visits, and pregnancy interval. A p-value below 0.05 was considered statistically significant.

Odds ratios with 95% confidence intervals were calculated for selected two-category variables. These variables included low MUAC, iron tablet non-adherence, inadequate antenatal care visits, and primigravida status. The odds ratio was used to estimate the strength of association between each selected factor and anemia status. An odds ratio greater than 1 indicated higher odds of anemia in the exposed group, while an odds ratio below 1 indicated lower odds of anemia.

Multivariable logistic regression was not performed because the available data were aggregated rather than individual-level data. Logistic regression requires respondent-level data for each variable in the same row, so the model can estimate adjusted associations between predictors and anemia status. In this study, the data were only available as frequency distributions for each variable. Therefore, the analysis was limited to bivariate testing. The relatively small sample size should also be considered when interpreting non-significant findings. The findings should be interpreted as statistical associations, not causal effects or independent determinants.

RESULTS AND DISCUSSION

Results

This study included 50 pregnant women attending antenatal care. The sample consisted of 25 pregnant women with anemia and 25 pregnant women without anemia. Among pregnant women with anemia, most respondents were aged 20-35 years, had senior high or vocational education, were housewives, were in the second trimester, and had either no previous childbirth or more than two childbirths.

Table 1

Characteristics of Pregnant Women by Anemia Status

Variables	Anemia n (%)	Non-anemia n (%)	Total n (%)
Age			
<20 years	4 (16.0)	15 (60.0)	19 (38.0)
20-35 years	19 (76.0)	6 (24.0)	25 (50.0)
>35 years	2 (8.0)	4 (16.0)	6 (12.0)
Education			
Elementary/Junior High School	10 (40.0)	6 (24.0)	16 (32.0)
Senior High/Vocational School	11 (44.0)	10 (40.0)	21 (42.0)
Higher Education	4 (16.0)	9 (36.0)	13 (26.0)
Occupation			
Civil servant	2 (8.0)	3 (12.0)	5 (10.0)
Entrepreneur	3 (12.0)	6 (24.0)	9 (18.0)

Farmer	4 (16.0)	2 (8.0)	6 (12.0)
Private employee	2 (8.0)	5 (20.0)	7 (14.0)
Housewife	14 (56.0)	9 (36.0)	23 (46.0)
Gestational age			
Trimester I	8 (32.0)	9 (36.0)	17 (34.0)
Trimester II	13 (52.0)	6 (24.0)	19 (38.0)
Trimester III	4 (16.0)	10 (40.0)	14 (28.0)
Parity			
No previous childbirth	9 (36.0)	5 (20.0)	14 (28.0)
1-2 childbirths	7 (28.0)	9 (36.0)	16 (32.0)
>2 childbirths	9 (36.0)	11 (44.0)	20 (40.0)
Nutritional status based on MUAC			
Low MUAC <23.5 cm	15 (60.0)	9 (36.0)	24 (48.0)
Normal MUAC ≥23.5 cm	10 (40.0)	16 (64.0)	26 (52.0)
Iron tablet adherence			
Adherent	11 (44.0)	17 (68.0)	28 (56.0)
Non-adherent	14 (56.0)	8 (32.0)	22 (44.0)
ANC visits			
Inadequate	13 (52.0)	9 (36.0)	22 (44.0)
Adequate	12 (48.0)	16 (64.0)	28 (56.0)
Pregnancy interval			
First pregnancy	16 (64.0)	6 (24.0)	22 (44.0)
<2 years	5 (20.0)	14 (56.0)	19 (38.0)
>2 years	4 (16.0)	5 (20.0)	9 (18.0)

Table 1 shows that most pregnant women with anemia were aged 20-35 years, had senior high or vocational education, were housewives, were in the second trimester, had either no previous childbirth or more than two childbirths, had low MUAC, were non-adherent to iron tablets, had inadequate ANC visits, and were in their first pregnancy. Low MUAC was found in 60.0% of the anemia group and 36.0% of the non-anemia group. Non-adherence to iron tablets was found in 56.0% of the anemia group and 32.0% of the non-anemia group.

Table 2

Factors Associated with Anemia Among Pregnant Women

Variables	Chi-square	p-value	Interpretation
Age	13.80	0.001	Significant
Education	2.97	0.226	Not significant
Occupation	4.24	0.375	Not significant
Gestational age	5.21	0.074	Not significant
Parity	1.59	0.451	Not significant
Nutritional status based on MUAC	2.89	0.089	Not significant
Iron tablet adherence	2.92	0.087	Not significant
ANC visits	1.30	0.254	Not significant
Pregnancy interval	8.92	0.012	Significant

Table 2 shows that maternal age and pregnancy interval were significantly associated with anemia among pregnant women. Education, occupation, gestational age, parity, nutritional status based on MUAC, iron tablet adherence, and number of antenatal care visits were not significantly associated with anemia in this dataset.

Table 3
Odds Ratios for Selected Determinants of Anemia

Determinant	OR	95% CI	p-value
Low MUAC <23.5 cm	2.67	0.85-8.37	0.093
Non-adherence to iron tablets	2.71	0.85-8.57	0.091
Inadequate ANC visits	1.93	0.62-5.98	0.257
Primigravida	2.25	0.63-8.06	0.213

Table 3 shows that pregnant women with low MUAC had 2.67 times higher odds of anemia than pregnant women with normal MUAC, although the association was not statistically significant. Pregnant women who were non-adherent to iron tablets had 2.71 times higher odds of anemia than adherent pregnant women, but this association was also not statistically significant. Inadequate ANC visits and primigravida status were not significantly associated with anemia.

Discussion

This study identified two factors significantly associated with anemia among pregnant women attending antenatal care: maternal age and pregnancy interval. Education, occupation, gestational age, parity, nutritional status based on mid-upper arm circumference, iron tablet adherence, and number of antenatal care visits were not significantly associated with anemia in this dataset. These findings indicate that anemia during pregnancy is a multifactorial condition, but the strength of association may vary according to the characteristics of the sample, distribution of risk factors, and sample size. The results also suggest that antenatal care should continue to apply universal anemia screening while giving special attention to pregnant women with vulnerable age patterns and pregnancy interval-related risks.

Maternal age was significantly associated with anemia. Most pregnant women with anemia in this study were aged 20 to 35 years. This finding needs careful interpretation because the age group of 20 to 35 years is generally considered the safest reproductive age group for pregnancy. In this dataset, however, this group contributed the largest proportion of anemia cases. This pattern may reflect the local distribution of pregnant women attending antenatal care, where the reproductive age group formed a major proportion of the anemia group. Therefore, the high frequency of anemia among women aged 20 to 35 years should not be interpreted as biological risk alone.

This finding shows that anemia prevention should not only focus on pregnant women aged less than 20 years or more than 35 years. Although adolescent pregnancy and advanced maternal age are often categorized as high-risk conditions, women in the optimal reproductive age group can also experience anemia when nutritional intake is inadequate, iron requirements increase, and iron supplementation is not consistently monitored. Pregnancy increases iron needs because of maternal blood volume expansion, placental development, and fetal growth. If this increased demand is not supported by adequate dietary intake, iron supplementation, and nutritional reserves, pregnant women in any age group may develop anemia.

The result is partly different from previous studies that identified adolescent or older maternal age as higher-risk groups. Sunguya et al. (2021) found that anemia among pregnant women in Tanzania was more likely among women aged 15 to 19 years than among those aged 20 to 34 years. Azzam et al. (2025), in contrast, reported that pregnant women aged more than 30 years had higher odds of anemia. Teshome et al. (2020) also found that maternal age was one of the significant predictors of anemia among pregnant women attending antenatal care in Southern Ethiopia. These differences indicate that maternal age should not be interpreted as a single determinant. It should be understood together with nutritional status, education, parity, dietary practices, household conditions, and quality of antenatal care.

The implication for antenatal care is that hemoglobin screening should be applied to all pregnant women, not only to women in conventional high-risk age categories. Midwives and maternal health workers should avoid assuming that women aged 20 to 35 years are automatically protected from anemia. Pregnant women in this age group still need regular hemoglobin measurement, dietary assessment, iron tablet counseling, and follow-up. Universal screening is more appropriate than selective screening because anemia can occur across all maternal age groups.

Pregnancy interval was also significantly associated with anemia. This is an important finding because pregnancy interval reflects the time available for maternal nutritional recovery between pregnancies. In this study, pregnancy interval showed a significant relationship with anemia status, although the distribution of the categories needs careful interpretation. A short pregnancy interval may reduce the time needed to restore iron stores and overall nutritional reserves after a previous pregnancy, childbirth, and breastfeeding. When nutritional recovery is incomplete, the next pregnancy may begin with lower iron reserves and increase the risk of anemia.

This finding is consistent with the broader literature. Azzam et al. (2025) found that birth spacing of less than two years was significantly associated with anemia among pregnant women. Kavitha and Hilda Devi (2026) also reported that short birth spacing was independently associated with anemia among pregnant women in rural primary health settings. These findings support the biological explanation that close pregnancies can increase nutritional depletion. Repeated pregnancies with short recovery periods may reduce maternal iron stores, especially when dietary intake is inadequate, supplementation is inconsistent, or antenatal care begins late.

The meaning of this finding is clinically relevant for antenatal care. Pregnancy interval should not only be recorded as demographic information. It should be used as a risk marker during maternal assessment. Health workers need to identify pregnant women with short pregnancy intervals and provide closer monitoring of hemoglobin levels, nutritional status, and iron tablet consumption. Counseling on birth spacing, postpartum nutrition, and family planning should also be integrated into maternal health services because anemia prevention is not limited to the current pregnancy. It also depends on maternal recovery before the next pregnancy.

Education was not significantly associated with anemia in this dataset. This finding differs from several previous studies that reported a significant relationship between education and anemia. Azzam et al. (2025) found that illiteracy increased the odds of anemia among pregnant women. Sunguya et al. (2021) also reported that anemia was more likely among pregnant women without formal education. Wemakor (2019) found that maternal knowledge of anemia was an independent determinant of anemia among pregnant women attending antenatal care in Northern Ghana. These studies show that education and knowledge can influence anemia through health literacy, food choices, understanding of iron supplementation, and ability to follow antenatal recommendations.

The non-significant finding in the present study may be influenced by the small sample size and the distribution of education categories between the anemia and non-anemia groups. Although education was not statistically significant, it remains clinically relevant. Pregnant women with lower educational attainment may still face barriers in understanding anemia prevention, consuming iron tablets correctly, and selecting iron-rich foods. Therefore, antenatal counseling should remain sensitive to maternal literacy. Health workers should use simple language, practical examples of local foods, and repeated instructions about iron tablet consumption.

Occupation was not significantly associated with anemia. In this study, respondents were distributed across several occupational categories, but occupation may not capture the broader social and economic conditions that influence anemia risk. Employment status alone may be too simple to explain anemia because income, workload, household food allocation, decision-making power, and access to health services may be more relevant than occupation category itself. Kavitha and Hilda Devi (2026) showed that anemia among pregnant women in rural primary health settings was associated with low income, heavy workload, limited decision-making power, and unequal food allocation within the family. This suggests that future studies should measure socioeconomic and gender-related factors more directly, not only employment status.

Gestational age was not significantly associated with anemia in this dataset. The distribution of trimester differed between groups, but the association did not reach statistical significance. This finding should be interpreted cautiously because trimester remains clinically important. Iron demand increases as pregnancy progresses due to maternal blood volume expansion and fetal growth. Azzam et al. (2025) reported that anemia prevalence was higher in the third trimester than in the second trimester. Wemakor (2019) also found that pregnant women in the third trimester had higher odds of anemia than those in the first trimester. The non-significant result in this study may be related to the limited sample size or to the distribution of trimester categories in the dataset.

Parity was not significantly associated with anemia in the new dataset. This result differs from the previous analysis, where primigravida status showed a significant relationship. In the current data, the distribution of anemia was found among women with no previous childbirth and among women with more than two childbirths. This pattern suggests that anemia risk may occur in both primigravida and multiparous women, but through different pathways. Primigravida women may be vulnerable because they have limited pregnancy experience, while multiparous women may be vulnerable because repeated pregnancies can reduce nutritional reserves.

Although parity was not statistically significant, it should remain part of antenatal risk assessment. Previous studies have shown that multiparity can be associated with anemia because repeated pregnancies and childbirth may deplete iron stores, especially when pregnancy intervals are short and dietary intake is inadequate. Azzam et al. (2025) found that multiparity was significantly associated with anemia among pregnant women. The present study did not find a significant association, but the small sample size may have limited the statistical power to detect this relationship.

Nutritional status based on mid-upper arm circumference was not significantly associated with anemia in this dataset. However, the odds ratio showed that pregnant women with low MUAC had 2.67 times higher odds of anemia than those with normal MUAC, although the association did not reach statistical significance. This pattern is important because it suggests a clinically meaningful direction. The confidence interval crossed 1, so the result cannot be interpreted as statistically significant. However, the elevated odds indicate that low MUAC may still be relevant for anemia prevention.

This finding needs careful interpretation. MUAC below 23.5 cm indicates chronic energy deficiency or poor maternal nutritional reserves. Pregnant women with low MUAC may have inadequate intake of iron, protein, folate, vitamin B12, vitamin A, and other nutrients needed for hemoglobin formation. The MINDI cohort supports this interpretation. González-Fernández et al. (2024) found that anemia in pregnancy may be associated with low ferritin, vitamin A, folate, and maternal nutritional indicators, suggesting that anemia can reflect undernutrition and multiple nutrient deficiencies. Therefore, even when MUAC is not statistically significant in this dataset, it remains important as a practical screening indicator in antenatal care.

Evidence from Indonesia also supports the role of diet and nutritional support. R. et al. (2024) found that dietary habits, dietary restrictions, Fe tablet consumption, and supplementary food provision were associated with anemia among pregnant women at Buakayu Community Health Center in Tana Toraja. This finding supports the need to combine MUAC measurement with dietary counseling, monitoring of iron tablet consumption, and food-based intervention. In the present study, the non-significant result may be related to the small sample size, but the higher odds among pregnant women with low MUAC should not be ignored.

Iron tablet adherence was not significantly associated with anemia in this study. However, pregnant women who were non-adherent to iron tablets had 2.71 times higher odds of anemia than adherent pregnant women, although this association was not statistically significant. This pattern suggests that iron tablet adherence remains clinically important. The non-significant finding may be caused by the limited sample size and the way adherence was recorded. The data only categorized mothers as adherent or non-adherent. It did not capture the number of tablets consumed, timing of consumption, side effects, consistency, food interactions, or whether supplementation started before or after anemia was detected.

Several studies show that iron supplementation remains an important factor in anemia prevention. Azzam et al. (2025) found that lack of iron supplementation increased the odds of anemia among pregnant women. R. et al. (2024) also reported that Fe tablet consumption was significantly associated with anemia among pregnant women in Tana Toraja. Nasir et al. (2020) and Yismaw et al. (2022) showed that adherence to iron-folic acid supplementation is influenced by counseling, knowledge, side effects, and health service support. Therefore, future data collection should measure adherence more precisely, including how many tablets were taken, how regularly they were consumed, and whether mothers consumed them with dietary inhibitors such as tea or coffee.

The number of antenatal care visits was not significantly associated with anemia. This result suggests that the quantity of visits alone may not guarantee anemia prevention. A pregnant woman may attend antenatal care several times, but anemia may persist if the visit does not include effective hemoglobin screening, nutritional counseling, iron tablet monitoring, and follow-up for low MUAC. The odds ratio for inadequate ANC visits was above 1, but it was not statistically significant. This finding indicates that the quality of antenatal care may be more important than the number of visits alone.

This result differs from several studies that found an association between ANC attendance and anemia. Azzam et al. (2025) reported that antenatal visits fewer than five times increased the odds of anemia. Sunguya et al. (2021) found that low frequency of ANC attendance contributed to the high burden of anemia among pregnant women in Tanzania. Hoque et al. (2022) showed that early antenatal booking was associated with lower anemia risk during pregnancy. These findings suggest that future studies should measure not only the number of ANC visits, but also timing of the first visit, quality of counseling, completeness of hemoglobin screening, MUAC assessment, iron tablet provision, and follow-up actions.

Overall, this study shows that maternal age and pregnancy interval were significantly associated with anemia among pregnant women attending antenatal care. Other variables, including education, occupation, gestational age, parity, MUAC-based nutritional status, iron tablet adherence, and ANC visits, were not statistically significant in this dataset. However, several non-significant variables still showed clinically relevant patterns. Low MUAC and non-adherence to iron tablets showed higher odds of anemia, although the associations did not reach statistical significance. This suggests that the absence of statistical significance should not be interpreted as the absence of clinical importance.

The findings support the broader evidence that anemia during pregnancy is a multidimensional problem. It involves maternal age, reproductive history, nutritional status, dietary behavior, iron supplementation, health literacy, social conditions, and quality of antenatal care. Therefore, anemia prevention in primary health care should not rely only on distributing iron tablets. It should include early hemoglobin screening, MUAC measurement, counseling on locally available iron-rich foods, monitoring of iron tablet consumption, attention to pregnancy interval, and family support for maternal nutrition.

The main contribution of this study is its analytical comparison between pregnant women with anemia and pregnant women without anemia using local antenatal care data. Previous local evidence only described the characteristics of pregnant women with anemia. This study goes further by identifying variables statistically associated with anemia status in the current dataset. The findings can help primary health care workers prioritize universal hemoglobin screening, counseling on pregnancy spacing, nutritional assessment, and follow-up for pregnant women with elevated clinical risk. This local evidence may support more targeted anemia prevention strategies in antenatal care services.

LIMITATION OF THE STUDY

This study has several limitations. First, the analysis used aggregated data, so individual-level multivariable logistic regression could not be conducted. Second, the findings should be interpreted as statistical associations rather than causal determinants. Third, the sample size was relatively small, consisting of 50 pregnant women, with 25 women in the anemia group and 25 women in the non-anemia group. This small sample size may have reduced the statistical power to detect associations for several clinically relevant variables, such as MUAC-based nutritional status, iron tablet adherence, parity, gestational age, and antenatal care visits.

Fourth, iron tablet adherence was measured as a categorical variable and did not capture the number of tablets consumed, timing of consumption, side effects, dietary inhibitors of iron absorption, or consistency of use. Fifth, the data came from one village, so the results may not represent pregnant women in other settings. Sixth, several potential determinants such as household income, dietary intake, infection history, food restriction, tea or coffee consumption after meals, maternal knowledge of anemia, and quality of antenatal counseling were not included in the dataset. Future studies should use individual-level data, larger samples, and multivariable analysis to identify independent predictors of anemia more accurately.

CONCLUSIONS AND SUGGESTIONS

This study found that maternal age and pregnancy interval were significantly associated with anemia among pregnant women attending antenatal care. Pregnant women aged 20-35 years formed the largest proportion of the anemia group, indicating that anemia screening should not only focus on pregnant women in conventional high-risk age groups. Pregnancy interval was also significantly associated with anemia, showing that reproductive history and maternal recovery between pregnancies should receive attention during antenatal assessment.

Education, occupation, gestational age, parity, MUAC-based nutritional status, iron tablet adherence, and number of antenatal care visits were not significantly associated with anemia in this dataset. However, low MUAC and non-adherence to iron tablets showed higher odds of anemia, although these associations did not reach statistical significance. Therefore, these variables remain clinically relevant and should still be considered in antenatal anemia prevention.

These findings suggest that anemia prevention during antenatal care should focus on universal hemoglobin screening, assessment of pregnancy interval, early nutritional screening, dietary counseling, and monitoring of iron tablet consumption. Antenatal care providers should not only distribute iron tablets, but also assess whether mothers understand how to consume them correctly and whether nutritional problems are being addressed. Counseling on pregnancy spacing, postpartum nutritional recovery, and family planning should also be strengthened as part of maternal anemia prevention. Further research using individual-level data, larger samples, and multivariable analysis is recommended to confirm the independent determinants of anemia among pregnant women.

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