



Factors Associated with Anemia Among Pregnant Women: A Case-Control Study in Madiun Regency, Indonesia

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Abstract

Anemia is a prevalent health problem among pregnant women in Indonesia, particularly in the working area of Balerejo Community Health Center, Madiun Regency. Anemia during pregnancy is associated with adverse maternal and fetal outcomes, including low birth weight, preterm birth, and maternal and fetal mortality. The prevalence of anemia in the Balerejo Community Health Center area increased from 27.3% in 2021 to 41.7% in 2024, representing the highest prevalence among community health centers in Madiun Regency. Several factors have been reported to be associated with anemia during pregnancy, including maternal age, adherence to iron supplementation, nutritional status, and dietary patterns. This study employed a quantitative case-control design involving 108 pregnant women, comprising 54 women with anemia in the case group and 54 women without anemia in the control group. Data were collected using questionnaires and analyzed using bivariate and multivariable analyses. Adherence to iron supplementation ($p=0.000$) and dietary patterns ($p=0.005$) were significantly associated with anemia. Maternal age ($p=0.265$) and nutritional status ($p=0.533$) were not significantly associated with anemia. In the multivariable analysis, adherence to iron supplementation showed the strongest association with anemia ($aOR=30.000$). Adherence to iron supplementation and dietary patterns were significantly associated with anemia among pregnant women. Non-adherence to iron supplementation showed the strongest association with anemia. However, the magnitude of the observed association ($aOR=30.000$) should be interpreted cautiously given the relatively small sample size and the potential for residual confounding and measurement bias. Strengthening antenatal counseling, adherence monitoring, and promotion of healthy dietary practices may inform targeted strategies for anemia prevention among pregnant women. Prospective studies with larger samples are needed to confirm these associations and establish temporal relationships.

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1. INTRODUCTION

Anemia is a condition characterized by a hemoglobin concentration below the normal range and remains an important public health problem among pregnant women. During pregnancy, anemia may impair oxygen delivery to maternal and fetal tissues and is commonly associated with symptoms such as fatigue, dizziness, pallor, shortness of breath, and increased heart rate (Lumbantobing & Nadeak, 2025; Reshid & Anato, 2024). Iron deficiency is one of the most common causes of anemia and may result from inadequate dietary iron intake or impaired iron absorption (Hidayah Afnas & Widya, 2024). Among pregnant women, anemia is generally defined as a hemoglobin concentration below 11 g/dL in the first and third trimesters and below 10.5 g/dL in the second trimester (Andira & Sulastri, 2025).

Anemia during pregnancy is associated with adverse maternal and fetal outcomes, including miscarriage, intrauterine fetal death, preterm birth, premature rupture of membranes, complicated labor, postpartum hemorrhage, and low birth weight (Seid et al., 2025). Therefore, early identification of factors associated with anemia during pregnancy is important to support appropriate prevention and management strategies. Several maternal and nutritional factors have been reported to be associated with anemia, including maternal age, adherence to iron supplementation, chronic energy deficiency (CED), and dietary patterns. Pregnancies at an age below 20 years or above 35 years may be associated with a higher risk of anemia because younger mothers may have additional nutritional requirements related to their own growth, whereas older mothers may experience increased pregnancy-related health risks (Azzam et al., 2025; Khezri et al., 2023). In addition, inadequate adherence to iron supplementation may increase the risk of iron deficiency and anemia during pregnancy, and previous studies have reported an association between adherence to iron supplementation and anemia among pregnant women (Laturake & Nurbaya, 2023; Meliyani et al., 2022).

Nutritional status and dietary patterns may also be associated with anemia during pregnancy. Chronic energy deficiency reflects inadequate energy and nutrient intake and may coexist with deficiencies of iron and other micronutrients, potentially increasing the likelihood of anemia (Agusmarinda, Ananti, & Purnamasari, 2025; Tendean et al., 2025). Similarly, an unbalanced dietary pattern may result in inadequate intake of essential nutrients required during pregnancy. Because nutritional requirements increase throughout pregnancy, an adequate and balanced diet is important for maintaining maternal nutritional status and supporting fetal growth (Eriza et al., 2023; Firmansyah et al., 2023). However, findings regarding the associations between maternal age, adherence to iron supplementation, nutritional status, dietary patterns, and anemia have not been consistent across different populations.

The burden of anemia among pregnant women remains a concern in Madiun Regency. In 2024, the Balerejo Public Health Center working area reported the highest prevalence of anemia among pregnant women in Madiun Regency, reaching 41.7% (Dinas Kesehatan Kabupaten Madiun, 2025). This high prevalence indicates that anemia remains an important local maternal health problem and highlights the need to identify factors associated with anemia in this specific population. Local conditions, including dietary practices and adherence to iron supplementation, may differ from those in other geographical and socio-cultural settings. Preliminary observations in the Balerejo area indicated that some pregnant women did not consistently consume iron tablets according to recommendations, suggesting the importance of further examining adherence to iron supplementation and dietary patterns in relation to anemia.

Although previous studies have examined maternal age, adherence to iron supplementation, CED status, and dietary patterns in relation to anemia during pregnancy,

their findings have not been consistent across populations. Furthermore, these factors have rarely been examined simultaneously within a single case-control study in a primary healthcare setting. Consequently, it remains unclear which of these factors have the strongest association with anemia among pregnant women in the Balerejo Public Health Center working area. This represents an important knowledge gap because Balerejo has reported the highest prevalence of anemia among pregnant women in Madiun Regency. To the best of our knowledge, no previous study has simultaneously examined maternal age, adherence to iron supplementation, CED status, and dietary patterns as factors associated with anemia among pregnant women in this setting using a case-control approach. Therefore, this study aimed to identify factors associated with anemia among pregnant women in the working area of Balerejo Public Health Center, Madiun Regency, specifically maternal age, adherence to iron supplementation, CED status, and dietary patterns, and to determine which factor has the strongest association with anemia. The study hypothesized that maternal age, adherence to iron supplementation, CED status, and dietary patterns are significantly associated with anemia among pregnant women in the working area of Balerejo Public Health Center, Madiun Regency. The findings are expected to provide evidence-based information for healthcare providers in developing targeted strategies for the prevention and management of anemia among pregnant women.

2. METHODS

This quantitative study employed an analytical observational design with a case-control approach and was conducted between April and June 2025. Data were obtained from both secondary and primary sources. Secondary data were collected from medical records at the Balerejo Community Health Center, while primary data were gathered through structured questionnaires and face-to-face interviews with the respondents. The case group consisted of pregnant women diagnosed with anemia (hemoglobin [Hb] <11 g/dL) who resided within the Balerejo Community Health Center service area and had complete medical records, including hemoglobin level, gestational age, and mid-upper arm circumference (MUAC). The control group comprised pregnant women without anemia (Hb ≥11 g/dL) who met the same eligibility criteria regarding residence and completeness of medical records.

The minimum sample size was calculated using the Lemeshow formula, resulting in a required sample of 54 participants per group. Participants were selected using simple random sampling. Eligible respondents were assigned random numbers in Microsoft Excel, and the RAND function was used to select 54 participants for the case group and 54 participants for the control group. The independent variables included maternal age, chronic energy deficiency (CED) status, adherence to iron supplementation, and dietary habits. Data on maternal age and CED status were obtained from standardized medical records and the Maternal and Child Health (MCH) handbook. As these instruments are routinely used in clinical practice and have established standards, validity and reliability testing was not required.

Adherence to iron supplementation and dietary habits were assessed using structured questionnaires developed by the researchers. Prior to data collection, the questionnaires underwent validity and reliability testing among 10 pregnant women attending the Wonoasri Community Health Center. Item validity was evaluated using the Pearson product-moment correlation test with a degree of freedom of $N - 2$ ($10 - 2 = 8$), yielding an r -table value of 0.6319. All questionnaire items demonstrated correlation coefficients exceeding the critical r -value, indicating satisfactory construct validity. Each questionnaire consisted of 10 items, all of which were retained for the study. Reliability

was assessed using Cronbach's alpha coefficient. A Cronbach's alpha value greater than 0.60 was considered indicative of acceptable internal consistency. The questionnaire assessing adherence to iron supplementation demonstrated high reliability, with a Cronbach's alpha coefficient exceeding 0.80, while the dietary habits questionnaire showed good reliability, with a Cronbach's alpha coefficient between 0.61 and 0.80.

Bivariate associations between independent variables and the incidence of anemia were analyzed using the chi-square test. Variables with statistical significance in the bivariate analysis were subsequently included in a multivariable logistic regression model to identify factors independently associated with anemia among pregnant women. Statistical significance was established at $p < 0.05$. This study was conducted to identify and analyze factors associated with the incidence of anemia among pregnant women attending the Balerejo Community Health Center, Madiun Regency, Indonesia. Ethical approval was obtained from the Health Research Ethics Committee of STIKES Bhakti Husada Mulia Madiun (Approval No. 096/E-KEPK/STIKES/BHM/II/2026).

3. RESULTS AND DISCUSSION

Table 1. Distribution of anemia incidence by age.

Mother's Age	Anemia Incidents				Total		p-value	OR (95% CI)
	Case		Control		N	%		
	N	%	N	%				
Risky	2	3.7	8	14.8	10	9.3	0.265	0.300 (0.057 – 1.582)
No Risk	52	96.3	46	85.2	98	90.7		
Total	54	100.0	54	100.0	108	100.0		

It can be concluded that among the 108 respondents, the non-risk age group represents the majority of pregnant women. (98; 90.7%), while only 10 (9.3%) were in the at-risk age group. Among the 54 pregnant women with anemia (case group), the majority (52; 96.3%) were in the non-risk age group, and only 2 (3.7%) were in the at-risk group. In contrast, among the 54 non-anemic pregnant women (control group), 46 (85.2%) were in the non-risk age group and 8 (14.8%) were in the at-risk group.

The Chi-square analysis showed that 2 cells (50.0%) had expected counts < 5 , with a minimum expected value of 4.00, indicating that Chi-square test is not met. Therefore, Fisher's Exact Test was applied, yielding a p-value of 0.265 ($p > 0.05$), which suggests no statistically significant association between maternal age and anemia incidence in pregnant women.

Furthermore, the odds ratio (OR) was 0.30 (95% CI: 0.057–1.582), indicating that pregnant women in the high-risk age group had lower odds of anemia than those aged 20–35 years. However, because the 95% confidence interval includes 1 and the association was not statistically significant ($p = 0.265$), no meaningful association can be concluded.

Table 2. Distribution of anemia incidence based on compliance with consumption of iron supplements.

TTD Consumption Compliance	Anemia Incidence				Total		p-value	OR (95% CI)
	Case		Control		N	%		
	N	%	N	%				
Disobedient	47	87	6	11.1	53	49.1	0.000	30.000 (9.168–98173)
Obedient	7	13	48	88.9	55	50.9		
Total	54	100.0	54	100.0	108	100.0		

It is recognized that of the 108 pregnant women, 55 (50.9%) were compliant with iron supplementation, while 53 (49.1%) were non-compliant. Of the compliant group, only 7 (13%) had anemia, and 48 (88.9%) did not. Conversely, in the non-compliant group, 47 (87%) had anemia, and only 6 (11.1%) did not.

The statistical analysis showed that iron supplementation compliance had a $p = 0.000$ ($p < 0.05$), represent association with the haps of anemia in pregnant women. The odds ratio (OR) was 30.00 (95% CI: 9.168–98.173), indicating that pregnant women who were non-adherent to iron supplementation had 30 times higher odds of anemia than those who adhered to iron supplementation.

Table 3. Distribution of anemia incidence Based on KEK status.

KEK Status	Anemia Incidence				Total		p-value	OR (95% CI)
	Case		Control					
	N	%	N	%	N	%		
KEK	12	22.2	14	25.9	26	24	0.533	0.676 (0.196– 2.328)
Non KEK	42	77.3	40	74.1	82	76		
Total	54	100.0	54	100.0	108	100.0		

It is evident that of the 108 pregnant women, 82 (76%) were categorized as not experiencing CED, while only 26 (24%) experienced CED. Of the case group, only 12 (12%) experienced CED, and 42 (77.3%) did not experience CED. Meanwhile, in the control group, 40 (74.1%) did not experience CED, and only 14 (25.9%) experienced CED.

The statistical analysis showed that the CED status variable had $p = 0.533$ ($p > 0.05$), there was no significant association between pregnant women experiencing anemia and CED status. The odds ratio (OR) was 0.676 (95% CI: 0.196–2.328), suggesting lower odds of anemia among women with CED. However, because the confidence interval includes 1 and the p-value was not statistically significant, no association between CED status and anemia can be established.

Table 4. Distribution of anemia incidence based on dietary patterns.

Dietary Patterns	Anemia Incidence				Total		p-value	OR (95% CI)
	Case		Control					
	N	%	N	%	N	%		
Poorly	38	70.3	17	31.4	55	52.8	0.005	3.600 (1.464 – 8.854)
Good	16	29.7	37	68.6	53	47.2		
Total	54	100.0	54	100.0	108	100.0		

Of the 108 pregnant women, 55 (52.8%) were categorized as having a poor dietary pattern, while 53 (47.2%) had a good dietary pattern. Among those with a poor diet, 38 (70.3%) were anemic and 16 (29.7%) were not. In contrast, among those with a good diet, 17 (31.4%) were anemic and 37 (68.6%) were not.

The statistical analysis showed that dietary pattern had a $p = 0.005 < 0.05$, demonstrating a significant link to the occurrence of anemia in pregnant women. The odds ratio (OR) was 3.60 (95% CI: 1.464–8.854), indicating that pregnant women with poor dietary patterns had 3.6 times higher odds of developing anemia than those with good dietary patterns.

Table 5. Multivariate analysis results.

Variables	Values B	aOR	95% CI	p-value
TTD Consumption Compliance	3.401	30.000	9.168- 98.173	0.000
Constant	-1,638	0,194		0.000

If the Exp (B) value is further from zero and has a p-value ≤ 0.05 , then the variable is the dominant variable. The adjusted odds ratio (aOR) was 30.00 (95% CI: 9.168–98.173), indicating that pregnant women who were non-adherent to iron supplementation had significantly higher odds of anemia than those who adhered to supplementation.

DISCUSSION

The present study found that adherence to iron supplementation and dietary patterns were significantly associated with anemia among pregnant women, whereas maternal age and chronic energy deficiency (CED) were not significantly associated with anemia. Among the variables examined, adherence to iron supplementation showed the strongest association with anemia in the multivariable analysis. These findings indicate that anemia during pregnancy is a multifactorial condition and that behavioral and nutritional factors may be more strongly associated with anemia than maternal age or a single indicator of nutritional status in this study population.

Maternal age was not significantly associated with anemia in the present study. This finding differs from the commonly accepted view that pregnancies occurring at younger ages (<20 years) or older ages (>35 years) may be associated with a higher risk of anemia. Younger pregnant women may have additional nutritional requirements because they may still be undergoing physical growth, whereas older pregnant women may experience increased pregnancy-related health risks (Azzam et al., 2025; Khezri, 2023). However, the present finding is consistent with Putri (2023), who reported no significant association between maternal age and anemia among pregnant women in Gresik Regency ($p = 0.742$), and Idyawati (2024), who similarly found no significant association between maternal age and anemia ($p = 0.298$). In the present study, most respondents (90.7%) were in the non-risk age group, while relatively few respondents were younger than 20 years or older than 35 years. This imbalance may have reduced the statistical power to detect differences between age groups. Therefore, the absence of statistical significance should not be interpreted as evidence that maternal age has no relationship with anemia. Rather, anemia may be more strongly influenced by other nutritional, behavioral, biological, or socioeconomic factors within this population. In addition, the present study did not comprehensively assess all potential confounding factors that may differ according to maternal age, such as nutritional intake, socioeconomic status, antenatal care, or supplementation adherence. Thus, the relationship between maternal age and anemia should be interpreted cautiously.

In contrast, adherence to iron supplementation showed a statistically significant association with anemia and was the strongest factor in the multivariable analysis. The adjusted odds ratio (aOR) of 30.000 indicated that pregnant women who were non-adherent to iron supplementation had approximately 30 times higher odds of anemia than those who were adherent. This finding is consistent with previous studies reporting significant associations between adherence to iron supplementation and anemia among pregnant women (Arfan, 2024; Salsabilah & Suryaalamasah, 2022; Nurahmawati, 2021). The association is biologically plausible because iron requirements increase substantially during pregnancy, and inadequate iron supplementation may contribute to insufficient iron availability for hemoglobin synthesis. However, the unusually high magnitude of the

observed association requires careful interpretation. An aOR of 30.000 is considerably large and may indicate an unstable estimate, particularly given the relatively small sample size of 108 participants. When observations in one or more exposure-outcome categories are limited, logistic regression estimates may become sensitive to small changes in the data and may produce imprecise estimates. Therefore, the observed OR should not be interpreted as a precise estimate of the magnitude of the association that would necessarily be observed in a larger population.

The large observed association may also reflect residual confounding. Although adherence to iron supplementation remained significantly associated with anemia after multivariable analysis, several factors that may influence both adherence and anemia were not assessed in the present study. These include maternal knowledge, motivation, side effects of iron tablets, family support, socioeconomic conditions, access to antenatal care, and the quality and frequency of counseling received by pregnant women. The absence of these variables from the analysis means that residual confounding cannot be excluded and may have contributed to the magnitude of the observed association. Consequently, the aOR of 30.000 should not be interpreted as evidence that non-adherence independently causes anemia or that non-adherent pregnant women would necessarily have 30 times the odds of anemia in other populations. The result should instead be interpreted as a strong association observed within the study population.

The measurement of adherence may also have influenced the magnitude of the association. Adherence to iron supplementation was assessed using self-reported information, which is susceptible to recall bias and social desirability bias. Participants may have had difficulty accurately recalling the frequency or number of iron tablets consumed, while some may have reported better adherence because they were aware of the recommended behavior. Such misclassification may have affected the estimated strength of the association. Similarly, dietary patterns were assessed using self-reported questionnaires and may also have been influenced by recall and reporting bias. Participants may not have accurately remembered the frequency or type of foods consumed or may have reported dietary practices that they perceived as desirable. Future studies should therefore consider objective or more reliable measures of adherence, such as pill counts, supplementation records, pharmacy records, or longitudinal monitoring, and should use more detailed dietary assessment methods when evaluating nutritional factors.

The significant association between dietary patterns and anemia observed in this study is consistent with previous research. Sembiring (2024) reported significant associations between vegetable consumption ($p = 0.001$) and fruit consumption ($p = 0.003$) and anemia among pregnant women, while Lestari (2024) reported a significant association between dietary patterns and anemia in the working area of Perdana Community Health Center ($p = 0.000$). Adequate dietary intake is particularly important during pregnancy because nutritional requirements increase throughout gestation. A balanced diet provides energy, protein, iron, folate, vitamin B12, vitamin C, and other nutrients involved in maternal health and fetal development. Conversely, inadequate or unbalanced dietary intake may result in insufficient nutrients required for erythropoiesis and hemoglobin synthesis. Nevertheless, the present study assessed dietary patterns rather than the actual quantity of individual nutrients consumed. Therefore, the findings cannot determine which specific nutrient, food group, or dietary component contributed most strongly to the observed association. This limitation is important when interpreting the relationship between dietary patterns and anemia.

The present study also found no significant association between CED status and anemia. This finding is consistent with Wahyuningsih (2023), who reported no significant association between mid-upper arm circumference (MUAC) and anemia among pregnant

women ($p = 0.475$), although it differs from the findings summarized by Fakhriza (2024), in which three of five reviewed studies reported a significant association between MUAC and anemia. In the present study, the proportion of women with CED was higher among controls than cases, which contrasts with the theoretical expectation that chronic nutritional deficiency would increase the likelihood of anemia. This unexpected distribution may partly explain the absence of a statistically significant association. Moreover, MUAC is an indicator of chronic nutritional status but does not directly measure iron status or dietary iron intake. Therefore, the absence of a significant association between CED and anemia should not be interpreted as evidence that maternal nutritional status is unrelated to anemia. Other nutritional, behavioral, biological, and clinical factors may contribute to anemia independently of MUAC. More comprehensive nutritional assessment, including dietary intake and biochemical indicators of iron status, may provide a better understanding of this relationship.

The findings of this study should also be interpreted within the limitations of its case-control design. Although the study identified significant associations between iron supplementation adherence, dietary patterns, and anemia, the design cannot establish a clear temporal sequence between exposure and outcome. In particular, it cannot conclusively determine whether non-adherence to iron supplementation preceded the development of anemia. Conversely, the diagnosis or experience of anemia may influence subsequent adherence because women diagnosed with anemia may receive additional counseling, treatment, or encouragement to consume iron supplements. Therefore, reverse causation cannot be completely excluded. Similarly, the cross-sectional assessment of dietary patterns cannot establish whether the reported dietary behavior preceded the development of anemia. These limitations mean that the findings should be interpreted as evidence of association rather than causation.

The relatively small sample size and single community health center setting also limit the precision and generalizability of the findings. The small number of participants in some exposure categories may have reduced statistical power for detecting associations, particularly for maternal age and CED, and may have contributed to the unusually large OR observed for non-adherence. Furthermore, the study did not assess several potentially important confounding variables, including maternal knowledge, motivation, side effects of iron supplementation, family support, socioeconomic status, access to antenatal care, and biochemical indicators of iron status. Consequently, residual confounding cannot be ruled out. These limitations should be considered when interpreting the finding that adherence to iron supplementation was the strongest factor associated with anemia.

Despite these limitations, the findings provide locally relevant evidence regarding factors associated with anemia among pregnant women in the Balerejo Public Health Center working area. The strong association observed between iron supplementation adherence and anemia highlights the importance of strengthening antenatal counseling, adherence monitoring, management of side effects, and family support. The significant association between dietary patterns and anemia also emphasizes the importance of promoting adequate and balanced dietary intake during pregnancy. However, these findings should not be interpreted as evidence of a causal effect based solely on the present case-control study. Future prospective studies with larger sample sizes, objective measures of iron supplementation adherence, more comprehensive dietary assessments, biochemical indicators of iron status, and measurement of relevant confounding variables are needed to validate these associations, clarify their temporal relationships, and provide stronger evidence regarding the factors contributing to anemia among pregnant women.

4. CONCLUSION

Among pregnant women attending the Balerejo Community Health Center, maternal age and chronic energy deficiency (CED) were not significantly associated with anemia, whereas adherence to iron supplementation and dietary patterns were significantly associated with anemia in the bivariate analysis. In the multivariable analysis, adherence to iron supplementation remained the only variable independently associated with anemia and showed the strongest association. These findings highlight the importance of strengthening antenatal counseling on the benefits and proper use of iron supplementation, improving adherence monitoring and follow-up, and involving family members in supporting pregnant women to maintain adherence. Promotion of healthy and balanced dietary practices should also be incorporated into antenatal care as part of comprehensive anemia prevention strategies. However, because this study employed a case-control design, the findings should be interpreted as associations rather than causal relationships. Further prospective studies with larger samples are needed to confirm these associations, establish temporal relationships, and evaluate the effectiveness of adherence-focused interventions in preventing anemia among pregnant women.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Mega Arianti Putri contributed to the conception and design of the study, revisions, and final approval of the version to be published. Riska Ratnawati contributed to data collection, data analysis, research supervision, methodological guidance, interpretation of findings, and critical revision of the manuscript. Achmad Vindo Galaresa contributed to research supervision, methodological guidance, review and interpretation of findings, and critical revision of the manuscript. All authors approved the final version of the manuscript for publication.

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The author used an AI-assisted language tool (ChatGPT, OpenAI) solely to improve the language, grammar, readability, and organization of the manuscript. The AI tool was not used for data collection, data analysis, interpretation of results, or generation of scientific conclusions. The author takes full responsibility for the accuracy, originality, and integrity of the manuscript.

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