

Chronic Energy Deficiency, Iron Supplementation, and Antenatal Care Utilization as Determinants of Anemia among Pregnant Women

Kekurangan Energi Kronis, Suplementasi Zat Besi, dan Pemanfaatan Pelayanan Antenatal sebagai Determinan Anemia pada Ibu Hamil

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ARTICLE INFO

Received:

November 01, 2025

Accepted:

December 10, 2025

Published online:

December 31, 2025

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Doi:

<https://doi.org/10.5463/0/ijahr.v2i2.128>

Keyword:

maternal anemia,
chronic energy
deficiency, iron
supplementation,
antenatal care

Kata Kunci:

Anemia ibu hamil,
Kekurangan Energi
Kronis, tablet tambah
darah, ANC

ABSTRACT

Maternal anemia remains a significant public health concern, particularly in developing countries, as it contributes to increased risks of maternal and neonatal morbidity and mortality. This study aimed to analyze the relationship between antenatal care (ANC) utilization, chronic energy deficiency (CED), and adherence to iron supplementation with the occurrence of anemia among pregnant women. A cross-sectional analysis was conducted using data from 121,338 pregnant women. The independent variables included ANC quantity, ANC quality based on the 10T standard, CED status, and adherence to iron supplementation. Data were analyzed using chi square test. The results showed that irregular ANC visits (OR=1.291; 95% CI: 1.245–1.339), chronic energy deficiency (OR=1.268; 95% CI: 1.227–1.310), and non-adherence to iron supplementation (OR=1.332; 95% CI: 1.298–1.367) were significantly associated with a higher likelihood of maternal anemia ($p < 0.001$). Strengthening maternal health services and nutrition interventions should be prioritized to support better pregnancy outcomes.

ABSTRAK

Anemia pada ibu hamil masih menjadi masalah kesehatan masyarakat yang signifikan, terutama di negara berkembang, karena berkontribusi terhadap peningkatan risiko morbiditas dan mortalitas pada ibu maupun bayi baru lahir. Penelitian ini bertujuan untuk menganalisis hubungan antara pemanfaatan pelayanan antenatal care (ANC), kekurangan energi kronis (KEK), dan kepatuhan konsumsi suplementasi zat besi dengan kejadian anemia pada ibu hamil. Analisis cross-sectional dilakukan menggunakan data dari 121.338 ibu hamil. Variabel independen dalam penelitian ini meliputi kuantitas kunjungan ANC, kualitas pelayanan ANC berdasarkan standar 10T, status KEK, serta kepatuhan konsumsi suplementasi zat besi. Data dianalisis menggunakan uji chi-square. Hasil penelitian menunjukkan bahwa kunjungan ANC yang tidak teratur (OR = 1,291; 95% CI: 1,245–1,339), kekurangan energi kronis (OR = 1,268; 95% CI: 1,227–1,310), dan ketidakpatuhan dalam mengonsumsi suplementasi zat besi (OR = 1,332; 95% CI: 1,298–1,367) berhubungan secara signifikan dengan peningkatan risiko anemia pada ibu hamil ($p < 0,001$). Penguatan layanan kesehatan ibu serta intervensi gizi perlu menjadi prioritas guna mendukung hasil kehamilan yang lebih baik



1. INTRODUCTION

Anemia remains a major health problem during pregnancy because it significantly elevates the risk of illness and death among mothers, fetuses, and newborns. Globally, the burden of anemia is still substantial, particularly in low- and middle-income countries. In 2019, the World Health Organization (WHO) reported that approximately 37% of pregnant women and nearly 40% of children under five years of age worldwide were affected by anemia. The highest prevalence has been reported in several regions, particularly West Africa, the Middle East, and South Asia, where nutritional deficiencies and limited access to healthcare services continue to contribute to the persistence of this condition¹.

In Indonesia, maternal anemia also remains a significant public health issue. National data indicate that the prevalence of anemia among pregnant women was 37.1% in 2013 and increased to 48.9% in 2018, exceeding the global prevalence of maternal anemia^{2,3}. However, findings from the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia/SKI) demonstrate a decline to 27.7%, representing a reduction of 21.2% compared with the 2018 Basic Health Research (Riskesdas). The most notable decrease occurred among women aged 15–24 years, where prevalence dropped sharply from 84.6% to 14.5%. Conversely, among women aged 25–34 years the age group in which most pregnancies occur the reduction was relatively small, declining only from 33.7% to 31.4%. To address maternal anemia, the Indonesian government has implemented iron and folic acid supplementation programs as a key intervention. Although the distribution coverage of iron tablets has reached 92.2%, adherence remains inadequate, with only 44.2% of pregnant women consuming the recommended minimum of 90 tablets during pregnancy. Low compliance with supplementation therefore continues to play a role in maintaining the burden of maternal anemia in Indonesia⁴.

Anemia during pregnancy remains one of the most common public health problems affecting women worldwide, particularly in low- and middle-income countries. Iron deficiency anemia contributes to adverse maternal and neonatal outcomes such as preterm birth, low birth weight, and increased maternal morbidity. Nutritional deficiencies and inadequate dietary diversity during pregnancy are major contributors to iron deficiency anemia, especially in settings where access to micronutrient-rich foods is limited. Studies have shown that poor dietary diversity and insufficient intake of iron-rich foods significantly increase the risk of anemia among pregnant women⁵.

Maternal anemia is influenced by multiple determinants including maternal nutritional status, socioeconomic conditions, and utilization of maternal health services. Evidence from epidemiological studies indicates that inadequate antenatal care attendance and low adherence to iron-folic acid supplementation significantly increase the risk of anemia during pregnancy. Women who do not regularly attend antenatal care services often miss opportunities for hemoglobin screening, nutrition counseling, and supplementation, which are essential for anemia prevention⁶.

Among nutritional determinants, chronic energy deficiency (CED) represents a critical indicator of long-term maternal undernutrition. CED reflects prolonged inadequate intake of energy and protein, which can reduce maternal nutritional reserves and increase vulnerability to anemia. Pregnant women with chronic energy deficiency are more likely to experience impaired hemoglobin synthesis due to insufficient micronutrient intake and depleted iron stores⁷.

In addition, adherence to iron supplementation remains a key preventive strategy in maternal health programs. Iron and folic acid supplementation is recommended

during pregnancy to meet increased iron requirements and prevent anemia. However, several studies report that many pregnant women do not adhere to the recommended intake of iron tablets, which reduces the effectiveness of anemia prevention programs⁸.

Given the multifactorial nature of maternal anemia, understanding the role of maternal nutritional status, iron supplementation adherence, and antenatal care utilization is essential for designing effective prevention strategies. Therefore, this study aimed to examine the determinants of anemia among pregnant women with a particular focus on chronic energy deficiency, iron supplementation adherence, and antenatal care utilization.

2. METHODS

This study used an observational analytic design with a cross-sectional approach. Secondary data from the Indonesian Health Survey (Survei Kesehatan Indonesia) 2023 were analyzed to examine determinants of anemia among pregnant women. The study population consisted of all pregnant women recorded in the Indonesian Health Survey 2023 database. The initial dataset contained 12,204 records of pregnant women with relevant variables.

After data cleaning and application of population weighting, the final analytical sample consisted of 121,338 pregnant women. Inclusion criteria included: 1) Pregnant women with hemoglobin examination data, 2) Pregnant women with mid-upper arm circumference measurements, 3) Complete data for all study variables. Records with missing values for chronic energy deficiency and iron supplementation adherence were excluded from the analysis.

The dependent variable in this study was anemia status, categorized as anemia and non-anemia based on hemoglobin measurements. Independent variables included: quantity of antenatal care visits, quality of antenatal care services (10T standard), Chronic energy deficiency (CED), and iron supplementation adherence.

Descriptive statistics were used to summarize the characteristics of the study population. Bivariate analysis using the chi-square test was performed to examine associations between independent variables and anemia status. Statistical significance was determined at $p < 0.05$. All statistical analyses were performed using SPSS.

This study used secondary data obtained from the Indonesian Ministry of Health open data platform. All data were anonymized and did not contain personal identifiers. Therefore, ethical approval was not required. Data access was obtained through the official data service portal of the Indonesian Ministry of Health. The data were obtained through the official Data Service Portal of the Indonesian Ministry of Health (<https://layanandata.kemkes.go.id/>) under document request number 2509E71F9CAE8424.

3. RESULTS

Table 1. Univariate Analysis

Characteristics	n = (121,338)	%
ANC Quantity		
Irregular	15,156	12.5
Regular	106,182	87.5
ANC Quality		
Incomplete	10,424	8.6
Complete	110,914	91.4
Chronic Energy Deficiency (CED)		
Yes	20,232	16.7
No	101,106	83.3
Iron supplementation adherence		
Non-adherent	71,847	59.2
Adherent	49,491	40.8

Source: Primary Data, 2025

The results of the univariate analysis from table 1 showed that the majority of pregnant women had regular antenatal care (ANC) visits, accounting for 87.5% of the study population, while 12.5% reported irregular ANC attendance. Most pregnant women received complete antenatal care services according to the 10T standard (91.4%), while 8.6% received incomplete services. 16.7% of pregnant women in this study experienced chronic energy deficiency (CED), while 83.3% did not. Large proportion of pregnant women (59.2%) did not adhere to iron supplementation recommendations, while only 40.8% reported adherence.

Table 2. Analysis of Factors Associated with Maternal Anemia

Variable	Anemia				p-value	OR Value (95%CI)
	Yes		No			
	n	%	n	%		
ANC Quantity						
Irregular	4,992	32.9	10,164	67.1	<0.001	1.291 (1.245- 1.339)
Regular	29,261	27.6	76,921	72.4		
ANC Quality						
Incomplete	1,618	15.5	8,806	84.5	<0.001	0.441 (0.417- 0.465)
Complete	32,635	29.4	78,279	70.6		
Chronic Energy Deficiency (CED)						
Yes	6,548	32.4	13,684	67.6	<0.001	1.268 (1.227- 1.310)
No	27,705	27.4	73,401	72.6		
Iron Supplementation adherence						
Non-adherent	21,962	30.6	49,885	69.4	<0.001	1.332 (1.298- 1.367)
Adherent	12,292	24.8	37,200	75.2		

Source: Primary Data, 2025

The bivariate analysis demonstrated from table 2 showed that pregnant women who had irregular ANC visits were more likely to experience anemia compared with those who attended ANC regularly. Specifically, anemia prevalence among women with irregular ANC visits was 32.9%, whereas the prevalence among those with regular visits was 27.6%. The odds ratio (OR = 1.291; 95% CI: 1.245–1.339) indicates that pregnant women who did not attend ANC regularly had approximately 1.29 times higher odds of experiencing anemia. The statistically significant p-value (<0.001) confirms that the frequency of ANC visits is significantly associated with maternal anemia.

Pregnant women who received incomplete ANC services had a lower recorded prevalence of anemia (15.5%) compared with those receiving complete ANC services (29.4%). The calculated odds ratio (OR = 0.441; 95% CI: 0.417–0.465) indicates that women with incomplete ANC services appeared less likely to be diagnosed with anemia. Nevertheless, this result should be interpreted carefully because it may reflect detection bias rather than a protective effect.

Anemia prevalence was higher among pregnant women with CED (32.4%) compared with those without CED (27.4%). The odds ratio (OR = 1.268; 95% CI: 1.227–1.310) suggests that pregnant women experiencing chronic energy deficiency had approximately 1.27 times higher odds of developing anemia. The p-value (<0.001) indicates that this relationship is statistically significant.

Anemia prevalence was significantly higher among pregnant women who were non-adherent to iron supplementation (30.6%) compared with those who adhered to supplementation (24.8%). The odds ratio (OR = 1.332; 95% CI: 1.298–1.367) indicates that pregnant women who did not adhere to iron supplementation had 1.33 times higher odds of developing anemia. The p-value (<0.001) confirms that this association is statistically significant.

4. DISCUSSION

Antenatal Care Quantity

Although the coverage of ANC visits appears relatively high, the presence of a substantial proportion of women with irregular visits indicates that gaps in maternal health service utilization still exist. Regular ANC visits are essential because they provide opportunities for early detection of pregnancy complications, including anemia, as well as for delivering preventive interventions such as iron supplementation and nutritional counseling.

This finding is consistent with several international studies showing that adequate ANC attendance plays a crucial role in preventing anemia during pregnancy. A systematic review conducted in low- and middle-income countries found that pregnant women who attended fewer than four ANC visits had significantly higher risks of anemia due to missed opportunities for nutritional counseling and iron supplementation^{9–11}. Similarly, a multi-country analysis demonstrated that regular ANC visits significantly improved iron–folic acid supplementation adherence, which directly reduces the risk of anemia during pregnancy¹². Therefore, improving ANC attendance remains a key strategy for strengthening maternal anemia prevention programs.

Antenatal Care Quality (10T Standard)

The 10T standard represents comprehensive maternal healthcare services, including clinical examinations, nutritional assessment, laboratory testing, counseling,

and supplementation. High coverage of complete ANC services suggests relatively good access to maternal healthcare in the study population.

Women who receive complete ANC services are more likely to undergo comprehensive clinical examinations, including hemoglobin testing. As a result, anemia cases are more likely to be detected among this group. This phenomenon has been reported in several epidemiological studies where improved screening leads to higher reported disease prevalence due to better case detection. For instance, a study published in *The Lancet Global Health* emphasized that strengthened antenatal care services improve early diagnosis of maternal anemia through routine hemoglobin monitoring¹³. Similarly, research in Ethiopia reported that women receiving complete ANC packages were more likely to be screened and diagnosed with anemia compared with women with limited healthcare contact¹⁴.

These findings highlight the importance of maintaining high-quality ANC services. Quality antenatal care ensures that pregnant women receive appropriate screening, counseling, and treatment interventions that are essential for preventing and managing maternal anemia¹⁵.

Chronic Energy Deficiency (CED)

reflects long-term inadequate nutritional intake and is commonly measured using mid-upper arm circumference (MUAC). The presence of CED among pregnant women indicates insufficient maternal energy reserves and poor nutritional status prior to and during pregnancy.

This association is biologically plausible because chronic undernutrition reduces maternal iron stores and interferes with hemoglobin synthesis. Several studies have demonstrated a strong relationship between maternal undernutrition and anemia. A study reported that inadequate dietary intake and poor maternal nutritional status are significant predictors of anemia among pregnant women in developing countries¹⁶. Similarly, research conducted in South Asia found that women with low MUAC measurements were significantly more likely to develop anemia due to insufficient macro- and micronutrient intake¹⁷.

These findings emphasize that anemia prevention strategies should not only focus on iron supplementation but also address overall maternal nutritional status. Improving maternal dietary intake and addressing chronic undernutrition are critical components of comprehensive anemia prevention programs.

Iron Supplementation Adherence

This finding indicates that despite national programs providing iron tablets to pregnant women, adherence remains a major challenge. Iron supplementation is widely recognized as the most effective strategy for preventing iron deficiency anemia during pregnancy. According to the World Health Organization, daily iron and folic acid supplementation significantly reduces the risk of maternal anemia and improves pregnancy outcomes. A Study published in *BMJ Open* reported that adherence to iron supplementation substantially increased maternal hemoglobin levels and reduced anemia prevalence among pregnant women in low- and middle-income countries¹⁸.

However, poor adherence remains a common issue due to several factors, including side effects, lack of knowledge, forgetfulness, and insufficient counseling from healthcare providers. A Meta Analysis from Sub Saharan Africa published in *Plos One* found that pregnant women who received adequate counseling during ANC visits were

significantly more likely to adhere to iron supplementation compared with those who did not receive proper health education¹⁹.

These findings suggest that improving counseling quality during antenatal care visits and strengthening health education programs are essential to increase adherence to iron supplementation and ultimately reduce maternal anemia.

5. CONCLUSION

This study demonstrates that several maternal health service and nutritional factors are significantly associated with anemia among pregnant women. The findings show that although most pregnant women had regular antenatal care (ANC) visits and received complete ANC services according to the 10T standard, a considerable proportion still experienced nutritional risks and inadequate preventive practices. In particular, chronic energy deficiency (CED) and low adherence to iron supplementation remain prevalent among pregnant women. These conditions highlight that access to maternal health services alone is not sufficient if nutritional status and behavioral factors related to supplementation are not adequately addressed.

The bivariate analysis confirmed that irregular ANC visits, chronic energy deficiency, and non-adherence to iron supplementation significantly increased the likelihood of anemia during pregnancy. Pregnant women who attended ANC irregularly were more likely to experience anemia, suggesting that missed opportunities for routine screening, nutritional counseling, and supplementation may contribute to poorer maternal health outcomes. Similarly, women with CED had a higher risk of anemia, indicating that long-term maternal undernutrition plays an important role in reducing iron reserves and impairing hemoglobin production. Non-adherence to iron supplementation also showed a significant relationship with anemia, emphasizing that supplementation programs cannot be fully effective without consistent compliance from pregnant women.

Interestingly, the analysis showed a lower recorded prevalence of anemia among women who received incomplete ANC services compared with those receiving complete services. However, this finding likely reflects detection bias rather than a protective effect, as women receiving comprehensive ANC are more likely to undergo laboratory examinations such as hemoglobin testing, which increases the likelihood of identifying anemia cases. Overall, these results highlight that strengthening both the utilization and quality of antenatal care, improving maternal nutritional status, and increasing adherence to iron supplementation are essential strategies for reducing the burden of anemia among pregnant women.

Future maternal health programs should prioritize strengthening the quality and continuity of antenatal care services, particularly by ensuring routine hemoglobin screening, effective nutritional counseling, and consistent monitoring of iron supplementation adherence. Health education strategies should also be enhanced to improve pregnant women's awareness of the importance of adequate nutrition and regular consumption of iron tablets during pregnancy. In addition, future research is recommended to explore other potential determinants of maternal anemia, such as dietary diversity, household socioeconomic status, and regional health system factors, using longitudinal or multilevel approaches to better understand causal pathways and inform more targeted interventions.

6. ACKNOWLEDGEMENT

The authors would like to convey their sincere gratitude to all individuals and institutions that contributed valuable support during the completion of this research. Special appreciation is extended to the Institute for Research and Community Service of Universitas Faletahan for providing institutional assistance and facilitating the implementation of this study. The authors also acknowledge the dedication and collaborative efforts of all members of the research team whose commitment played an essential role in successfully carrying out this research.

Contribution of Authors

HK: Conceptualized and designed the research, performed data analysis, and wrote the initial draft of the scientific article; AJ: Designed the methodology, collected data, processed and interpreted the data; IS: Assisted in data collection, data analysis, and reviewed and revised the content of the article.

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