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The Influence of Interpregnancy Interval and Iron Tablet Adherence on the Occurrence of Anemia Among Pregnant Women

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ABSTRACT

Anemia in pregnancy is a significant public health concern that contributes to maternal morbidity, adverse pregnancy outcomes, and neonatal complications. This study aimed to analyze the effects of the interpregnancy interval and adherence to iron–folic acid (IFA) tablet use on the incidence of anemia among pregnant women. A cross-sectional analytic survey was conducted in Tanjung Sari District, Lampung, Indonesia, involving 114 pregnant women selected through purposive random sampling from a total population of 334, including pregnant women aged 18–45 years in the first or second trimester, with at least one previous pregnancy, complete ANC records, and willingness to participate. Data were collected through structured questionnaires, anthropometric measurements, and documentation review. Anemia was assessed based on hemoglobin levels, while interpregnancy interval and IFA adherence were measured using standardized tools. Bivariate analysis was performed using the chi-square test, and multivariate analysis employed logistic regression to identify predictive factors. Results revealed that 40.4% of respondents were anemic. Pregnant women with an interpregnancy interval of less than 24 months were more likely to experience anemia compared to those with an interval of 24 months or more (p=0.002). In addition, poor adherence to IFA tablet consumption was strongly associated with a higher prevalence of anemia (p<0.001). Logistic regression confirmed both interpregnancy interval and IFA adherence as significant predictors of anemia. Maintaining an optimal interpregnancy interval and improving adherence to IFA supplementation are critical strategies to prevent anemia during pregnancy.

INTRODUCTION

Anemia during pregnancy remains a significant public health concern worldwide and is associated with increased risk of maternal and neonatal complications, including preterm birth, low birth weight, and perinatal mortality (Buciu et al., 2025; Seidu et al., 2024; WHO, 2023a). Globally, nearly 37% of pregnant women were affected by anemia in 2023, with the highest prevalence in low- and middle-income countries (Pokhrel et al., 2024; World Health Organization, 2023b). In Indonesia, the prevalence of anemia among pregnant women remains high, with estimates ranging from 40% to 48% in recent national surveys (Ministry of Health Republic Indonesia, 2023).

The etiology of anemia in pregnancy is multifactorial. However, iron deficiency is recognized as the leading cause, often compounded by short interpregnancy intervals, inadequate nutritional intake, and poor adherence to iron–folic acid (IFA) supplementation programs (Engidaw et al., 2025; Locks et al., 2024; World Health Organization, 2022). Short interpregnancy intervals (IPI) of less than 24 months have been strongly linked with maternal anemia, due to insufficient time for replenishment of iron stores between pregnancies (Hassen et al., 2024; Beyene et al., 2025). Several meta-analyses confirm that a short IPI increases the odds of maternal anemia and adverse perinatal outcomes by two to three times compared to longer intervals (Hassen et al., 2024; Umezuluike et al., 2021).

Another important determinant is adherence to IFA supplementation, which remains suboptimal despite being a cornerstone of anemia prevention programs (Seidu et al., 2024; Engidaw et al., 2025). Studies indicate that only about 30–50% of pregnant women achieve recommended adherence levels, and poor compliance significantly reduces the effectiveness of supplementation in improving hemoglobin concentrations (Winarni et al., 2024; Wedderburn et al., 2022). Factors affecting adherence include gastrointestinal side effects, lack of counseling, misconceptions about supplementation, and inadequate family support (Pokhrel et al., 2024; Alfiani et al., 2025).

In Indonesia, the Ministry of Health recommends pregnant women consume a minimum of 90 IFA tablets during pregnancy (Ministry of Health Republic of Indonesia, 2023). However, adherence remains low, with fewer than half of women meeting this standard in several provinces (Winarni et al., 2024; Nasruddin et al., 2021). Improving compliance requires multi-level interventions, including effective counseling during antenatal care (ANC), community-based support, and monitoring systems (Anato & Reshid, 2025).

This study investigates the association between interpregnancy interval and adherence to IFA supplementation with the occurrence of anemia among pregnant women in Tanjung Sari District, Lampung, Indonesia. The novelty of this research lies in combining maternal reproductive factors (IPI) and behavioral adherence factors (IFA intake) to model anemia risk within a rural Indonesian setting. The specific hypothesis is that short interpregnancy intervals and low adherence to IFA supplementation significantly increase the risk of anemia during pregnancy.

METHOD

This study employed an analytical survey with a cross-sectional design to investigate the association among interpregnancy interval, iron–folic acid (IFA) adherence, and anemia among pregnant women. The study was conducted in Tanjung Sari District, South Lampung Regency, Indonesia, from January to June 2024.

The target population comprised all pregnant women residing in Tanjung Sari District (n=334). The sample size was determined using the Slovin formula with a 5% margin of error, yielding a sample of 114 respondents. Sampling was conducted using purposive random sampling, with inclusion criteria: (1) pregnant women at any trimester, (2) residing in the study area for at least six months, and (3) willing to participate by signing informed consent. Exclusion criteria included women with chronic illness (e.g., thalassemia, chronic kidney disease).

Data were collected through direct measurement, documentation, and structured questionnaires. Hemoglobin levels were measured using a portable hemoglobinometer (HemoCue Hb 301 System, HemoCue AB, Sweden). Interpregnancy interval and parity were obtained through maternal health records. At the same time, adherence to IFA supplementation was assessed using a validated self-report questionnaire adapted from the Ministry of Health of the Republic of Indonesia (2023). Nutritional status was evaluated by calculating mid-upper arm circumference (MUAC) using a standard MUAC tape (SECA®, Germany).

This study was approved by the Research Ethics Committee of Poltekkes Kemenkes Tanjungkarang, Indonesia (Approval No:506/KEPK-TJK/VII/2024). All respondents received detailed information about the study objectives, risks, and benefits, and written informed consent was obtained before data collection. Confidentiality and anonymity were ensured throughout the research process.

Data were analyzed using statistical software. Descriptive statistics were used for the univariate analysis (frequency and percentage). Descriptive statistics were used for univariate analysis (frequencies and percentages). The chi-square test was used in a bivariate analysis to examine the association between the independent variables (interpregnancy interval and IFA adherence) and the dependent variable (anemia status). Multivariate analysis was conducted using binary logistic regression to develop a predictive model for anemia occurrence. The significance level was set at $p<0.05$. Data are presented as percentages or mean ± standard error of the mean (SEM) where appropriate.

RESULTS

Table 1. Frequency distribution of respondents

Variable	Category	n	%
Age	Age <20 years	12	10.5
	Age 20–35 years	82	71.9
	Age >35 years	20	17.6
Parity	Primigravida	28	24.6
	Multigravida	86	75.4
Nutritional Status	Normal nutritional status	96	84.2
	Chronic energy deficiency	18	15.8
IFA Adherence	Good IFA adherence	62	54.4
	Poor IFA adherence	52	45.6
Anemia Status	Anemia	46	40.4
	Non-anemia	68	59.6

Table 2 shows the results of the bivariate analysis using the chi-square test. Interpregnancy interval (p=0.002), IFA adherence (p<0.0001), and nutritional status (p=0.039) were significantly associated with anemia in pregnancy. Age, parity, and education were not significantly associated with anemia.

Table 2. Bivariate analysis of factors associated with anemia

Variable	Anemia (n=46)	Non-anemia (n=68)	p-value
Short interpregnancy interval	28 (60.9%)	18 (39.1%)	0.002 **
Normal interval	18 (27.3%)	50 (72.7%)	
Poor IFA adherence	32 (61.5%)	20 (38.5%)	<0.0001 **
Good IFA adherence	14 (22.6%)	48 (77.4%)	
Chronic energy deficiency	12 (66.7%)	6 (33.3%)	0.039 *
Normal nutritional status	34 (35.4%)	62 (64.6%)	

*Significant at p<0.05, **Significant at p<0.01.

Binary logistic regression (Table 3) identified interpregnancy interval and IFA adherence as the strongest predictors of anemia among pregnant women. Pregnant women with a short interpregnancy interval had 2.8 times higher odds of anemia compared to those with a regular interval (OR=2.83; 95% CI=1.35–5.95). Similarly, poor IFA adherence increased the odds of anemia by 4.5 times (OR=4.52; 95% CI=2.01–10.14).

Table 3. Logistic regression model of predictors of anemia

Variable	OR	95% CI	p-value
Short interpregnancy interval	2.83	1.35–5.95	0.006 **
Poor IFA adherence	4.52	2.01–10.14	<0.0001 **
Chronic energy deficiency	1.87	0.71–4.93	0.206

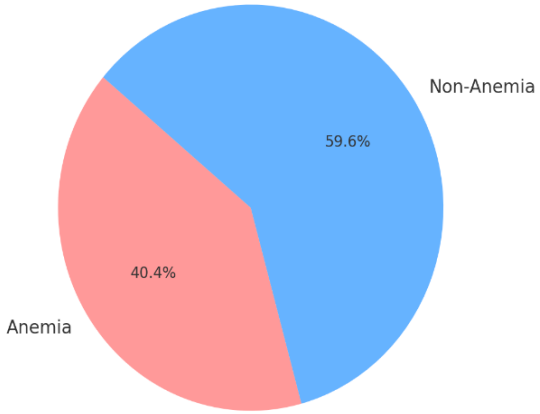

Figure 1. Prevalence of anemia and non-anemia among pregnant women.

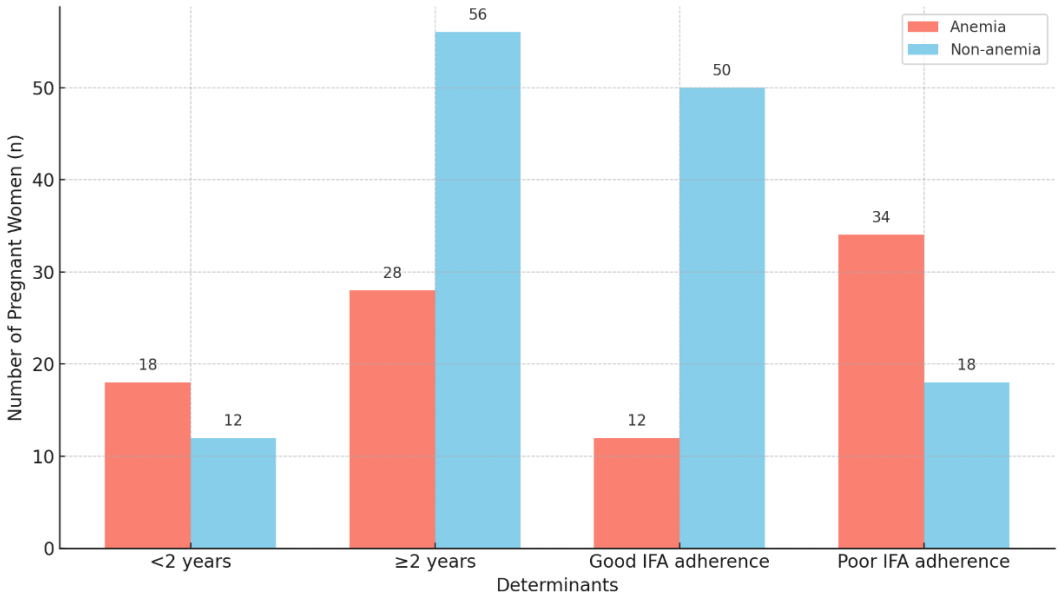

Figure 2. Distribution of anemia by interpregnancy interval and IFA adherence

DISCUSSION

This study found that pregnancy spacing and adherence to iron-folic acid (IFA) supplementation were significantly associated with anemia among pregnant women in Tanjung Sari District, Lampung. These findings highlight that anemia remains a public health problem of concern, particularly in rural areas. The higher prevalence in rural areas may be attributed to several factors, including limited access to quality antenatal care services, lower health literacy, inconsistent IFA consumption, inadequate dietary intake of iron-rich foods, and higher rates of short interpregnancy intervals among women in rural communities. Socioeconomic constraints may also contribute, as households with limited resources often face challenges in obtaining diverse and nutritious foods, while cultural beliefs may influence maternal health-seeking behaviors. Further research is needed to explore the underlying determinants of poor IFA adherence, barriers to achieving optimal pregnancy spacing, and contextual sociocultural factors that influence maternal nutrition in rural settings. Additionally, qualitative studies may provide deeper insights into community perceptions and structural barriers that hinder anemia prevention efforts.

Pregnancy spacing plays an important role in maternal nutritional status and anemia risk. Women with shorter interpregnancy intervals are more likely to experience nutrient depletion, especially iron, due to inadequate recovery time between pregnancies. Recent evidence shows that interpregnancy intervals of less than 24 months significantly increase the risk of maternal anemia and adverse pregnancy outcomes (Hassen et al., 2024; Putri & Fauzia, 2022). Short intervals limit the time available for restoring iron stores, which are already heavily utilized during pregnancy and lactation.

The results of this study reinforce these findings, showing that mothers with shorter pregnancy spacing had a considerably higher prevalence of anemia than those with adequate intervals. This suggests that insufficient recovery time may amplify the physiological demands of subsequent pregnancies, leaving mothers more vulnerable to iron depletion. Given the magnitude of this association, strengthening family planning services, expanding counseling on optimal pregnancy spacing, and integrating anemia prevention strategies into routine antenatal care could provide substantial benefits. Further research should continue to explore biological, behavioral, and contextual factors that mediate the relationship between pregnancy interval and anemia, particularly in rural populations where short interpregnancy intervals remain more common.

In addition, adherence to IFA supplementation was strongly related to anemia status. Pregnant women with poor adherence had a higher risk of anemia compared to those who

regularly consumed IFA tablets. Several studies across low- and middle-income countries have consistently reported that poor compliance with IFA supplementation is among the strongest predictors of anemia in pregnancy (Bhatnagar & Padilla-Zakour, 2021; Anato & Reshid, 2025; Buciu et al., 2025). Bhatnagar & Padilla-Zakour (2021) demonstrated that inconsistent intake of IFA tablets substantially reduced hemoglobin improvement during pregnancy, mainly due to inadequate daily iron absorption. Their study emphasized that even short periods of nonadherence can disrupt iron replenishment. Similarly, Anato and Reshid (2025) found that women who missed IFA doses for more than three consecutive days were nearly twice as likely to develop anemia compared to adherent mothers. They attributed this to both physiological depletion and poor nutrition knowledge. Furthermore, Buciu et al. (2025) reported that low IFA compliance—often influenced by gastrointestinal side effects and limited counseling—was a key determinant of persistent anemia among pregnant women in rural communities.

The results of the present study are consistent with these findings, as mothers with poor adherence demonstrated a markedly higher prevalence of anemia. This suggests that adherence plays a crucial role in preventing iron depletion during pregnancy, particularly in settings where dietary iron intake may be insufficient. Strengthening IFA counseling, improving follow-up, and addressing common barriers, such as side effects and misconceptions, could improve adherence and reduce anemia risk.

Barriers to adherence include gastrointestinal side effects, forgetfulness, low awareness, and limited health worker follow-up (Seidu et al., 2024). This implies that beyond providing supplements, sustained health education, counseling, and family support are essential to improve compliance. According to the Health Belief Model (HBM), adherence to supplementation is strongly influenced by a mother's perceived susceptibility to anemia, perceived benefits of IFA, perceived barriers (such as side effects), and cues to action, such as counseling received during ANC visits.

These factors align with the findings of the present study, which showed that mothers with poor adherence had a substantially higher prevalence of anemia. In rural settings, barriers such as low health literacy, irregular ANC attendance, and limited family involvement often exacerbate non-compliance. Furthermore, inadequate dietary intake of iron-rich foods may intensify the physiological consequences of missed supplements. This suggests that a comprehensive approach that addresses knowledge gaps, enhances ANC-based counseling, manages side effects, and engages family members is crucial to improving IFA adherence and reducing anemia risk. Future research should explore behavioral and sociocultural influences on adherence to develop more targeted and context-specific interventions.

The association between chronic energy deficiency (CED) and anemia observed in this study also aligns with previous reports. From a physiological perspective, CED reflects prolonged inadequate intake of energy and essential micronutrients, particularly iron, folate, vitamin B12, and vitamin A, which are critical for erythropoiesis. Malnutrition exacerbates iron deficiency not only by reducing dietary intake but also by impairing iron absorption and limiting the substrates required for hemoglobin synthesis. The nutrient-depletion theory explains that women with insufficient caloric and micronutrient intake have diminished red blood cell production and lower metabolic reserves, making them more vulnerable to anemia (Haque et al., 2023). Additionally, CED increases susceptibility to infection and chronic inflammation, which can elevate hepcidin levels and block iron mobilization, further restricting the body's ability to utilize stored iron. Malnutrition exacerbates iron deficiency and reduces the body's capacity to produce healthy red blood cells (Haque et al., 2023). This emphasizes the importance of integrating nutritional interventions, such as balanced diet promotion and supplementary feeding programs, into antenatal care services.

Previous studies have consistently demonstrated that women with CED are significantly more likely to experience anemia due to a combination of low dietary diversity, poor protein–energy intake, and a higher burden of infection. Research from various low- and middle-income countries has shown that undernourished pregnant women exhibit lower hemoglobin concentrations, poorer immune function, and greater physiological stress, all of which increase anemia risk. These findings reinforce the results of the present study, suggesting that addressing anemia requires more than iron–folic acid supplementation alone. Integrating comprehensive nutritional interventions—such as balanced diet counselling, dietary diversification, protein–

energy supplementation, and community-based nutrition programs—into antenatal care services is essential. Such approaches not only improve maternal nutritional reserves but also address upstream determinants of CED that contribute to persistent anemia.

The findings of this study have practical implications. First, local health authorities should prioritize strengthening antenatal care by promoting adequate pregnancy spacing and enhancing adherence to IFA supplementation. Second, involving families and community health workers could improve compliance and reduce the burden of anemia. Lastly, nutrition-sensitive interventions addressing dietary diversity and chronic energy deficiency need to be incorporated to achieve sustainable anemia reduction. So, this study confirms that short pregnancy intervals and poor IFA adherence significantly contribute to anemia among pregnant women. Addressing these modifiable factors through health promotion, family planning, and strengthened antenatal programs could substantially reduce anemia prevalence and improve maternal and neonatal outcomes.

CONCLUSION

This study demonstrated that the majority of respondents were in the reproductive age group (20–35 years), multigravida, and had normal nutritional status. However, nearly half of the respondents showed poor adherence to iron-folic acid (IFA) supplementation, which was significantly associated with anemia during pregnancy. The findings indicate that poor IFA adherence remains a significant determinant of anemia prevalence among pregnant women, even in those with normal nutritional status.

These results highlight the critical role of strengthening antenatal counseling and peer-support-based interventions to improve adherence to IFA supplementation. The strong association between poor adherence and anemia found in this study indicates that optimizing maternal knowledge, awareness, and support systems is essential to achieve effective anemia prevention. Based on these findings, midwives and health workers should intensify routine monitoring, individualized counseling, and follow-up during antenatal visits to address barriers to IFA intake, such as side effects, forgetfulness, or misconceptions. Strengthening community-level peer support, involving family members, and integrating nutritional education into ANC services may further enhance adherence and ultimately reduce anemia cases among pregnant women.

AUTHOR'S DECLARATION

Authors' contributions and responsibilities

All authors have contributed substantially to the work reported in this manuscript and take full responsibility for the content and integrity of the publication. The specific contributions of each author are as follows: **YA:** Writing original draft, visualization, funding acquisition, conceptualization; **SS:** Writing original draft (supporting), funding acquisition; **DP:** Supervision (lead), validation (equal), visualization (equal), funding acquisition (equal), review and editing; **NN:** Writing original draft, formal analysis, conceptualization; **RP:** Supervision (lead), validation (equal), visualization (equal). All authors have read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Availability of data and materials

All data generated or analyzed during this study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare no competing interests.

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